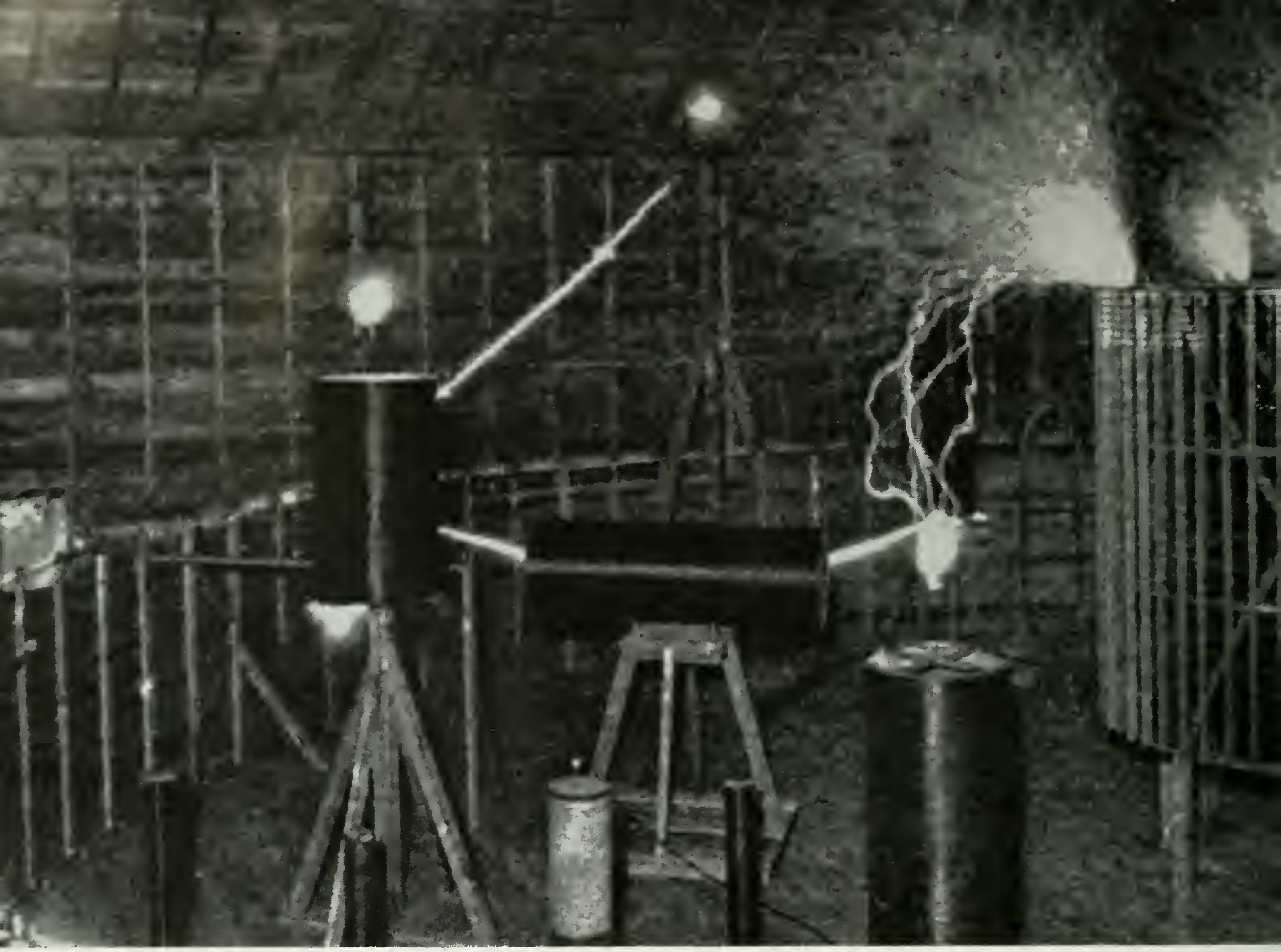
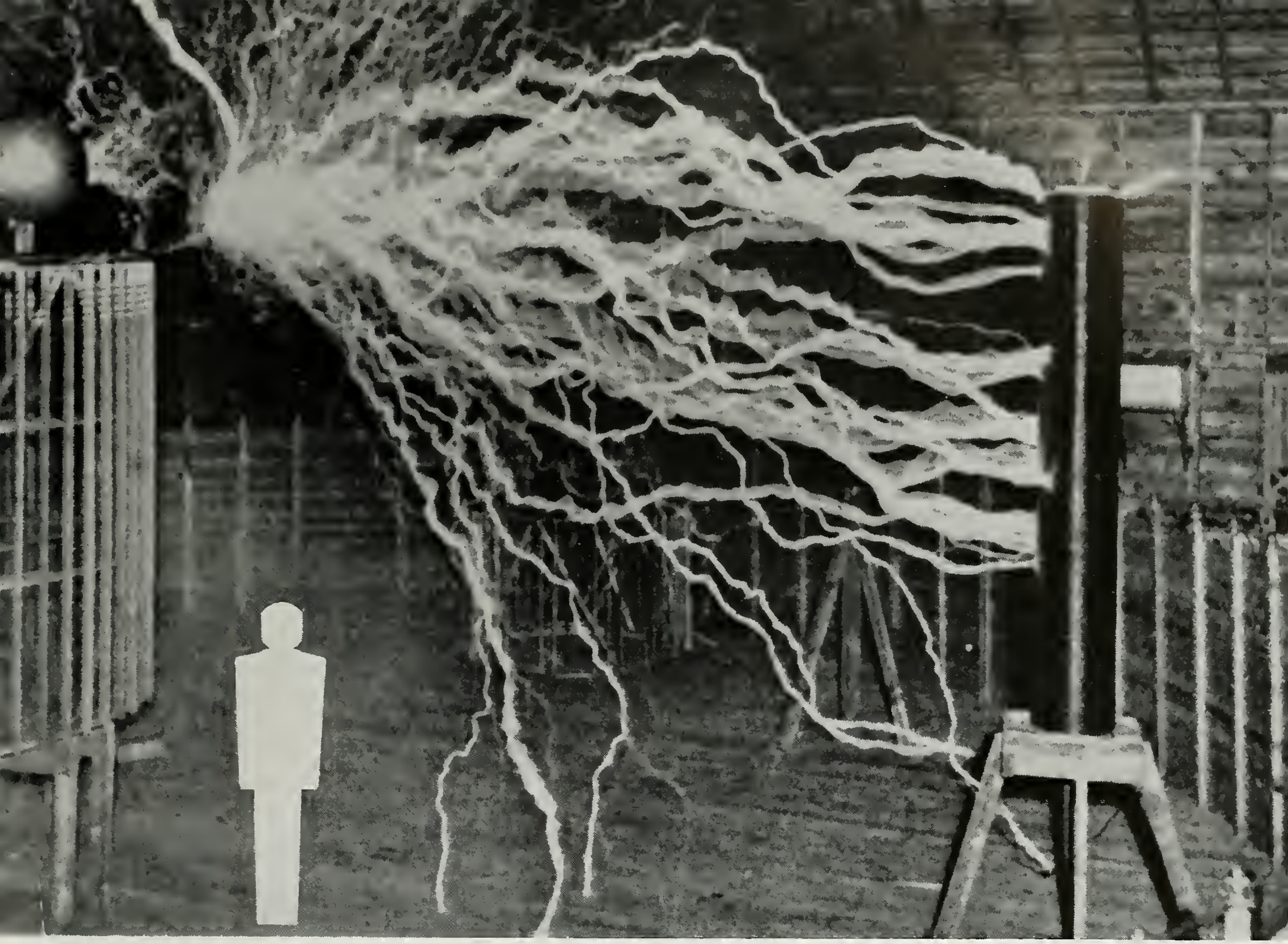
RYAN REPORTER



ELECTRICITY ↑ for ↓ SPACE EXPLORATION

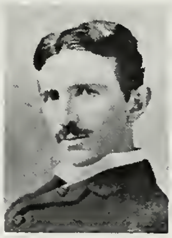
by Vjekoslav Gradecak,
Staff Engineer, Advanced Systems,
Ryan Aerospace



GIANT TESLA OSCILLATOR IS SHOWN OPERATING AT 12,000,000 VOLTS AND 100,000 CYCLES PER SECOND. SIX-FOOT SYMBOLIC MAN INDICATES SIZE OF ROOM.

"I have produced electrical discharges the actual path of which, from end to end, was probably more than one hundred feet long; but it would not be difficult to reach lengths one hundred times as great.

"I have produced electrical movements occurring at the rate of approximately 100,000 horsepower, but rates of 1-, 5- or 10,000,000 horsepower are easily practicable.



"Instead of sending sound-vibrations toward a distant wall, I have sent electrical vibrations toward the remote boundaries of the earth, and instead of the wall the earth has replied. In place of an echo I have obtained a stationary electrical wave, a wave reflected from afar.

"My measurements and calculations have shown that it is perfectly practicable to produce on our globe, by the use of these principles, an electric movement of such magnitude that, without the slightest doubt, its effect will be perceptible on some of our nearer planets, as Venus and Mars. In fact, that we can produce a distinct effect on one of these planets in this novel manner, namely, by disturbing the electrical condition of the earth, is beyond any doubt.

"We are whirling through endless space with an inconceivable speed, all around us everything is spinning, everything is moving, everywhere is energy. There must be some way of availing ourselves of this energy more directly. Then, with the light obtained from the medium, with the power derived from it, with every form of energy obtained without effort, from the store forever inexhaustible, humanity will advance with giant strides. The mere contemplation of these magnificent possibilities expands our minds, strengthens our hopes and fills our hearts with supreme delight."

Nikola Tesla —*1895*

TESLA was an electrical genius whose scientific discoveries and inventions were basic to modern electrical and electronic engineering. He also discovered and demonstrated the principles of high frequency, high potential currents shown in the historic photograph on the preceding page. These were the famous Colorado Springs experiments. The electromagnetic fields created were so intense that they perceptibly affected the distribution of the electrical potential of the earth. In Tesla's words, "In these experiments, effects were developed incomparably greater than any ever produced by human agencies, and yet these results are but an embryo of what is to be."

Such a force field can be applied widely, including electric aerospace propulsion. Within the next ten years electric propulsion will play a leading role in making extensive space trips possible. This conclusion has been expressed in recent years by many researchers. They have compared the advantages and limitations of various space propulsion methods.

Chemical propulsion is the only presently available means for attainment of orbital speeds and altitudes. This is its chief value. Multimillion pound chemical superboosters can put significant payloads into interplanetary orbits for manned expeditions to the moon, and possibly Venus and Mars. The estimated cost of these projects is staggering. In addition, the exploration of our nearest planets requires transit times of one to three years for a round trip planned on the capability of chemical propulsion. This aspect alone is sufficient to make electric propulsion a highly advantageous method of fuel conservation. For trips beyond Mars, electric propulsion is mandatory both to conserve fuel and also to shorten transit time. Chemical systems would require years or even decades for a round trip. Electrically propelled space vehicles have great payload capability. A Martian round trip, for example, has a payload ratio of almost 50 per cent. This means that these electric vehicles will offer comfortable living space for "shirt-sleeve" environment and adequate power for utilities.

Most electric propulsion systems are very small thrust devices. This limits them to missions beyond the atmosphere of the earth. Because of this, it is believed that this shortcoming is in the nature of electric propulsion. Consequently, it appears that orbit injection can only be accomplished by chemical means, and by chemo-nuclear means in the future. Once the orbit is established, the electric system would take over in providing thrust.

There are very severe problems in maneuvering space-

Experimental section of electric air breathing engine used in Ryan tests is examined by engineers Vjekoslav Gradecak and Guy Cooper.

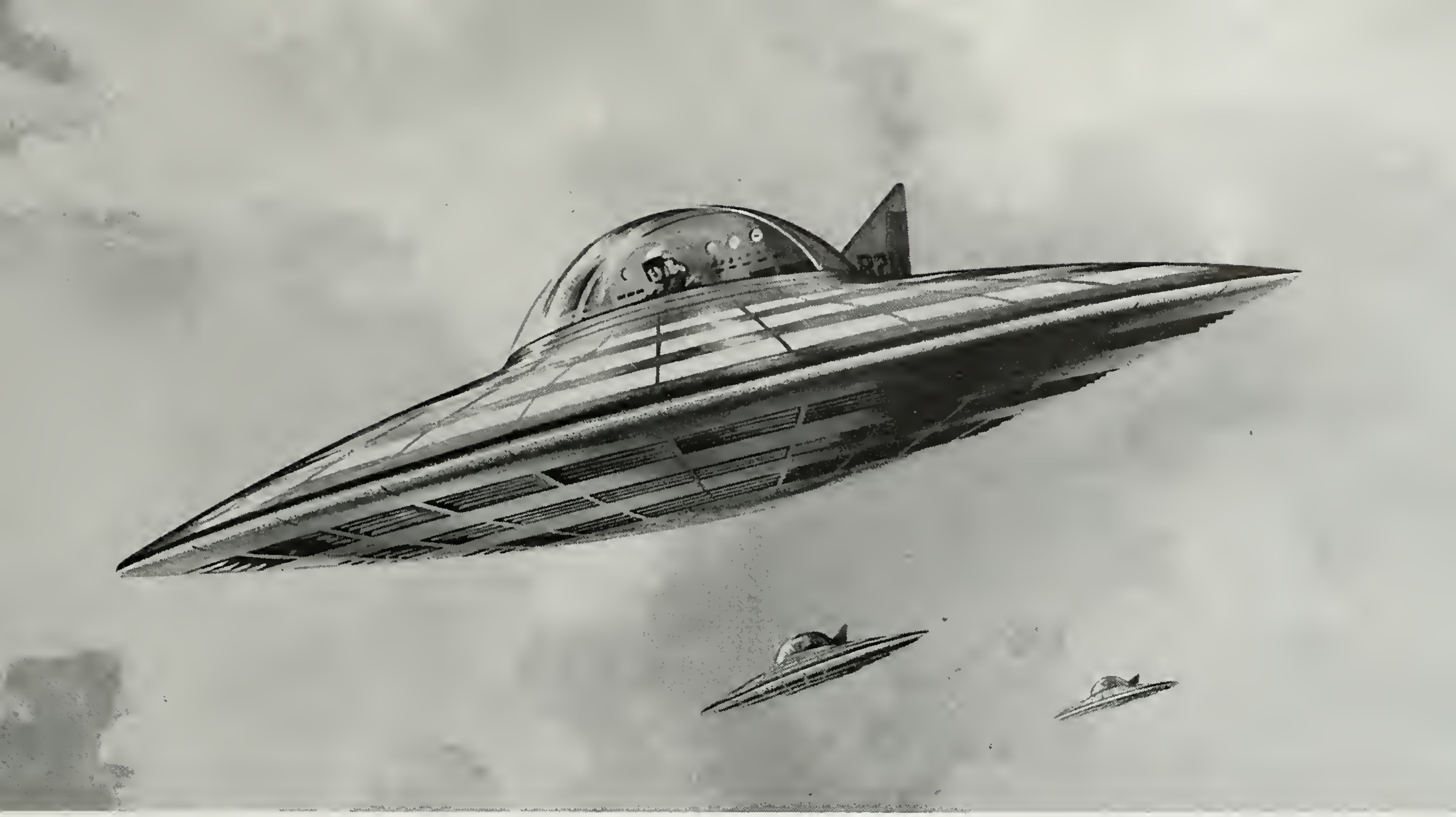


Illustration of an aerospace vehicle which incorporates an aero-electric propulsion system features circular disk configurotion.

craft. For example, the spacecraft may require a radically changing course, should an unexpected emergency occur during any point of trajectory.

Such maneuverability is absolutely necessary for practical space systems of the future which have progressed beyond the development stage of present rockets. Both the injection into orbit and practical maneuverability in space demand high thrust propulsion and fuel economy simultaneously. A possibility of meeting these requirements is electro-chemical propulsion. Here, chemical fuels provide a slight exhaust mass which is accelerated by ultra high electromagnetic fields. The prime source of vehicle energy, capable of producing the extremely high force fields, must not require chemical fuels for its own operation. This requires nuclear energy sources or some practical system of converting radiation energy pervading space. In either case, the vehicle size is certain to be large to accommodate the primary energy source. Its weight must not exceed a reasonable fraction of the vehicle's gross weight. Spaciousness is required for physiological and psychological comfort of the crew as well as to increase the safety against meteorite hazards by an interlock escape system.

Most approaches involve the study of assembling large structures in space by combining rendezvous techniques with payload capability of large chemical boosters. How-

(Continued on Page 25)

Checking out various Tesla oscillators, installed at Ryan's San Diego plant for high to ultra high voltage research, are Frank Chaussee, engineer, and Oliver Peterson, technician.

Lift fans submerged in wing and (in this configuration) nose would make possible vertical take-off from narrowly confined areas.

FAN-IN-WING FOR

A unique new jet V/STOL research aircraft — the Army VZ-11 — will be designed and built by Ryan and powered by General Electric's lift-fan propulsion system (See cover).

Winner of a design competition sponsored by the Army's Transportation Research Command, Ryan will build two aircraft, under contract to General Electric which has received a prime contract from the Army covering a 24-month, $10.5 million program. The Ryan airframe portion of the contract will be approximately one half. The new Army vertical take-off plane is an extension of work pioneered by Ryan on its unique Vertifan concept.

First flight for the VZ-11 is targeted for May, 1963 and operational V/STOL models could be flying soon after this date.

The research aircraft will be capable of taking off vertically, then entering a conventional flight pattern at speeds of over 500 miles an hour. This dual capability of "straight-up" take-offs and high forward speed means that such aircraft will be capable of operating from small widely dispersed areas where no airfields exist.

The propulsion system's distinctive feature is a set of five-foot diameter lift fans horizontally submerged within the wings and driven by the exhaust of two G-E J85 jet engines to provide the lift for vertical take-off and hovering.

For vertical flight, diverter valves direct the jet exhausts to the tip turbines to drive the lift fans. The fans multiply the available thrust of the basic engines which are sized for cruise conditions. For forward flight, the diverter valves close the fans off and allow operation as a conventional jet aircraft.

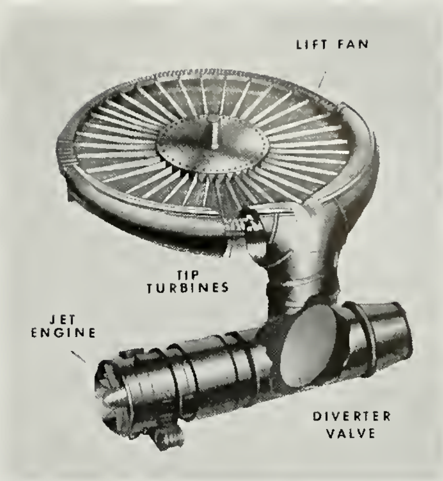
Aircraft capable of vertical take-off, hovering and high forward speed with use of the "lift fan" principle, have high potential for application to surveillance, close support and logistic transport missions.

The "fan-in-wing" concept was extensively investigated by Ryan and G-E in an Air Force contract two years ago, with Ryan providing overall direction in the aircraft design and G-E furnishing propulsion data. A significant advancement in the state-of-the-art was achieved in correlation of the aerodynamic characteristics of the wing and fan.

More than 160 hours of lift fan testing has been completed to date. Much high subsonic-speed aircraft requirements.

Recently, Ryan was awarded a contract with Vought and Hiller to design and build a new experimental V/STOL tri-service transport, under a four-year program which may exceed $70 million. Awarded by the Department of Defense, this contract calls for five tilt-wing type V/STOL transports which can take off vertically, hover and cruise at speeds of between 250 and 300 knots and carry 32 fully-equipped combat troops.

Ryan's experience in V/STOL techniques dates back more than 20 years, to the first STOL airplane for the Army. Ryan produced the Air Force's X-13 Vertijet, the world's first jet VTOL aircraft, after a 10-year development program which achieved many important technological breakthroughs. Among these was the use of jet reaction controls to stabilize a full-scale airplane, permitting precise maneuvering during vertical take-off and landing in a tail-down, nose-up position. Many successful transitions to and from horizontal flight were demonstrated by the X-13.



Diverter valve directs jet thrust to the lift fan turbine for vertical flight, and closes the wing fan directing the exhaust thrust normally for forward flight.

The Vertijet was followed by the Army's VZ-3RY Vertiplane, now being flown by NASA after Ryan completed exhaustive tests early in 1960 to confirm the effectiveness of its deflected slipstream principle. The Vertiplane is a propeller-driven aircraft of conventional configuration which rises and descends vertically while in horizontal attitude.

V/STOL

of it has been carried out with lift fan hardware installed in full-scale aircraft wind tunnel models at NASA's Ames Research Center, Moffett Field, California. These include both fan-in-wing and fan-in-fuselage versions.

Purpose of the Lift Fan Flight Research Program is to evaluate the flight characteristics of the lift fan propulsion system in hover and transition, and to demonstrate in flight that the fan-in-wing configuration is compatible with

After taking off vertically, unique jet "lift fan" plane would demonstrate dual capability by entering conventional flight pattern at over 500 mph speeds.

THE

Versatile

FLEX WING

SUCCESSFUL completion of the first phases of flight testing of Ryan's remarkable new Flex Wing powered test vehicle has been accompanied by disclosure of another potential application of the concept.

The unusual aircraft with the flexible wing, in which Project Engineer Lou Everett has made approximately 200 flights out of the Navy's Auxiliary Air Station at Brown Field, near San Diego, is now at the National Aeronautics and Space Administration's facility, Langley Field, Virginia.

There it will undergo full-scale wind tunnel tests and a continuation of flight tests by NASA pilots in a program to be supported by a Ryan crew including Everett.

At about the same time the Flex Wing was air-lifted to Langley Field in a C-130 Hercules transport, it was officially revealed that Ryan engineers are investigating the flexible wing concept for possible surveillance drone applications under a contract from the U. S. Marine Corps.

Test vehicles built by Ryan have been undergoing functional and flight testing at the Marine Corps' desert facility at Twenty-Nine Palms, California.

This is the latest of several orders awarded Ryan by various agencies for different applications and studies of the new flexible wing.

(Continued on Next Page)

Flex Wing models dropped from helicopter gave Ryan engineering team a better understanding of wings' aerodynamic properties under varying loads.

← **Ryan test model of Flex Wing surveillance drone shown moments after launch in test flight at Marine Corps facility, Twenty-Nine Palms, Calif.**

Ryan engineers Herb Kreidiet (left) and Orville J. Saholt (on jeep) explain launch procedures to Marine Captains Endicott and Stien, and Major Francis at Twenty-Nine Palms.

The manned powered vehicle, designed and built in the San Diego plant, underwent flight testing and engineering studies under contract from the U. S. Army Transportation Research Command.

The flight test program consisted of ground tests, taxi and lift-off tests and performance, stability and control evaluation. Data obtained will be applicable to the design of similar vehicles intended for many other uses.

Other announced studies of the Flex Wing are as an unmanned towed glider to transport cargo for logistics requirements (Army Transportation Research Command) and as a recovery "carrier" of the Saturn space vehicle first stage booster (NASA).

Helicopters, towing the Flex Wing as a glider, will be able to transport several times as much weight in troops, cargo or fuel as the helicopter alone can carry without appreciable reduction in performance. In this respect, the helicopter capability is greatly expanded enabling it to

Artist's rendering demonstrates tactical combat capabilities of the Flex Wing drone. The low flying vehicle could carry photographic or television equipment to spot enemy troop and vehicle movements.

Major Richard Francis, contract liaison officer, Marine Corps Equipment Board, Quantico, Va., tucks surveillance drone under his arm.

transport large amounts of cargo between bases and from ship to shore.

The newest contract, from Marine Corps headquarters in Washington, D. C., will determine the capabilities of a flexible wing drone for surveillance over enemy territory in support of tactical combat operations.

Launched from a portable field launcher by two Marine infantrymen, such a low-flying drone could carry photographic or television equipment to report enemy movements and positions. The drone also could be used as a platform for numerous other sensing systems.

Voluminous engineering and performance data were obtained in the many hours of flight testing of the manned vehicle in the San Diego area. The flying test bed demonstrated a new mobility concept for the Army — a flexible wing of plastic coated material, which can be packed in a small space and quickly deployed to provide a large aerodynamic

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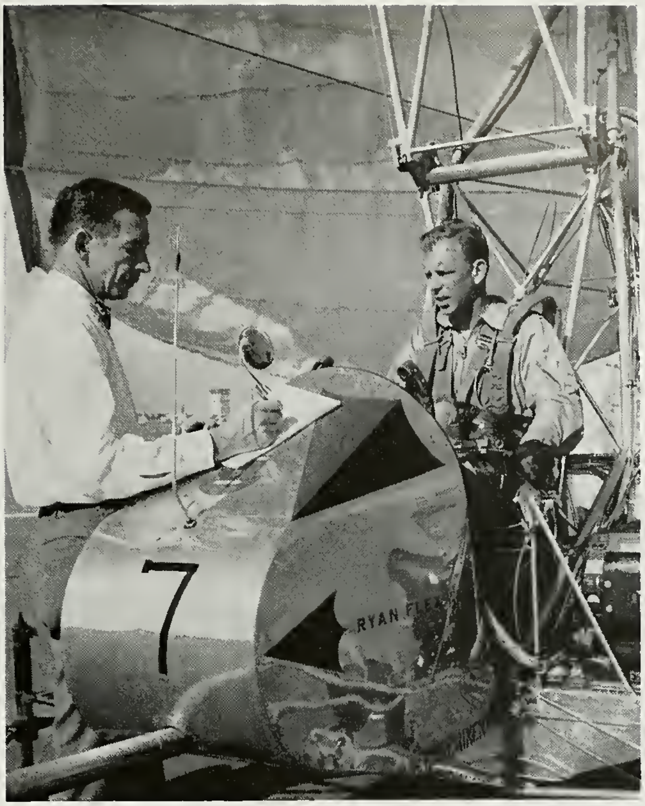
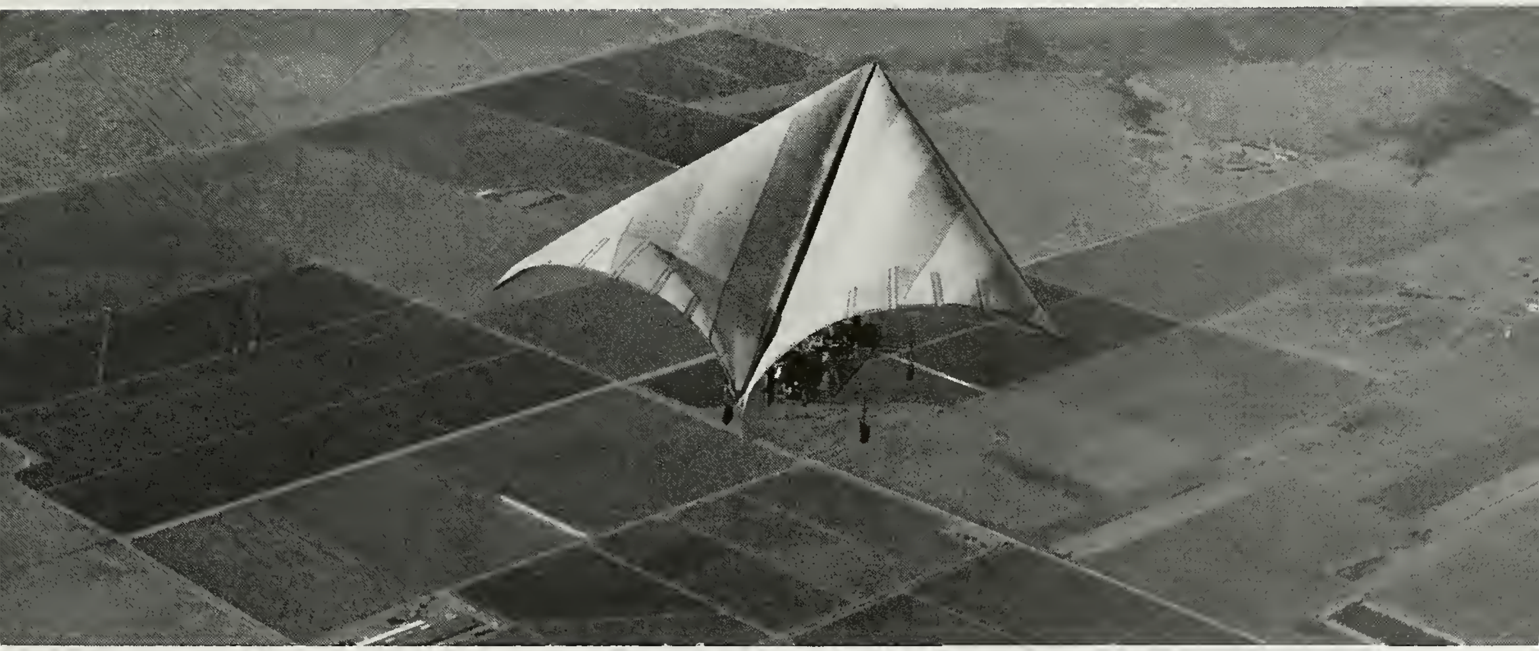


C. E. Craigo, (left) Ryan Flex Wing Projects Program Manager and Lou Everett, Project Engineer (in cockpit) talk over ground and air characteristics of Flex Wing manned test bed.



Valuable engineering and performance data on aerodynamic characteristics of Flex Wing were obtained in flights over San Diego.

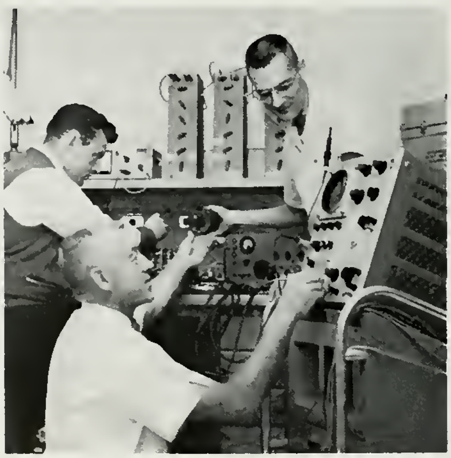
"NAVIGATORS" ON THE CAMPUS

Ryan Electronics' military customers go to college

ATOP a picturesque plateau overlooking the "trail of the padres" in Mission Valley, San Diego, Ryan Electronics conducts its own program of higher learning.

This is the campus of the University of San Diego, where a year-round curriculum is maintained for specially selected students drawn from far-flung military bases.

When each class completes its several weeks of intensive instruction, the "graduates" have the necessary practical knowledge of how to service and maintain Ryan Electronics' Doppler airborne automatic navigation equipment in the field.

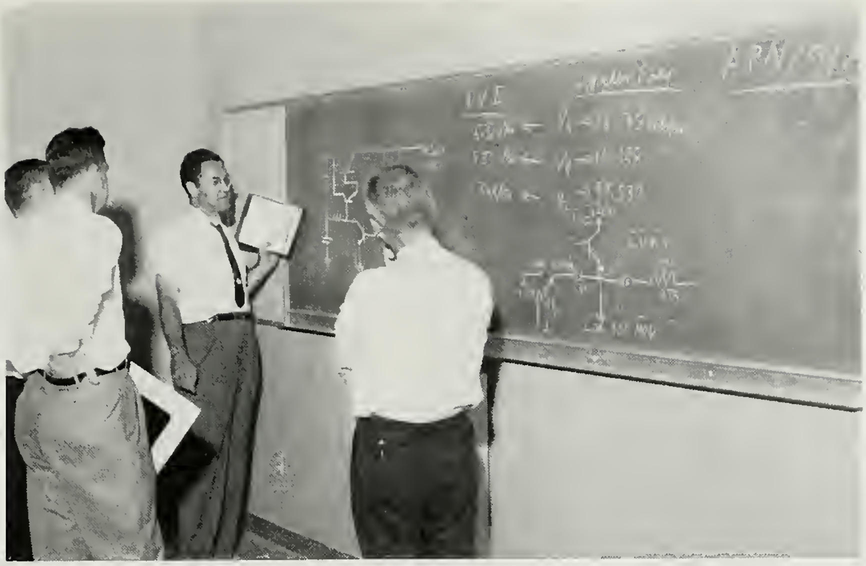


Laboratory work on Ryan Electronics' navigation equipment is emphasized, with maximum of work on an operating system.

The continuing customer training program assures the highest possible operational reliability of these systems.

As the world's foremost producer of such Doppler equipment, Ryan Electronics devotes considerable effort to the indoctrination of the Navy and Army personnel—civilian as well as military—who are responsible for the installation and maintenance of these automatic navigators.

Ryan Electronics' training approach is predicated on a maximum of bench work on an operating system, and a minimum of classroom instruction. Laboratory work is emphasized during the training period. Hence, Ryan Elec-



Brainstorming sessions in classrooms feature several weeks of intensive instruction in service and maintenance of Ryan Doppler airborne navigation equipment.

tronics maintains two completely equipped electronic laboratories on the University of San Diego campus, as well as two modern classrooms.

Complete operating Doppler navigation systems are set up in the laboratories to give the students practical experience in troubleshooting on equipment as it is actually installed in the aircraft. System theory, maintenance, testing and corrective procedures are taught in the classrooms adjoining each laboratory.

According to Ryan's Customer Engineering Services, the complexities of these courses require concentrated study, and the campus location affords an excellent learning atmosphere removed from the normal distractions associated with in-plant classes. At the same time, these facilities are close enough to Ryan's Kearny Mesa center to provide the necessary liaison with specialized engineering personnel and facilities.

All courses are specifically tailored to meet the students' requirements. A typical AN/APN-122(V) course of five weeks follows this curriculum:

The first day is devoted to system theory and introduction to components, to acquaint students with the broad capabilities of the Ryanav set. The next three days are concentrated on transistor theory, stressing the transistor as a circuit element. For the next eleven days of the course, the students receive system theory and demonstrations — developing system circuit diagrams and schematics from blocks to functionals and, ultimately, to overalls. The course is concluded with 10 days of intensive practical experience including alignment and troubleshooting techniques.

The students are required to complete an examination each week. The material covered is then reviewed by the students and instructors. Upon completion of the course, the students are given a final examination to determine their capabilities in the maintenance of sophisticated Ryanav equipment.

Thousands of Ryan Doppler units have been ordered for installation in more than 25 different military aircraft. While teaching military customers, the instructors follow military training procedures in the preparation of course outlines, lesson guides and lesson plans. Since the U.S. Navy is one of Ryan's biggest customers, it is no wonder that Ryan's training supervisor, training coordinator, and special course instructors, represent more than 155 years of active U.S. Naval service. Ryan's instructors are chosen for their technical electronic knowledge, educational background and their experience

(Continued on Page 24)

"Graduates" of each class, including civilian and military personnel from far-flung bases, are honored at ceremonies in which instructors award certificates.

GHQ FOR M

NAGEMENT - - - - -

Ryan executives M. P. Kissinger, Quality Control Director, Rutherford, Fink and Clark at briefing to open weekly sales-engineering session.

Frank Fink, Vice President Engineering, flanked by Robert Clark, Vice President and Works Manager, Tom Echols, Chief of Contracts and Ted Beck, Director of Aerospace Engineering hear progress report on Army VZ-11.

Management control center staff member listens attentively as a program director emphasizes discussion point.

G. W. Rutherford, Vice President-Operations, busy penciling note, is over-all director of management control center activity. Robert Clark concentrates.

Jane Rone, Aerospace Marketing Director, (left) and Bob Knowlton, Director Operational Planning and Estimating, attend.

BE competitive; maintain production schedules; increase sales; fulfill responsibilities to employees; make a profit—the complex problems of top management are endless and challenging.

The management team's ability to solve problems, and stay abreast of the corporation's constantly changing productive process, dictates the ultimate success of a company in the sink or swim competition of today's aerospace industry.

How does management master this monumental task? What tools do they have at their disposal? How do vice presidents compare notes?

The most successful tool introduced to Ryan management in recent years, an operational control center, is the com-

(Continued on Page 23)

Al Auerbach, Manufacturing Programs Director, (left) and H. H. Berlinghof, Jr., Assistant Director Estimating and Operational Planning, hear progress report an flight testing of various Ryan Flex Wing projects.

Contral center personnel frequently update progress charts available for regular top management planning sessions.

SUN POWERS MARINER R VENUS SHOT

ENERGY from the sun will be captured by Ryan solar panels to provide electrical power for the research functions of a major space vehicle, the National Aeronautics and Space Administration's Mariner R.

Thousands of tiny photoelectric solar cells will be mounted on the aluminum panels to convert radiant energy for the scientific tasks of Mariner R, a spacecraft scheduled for two flights to the vicinity of Venus this summer.

The panels are products of the Ryan Aerospace engineering shop, San Diego, for NASA's Jet Propulsion Laboratory, California Institute of Technology.

The rectangular panels, 29 inches wide and 60 inches long, will deploy in space to provide a winglike appearance for the Mariner R. In the flight toward Venus, Mariner R will be oriented toward the sun at all times, hence its solar panels will be equipped with photoelectric cells only on one side.

A new structural concept developed by Ryan combines low weight with the high strength and reliability characteristics required of the panels. The aluminum skin is stabilized by continuous corrugations attached by resistance welding to provide structural integrity.

The open back construction enhances versatility, in providing access for mounting of other equipment. At the same time, such a structure prevents overheating of the solar cells as the panel dissipates heat and enables the cells to operate more efficiently, at lower temperatures.

The Mariner R spacecraft, weighing about 400 pounds, will be launched by the Atlas-Agena B vehicle. The mid-1962 timing of the space probe will take advantage of the first opportunity for a Venus flight, when the earth and Venus are in the most favorable relative position. The Mariner project will provide an early test of basic equipment which will be used in later interplanetary flights.

Being considered by NASA for inclusion in the probe are a fluxgate magnetometer to investigate magnetic fields in space; radiation experiments to detect and count energetic particles from the sun and from outside the solar system; a micrometeoroid detector, and a radiometer to scan the surface of Venus for temperature distribution.

Ryan some time ago joined the quest for tapping the greatest known source of power in our solar

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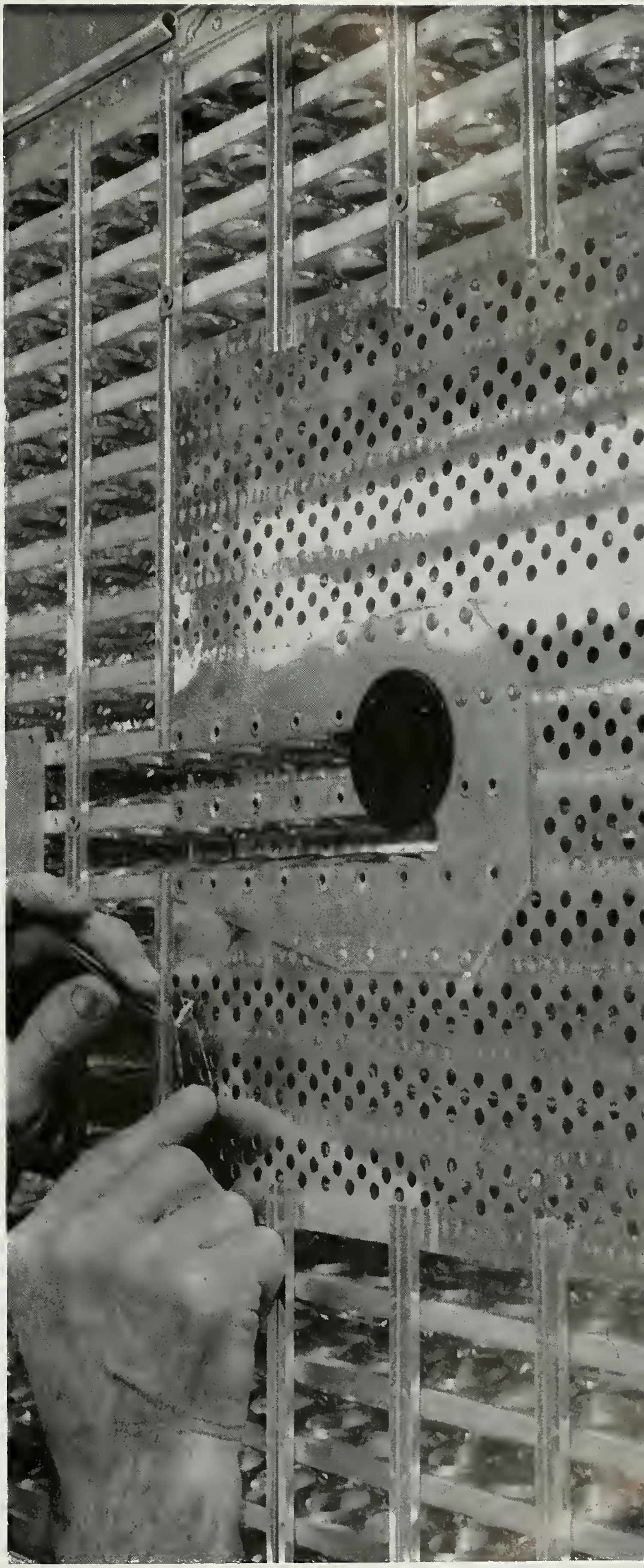
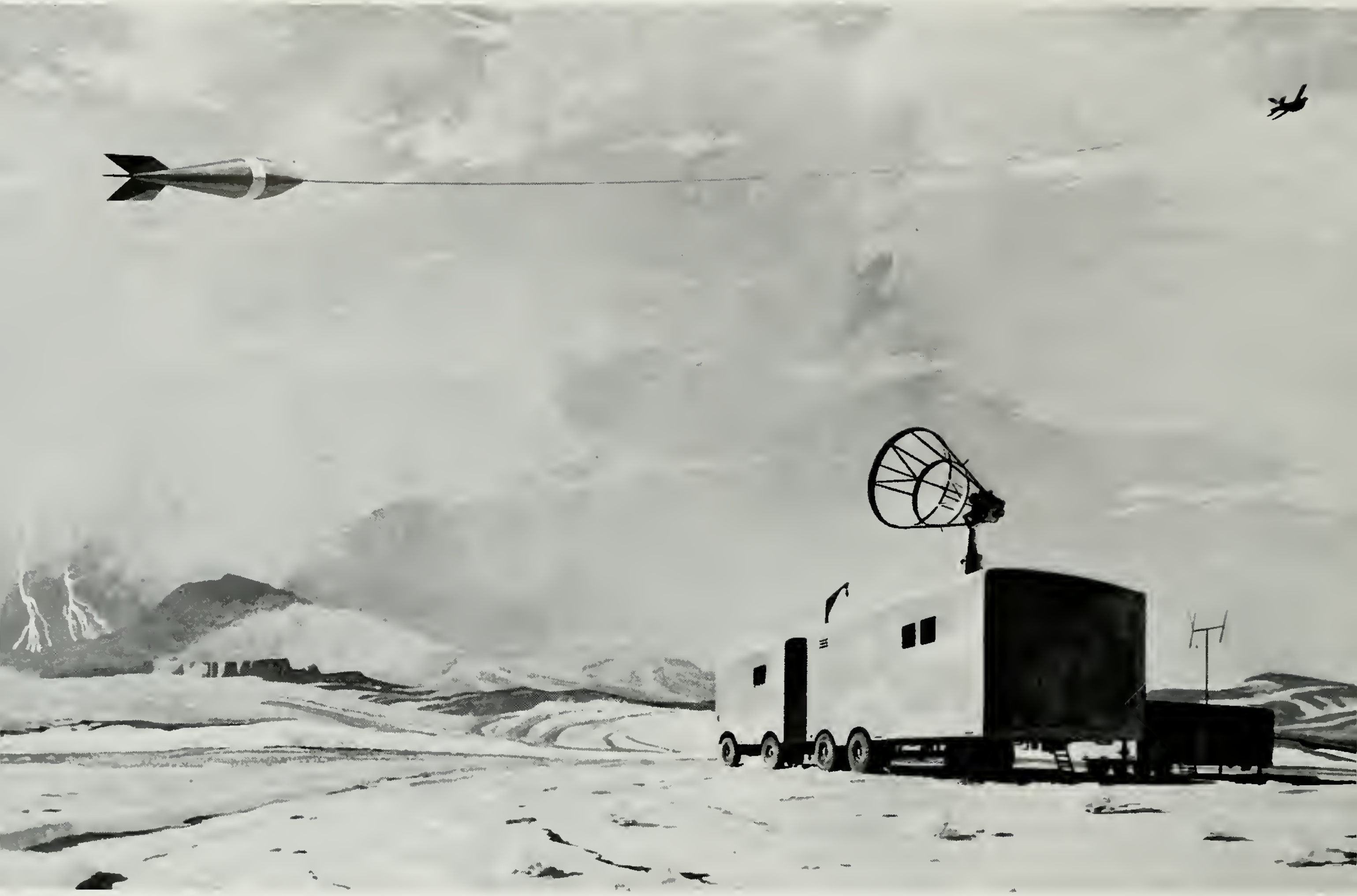


Precision crafted solar panels take advantage of new structural concept developed by Ryan to combine low weight with high strength. Panel skin is aluminum.



New target technique for air defense is Ryan "Towbee" concept, in which bomb-like target trails 1800 feet behind Firebee jet drone.

PICK-UP AND—TOW!

THE Army has successfully demonstrated the feasibility of a new target concept for air defense missile firing tests that could result in dramatic cost savings.

In successful tests at White Sands Missile Range, New Mexico, the Ryan Firebee jet powered drone missile picked the target from the ground and towed it at speeds up to 400 knots and at altitudes up to 30,000 feet. No appreciable reduction in the Firebee's normal performance was noted.

Being developed under the technical supervision of the Army Rocket and Guided Missile Agency at Redstone Arsenal, Alabama, the concept called "Towbee" involves towing the actual target behind a standard Army target missile.

The Towbee target used is a cylinder 7 feet long and approximately 1 foot in diameter made of inexpensive composition material and fitted with fins. It resembles a bomb. Weighing approximately 20 pounds, the Towbee trailed behind the target missile on an 1800 foot nylon line.

The concept is similar to one in use for years in which aerial targets were trailed behind manned aircraft. Safety restrictions preclude extensive use of manned aircraft in guided missile testing.

Obtained from the Air Force, the Towbee target used in the test has internal sheet material reflectors that give the towed target the same radar characteristics as an enemy bomber.

ARGMA target missile experts feel larger savings could result by using a

(Continued on Page 25)

FIREBEES TEST AMERICA'S DEFENSE SHIELD

by William Brotherton

IN the most realistic test of America's shield against manned bomber attack — WILLIAM TELL 1961 — the Air Force's Air Defense Command chalked up a shining record which should make every American feel more secure.

Lt. Gen. Lee

Lieutenant General Robert M. Lee, Commander of the Air Defense Command, wrapped it up this way, "During William Tell, 142 weapons were fired at Firebee targets. Considering the envelope around the target which is made to simulate an enemy bomber, 137 of these rounds were within lethal range which would have destroyed current air-breathing, manned aircraft."

This was the big news of the William Tell 1961 Weapons Meet held recently at Tyndall Air Force Base, Florida by the Air Defense Command. The news is significant when it is realized that just a few short years ago, Air Force officials admitted that they were powerless to prevent two-thirds of an attacking bomber force from penetrating their defenses.

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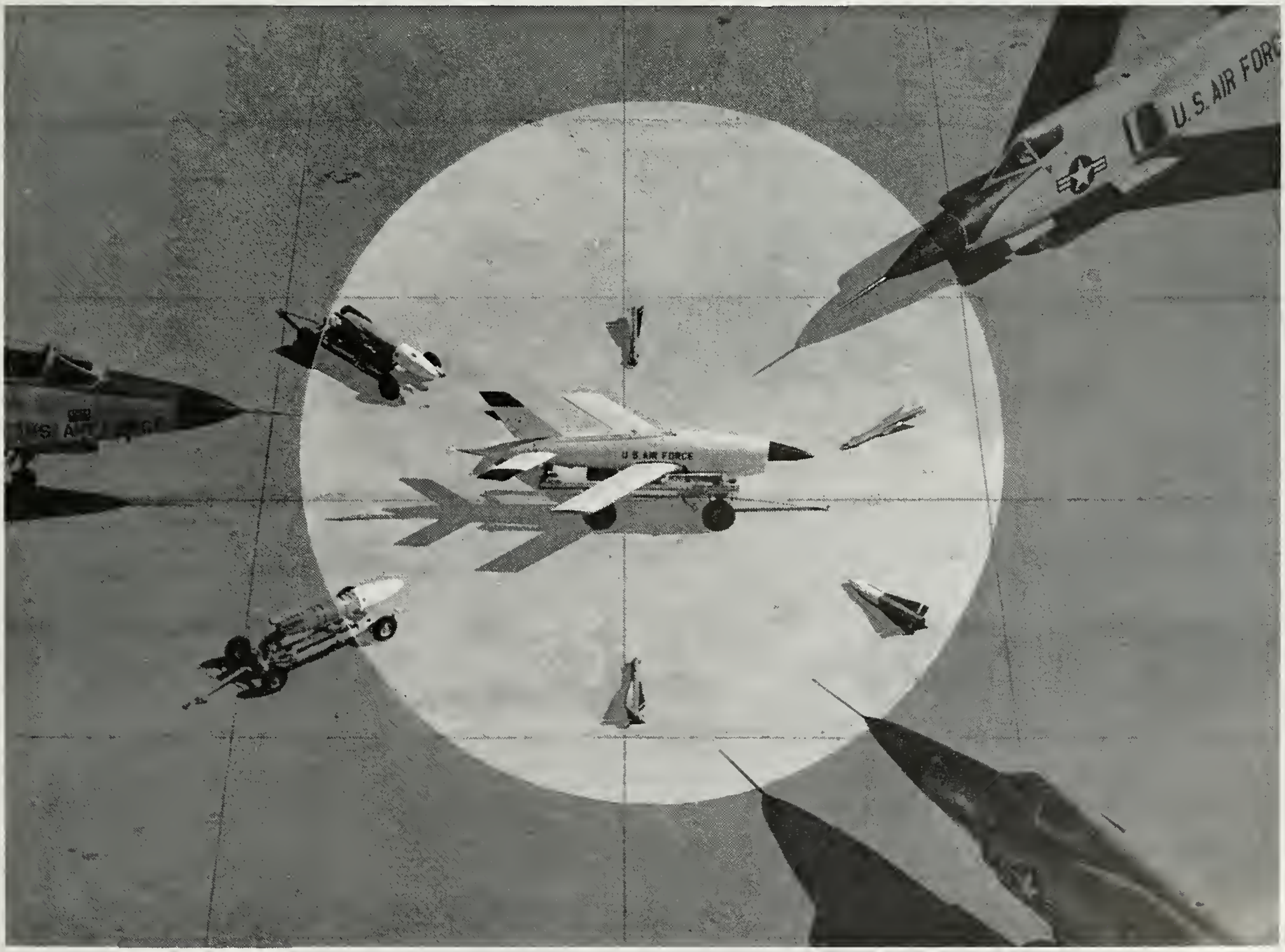

Missiles and rockets fired by supersonic F-101, F-102 and F-106 interceptors were aimed at Firebee targets in "William Tell 1961."

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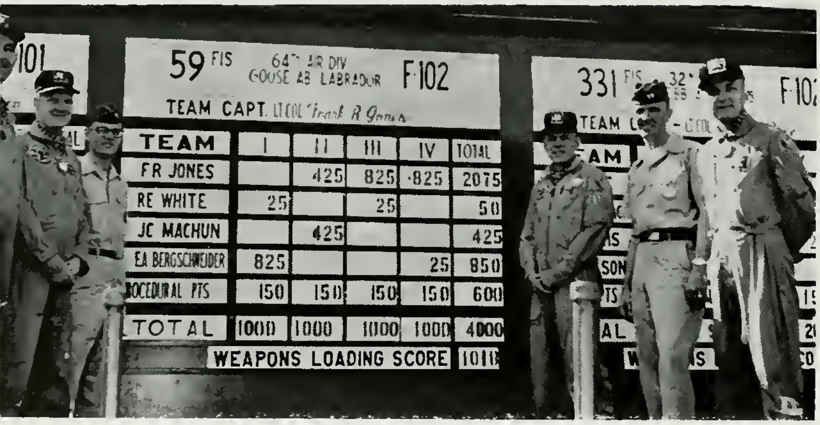

3.

4.

1. Firebee drones were parachuted into Gulf of Mexico after each mission, and were recovered by Army helicopters for re-use.

2. Q-2C Firebee target mission at Tyndall Air Force Base, Florida, is plotted by technicians in ground control station.

3. Perfect score against Firebee drones was tallied by Labrador interceptor squadron team led by Lt. Col. F. R. Jones, at left.

4. Firebee ground launchings, first for a weapons competition, provided an exciting spectacle at "William Tell 1961" meet.

Sharpshooting team of 445th Fighter Interceptor Squadron, Wurtsmith AFB, Mich. won F-101 Voodoo competition in "William Tell 1961."

At his press conference, General Lee stated further, "In World War II, a kill probability of 15 percent against attacking bombers was generally considered excellent. Today, we are confronting an aggressor fleet with a *loss* probability far in excess of World War II experience and much greater than estimates of our most optimistic air defense experts of yesterday."

As they have at three previous major weapons meets, Ryan Firebee jet targets performed as the sophisticated "Apples" of William Tell 1961. Forty six Firebees were launched into the firing range with an all-time high record of mission reliability. Firebee target systems, as well as all other weapons systems achieved such smooth, clock-like precision that the meet was concluded in just six of the nine days of scheduled flight operations. This unanticipated development permitted time for top Generals Curtis E. LeMay, Chief of Staff, USAF, and Robert M. Lee, Commander, Air Defense Command, to fly in and

(Continued on Page 24)

Supersonic cameraman TSgt. C. E. Galyon aims four-pound, all-transistorized television camera to record missile and rocket competition from Convair F-106 Delta Dagger "chase" plane.

RYAN LIBRARY DEDICATED AT CALIFORNIA WESTERN UNIVERSITY

On a bronze plaque in the new $600,000, three-story Ryan Library, largest single building of California Western University's campus on Point Loma, San Diego, is the following inscription:

"Named in recognition of the Ryan Aeronautical Foundation and the David Claude Ryan Foundation for their generosity in helping make this building possible."

The new library was dedicated recently in impressive ceremonies at the University's Greek Theater, attended by 1,500 civic and educational leaders who honored the Ryan Aeronautical Company and Mr. and Mrs. T. Claude Ryan and family.

The Ryan Aeronautical Foundation, established in 1952, handles company activity in educational, charitable, cultural and scientific projects. The David Claude Ryan Foundation perpetuates the memory of Mr. and Mrs. Ryan's son, who interrupted his college education to enter the Air Force, and later gave his life during the Korean War at the age of 22. Through this Foundation, the Ryan family supports educational and charitable interests.

Impressive bronze plaque was installed on $600,000 structure by Dr. William C. Rust, California Western University President, and Mr. and Mrs. T. Claude Ryan.

Recalling the fact that Charles Lindbergh flew the Atlantic in a Ryan monoplane, Dr. William C. Rust, California Western University president, declared at the dedication services:

"I remember the landing of Charles Lindbergh in Paris from the time of my boyhood. I have had the name of Ryan in my mind ever since. When I first came to San Diego, the Ryan Aeronautical Company was mentioned to me in terms of leadership in the San Diego community. I have come to appreciate the leadership of the company, its foundations and its board chairman, T. Claude Ryan."

THE VERSATILE FLEX WING

(Continued from Page 9)

surface with high lift properties.

In the flexible wing principle, a simple center of gravity control system is utilized. The wing can be moved by means of controls, either manually or by radio command, providing maneuvering characteristics similar to more conventional aircraft.

In addition, a means of moving the wing keel fore and aft with respect to the body provides a method of trimming the aircraft for steady flight conditions.

The aircraft's flight trajectory is controlled by shifting the center of gravity with respect to the center of pressure of the wing.

Typical applications may include utility aircraft, towed gliders, equipment and personnel delivery vehicles, logistics delivery systems, weapons delivery systems, atmospheric recovery systems, space recovery and re-entry systems, reconnaissance vehicles, and as emergency wings for use with V/STOL aircraft.

Commenting on the versatility of the Flex Wing concept, the Principal Assistant for Aviation, Office of Army Chief of Transportation said, "applications of the flexible wing are limited only by the imagination of military planners."

GHQ FOR MANAGEMENT

(Continued from Page 15)

pany's command post for decisions.

An unobtrusively situated room on the second floor of Ryan Aeronautical Company's administration building, is the corporate equivalent of a General Headquarters, where all commands gather to analyze critical data and determine broad strategy.

At regular intervals, key personnel gather in the conservatively furnished chamber, their attention focused on a three dimensional wall where charts and graphs analyzing various corporate functions are mounted on sliding panels. Key company officers preside at such gatherings, the chair responsibilities determined by the subject matter to be discussed in any given session.

At a glance, the charts tell the company's sales, engineering and production officers the current status of individual projects or the broader picture of plantwide activities.

When it is necessary to penetrate in depth behind the figures and the graphs, special project personnel are brought into the conference.

A steady stream of information flows into this management control center from financial, sales, manufacturing and engineering departments. The charts are updated frequently to provide management with an over-all view, for each of its programs, of engineering progress, maintenance of production and delivery schedules; direct labor hours (actual as compared with budgeted) and total factory cost.

When are certain projects due to phase out? When will we have facilities available for new business? In considering new proposals, when can we fit them into our schedules? What is the accumulated quantity for each program as of the end of each month, and the total for each part since production began?

These are but a few of the questions for which answers are instantly provided in what may be considered a highly detailed intelligence system. The past, present and future form a kaleidoscopic pattern for management as it strives for the most beneficial decision possible.

It is estimated that policy making executives can be briefed on total company operations and potential capabilities in less than two hours by means of the conceptual presentations contained in the charts.

One of the greatest values of the management control center is its capacity to spotlight difficulties while they are developing. "We can see the problem taking shape and take corrective action before it assumes major proportions," a Ryan official pointed out.

The indispensable nature of this GHQ for management is described by one of its foremost boosters, G. W. Rutherford, Vice President-Operations:

"I consider the management control center one of our most effective management tools. It presents a quick look at all the major operational activities of the company, and emphasizes those potential problem areas that require close management attention.

"I am able to use this room as a centralized point of data presentation so that key management personnel may focus their attention on all aspects of sales, engineering and production matters."

SPECIALISTS IN FOREIGN MARKETS JOIN RYAN STAFF

Two specialists in foreign marketing of military and commercial products of the aerospace industry have joined the Aerospace and Electronic sections of Ryan Aeronautical Company, R. C. Jackson, President, has announced.

A. W. Abels

A. W. Abels, formerly Export Sales Manager of General Dynamics/Convair, was appointed Manager of Export Marketing for Ryan Aerospace, reporting to John W. Rane, Aerospace Marketing Director.

Abels was associated with Convair for 30 years, and prior to becoming Export Sales Manager, was Contract Administrator and Chief of Contracts. In his most recent post, he was responsible for commercial jet transport sales in all areas of the world outside the United States and Canada.

W. C. Keller

W. C. Keller, former Assistant to General Dynamics/Convair's Vice President-Military Relations, with responsibility for both foreign and domestic military sales, has been named Assistant to Owen S. Olds, Ryan Electronics Vice President-Electronics Sales and Engineering. Keller, who will be responsible for foreign sales of the firm's electronic products, was with the Ryan engineering organization for two years prior to an 18-year tenure with Convair.

FIREBEES TEST DEFENSE SHIELD

(Continued from Page 21)

try their hands at shooting the elusive Firebee "bull's-eye" out of the Florida skies.

For the entire William Tell 1961 program, including verification flights, rehearsals and the meet, 89 Firebee flights were conducted with a loss of only six targets for reasons other than operational kills. This is an outstanding record of approximately *15 flights per drone expenditure.*

The most dramatic sight at the meet was the ground launching of the Q-2C Firebees. This was a "first" for a weapons meet and provided an exciting spectacle which every important visitor was taken to see.

Poised on two ground launching stands, a few miles from the Tyndall AFB airport, two bright orange Firebees were always ready for blast off over the Gulf of Mexico. Watching the procedure was something like viewing a big missile launch, except that things happened faster. With its jet engine whining at full rpm, the Firebee simply explodes into the horizon under the fierce urging of an 11,000 pound thrust rocket bottle, which falls away in two seconds. The whole event takes place so fast that the Firebee has disappeared into the distance while your ears are still ringing from the roar of the launching charge.

Another "first" for William Tell 1961 was the use of all century-series interceptor aircraft, making it the first supersonic weapons meet. The three types of aircraft competing were McDonnell F-101 VooDoo's and Convair F-106 Delta Darts and F-102 Delta Daggers.

Highest scores registered in the meet were chalked up by the team which won the F-102 competition, the 59th Fighter Interceptor Squadron from Goose Bay, Labrador. With incredible marksmanship, this team, headed by Lieutenant Colonel Frank R. Jones, made a perfect score of 4000 points.

First place winner in the F-101 class was the 445th Fighter Interceptor Squadron from Wurtsmith AFB, Michigan, captained by Lieutenant Colonel Sam C. Wilkerson, with a five-mission total of 3,300 points.

In the F-106 competition, the 456th Fighter Interceptor Squadron from Castle AFB, California, under the leadership of Lieutenant Colonel James L. Price, won first place honors with 2850 points.

The unsung heroes of the meet were the maintenance men of the 13 competing squadrons, to whom the aircrews entrust their lives. They did a magnificent job at William Tell 1961.

A major milestone in the use of Ryan Firebees was passed recently at White Sands Missile Range, N.M., where U.S. Army missilemen conducted the 200th ground launch of these jet targets.

Since intensified use of Firebees began at White Sands in August, 1959, the Army has advanced from the early XM-21 drone to the Q-2A model and most recently to the Model 124-E, Army configuration of the Q-2C in wide use by the Air Force and the Navy.

Concurrent with developmental testing of the Firebees at White Sands is their function as target support for Army air defense weapons, such as the Hawk and Nike family missiles.

Spokesmen at White Sands reported the life expectancy of each Firebee drone, retrievable after recovery by radio-controlled parachute release, is 10 missions. An average of four missions is conducted weekly at White Sands.

The third "first" achieved at William Tell 1961 was the full use of the SAGE (Semi-Automatic Ground Environment) system to perform the basic functions of detection, identification and interception for the aircrews. The use of SAGE puts 275 tons of computers, 58,000 vacuum tubes, 600,000 resistors, 170,000 diodes and 1042 miles of wiring "in the back seat" of a pilot's aircraft. That amount of complex equipment, which can compute problems in millionths of seconds, is helping the aircrews accomplish their objectives. SAGE is "semi-automatic" only because, as one project officer put it, "We don't want the machine to do everything. We want men to make the key decisions such as choosing the weapons and pulling the trigger."

The Q-2C Firebee target operation was conducted at William Tell 1961 by the 4756th Drone Squadron, of Tyndall AFB, which was under the command of Major Bill Skinner. This group was responsible for both the firing and recovery of Firebees used at the meet. For recovery, a tiny band of men, whose motto was "You crash —We dash," performed a herculean job. These were 11 members of Detachment 56, Air Rescue Service, who operated the helicopters which picked the Firebees from the water and flew them back to Tyndall AFB for decontamination.

Assisting in this work was the fine team of airmen and civilians from Mobile Air Materiel Area (MOAMA).

Thousands of visitors attended the William Tell 1961 weapons meet, including thirty-five Generals and hosts of officers from foreign countries. During this meet, they witnessed intercepts at 55,000 feet altitude and Mach 1.5 speeds. No one could fail to be impressed with the capabilities of the Air Defense Command in meeting the threat from air-breathing weapons because William Tell 1961 was not a one-time show. It was a demonstration of the kill capability which exists throughout the Air Defense Command.

CAMPUS "NAVIGATORS"

(Continued from Page 11)

in teaching both military and civilian classes.

Classes are designed to fit the needs of men who will be working at line maintenance, overhaul and repair, shop maintenance and other specialized tasks. These customer technicians arrive from far removed geographic points for instruction by the Ryan training staff. A typical class in a Ryanav AN/APN-122(V) course might be composed of U.S. Navy Aviation Electronic Technicians based at Florida, Virginia, Maryland, Maine, and Bermuda.

The success of Ryanav equipment, and its wide acceptance as the most advanced state-of-the-art, underscore the years of design, development, and

(Continued on Next Page)

manufacturing skills devoted by Ryan Electronics to this vital project.

In addition to being the most widely used Doppler navigation equipment in the U.S. Government, Ryanav sets are being installed in aircraft scheduled for service under the North Atlantic Treaty Organization. To further illustrate international acceptance, Ryan's customer training course has been attended by technicians from throughout the Free World, including France, the Netherlands, England, Holland, Denmark, and Australia. Ryan's Training Coordinator predicts an increased number of customer trainees from outside the United States as more and more units are put into service.

PICK-UP AND–TOW!

(Continued from Page 18)

Towbee as a target in firing of the Army's Nike Hercules and Hawk air defense guided missiles.

The Towbee is positioned several hundred feet in front of the ground launcher used for the Firebee and tow line connection made. As the Firebee takes off it passes over the Towbee, lifting it from the ground and towing it aloft. The Firebee is controlled in flight from the ground and recovered for re-use by radio commanded parachute drop. The tests are believed to be the first time that a target missile has been used in such a manner.

MARINER R

(Continued from Page 17)

system by constructing a model "space mirror" for a company developing a large solar mechanical engine (RYAN REPORTER, August, 1961).

The unique quarter-scale model, 10 feet in diameter, was a solar radiation concentrator for a 15-kw power system in a space vehicle.

In contrast with the panel type construction for Mariner R the concentrator mirror consisted of 36 blade sectors in paraboloidal shape, designed for folding during boost and automatic deployment in orbit to concentrate the sun's rays into the power package where they are converted into heat to provide power for engine operations.

ELECTRICITY FOR SPACE

(Continued from Page 3)

ever, there are severe problems of weightlessness, inertial forces of large parts floating in space, gyroscopic and tidal forces warping large space structures in various stages of assembly, and hazards to men working in free space.

An alternative to this approach of assembling large vehicles in space is being investigated at Ryan as a part of an Electric Aerospace Propulsion concept based on the following:

A completely assembled, large aerospace vehicle should be capable of performing throughout the altitude range, from hovering at sea level to the attainment of orbital speeds, in such a manner as to include the performance characteristics of a helicopter, a propeller aircraft, a jet airplane, a ramjet and a space vehicle into an integrated system design.

Theoretical investigations based on this premise and supported by an initial experimental program have indicated a possible solution to this objective. The key is contained in the aforementioned concept of electro-chemical propulsion, enlarged by the concept of an electric air breathing engine. Efficiency requires that the velocity of the exhaust jet should be matched to the vehicle velocity. At low speeds the jet velocity should be small. As vehicle speed is increased, so also should the jet velocity be increased to maintain high efficiency of energy conversion. However, using small jet velocities for take-off requires a large exhaust mass, as in the case of a helicopter whose rotor causes a large air mass to move with relatively small downwash velocity. At the somewhat higher speeds developed by subsonic aircraft, the rotor of a helicopter is replaced by a propeller which moves a smaller air mass at higher speeds. At the supersonic velocities of a jet airplane, the flow of exhaust mass is still smaller but its velocity is further increased.

With an electric air breathing engine this can be achieved by force field control, capable of moving large air masses at low speeds and smaller air masses at higher velocities. A number of vehicle geometries are suitable for satisfying the requirement of velocity and mass control of the exhaust jet. One such geometry, offering additional design advantages of minimum structural weight, large volume and cargo capacity combined with desirable aero-thermodynamic characteristics, is shown in the illustration as a circular disk vehicle. This geometry is also particularly suitable for hovering close to ground, because the annular jet augments very substantially the cushion effect of the air trapped between the vehicle and the ground.

By these principles, the efficiency and the thrust of electric aerospace propulsion can be maintained at high levels throughout the entire velocity and altitude range. After leaving the atmosphere, electric propulsion consists of a combination of intense force fields accelerating colloidal chemical plasma; the heavier elements being used for high thrust performance and lighter elements for sustained vehicle acceleration.

Research is continuing in the area of generation and control of high electromagnetic field intensities and colloidal plasma combined with the principle of an electric air breathing engine. Aero-electric propulsion is expected to be a practicable and valuable method for powering aerospace vehicles.

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ON THE COVER

The Army VZ-11, a high performance V/STOL fan-in-wing aircraft now on the drawing boards at Ryan, makes its debut in this issue of Reporter. First VZ-11 flight is targeted for May 1963.

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RYAN FIREBEES

keep more U.S. combat teams "on target" than all other jet targets combined!

WITH THE AIR FORCE

Ryan Firebees were again the only jet targets used at the Air Force's World Wide Weapons Meet, William Tell—1961, in October. This is the third time Firebees have been selected for this important meet since 1958 when the Firebee pioneered the use of free-flying targets at a weapons meet. This year, squadrons of the U.S. Air Force's best Century Series fighter-interceptors pitted their skills against Q-2C's, the most reliable "enemy" jet target to challenge the Air Defense Command.

WITH THE NAVY

Since 1956, earlier version Ryan Firebees have made hundreds of operational flights with the U.S. Navy. Today, the newest Firebee, the transonic Q-2C, is operational with Fleet units of the Navy and ordered in quantity for extensive use. Firebees pioneered as the first jet targets selected for Navy Weapons Meets—at Operation "Top Gun," in 1959—and have established unmatched records of reliability for continuous on-range performance at these extended military competitions.

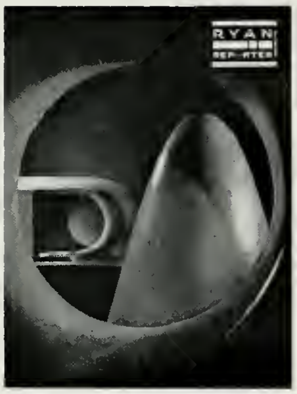
WITH THE ARMY

Firebees are flying at White Sands Missile Range under Ryan logistics crews who assemble, fly and maintain the jet targets, in coordination with U.S. Army missile teams. For Army low-level target needs, Ryan developed the successful Firebee ground launch capability, in 1959, which is now available to all Military Services with all Firebees. Newest Army Firebees are transonic 124-E targets now used to evaluate Army missiles for both low and high altitude performance.

RYAN REPORTER

MARCH-APRIL/1962

RYAN
REPORTER
MARCH-APRIL 1962/VOLUME 23 • NO. 2



About the Cover: Distinctive features of the Army's new VZ-11 jet V/STOL aircraft being fabricated at Ryan, are subjects for an interesting abstract photograph. VZ-11 nose and engine nacelle air intakes are viewed through aircraft's unique nose fan cowling. (Article, page 20.)

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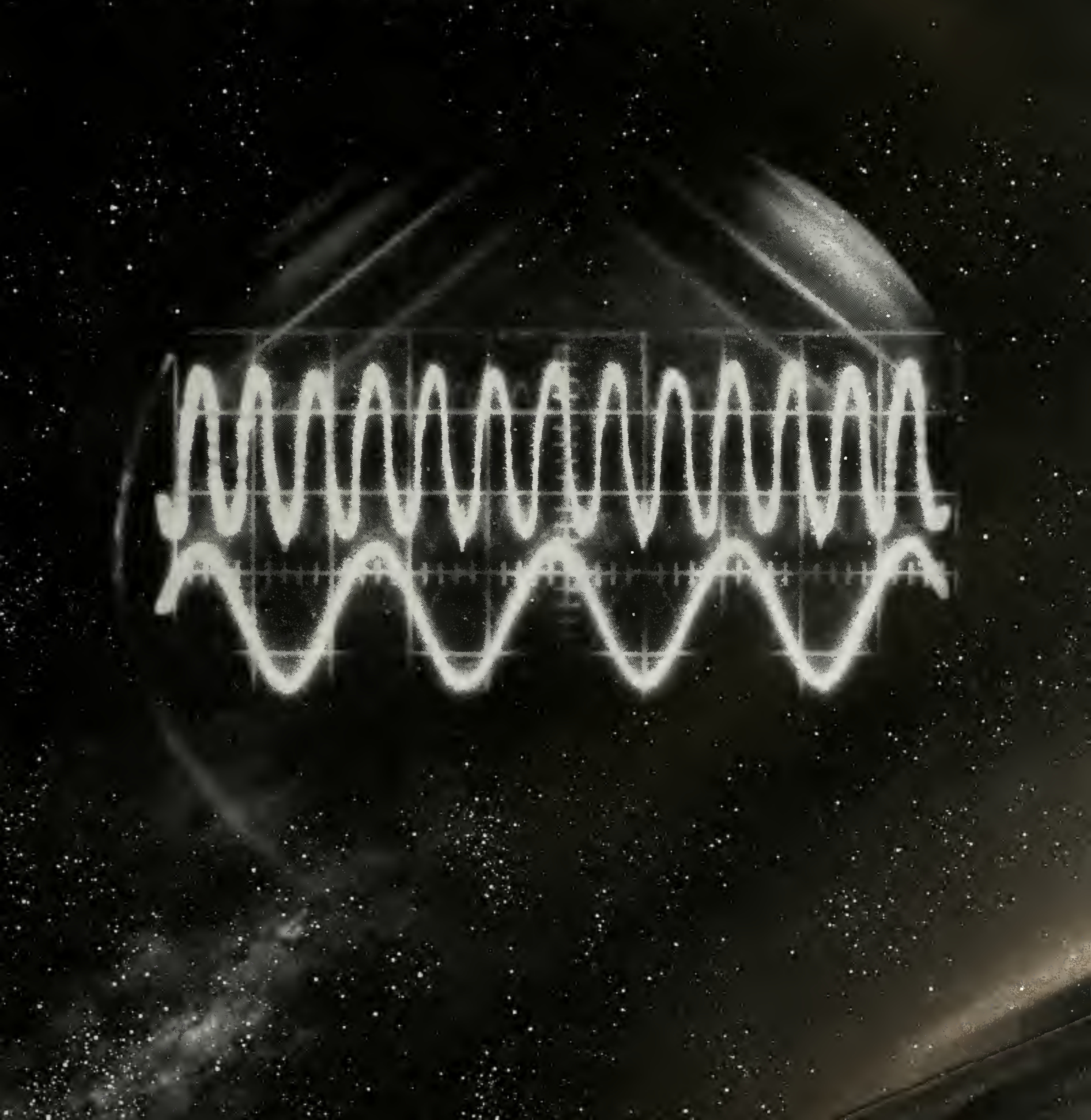
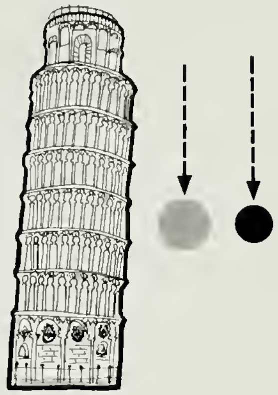
ARE EARTH-MEASURED VALUES VALID IN SPACE?

By Meredith Beyers
Senior Research Engineer
Ryan Electronics

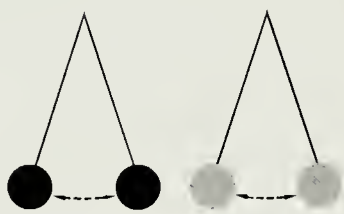
Is a bluebird always blue? Is a constant always invariable? Author Beyers suggests that we take another look at our inveterate earth-bound measuring concepts, and investigate the validity of these seemingly ineradicable suppositions if they must assess other space environs.



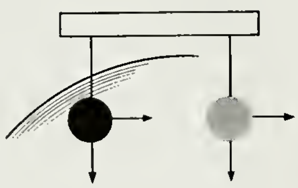
A provocative private study questions



GALILEO *proved that two masses of different weights react to the force of gravitation with the same acceleration.*



ISAAC NEWTON *showed that the periods of pendulums supporting bodies of different substances react to the force of gravitation in the same manner.*



EOTVOS *in 1889 and 1908 demonstrated that two masses of different composition do not react differently to either the gravitational force or the centrifugal force of the earth's rotation. These experiments marked the fork in the road of progress in theoretical physics. Einstein chose the way of geometrical interpretation leading to the theory of a 4 dimensional curved space and relativity.*

THE UNIVERSAL CONSTANCY of fundamental physical measurements made on earth has long been assumed without experimental confirmation. During recent years, however, some doubt has been cast on the universality of Newton's law of gravitation and certain elementary particle parameters which have heretofore been considered as constants.

What will be the effect on the Radar Range Equation if the Boltzman Constant should be found to vary as a function of astronomical position?

Will the dielectric constant of a capacitor, the resistance of a resistor and the resonant frequency of a given circuit have the same values elsewhere in space as they have on earth, even if maintained at the same temperature and pressure?

Will chemical, electrochemical and nuclear reactions elsewhere in space conform quantitatively to values determined by earth-laboratory experimentation?

We do not know—and, we have reached a point where we can ill afford not to know—but some of us are beginning to doubt the validity of earth-measured values in space.

We are sending up rockets, satellites and space probes dependent on electronic instrumentation for guidance, power and scientific measurement, and on the development of exotic fuels and new design concepts for propulsion. If any of our fundamental constants do vary even slightly with position on earth, and to greater amounts with position in space and the fields of influence of other astronomical bodies, it is important that we discover and confirm the basis and extent of such variation; and that we do this before we proceed too far in expending billions of dollars on space instrumentation or predictive computations that might be improved by the knowledge.

Records Prompt Controversy

Even a superficial review of the records of scientific measurements reveals the following facts which are subject to controversial interpretation:

A. Measurements of the same "constants" have yielded different values at different times of day, year or century.

B. Measurements by similar methods of the same "constants" have yielded different values as reported by scientists in laboratories at different locations.

Einstein theory . . .

Recently attempts have been made to deal with and to explain by statistical methods the unexpectedly large differences between values obtained in different laboratories.*

Belief in the fundamental constancy of assumed "constants" has persisted however, perhaps largely because of mathematical convenience, theoretical predisposition and practical expedience.

Newton, Einstein Questioned

The following are mileposts on the road to discoveries which appear on the approaching horizon.

■ *Dr. Fritz Zwicky, of the California Institute of Technology, has reported that an examination of the interactions between clusters of galaxies suggests that Newton's law breaks down at distances considerably smaller than expected in any of the current cosmological theories.*

■ *Leahy and others think it very likely that a reversion of attraction into repulsion takes place when the distances under consideration are of the order of galactic or extragalactic magnitude.*

■ *It is now realized that if the law of gravitation is not universal and if the gravitational constant is not a universal constant we are faced with several serious consequences requiring modification if not abandonment of the general theory of relativity in its present form.*

■ *Dr. R. H. Dicke of Princeton University, has proposed a modification of the general theory of relativity in which the gravitational interaction is a variable quantity. This suggestion is supported by the fact that certain apparent difficulties with the general theory of relativity having their origin in the concept of inertia have recently been traced to the assumption of a constant gravitational interaction.*

■ *Dr. Dicke asked (*SCIENCE*, March 6, 1959), "Are the observed physical constants independent of the position, epoch and velocity of the laboratory?" He proposed that the comparison of an atomic clock and the period of a far-out satellite acting as a gravitational clock might resolve the question about the gravitational "constant", and that the comparison of a cesium beam and ammonia Maser clock to better than one part in 10^{10} could settle the question about the fine structure "constant".*

The Eotvos Crossroads

In re-examining the presently accepted theoretical foundations of our space technologies, the road inevitably leads back to the Eotvos experiment which has recently (and it would seem with greater accuracy) been performed by Dr. Dicke. (SCIENTIFIC AMERICAN, December, 1961, page 84).

Einstein reasoned, so we are led to believe, that if substances of all kinds experience the same gravitational acceleration then the acceleration could be regarded as characteristic of the physical space in which the matter is "falling" rather than the matter itself. He proposed that the gravitational acceleration be interpreted as a purely geometric effect, and that the trajectories of gravitating bodies be regarded as geometric curves imposed on them by the curvature of space. This is the foundation of the general theory of relativity which gained acceptance by providing a successful mathematical description of motion in agreement with observational data in the domain of celestial mechanics.

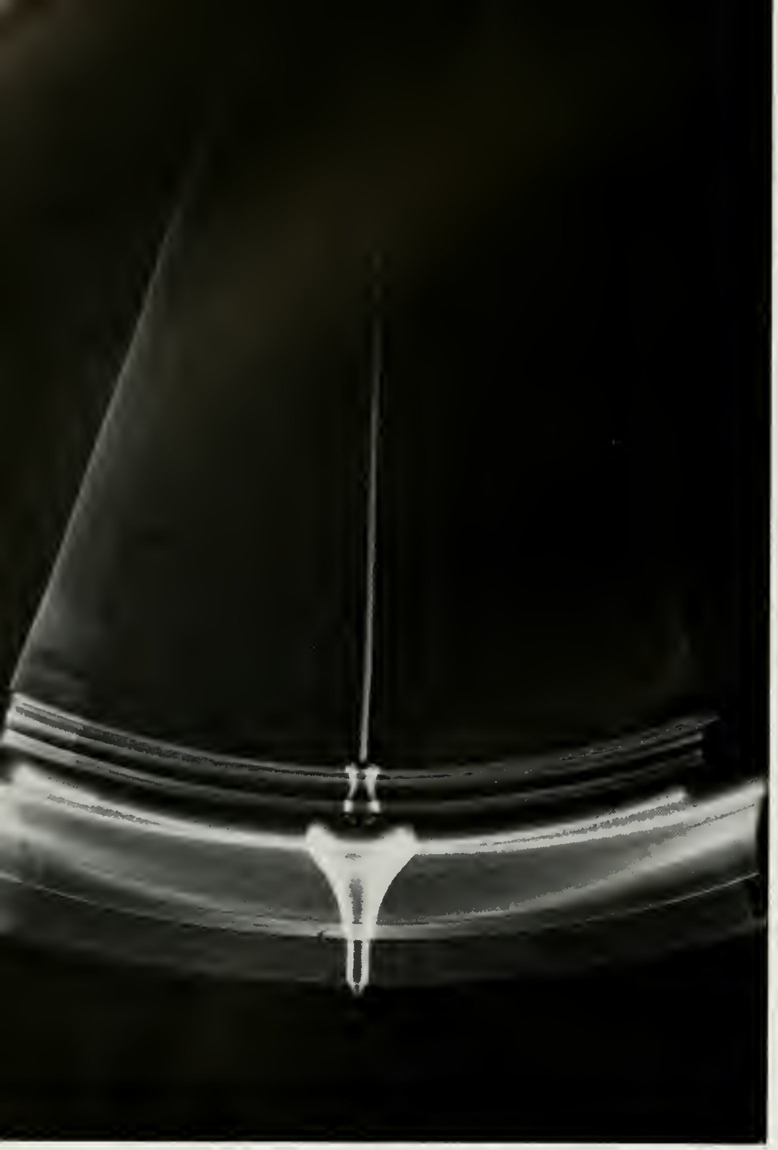
A geometric description of motion is a valid mathematical device which is subject to any modifications required for the purpose of successful computation. It is not, nor did Einstein himself or anyone else claim it to be, a logical foundation to the whole of physics. There is an alternative, equally valid, interpretation of the Eotvos experiment.

Fundamental Particles

A theoretical alternative to a curved and warped space is a dynamic, deflectable, fundamental particle constrained by mutual association with other particles in the radiation fields of other aggregates of particles to follow curved paths in Euclidean space. Observed trajectories and the purely geometric description of motion will be the same, but we have now a tool which is more useful as a guide to investigations of the laws of nature which may or may not be evident in the laws of geometric or statistical mathematics which currently cloak our ignorance in a mantle of technological respectability.

Why have we not yet been able to provide a logical foundation to the whole of physics? We have made measurements and assumptions on earth which we have assumed to be universally valid and constant. Now the suspicion is growing

*PHYSICS TODAY, Vol. 14, No. 9, September, 1961, page 32, "Systematic Errors in Physical Constants" by W. J. Youden, consultant to the National Bureau of Standards on the statistical and mathematical design of experiments in physics, chemistry and engineering.



Newton measured the periods of pendulums supporting bobs made of different materials. Conclusion; all kinds of matter reacte to gravitation in the same way.

that some of our assumptions are not only unconfirmed, they may even be unjustified.

For example, we may have extrapolated and intrapolated our concepts of isotropic radiation and the inverse square law of attraction between bodies beyond the realm of their validity. It may well be that the vibratory source of radiation from single fundamental particles, the electron and the individual nucleon or sub-nuclear building block of matter is anisotropic . . . predominantly unidirectional . . . and that in conformance with Newton's third law of motion, this directional radiation will produce an equal and opposite reaction, a recoil that will impart motion to the particle, if free to move and thrust, if bound in configurations of other particles.

If we thus substitute for our concept of "attraction" a concept of fundamental particle thrust, the difficulty of explaining the "binding force" which holds nucleons together disappears, and with it the chief remaining obstacle to a unified electrodynamics capable of correlating the behavior of electrons, planets, satellites and stars.

The recoil-thrust of anisotropic vibration and radiation enables us to explain the "binding force" that holds nucleons together without the need to postulate any form of "glue", cohesion or force of "attraction" by which Newton (according to his own words) never intended to imply a "pull".

This concept, which provides a valid alternative to Einstein's interpretation of the Eotvos experiment, is not contrary to relativistic considerations; it predicts the apparent increase of "mass" (when mass is defined as a measure of resistance to change of motion) with increase of velocity. The resulting dynamic quantum "deflection-recoil" model of the common denominator of all matter not only predicts and explains the "particle-wave" dilemma but, also accounts for the "mass-defect" encountered in nuclear aggregates, the discrete energy levels of radiation theory, the limiting velocity of all matter, and other fundamental considerations of theoretical physics.

Anisotropic Quantization Logical

This single concept of anisotropic quantization of energy applied to the formation of "matter" appears to provide a logical foundation to the whole of physics, and thereby it appears to provide a new approach to basic research in space sciences.

With a valid theoretical basis for predicting variation where unconfirmed assumption assigns earth-measured values as universal constants, a suggestive guide is provided both for analysis of

"If we analyze the concept of fundamental particle thrust . . ." author Beyers discusses theory.

ABOUT THE AUTHOR

MEREDITH BEYERS *joined Ryan Electronics in September, 1959. Since then, as Senior Research Engineer in the Advanced Design section, he has investigated physical phenomena associated with aerospace vehicle guidance and advance weapons systems. Before coming to Ryan, Beyers was a research analyst consultant.*

For more than twenty-five years Beyers was associated with Educational Research Laboratories, pursuing independent projects and studies which led to the considerations introduced in his article "Are Earth-Measured Values Valid In Space?" The questions posed in this article were stimulated in part by Mr. Beyers' participation in research projects and theoretical studies which include an investigation of unvalidated assumptions in the foundations of modern scientific theories and technologies—investigation of the function of gravitation in the experimental determination of fundamental constants and ratios of the physical sciences—investigation of lunar tidal effects on atmospheric diathermancy—investigations of geophysical experimental evidence of a correlation between gravitation and electromagnetism—theoretical development of sub-nuclear dynamics as a logical foundation to the whole of physics from a correlativistic viewpoint—and the astronomical validation of resulting basic equations.

consequences, and for selection of design considerations in planning instrumentation to determine whether earth-measured values vary with latitude and elevation, or whether they are constant and also valid in space.

The basic concept of anisotropic radiation and recoil-thrust at the individual nucleon level leads to consideration of astronomic aggregates of fundamental particles (planets) as nearly spherical capacitors rotating in the fields of other bodies, generating or empowered by slightly deflected centripetal dielectric displacement currents which may provide a novel explanation of what we know as "gravity".

This model predicts a gravitational "constant" which is a function of the resonant period of axial rotation of the source of the gravitational field. Computation for the earth gives a value in close agreement with the accepted value for the gravitational constant. We may assume that this value is constant for the earth's field, as far as that field extends, though its possible variation with latitude and elevation should be investigated. A different value entirely is obtained for the gravitational constant of the solar field, and of the gravitational field of every other astronomical body. This alters the mass and densities assigned to bodies other than the earth, but the structure of celestial mechanics is unaffected by this possibility.

Mysteries Still Unsolved

From our present view the significance, if true, is chiefly in resulting predictions of variation in other general physical constants which may not be universally constant as we have assumed. What is now urgently needed is experimental evidence to determine whether earth-measured values of physical constants pertinent to space vehicle instrumentation are valid elsewhere in space. Did the battery of Pioneer V spring a leak in the vacuum of space, or was its unexpected weakness a more fundamental function of its environment?

The mysteries that are still unsolved, and man's audacity in gambling millions of dollars on still unconfirmed assumptions, calls for a continual open-minded re-investigation of the foundations of our space technologies. It is to be hoped that a few far-sighted space research workers and sponsors will pursue the subject experimentally to provide us with a conclusive answer to the question "Are Earth Measured Values Valid in Space?" ■

EDITOR'S NOTE: Dr. Albert Einstein agreed to study Beyers' equations. He died before completing his evaluation or reporting his conclusions.

RE-ENTRY & RECOVERY

by J. Dale Sutliff
Project Engineer-Aerospace Systems

BILLIONS OF DOLLARS will be spent in the next few years in man's effort to conquer the space between the earth and its nearest celestial neighbor—the moon.

An average of over one hundred million dollars a year will be spent on vehicles whose operational life is measured in minutes. Fantastic costs associated with space exploration, continue to be a source of concern to scientist and layman alike and are primarily attributed to the one-time usage of space and booster vehicles.

Early boosters used in the nation's space programs were basically designed for military applications and are relatively dispensable when compared to space conquering hardware now on the drawing boards. Their relative payloads were also small.

Justify Recovery

Booster configurations, such as the Saturn and projected larger classes now in early development or planning stages however, justify the cost of a true re-entry and recovery system. These new boosters, if properly designed with the necessary re-entry and maneuvering capability, can be used as a space-age transportation system.

A year ago, Ryan in cooperation with the National Aeronautics and Space Administration's Marshall Space Flight Center, began studies in an effort to slash the costs of building and testing space boosters through the use of a Flex Wing recovery program. The results have been most encouraging.

The NASA-Ryan studies indicated that a booster development program utilizing a flexible wing recovery system will cost the government about one-half that of a program in which recovery is not used. The costs savings are due largely to the fact that a program director can use the same booster, after slight refurbishment, for several launches.

Boosters Used 3 to 4 Times

The Ryan program indicated that one booster could be used for 3 to 4 test flights. On such a re-use program, refurbishment of the booster after a flight should not exceed 20 per cent of the initial booster cost, and in most cases is expected to not exceed 10 per cent. In round figures, analyzed costs associated with development of the Saturn C-1 and C-2, show that savings based on the 3 to 4 times re-use rate could total over one half a billion dollars in the complete development program.

Besides costs savings, the capability to recover boosters after they have completed their primary function of delivering space systems into specified mission profiles, allows engineers the valuable ability to perform post-flight inspections.

The inherent advantages to post-flight inspection are vast and rewarding. System failures can be analyzed and solved, weak points in construction, and conditions of stress can be observed and the necessity for on-board instrumentation to telemeter system performance is reduced, since some of these functions can be observed in post-flight inspection.

Post-flight Inspections

Perhaps the greatest advantage to be gained from post-flight inspections of recovered boosters is the reduction in development time for the recovered vehicle. The ability to evaluate flight tested components will not only minimize the component failure rate on future launches but will also

OF SPACE VEHICLES

Astronauts enter Earth's atmosphere on glider-like wings.

increase the booster reliability above that of an expendable system.

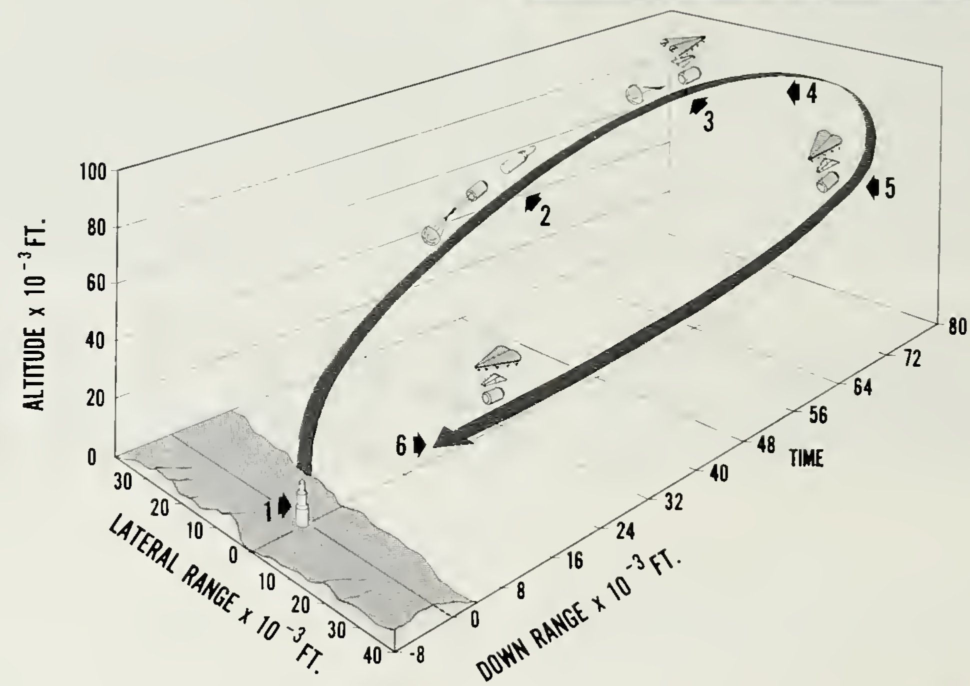
The addition of a recovery capability only slightly decreases the effective payload capacity of the booster system. For the large three-stage boosters being considered for various NASA space missions, studies have shown that the weight of a Flex Wing first stage recovery system will reduce a 300 mile-high altitude orbital mission payload by one per cent or less and reduce escape mission payloads by only four per cent or less.

Performs Like Glider

In the Saturn rocket booster recovery system, the Flex Wing performs like a glider and is capable of carrying tremendous loads from space back to earth. Simply defined, the Flex Wing will be deployed from the booster at burnout to carry the rocket back to a pre-selected site on land through remote-controlled radio or internally programmed guidance. The technique would save the 122,000 pound booster for repeated re-use.

Objectives of the NASA-Ryan studies were to reduce system development costs, and increase mission capabilities, while achieving the recovery capability with a minimum payload penalty on the booster. All studies were based on the Saturn C-1 and C-2 design.

Unlike the conventional wing composed of a



In a typical Flex Wing booster recovery mission, at (2) 116.4 seconds after launch the booster burns out and drogue chute is deployed. (3) 134.4 seconds, chute separates, wing deploys and the booster begins to execute turn. (4) 176.4 seconds, apogee. (5) 254.4 seconds, turn completed, Flex Wing system enters glide phase. (6) 425 seconds, flyback to landing site is completed.

rigid skin and a forming structure, the Flex Wing is composed of a membrane of flexible material attached to three supporting members, the center keel and the two side members, or leading edges, are joined at the foremost point to define a triangular envelope. The edges of the flexible membrane are continuously attached to the leading edges and keel, which may be either inflatable or conventional as in a rigid aircraft structure. If rigid components are used, a spreader bar may be used to force the wing leading edges to the desired fixed sweep angle rather than experience the aerodynamic variable sweep angles of free floating leading edges. The wing suspension lines may attach directly to the booster, or to a control bar, which in turn is attached to the booster. Movement of the booster center of gravity, longitudinally or laterally, controls glide angle and provides coordinated turns.

Inflatable, Rigid Designs

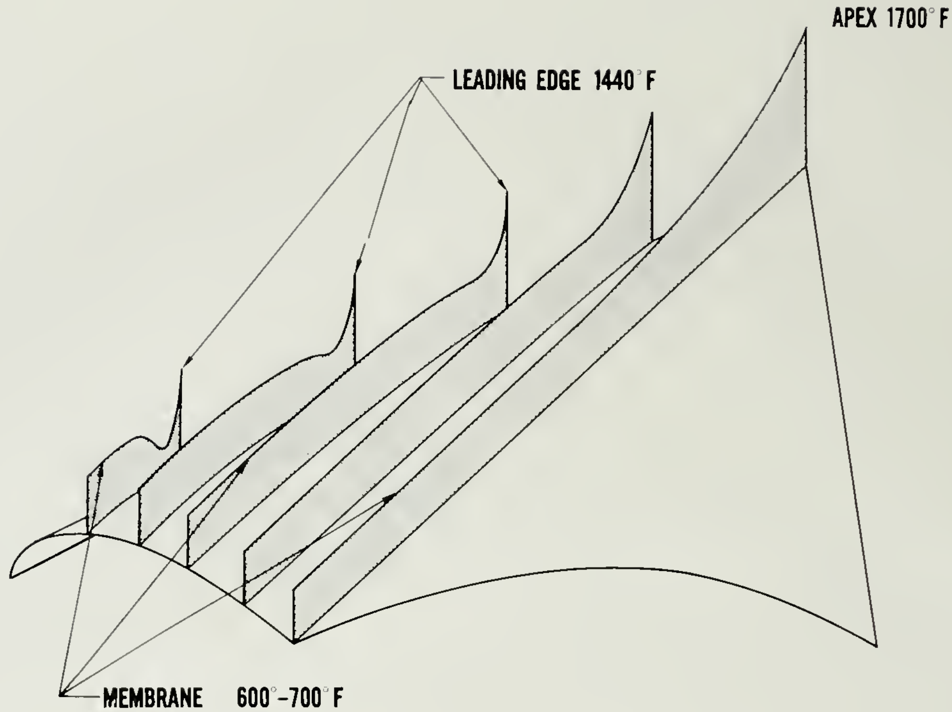
Different mission profiles will require various wing configurations, but a comparison between rigid leading edge and inflatable leading edge wings show that higher lift-drag ratios may be obtained with the rigid leading edge design.

In the NASA-Ryan tests, rigid leading edge lift-drag ratios of 8 were achieved with maximum wing-lift coefficients of 1.5.

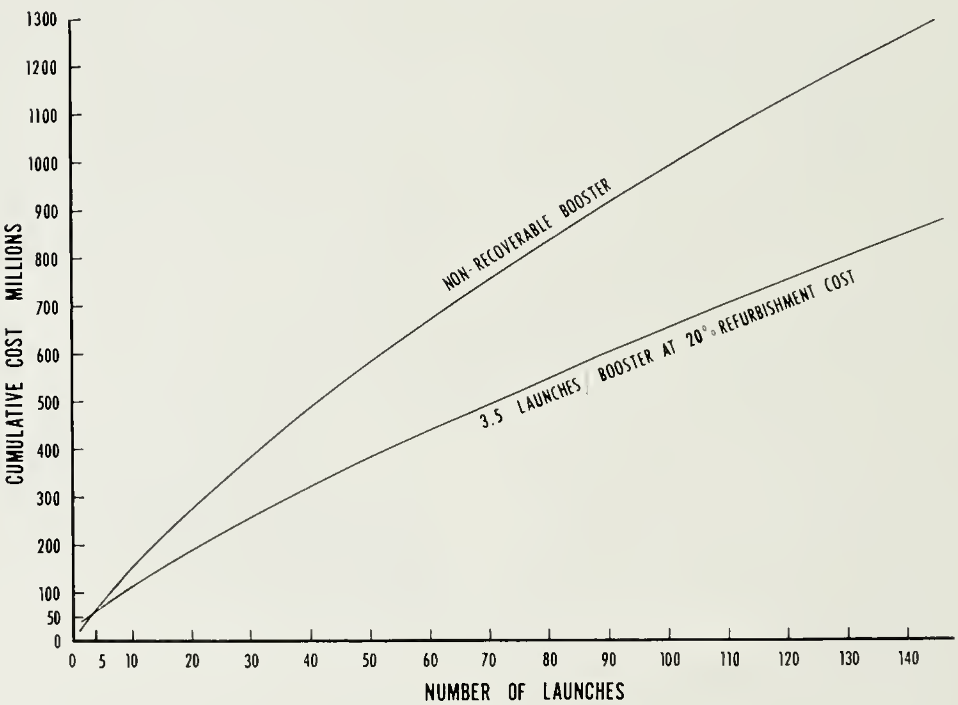
Inflatable wings on the other hand have some inherent advantages. Ryan studies show that inflatable designs are lighter and, because of their flexibility, can be almost as densely packaged as a parachute of equivalent sinking speed.

In a typical trajectory profile for the C-2 Saturn, a stabilizing parachute is deployed at booster burnout instead of the wing deployment. The booster coasts to somewhat higher altitude and lower velocity, and approximately 18 seconds after burning out, the wing is deployed and a turning maneuver commanded. The Flex Wing system, remote-controlled by a ground controller, will make a 180° turn, and the wing-booster system is allowed to glide back toward the launching area.

In a landing profile for the recovery system, approach speed is 110 knots, with 60 feet per second sink speeds. By remote control of the c.g. location, the booster is oriented to a horizontal attitude by the flight control reference system. Flare is initiated at approximately 250 ft.



Flex Wing re-entry temperatures vary as a function of the wing's angle of attack. Illustration depicts temperature distribution on the wing during orbital re-entry. Angle of attack is computed at 55 degrees.



Booster system development costs can be curtailed. Illustration compares a non-recovery program with one in which boosters may be used three to four times.

A year ago, Ryan in cooperation with NASA, began studies in an effort to slash costs in the basic function of building and testing space boosters through a Flex Wing recovery program.

altitude, and is controlled automatically from the ground by a programmed rate of sink as a function of altitude. Booster touchdown occurs between 60 and 70 knots and 2 to 5 feet per second sink speeds, with a ground contact attitude of 5° or less.

Similar to Parachute

The real potential of the Flex Wing lies in its exceptional re-entry capability. Studies of flight systems utilizing the wing prove its wing loading characteristics approach those of a parachute (from .5 to 5 lbs. per square foot).

The weight penalty for the low wing loading design is considerably lower than that of conventional aircraft with the same wing loading factors, due to the single membrane construction. In a light wing loading re-entry configuration peak radiating temperatures may be kept lower than 2000° F. Thus, conventional materials may be used without the heavy weight requirement of ablative heat protection, such as that used on the Mercury capsules.

Light wing loadings also provide low landing velocities. The Ryan Flex Wing test bed, flying at wing loadings between two to four lbs. per square foot has demonstrated touchdown speeds of twenty-eight knots. With such a low speed, only 500 feet of landing strip is necessary.

Flying the Flex Wing equipped re-entry vehicle would be like flying a glider—and equally as safe. Low speeds allow for considerable time to make decisions in an emergency situation.

Stores Easily

As with a boat sail, the wing, when not in use, may be stored in a long cylindrical column alongside the orbital carrier or in some configurations, may be packed as a parachute. This storage capability is very desirable during the launch phase, eliminating drag and minimizing possible wind disturbing forces during the critical boost phase.

Prior to a re-entry from orbital or escape velocities, the wing would be deployed to the flying attitude. The membrane is free to float in a zero gravity state, taking whatever shape it desires within the restrictions of the leading edges and keel. As the outer fringes of the atmosphere are encountered, the wing gradually fills, much as the sail of a sail boat. As larger aerodynamic forces develop, control will gradually transist from the jet reaction systems required for space penetration, to the more economical c.g. or aerodynamic Flex Wing control. The maximum loads developed during the re-entry phase will not exceed three to four G's and then only for a few seconds, well within a pilot's performance capability and considerably lower than those experienced by ballistic systems such as Mercury.

The stagnation temperature, the highest the vehicle will experience during the re-entry, occurs at the wing apex and will not exceed 2000° F. under radiating conditions, and in many missions will be closer to 1200° F. or 1800° F.

A re-entry system based on the wing concept will not exceed the weight of a vehicle using an ablative type heat shield.

Turns Increase Range

Highly maneuverable, the Flex Wing can bank and turn. Varying the wing angle of attack after the peak re-entry temperature has been reached allows range increases up to 1200 miles.

The maneuvering capability allows the pilot to decide his point of orbital termination and select a suitable landing site.

The NASA-Ryan studies proved that the Flex Wing as a re-entry and recovery system is both economically sound and technically feasible. ■

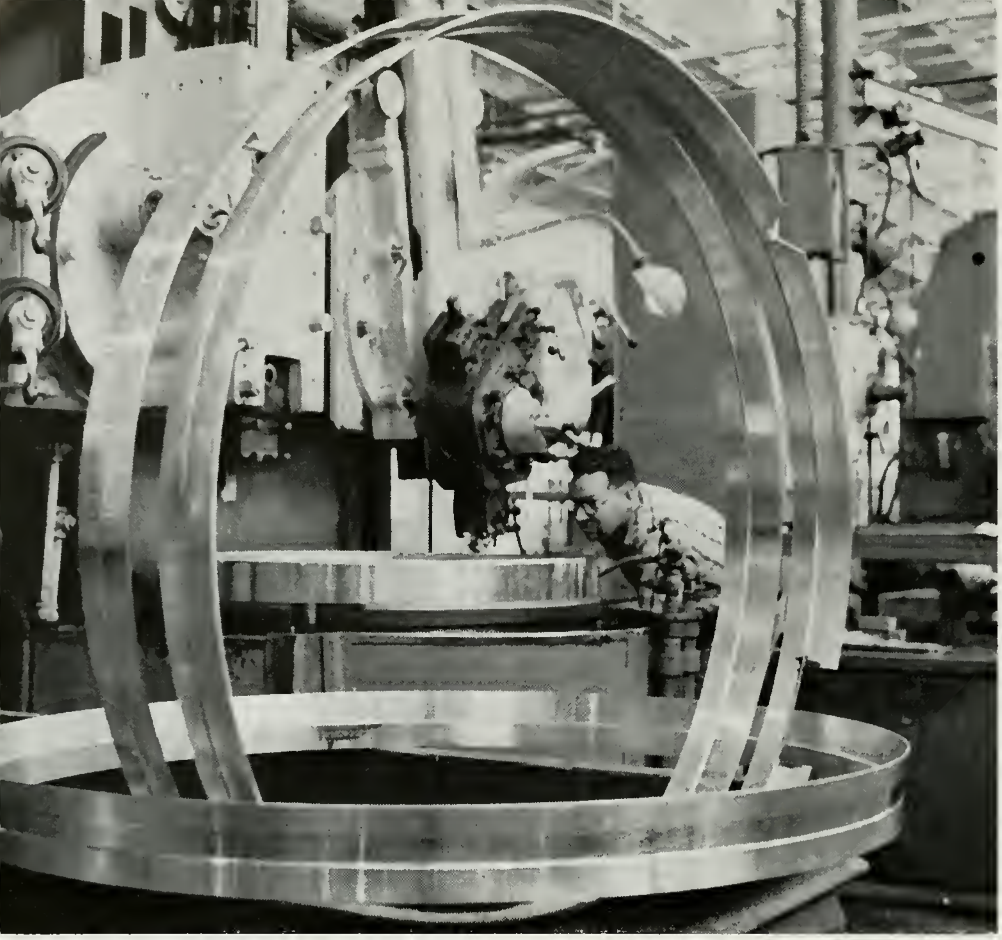
Wind tunnel tests of the Ryan Flex Wing powered test vehicle, first aircraft of its kind in aviation history, have been successfully completed at the National Aeronautics and Space Administration's facility at Langley Field, Virginia. Data obtained from several weeks' wind tunnel work confirmed and correlated data obtained by actual flights of the test vehicle in San Diego for the Army Transportation Research Command. Engineers appear dwarfed by kite-like aircraft in the cavernous throat of the NASA wind tunnel.

Workmen fit nose-fan ducting as the Ryan designed, U.S. Army VZ-11 mock-up begins to assume the distinctive "look" of a V/STOL aircraft at Ryan's Lindbergh Field facility in San Diego. The high performance jet is being designed and built under contract to General Electric for the U.S. Army Transportation Research Command, Ft. Eustis, Virginia.

A $7,373,496 Contract calling for continued production of Q-2C Firebees through 1963 was awarded to Ryan in late February. The order is for more than 200 of the transonic missiles, of which approximately 90% will be delivered to the Navy and the balance to the Air Force.

Additional orders totaling $4¾ million were received in March for augmentation and ground support equipment and spares for the Navy Q-2C Firebee jet targets. The new business calls for augmentation equipment, including Ryan-developed traveling wave tube systems, smoke kits which visually locate the target, and L-band and S-band radar beacons used for target identification and target tracking by control crews. Ground support equipment and ground launch facilities will also be supplied to three Navy bases—Naval Missile Center, Pt. Mugu, Calif.; the Naval Ordnance Test Center, China Lake, Calif.; and the Naval Air Facility at Naha, Okinawa.

Air Force crews work into the night readying Q-2C Firebee targets for "enemy" missions (top). Navy crews, meanwhile, (bottom) marry a Q-2C target to a P2V Neptune mother plane for one of the first flights of the latest Firebee series under Navy colors. Navy recently purchased the new model after many years of operating KDA-4 Firebees.



Big vertical turret lathes are turning out missile parts at Ryan — separation rings for the Minuteman missile. Under a Boeing contract, several configurations of the rings, ranging from 37½ to 65 inches in diameter, are being made of aluminum alloy. The initial order calls for production of nearly 2,000 rings.

General Electric officials conferred recently with Ryan executives on installation of G.E. T-64 turbo jet engines in the tri-service VTOL transport for which Ryan will build the nacelle, aft fuselage, outer wing and other parts. Examining artist's concept of vertical-rising transport are, left to right, H. H. Dearing, Jr., General Electric's Manager, T-64 engine project; E. V. Albert, Manager, G.E. San Diego territory field sales operations; T. H. Beck, Ryan Engineering Director; John Rane, Ryan Marketing Director; and Frank W. Fink, Ryan Vice President-Engineering.

The aerial spying capabilities of Ryan's tiny remote controlled Flex Bee, were sharply focused recently when the drone photographed its Ryan ground crew during flight tests at the Marine Corps facility, Twenty-Nine Palms, California. The aerial was taken from approximately 550 feet, as the little Flex Wing equipped drone flew over at 60 knots. Camera lens was set at F 5.6, shooting six frames per second. Flight tests were being conducted in a Marine Corps evaluation of the Ryan craft.

REPORTER NEWS

Reindeer Steaks sizzling over an open fire in a vast arctic wasteland, with Laplanders as their hosts, was a surprise experience for a team of Ryanites on a sales mission to Europe. The Ryan group included A. W. Abels, Export Marketing Manager; J. N. MacInnes, Military Relations Senior Engineer; Larry Emison, Project Engineer, Army Target Systems; and Ed Sly, Group Engineer. Elsewhere on their sales mission, the team conferred with NATO, SHAPE and AGARD officials in Paris, with the Swedish Air Force in Stockholm, the Greek Air Force in Athens, the Ministry of Aviation in England, the Italian Air Force in Rome, with the West German Ministry of Defense and with executives of private firms in England, Germany and France. V/STOL, Firebee, Flex Wing, and explosive forming, were among the Ryan products and capabilities discussed.

Safety Awards from the National Safety Council were accepted recently at Ryan's Lindbergh Field and Ryan Electronics Kearny Mesa facilities. No lost time accidents in more than 1,250,000 man-hours during 1961 calendar year placed the Kearny Mesa plant first among 14 companies in the National Safety Council's research and development group. Only two lost-time injuries in 5,575,000 man-hours earned the San Diego plant a second place award among 14 major aerospace firms throughout the nation.

Construction began recently on a 6,000 square foot flight simulator building at Ryan's main plant, Lindbergh Field, San Diego. Scheduled for completion about April 1, 1962, the laboratory will be utilized primarily for flight simulation studies in connection with the U.S. Army VZ-11 fan-in-wing V/STOL research aircraft to be designed and built by Ryan and G.E. The building will also house analog computers and a hydraulics laboratory.

"Manned" Flex Wing drops recently proved a new application of Ryan's versatile Flex Wing. A half-scale model human-figure dummy using a Flex Wing paraglider system successfully completed preliminary drops from 2,000 foot altitudes at Brown Field, San Diego. Demonstrations were conducted as part of a Ryan proposal to the Army Transportation and Research Command to design a paraglider system and build full scale Flex Wings and instrumented dummies for an experimental drop program.

A Pin-Point Land Recovery system of Firebee jet target missiles has been successfully tested at Tyndall Air Force Base, Florida. The system involves parachute recovery of the Q-2C in a two-mile square area at Tyndall, which has been cleared of pine trees, palmettos, and tree stumps. To date the principal means of recovery has been by parachute into the Gulf of Mexico, where the targets are picked up by helicopter and drone retrieval boats. Land recovery is being tested to reduce maintenance costs and to prolong serviceable life of the drones by eliminating salt water corrosion and necessity for decontamination after the "bird" is returned to base.

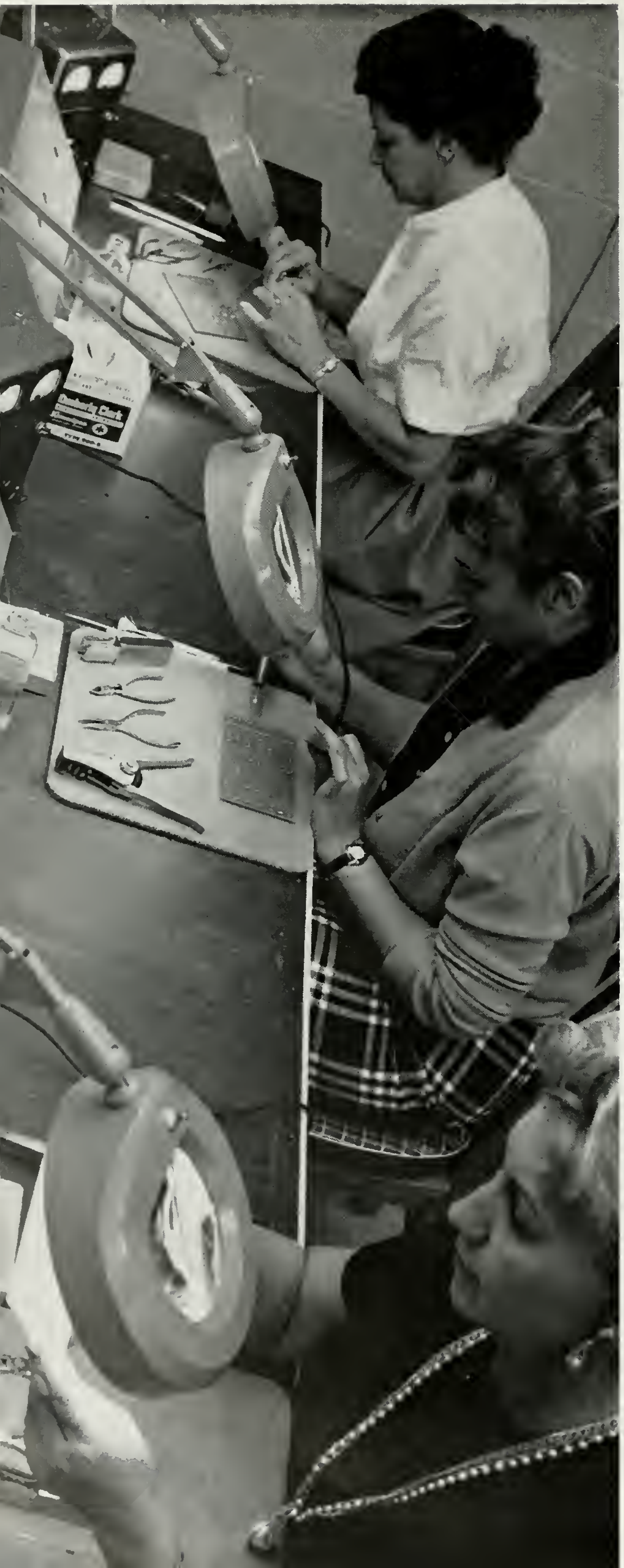
Ryan personnel will continue to support Firebee operations at the White Sands Missile Range, N.M. as a result of a $338,000 contract from the U. S. Army. The crew will support Model 124-E operations at White Sands. The 124-E is a special Army configuration of the Q-2C, most advanced Firebee in production.

A Ryan Q-2C Firebee jet target lost in the Pacific off the California Coast for six days has been recovered and returned to service, setting a new record for Firebee durability and resistance to seawater damage. The "Bird" was air-launched March 10 by Squadron VU-3 from a P2V Neptune off San Nicolas Island in a Pacific Fleet support mission for surface-to-air missile firing. Pt. Mugu based helicopters were unable to find the Firebee in heavy seas after the mission had been completed. Six days later a Navy ship found the Q-2C, retrieved it and dumped it ashore at Port Hueneme, to eventually be flown back to North Island, San Diego. On March 19, after a thorough decontamination and a new engine, the Firebee was back on the flight line.

The Atlantic Fleet is operating the Q-2C Firebee. First missions were scheduled this month from Roosevelt Roads Naval Air Station, Puerto Rico, where Squadron VU-8 is equipped with the transonic targets. In later operational Q-2C flights with the Atlantic Fleet, shipboard-based missiles will be fired at the Ryan targets.

Initial Funding on a contract which will total approximately $3.5 million when finalized was awarded Ryan Electronics by the U. S. Army Signal Supply Agency in March. The contract calls for Ryan navigation sets for use in the Army's AO-1 Mohawk observation aircraft. Initial funding totaled $1,791, 621. In February, Ryan Electronics received an order from Japan for Doppler navigators totaling nearly $500,000. Delivery is scheduled for completion before mid-year. The new order boosts total Japanese orders to Ryan Electronics in the past few months to well over $1 million.

"Students must unlear



SOLDERING SATURN'S ALTIMETER

In an atmosphere bordering on surgical cleanliness, Ryan Electronics technicians are learning to cope with the torture endured by space conquering electronic components. The electronics specialists are attending classes designed specifically for Ryan personnel directly associated with the National Aeronautics and Space Administration's Saturn Program. The school is conducted by Ryan personnel.

The instructor has attended NASA schools in Los Angeles and Huntsville, Alabama, and has subsequently been certified by NASA to instruct Ryan employees in special soldering techniques developed for use in space vehicles.

NASA Fostered

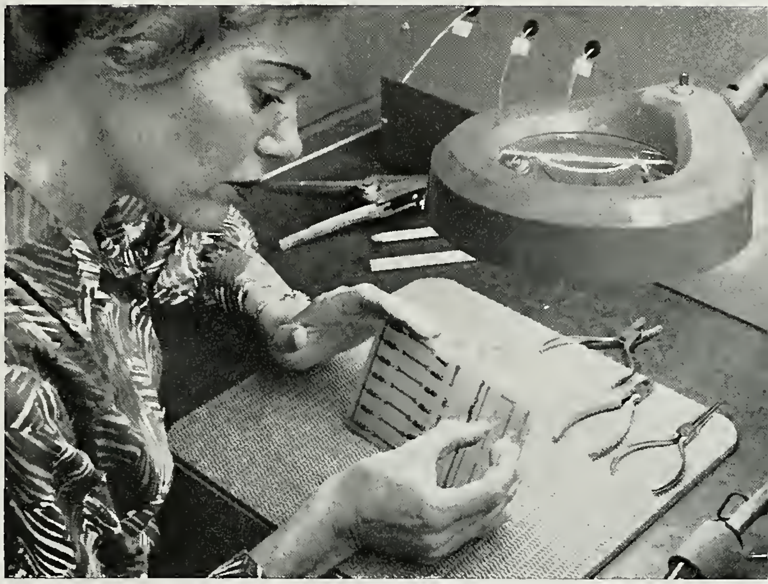
The Ryan/NASA school curriculum is the result of years of testing and experience by the Army Ballistic Missile Agency and NASA, who have developed standards and specifications which will withstand the rugged environment of space programs, and result in greater system reliability.

Ryan will use the NASA school techniques in the production of the Saturn vehicle's radar altimeter. The altimeter, designed by Ryan Electronics under contract to the George C. Marshall Space Flight Center, NASA, measures the altitude from the Saturn launch vehicle to the surface of the earth during pitch-over and in orbit.

NASA officials pointing up the importance of

ommon techniques not acceptable for space vehicles."

NASA schooled instructor monitors students in soldering class.



Cleanliness emphasized, tools and work areas are cleaned before each assembly step.

fundamental techniques in the construction of space age components said the school was organized and the techniques and methods were developed as a result of analyzed failures of components—and NASA's desire for a high quality product.

Reliability Stressed

The school is attended by technicians of all levels. With reliability the key to all instruction, the course begins with the basic fundamentals of soldering and progresses to the most advanced fabrication techniques known to the missile electronic assembly field.

Special techniques developed for bonding reliability, coupled with the utilization of newly discovered chemicals and specially designed soldering equipment, insure a greater degree of built-in reliability for space components to be assembled by the graduates of the unique school.

With emphasis on cleanliness, tools and work areas are cleaned before each assembly operation begins. Special acids, alcohol, and flux are used for various wicking operations. Special tools include diagonals, pliers, soldering aids, vices, resistance irons for connector pin connections, and thermal strippers for removing insulation from leads.

In another technique, students learn to assemble components with special heat shots to prevent the solder from flowing beneath the terminals and leads.

Commenting on the school and the high degree of dependability required in space vehicles, Mr. Albin E. Wittman, Chief of the Electrical System Analysis Branch, Quality Division, Marshall Space Flight Center (NASA) said, "Good workmanship and quality control remain the key to dependability. To insure the desired quality and reliability in missile components, more rigorous standards and specifications must be developed than those now in general use by industry and the military services. Such standards and specifications must be adopted exclusively as the criterion for design, manufacture, and acceptance of space vehicle components." Pointing to the Ryan school he said training sessions should instruct personnel in proper techniques, tools, materials and standards. During this training it may be necessary for the students to unlearn common practices not acceptable for space vehicles.

Recorded altitude measurements taken by the Ryan-designed Saturn radar altimeter can be played back as the vehicle passes within range of a ground station. The Ryan-manufactured radar altimeter is capable of measuring altitudes up to 400 kilometers, and will provide information for determination of Saturn's orbit. ■

V/STOL WITH AN ARMY PUNCH!

Ryan helps Army probe for V/STOL answer

THE U. S. ARMY's dreams of a high performance V/STOL aircraft, with the versatility of a helicopter, took major strides toward reality recently as the VZ-11 airplane began to take shape on Ryan engineering drawing boards.

A research aircraft, the unique VZ-11 will be designed to operate primarily from areas of opportunity and free of prepared runways.

The VZ-11 will take off straight up, dart away in a high performance mission, then return to land in an area no bigger than a tennis court!

A future operational aircraft of the VZ-11 type could be an observation platform or could provide suppressive fire support to advanced troops in front line positions. It could be an integral part of such advance troops, and would be able to move with them as they progress from one objective to the next in rapid battle sequence, eliminating the need for construction and support of expensive, hard-to-maintain-and-protect runways and airfields.

Studies Began in '55

Ryan's selection to design and build the VZ-11 has climaxed years of developing the Vertifan* approach to vertical take-off pioneered by Ryan and dating back to 1955. In 1959, Ryan began a comprehensive investigation of fan-in-wing vertical take-off principles in a "Submerged Fan Type VTOL Aircraft" study for the Air Force. This investigation defined the methodology to obtain an optimum airframe-engine match for this superior type of high performance V/STOL aircraft.

Two VZ-11 aircraft will be built under a General Electric prime contract for the Army's Transportation Research Command at Ft. Eustis, Virginia. Test flights on the aircraft are scheduled to begin in mid-1963.

The General Electric Company will supply the lift fan propulsion systems, while Ryan will design, build and flight test the VZ-11.

Previously, Ryan pioneered in jet vertical take-off with its X-13 Vertijet that startled the aircraft industry and the world in 1957 with its remarkable ability to take off and land in a vertical attitude, on a column of seething hot jet exhaust. The X-13 was the result of more than 10 years research by Ryan engineers.

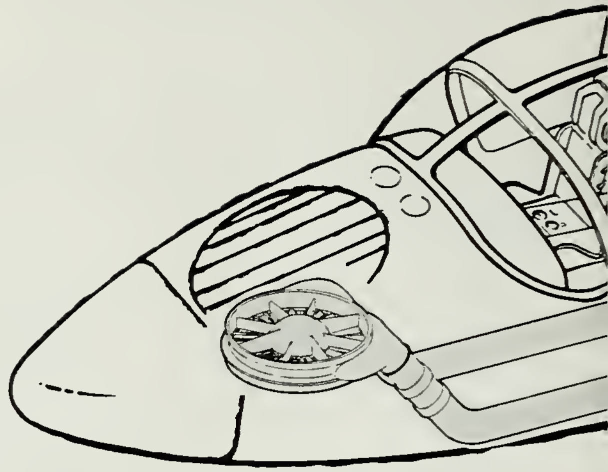
The VZ-11's distinctive feature is a set of counter-rotating fans "submerged" in the wings and powered by tip turbines, driven by the jet engine exhaust, to provide the lift for vertical take-off and hovering.

For vertical flight, turbojet exhaust is directed to the tip turbines, driving the lift fans. The rotating fans create columns of relatively cool, low speed air for lift.

Nose Fan Controls Trim—Pitch

A smaller fan in the nose of the airplane provides trim and pitch control. All three fans will be powered by two General Electric J85 gas generators. These turbojets will supply power for both vertical take-off and landing and for straight and level flight.

In normal and horizontal cruise, the power of the jet engines is diverted from the fans to straight thrust. The jet engines serve a dual function. They provide conventional jet thrust for normal flight, and furnish exhaust gas which is conducted



to the fans by means of a thin curving pipe or "scroll", to tip turbines mounted on the periphery of the fan.

For vertical take-off, the diverter valves installed behind the engines direct exhaust flow to the lift fans, multiplying effective engine thrust by a factor of three-to-one and thus generating lift. In its hovering configuration, the aircraft will literally be supported by the two wing fans and nose fan on a tripod of air.

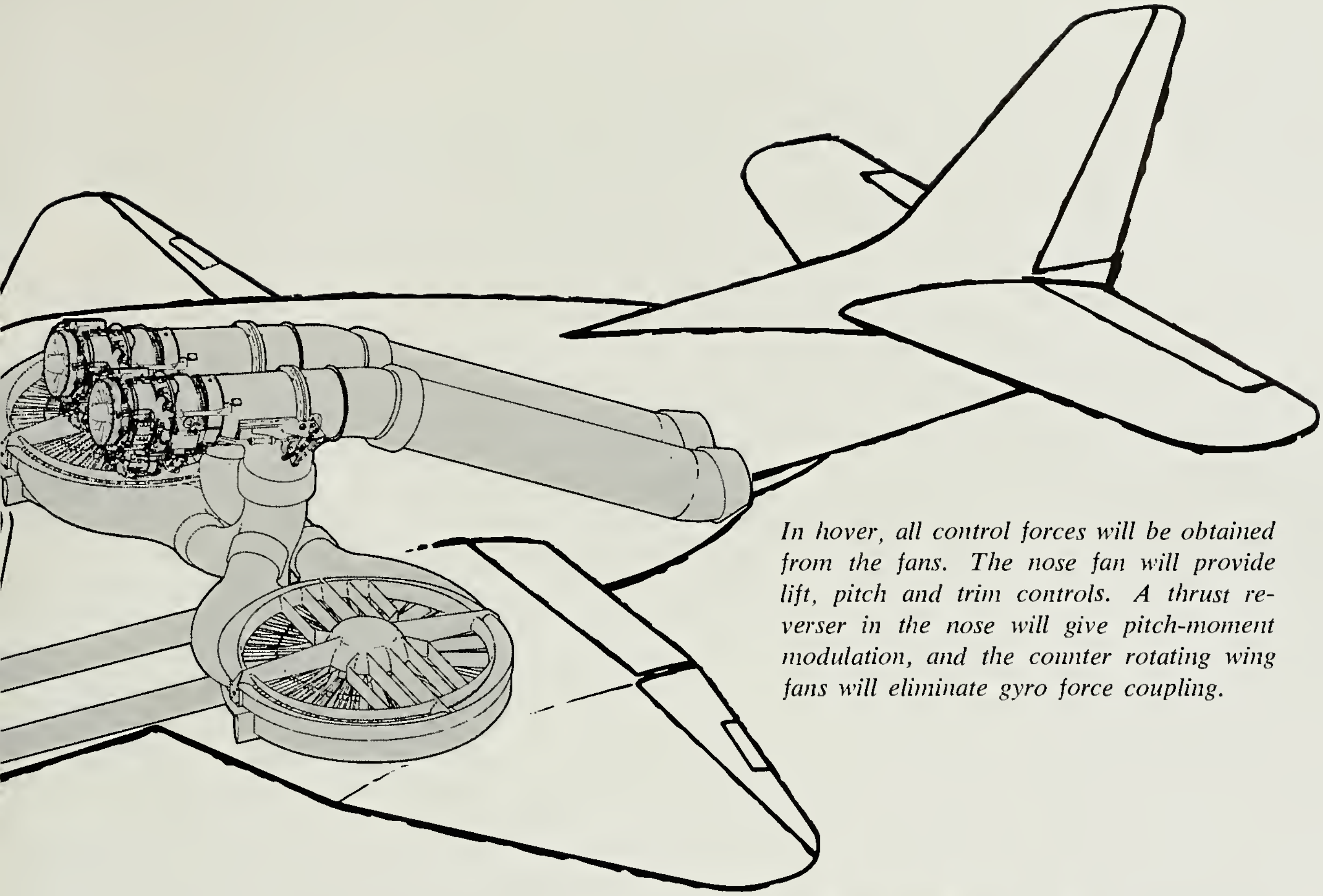
Mounted on the upper wing surfaces are large "butterfly"-type doors which cover the fans. The fan enclosures on the lower surfaces of the wing are movable shutter-like vanes which deflect the mass flow of air from the fans during transition.

Fans Control Takeoff

For vertical take-off and hovering, the exit vanes would be in a vertical position. For forward flight, the butterfly doors remain open and the lower vanes slant aft, deflecting the slipstream (air flow) during transition from vertical to horizontal flight. As sufficient speed is attained for wing-supported flight, the diverter valve will redirect engine exhaust through engine tailpipes for high-speed cruise.

When changing to the conventional jet configuration for forward flight, the lower vanes are closed, and the butterfly closures cover the upper

*TRADEMARK



In hover, all control forces will be obtained from the fans. The nose fan will provide lift, pitch and trim controls. A thrust reverser in the nose will give pitch-moment modulation, and the counter rotating wing fans will eliminate gyro force coupling.

surface of the wing fans to provide a smooth upper airfoil surface.

For landing, the upper butterfly doors and the lower exit vanes would open to give a decelerating force, and the exit vanes would gradually move to the vertical position as the aircraft's forward air speed drops to zero.

In hover, all control forces will be obtained from the three fans. The nose fan will provide lift, pitch and trim control, and a thrust reverser in the nose fan will give pitch-moment modulation.

GE J85's Supply Power

Each J85 turbojet will supply one-half the power for each of the three fans, with cross-over ducting providing an important margin of flight safety. Under standard conditions, adequate lift will be available to make a satisfactory vertical landing in case of single engine failure. Conventional landing can be made with a single engine under any loading conditions.

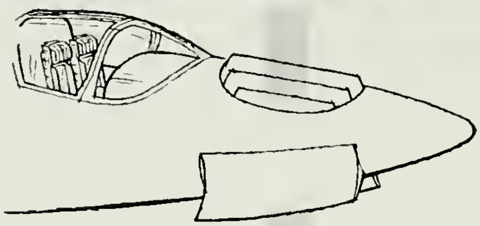
The diverter valve, used to direct engine thrust to the lift fans for V/STOL flight, and straight-through for conventional flight, was developed for the Air Force by General Electric as part of a VTOL research program. The valve has been highly reliable in various test programs. All linkages and stops are external for simple maintenance or adjustment. Mechanically simple, the diverter valve's rapid actuation rate is designed to permit rapid changes from V/STOL to the conventional jet powered flight mode.

The Army VZ-11 is designed as a single seat research airplane incorporating a 300 pound instrumentation package. In an alternate configuration, it provides for conventional two-place side-by-side seating.

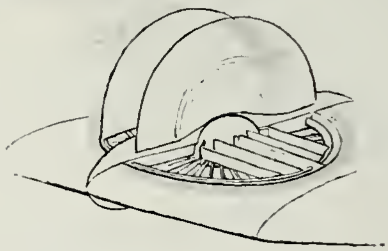
VZ-11 DESIGN DATA

Weight, empty	7,054 Lbs.
Design Gross Weight (VTOL at 2500' alt., on ANA 421 std. hot day, ult. load factor 6)	9,159 Lbs.
VTOL Gross Weight (S.L. Std. day)	12,200 Lbs.
Max. Allowable Gross Weight (ult. load factor 3.75)	13,600 Lbs.
V Cruise, maximum Range	Mach .70
V Maximum, 25,000' alt.	Mach .83
V Stall., clean, no flaps	82.5 knots
V Transition (145.5% V stall, both engines powering fans)	120 knots
Ferry Range (13,600 Lbs., 10% fuel reserve)	1,810 N miles
Service Ceiling (8,350 Lbs.)	50,000 feet
Allowable C. G. Travel	7.5% MAC

Two VZ-11 aircraft will be built for the Army's Transportation Research Command at Ft. Eustis, Virginia. Test flights are scheduled to begin in mid-1963.



Nose fan doors are pivoted to function as nose fan thrust modulators.



The fan butterfly closure provides a smooth upper airfoil surface.

The fuselage design features high engine air inlets, minimizing the possibility of foreign material and hot gas ingestion. A spacious cockpit with large window area provides excellent visibility with optimum pilot-passenger communication.

Thrust spoilers, located aft of the jet engine exhaust nozzles permit full engine RPM at reduced flying speeds, reducing fan spin-up time in transition from conventional flight to fan-supported flight.

Conventional Cockpit Controls

From the pilot's viewpoint, the cockpit controls for wing-supported flight are identical to conventional airplanes. The only control unique to the VZ-11 is a vertical control stick which is utilized with the conventional control stick and rudder pedals for fan-supported flight. The pilot is not required to shift hand or foot control positions throughout the entire transition.

Vertical take-off and transition to wing-supported flight can be accomplished while maintaining a constant level attitude. Transition may be performed at constant altitude or in a climb.

Initially, throttles are advanced and airplane trimmed for zero stick forces with flaps lowered. Throttle is advanced to 100% with louvers at zero deflection. Lift-off and vertical climb is controlled by the lift control. As the airplane reaches sufficient altitude to clear any obstacles, the exit louvers are gradually deflected rearward and the airplane begins to accelerate. The landing gear is retracted and attitude remains level. When the airplane reaches 120 knots with exit louvers fully deflected, diverter valves are actuated, inlet butterfly doors and exit louvers close, and the airplane is in conventional flight.

Nose-Up Landing Attitude

To complete a landing operation, the airplane is throttled back, flaps and gear lowered. A trimmed condition is established at approximately 150 knots. The inlet doors and exit louvers are automatically opened when the diverter valves are actuated. A nose-up attitude is maintained and louvers steadily vectored from 30° to 0° to slow the airplane to a hover. As the VZ-11 reaches a hover condition above the obstacle altitude, the lift control is eased off to establish a sink rate of 3.5 feet per second. The airplane is level during the descent, then a gentle flare is accomplished with the lift control and the airplane is touched down at near zero sinking speed.

The VZ-11 test program is divided into four major efforts: propulsion system, airframe, ground test and flight test. ■

RYANAV

ROADSHOW

In coast to coast tour RYANAV IV whips all weather navigation problems.

Test flights challenged winds ranging from a dead calm to gusts up to 60 knots, and sea states from flat to Beaufort 3 or 4.

MILITARY and civilian pilots and navigators across the nation took turns in trying to confuse Ryan's new Ryanav IV recently, when the versatile Doppler navigator took a nationwide tour aboard the company's custom-fitted DC-3.

Handling bad weather with ease, the Ryanav IV made its debut at the Whidbey Island Naval Air Fair in November. From Whidbey Island the DC-3 hopped in rapid succession through the Southeastern United States to a premiere performance in Washington, D.C. Completing a dawn to dusk program the Ryan aircraft and crew left Washington, stopped in New York City, toured the New England states, then the Midwest before returning to San Diego.

Logs 30 Flights

In all the Ryanav IV was put through its paces more than thirty times, and the versatile unit logged more than 100 hours of service on the inaugural trip.

The Ryanav IV is universal in application, providing both navigation and hovering capabilities. It is adaptable to supersonic jets as well as other fixed-wing aircraft, helicopters, V/STOL aircraft and drones.

The versatile Ryanav IV Doppler navigator is designed to accommodate speed ranges between minus 50 and plus 2,000 knots, altitudes from zero to 70,000 feet, drift velocities from zero to plus or minus 300 knots, ground track from zero to 360 degrees, and vertical velocities to 60,000 feet per minute.

Throughout the entire trip observers were encouraged to participate in the demonstration by suggesting problems (course and maneuver, bank angles, type of turns, etc.) to be solved by the Doppler navigator. Flights were conducted in winds ranging from a dead calm to gusts up to 60 knots, and sea states from flat to Beaufort 3 or 4. The Ryanav IV performed at all times with accuracy and precision.

Cabin Modified For Ryanav

The DC-3's passenger cabin is modified to accommodate a special Ryanav IV demonstration console. Included in the display panel are navigation instruments of the Ryanav set including read-outs for ground speed and drift angle, navigation computer set-in and readout, bearing and distance indication, hovering indicator for demonstrating the zero speed sensing capability of the Ryanav IV, ground track/wind velocity and direction indicator, control indicator and a standard altimeter and air speed indicator.

Installed in the area just aft of the pilot's cockpit is a drift sight for visually checking ground reference points and a plotting board that traces and displays the aircraft's exact position as indicated by the Ryanav IV on a sectional map or overlay.

70° Bank Angles

During pre-flight briefings the passengers were familiarized with the various instruments and Ryanav IV demonstration equipment. Questions were invited. In-flight, typical navigation problems were automatically solved by Ryanav IV as the aircraft was flown over check points to permit frequent visual cross checks by flight participants between the drift sight and the plotter. Upon return to the airfield, touchdown was made within feet of the precise spot set into the Ryanav IV computer at takeoff.

In other problems, predetermined navigation legs were also flown to verify the readings of the Ryanav's bearing and distance indicator. One phase of the program featured a series of turns at low altitudes, and high bank angles in excess of 50 degrees over a Beaufort 0.5 sea state.

During several demonstrations, passengers requested a flight involving roll angles and high speed turns at bank angles up to 70 degrees to determine the Ryanav IV's capability during maneuvers in extreme flight conditions.

With more than 15 years' experience in the Doppler field, Ryan Electronics has demonstrated that the C-W technique is the most suitable to accommodate the positive, negative, and zero speed domains; the near-zero altitude requirements of helicopters and V/STOL vehicles, and the high altitude, high speed requirements of modern jets. ■

The DC-3's passenger cabin is modified for a special Ryanav IV demonstration console.

BUILDING NAVIGATORS
An Exacting Task

COMBINE AN ULTRA MODERN production facility with a corps of seasoned manufacturing experts, then blend in a generous helping of "desire to serve the customer" and you have Ryan's production facility at Torrance—a manufacturing success story.

The Ryan plant's gleaming white buildings, identified in the Torrance, California area with a sky-high water tower labeled Ryan, are located on a 40-acre site adjacent to the Torrance airport. A rail spur for shipping and the neighboring airport for fast air freight service are valuable ingredients to the Torrance success recipe.

For more than fifteen years, Ryan Electronics has specialized in the development and manufacture of electronic products for aircraft, missiles, space vehicles, and weapons systems.

$40 Million in 1961

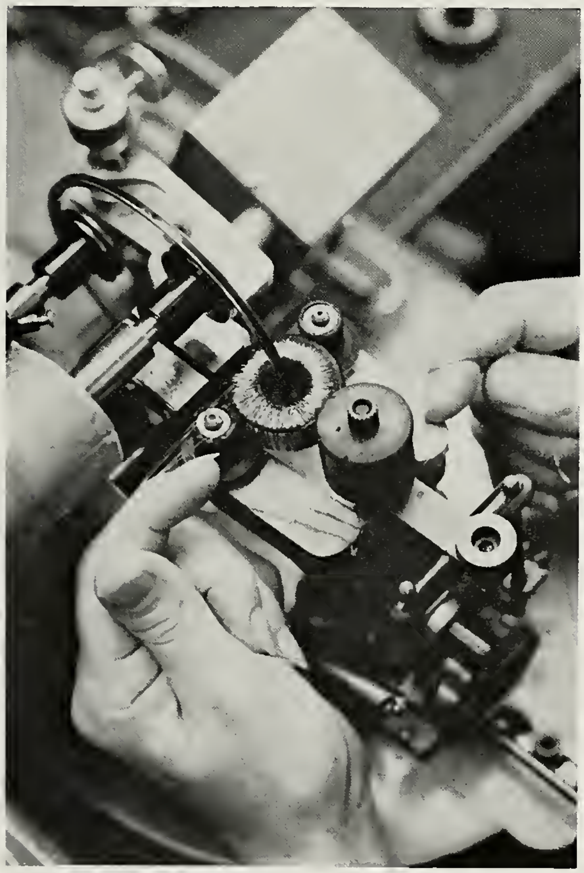
During 1961, Ryan's Torrance plant produced $40 million worth of Doppler navigators.

Ryan's continuous-wave Doppler navigational systems—RYANAV* —are extending the operational capabilities of nearly every type and size of aircraft—from terrain-hugging helicopters and reconnaissance planes to high altitude, high speed jets. Thousands of these sets have been ordered for use in more than 25 types of aircraft by the United States military and other countries of the Free World.

*TRADEMARK

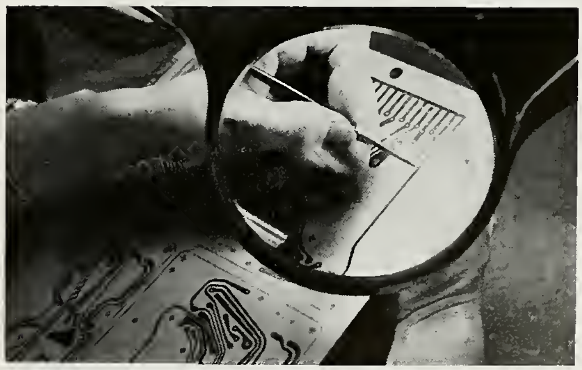
Navy - Army rely on Ryanav eyes

Thorough receiving inspections insure that even the smallest transistors purchased for Ryanav Doppler navigation systems conform to Ryan standards. In addition to standard commercial bench test equipment, the inspection lab is equipped with Ryan-designed test stations.



Skilled technicians create critical magnetics components. Hairlike wires wound again and again form a tiny coil, whose value must be precise for it to perform its function in the completed navigation system.

Production of magnetics components is keyed to high volume production. An extensive staff of magnetics specialists constantly monitors performance of Ryan produced components.



Fabrication steps, from circuit boards to final system check-out receive microscopic attention. Circuit boards get artists touch-up before etching.

In production, wiring harnesses make an interesting pattern in one stage of assembly at Torrance. Special boards ease the complicated task of routing, lacing and tieing hundreds of tiny wires.

Unique machine checks the complicated wiring harnesses that tie components of the electronic navigator into a complete system.

Outstanding facilities and personnel skills enable Ryan to deliver operational hardware on schedule, to customer specification and at minimum cost.

Foreign Clientele

Ryan is currently delivering systems to the U.S. Navy for both fixed-wing aircraft and helicopters with additional quantities to follow. Supplementing the hundreds of navigators already in helicopter service with the United States, United Kingdom and Netherlands Navies, sets have been ordered for use in Australia, France, and Japan.

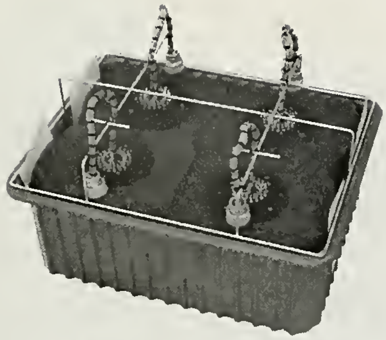
A quantity of navigators are presently being installed in U.S. Army aircraft, and more are expected to be ordered this year.

Ultra-Modern Facilities

Modern, specialized and complete, Ryan's Torrance plant is geared for high volume, high quality production of complex electronic units and systems. "Under roof" manufacturing floor area covers nearly 300,000 square feet and complements a 100,000 square foot electronics engineering center in San Diego. Electronics production at Torrance is under over-all direction of H. L. Fontaine, Manufacturing Vice President.

Torrance production, reflects the latest developments in industrial engineering and material handling techniques, ultra-modern assembly and test equipment, and a line balance that accommodates several concurrent programs.

Ryanav navigator accuracy is zeroed-in at Ryan's specially designed boresight range. Beam angles can be adjusted to one minute of arc.



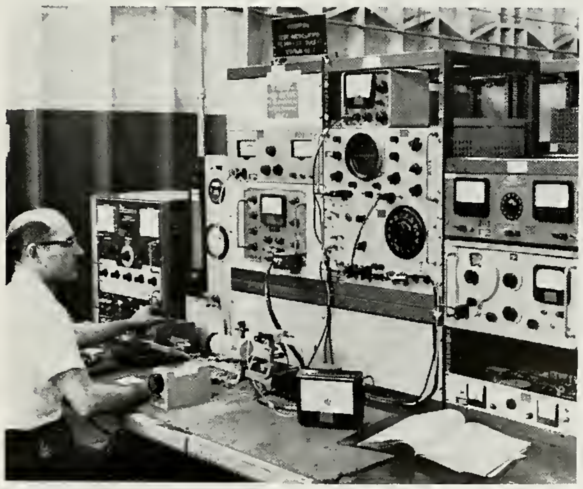
Specially designed handling containers guard critical parts against damage as they proceed along production lines.

Dental tools in artist-like hands put finishing touches on plastic shells that soon will be Doppler navigator antennas. Zinc plating and pressure testing follow, before electronic components are added and calibrated.

Navigator production begins at receiving inspection where purchased components undergo rigorous screening to critical Ryan standards. Electrical and electronic tests are conducted with Ryan-designed test instruments, supported by standard test equipment. Additionally, mechanical and visual tests are performed in a precision inspection laboratory.

Components Become Systems

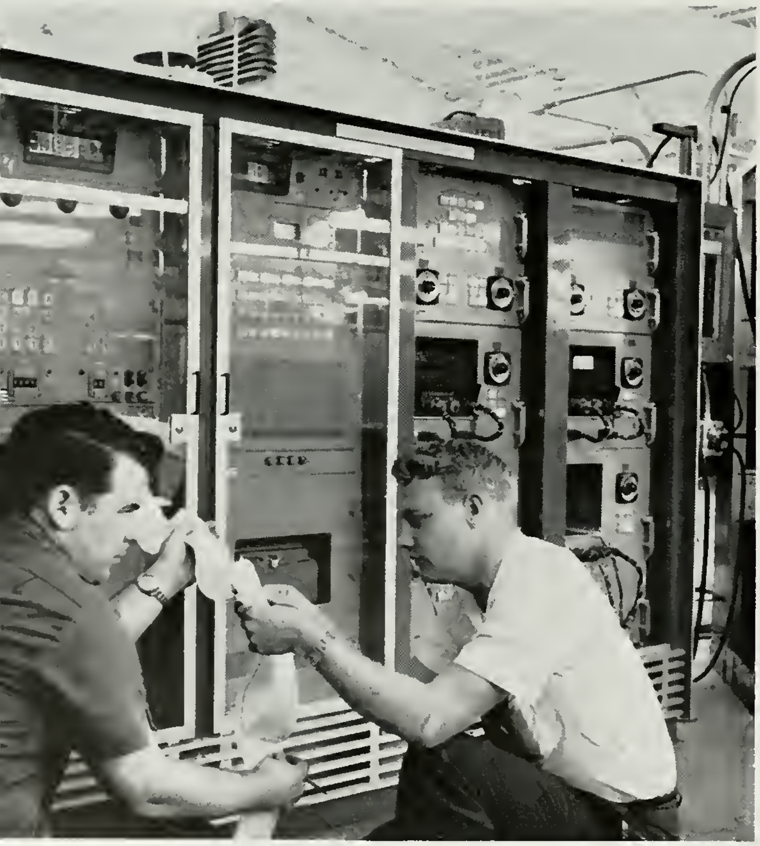
Ryanav navigators are created inside a massive 75,000 square foot air conditioned, dust-free assembly building. At neat rows of assembly lines, the skilled hands of electronic assemblers work deftly with multi-colored wires, transistors, coils, circuit boards and hundreds of other parts. From tiny component to completed system, production steps follow a logical building block sequence where components are tied together on circuit boards to become subassemblies and subassemblies are combined with like sub-assemblies to become modules. Next, several modules are pulled together to make a unit, capable of performing a specific function in the finished navigator, and finally several such units make up a completed system.



Test equipment at the Torrance facility includes radar transmitter and receiver test stands for precision alignment, precise frequency measuring, and stabilization. Here antenna klystron is calibrated.

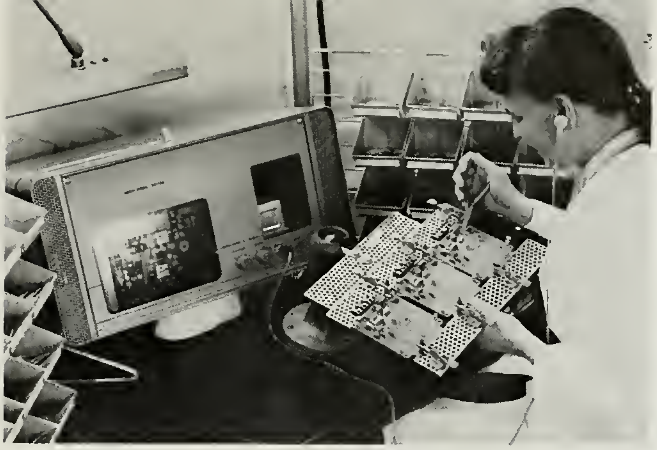
Manufacturing equipment, facilities, and assembly areas are completely modern; geared for high volume, high quality production of complex electronic components and systems.

The high operational reliability of Ryanav navigators, now operational with the Navy and Army, attests to the skill, experience and abilities of Ryan personnel.



From design through final production, each module and unit in each navigator is subjected to exhaustive tests. This automatic run-in and test installation simultaneously checks two complete Doppler navigator systems.

Reflecting the most modern production equipment and techniques in electronics assembly, components are soldered to circuit boards in this unique flow solder machine.



Audio-visual production aids add a measure of reliability to critical assembly operations. The technique combining taped voice instructions, color slides, and the skill of trained technicians, is a major development in electronics production.

Ryan technicians design, build and maintain extensive checkout and testing systems for electronic production.

Ryan's electronics manufacturing plant at Torrance is located on a 40-acre site.

Importantly, each production step incorporates several extensive and exacting tests, designed to isolate problem components, subassemblies, or larger modules and units before they cause expensive line shutdown requiring lengthy troubleshooting operations.

In another building, workmen dressed in white smocks, looking every bit like artists, dexterously manipulate dental tools, to fashion the final touches on the unique lightweight plastic antennas used in the navigator. Rough edges are cut and sanded, then the antenna shells are pressure tested, and zinc sprayed, before technicians attach precision klystron tubes and associated wave generating components.

The antennas are then "zeroed-in" on a modern boresight range, where technicians adjust antenna components until a specified Doppler radar beam geometry has been achieved. Antenna beam measurements are taken and spectrum analyses are observed. Voltage standing wave ratios and RF (high frequency) leakage tests are conducted at the boresight facility.

Torrance officials point to control as the key to quality and reliability in electronics production. "With control in mind, we have established one of the finest magnetics build-up and circuit board fabrication capabilities in the industry".

"Additionally, our extensive capability to design and build complex test instruments insures the highest quality in our completed systems."

Inspection Ends Production

Each completed navigator must pass more than 80 hours of tests, which may incorporate small component, module, unit and system test, troubleshooting and adjustment. Additionally, most units must pass a final 25 hour operational shakedown in a unique Ryan designed test instrument.

To the layman, the completed system emerges from the final test line—a series of black boxes, and a dish-pan-like antenna—but it is much more. It represents endless engineering research, molded into a complex electronic machine by skilled technicians.

Torrance employees realize that how well they do their respective jobs dictates the accuracy that allows a Navy helicopter crew to seek out an enemy submarine in zero-visibility weather —that guides a DEW line patrol craft over cold arctic waters—that helps an Army pilot pick his way through rugged terrain on a night reconnaissance mission. All agree—"Ours is an exacting task". ■

A V/STOL transport that can scramble is a

TILT-WING TROUBLE SHOOTER

THE ALERT IS GIVEN—troops and equipment are needed immediately in a far-off country. No air fields are available near the action! The decision is made — send in V/STOL transports.

In the complex picture of the world today, a conflict requiring immediate action may arise at any time and in any place. Most conventional aircraft are unable to meet the short takeoff and landing requirements necessary in wild jungle areas and rocky, mountainous country.

The Vought-Hiller-Ryan C-142 is the Defense Department's answer to the problem of providing tactical logistics transportation to any trouble spot in the world. The three-company effort is aimed at development of a V/STOL aircraft that will swiftly transport combat troops, equipment and supplies from assault ships or unprepared airfields.

These aircraft will have the vertical take-off advantages of a helicopter with the speed of a transport for rapid deployment of troops and cargo in any terrain, under all weather conditions.

Pooling their extensive backgrounds in V/STOL aircraft, Vought, Hiller, and Ryan are developing five of these transports for the three services.

A $70 Million Program

The tri-service program may exceed $70 million, with the Air Force designated as government monitoring agency. Each of the three services—the Air Force, Navy and Army will contribute $7 million for the fiscal years of 1961 and 1962, and will share remainder of the costs over a four-year period.

Ryan is designing and building the fuselage aft section assembly, including the cargo ramp, fin, rudder, horizontal tail and tail boom. Ryan is also designing and constructing the wing and engine nacelles, including access doors, engine inlet and oil cooler screens, and miscellaneous wiring and de-icing controls.

Ryan engineers in the past 20 years have accumulated a backlog of more than three million man-hours of V/STOL experience. During the time Ryan developed the world's first pure jet VTOL, the X-13 Vertijet, and the deflected slipstream VTOL VZ-3RY Vertiplane.

Preliminary designs indicate that this tri-service transport will be 58 feet long, 26 feet high and have a wingspan of 67½ feet.

Unique feature of the transport will be the tilt-wing, which has an aspect ratio of 8.6. At takeoff the four General Electric T-64-GE-6 turboprop engines mounted on the tilt-wing will be pointed skyward. After sufficient altitude is gained, the wing will tilt forward for level flight. Fuselage mounting at four points will secure the tilt-wing. (This design proved satisfactory in the two-position wing of the F8U Crusader series built by Chance Vought for the Navy and Marine Corps, also in the Hiller X-18 tilt-wing aircraft.)

A Vought technician inspects tilt-wing transport model, prior to wind tunnel tests.

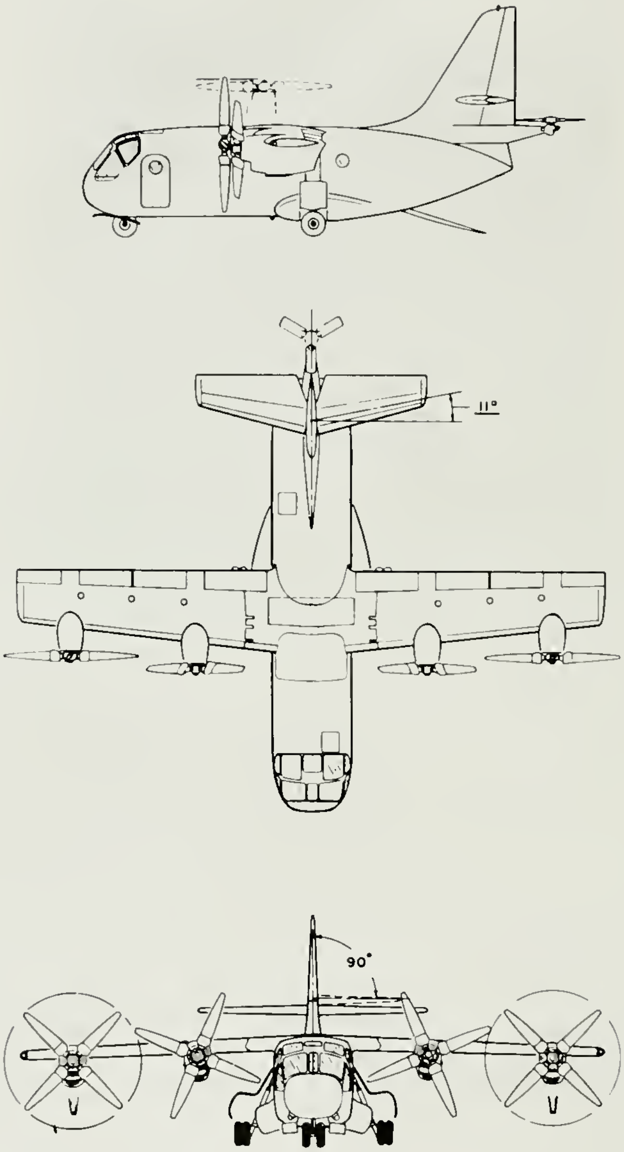
Wing tilt is accomplished by dual synchronized wing-tilt actuators to provide "fail-safe" reliability and stiffness of wing support.

Can Fly Backwards

Since the wing will be designed to tilt through an angle of 100 degrees, the plane will be able to hover in a tail wind, or, if necessary, fly backwards.

The wing design calls for full-span, double-slotted flaps with the aft outboard sections operating independently as ailerons. Leading edge flaps for stall suppression will be incorporated on the outboard side of each engine nacelle to compensate for the upflow of the propeller slipstream during transition from vertical to horizontal flight.

The vertical tail of the aircraft will consist of conventional fin and rudder arrangement centrally located on the fuselage and supporting the all-movable horizontal tail assembly. A horizontal eight-foot tail rotor with variable pitch blades will



Preliminary designs indicate that the transport will be 58 feet long, 26 feet high, with a wingspan of 67½ feet. The tilt-wing has an aspect ratio of 8.6. The vertical stabilizer will fold for carrier hangar deck storage.

give the pilot longitudinal control during hover.

Safety precautions have been designed into the tri-service transport to take care of an engine failure in flight. Through a system of cross-shafting, connecting all four engines and the tail rotor, the plane can remain aloft even if two engines are shut down.

Lightweight gear boxes are provided integrally with the lightweight 15-foot propellers. Overrunning clutches are installed between each engine and propeller to permit shutdown of any engine while in flight. Cross-shafting natural frequencies are kept well above operating speed by strategically located self-lubricating bearings.

The engines will be started using a hydraulic motor-pump. Retractable, self-cleaning inlet screens protect the engines from foreign objects during takeoff and landing operations.

Four Function Stabilizer

All primary flight controls will be powered by dual hydraulic systems. The unusual feature of the control system is a mechanical integrator linkage that transmits cockpit control motions to the proper control surface as a function of wing incidence. A dual four-function stabilization system will control yaw, roll, pitch, and altitude during instrumented flight. During hovering and transition the stabilization system also will assure smooth flight.

The cargo area (30′x7′x7½′) was specially designed to facilitate easy loading and unloading of troops and supplies. A ramp in the aft portion of the fuselage lowers for loading. Supplies and passengers can also be loaded through a side door. Paratroop or air drop operations are accomplished through the ramp. Fully loaded, the V/STOL transport can hold 32 combat-ready troops or 8,000 pounds of supplies or equipment.

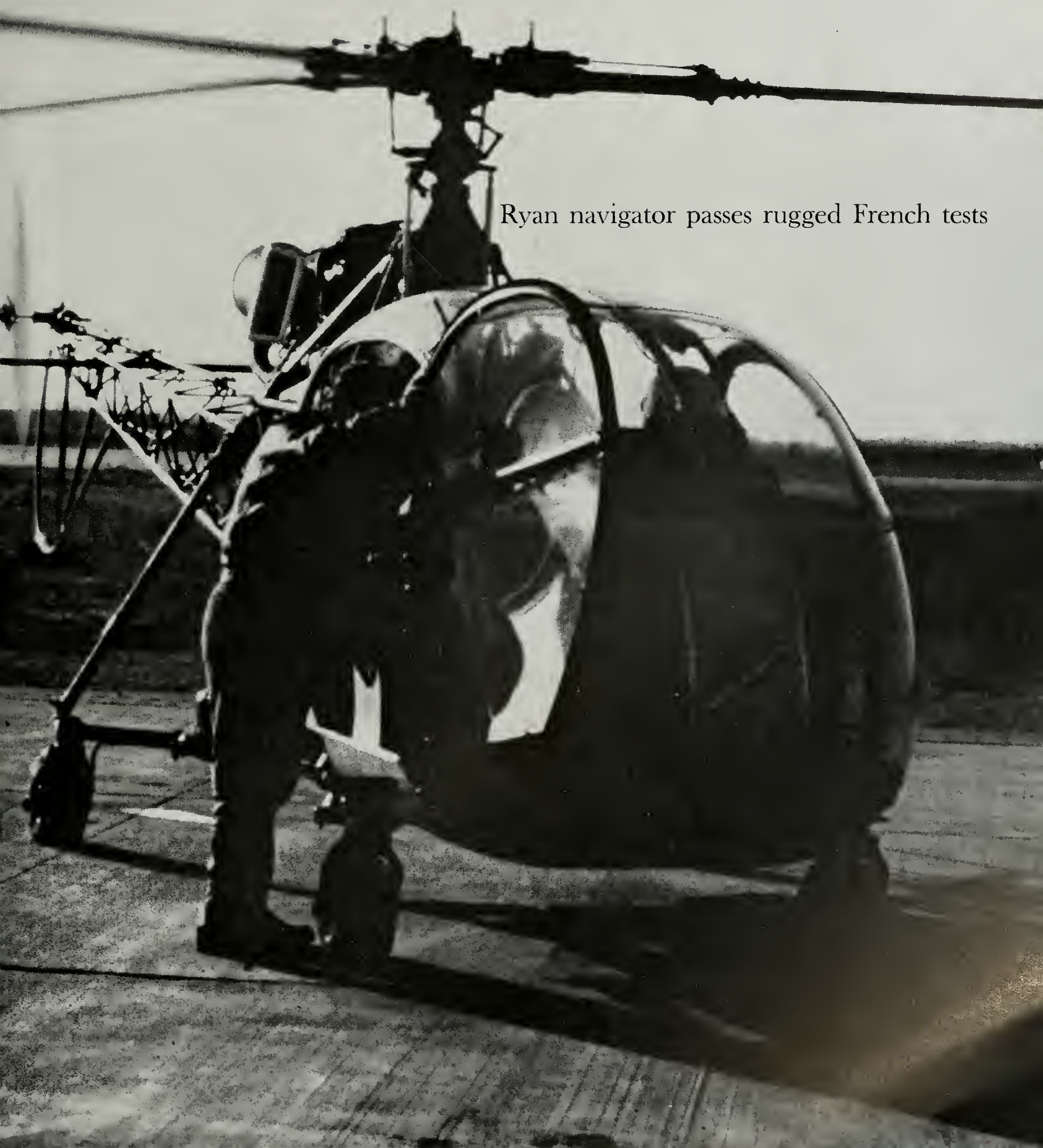
Vought has modified its low-speed wind tunnel for testing a 20-foot model of the C-142. The model is placed in a special 20-foot square area of the tunnel instead of in the tunnel's test throat; thus minimizing the recirculation effects.

Combat radius of the fully loaded plane is 200-300 miles; it will cruise at 250-300 knots; and with auxiliary fuel tanks in place of cargo, it will have a ferry range of nearly 2,600 miles.

The transport will serve the needs of all services by being highly mobile under all conditions and capable of rapid loading. The transport could be carried aboard an aircraft carrier and stationed near world trouble spots, or, during combat, kept close to troop movements to provide immediate support where needed. ■

Vive le Doppler!

Ryan navigator passes rugged French tests



Jean Boulet, Sud-Aviation's chief test pilot, broke six world helicopter records in the Alouette.

PARIS, FRANCE—The Ryan Electronics' AN/APN-130 (V) Doppler navigator teamed recently with Sud-Aviation's record holding "Alouette" helicopter to successfully complete three months of rugged operational flight tests.

The program was conducted at Bretigny-sur-Orge under the direction of the Center Essais en Vol. (C.E.V.), official flight test center for all military and civilian aircraft and aeronautical equipment to be certificated for use in France.

The accomplishment signaled a major advance for Ryan in the European market, and gained new and far reaching international recognition for the capabilities of Ryan's C-W Doppler navigators.

An Official Agency

Free World European Governments have long accepted aeronautical evaluations of the official French agency as the critical and deciding factors involving aeronautical contracts pertaining to their particular country.

The program, that started last fall, was under evaluation for the acceptance of the Ryan system in the French military helicopter program. The Doppler navigator turned in a flawless performance and, during more than 40 critical flight hours required no maintenance, adjustment or repairs. The Alouette was flown by various French pilots with an engineering officer from the French Air Force aboard for each flight. The tests were made over the French countryside, and some phases of the program called for flight operations over the Mediterranean.

Early in September, 1961, Ryan's team arrived in France. Mr. Mangin, test engineer for the French Air Force, served as coordinator and liaison officer during the extended testing phases.

Ryanav-Alouette Mated

Ryan's AN/APN-130(V) was installed in what is probably the most famous helicopter in France. On June 13, 1958, at Bretigny-sur-Orge, this same "Alouette" helicopter, fitted with a Turbomeca Artouste turbine and piloted by Jean Boulet, head of Sud-Aviation's helicopter flight test section, smashed six world records for helicopters. The world altitude record for helicopters of all categories, and the world's record for category B helicopters—36,350 feet in 35 minutes—for the first

French pilots fly the Alouette over scenic Paris.

time in aeronautical history a helicopter flew in the stratosphere. The Alouette broke three altitude records and three climbing speed records. Ryan's Doppler navigator operated proficiently during the flight test program at the maximum capacity of this aircraft, both in flight and hover.

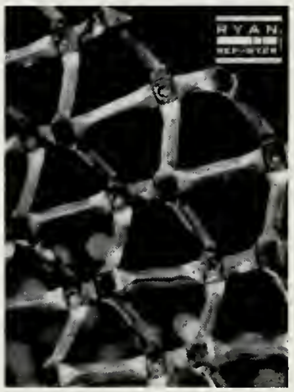
From start to finish, the program was on schedule to the minute. The Doppler navigator performed effectively without even the most minor adjustment. One hundred per cent successful. In reporting the success of the program, Ryan's team not only lauded the performance of the sophisticated navigation system, but also paid high tribute to the excellent cooperation and attitudes of the officials of France, and their efforts in seeing the program through to its successful conclusion.

Navigators Widely Used

Ryan's AN/APN-130(V) is presently installed in the United States Navy's HSS-2 and HU2K antisubmarine warfare helicopters. The HSS-2 helicopter squadron from San Diego's Ream Field recently set an unofficial transcontinental speed record from Key West, Florida to San Diego. The AN/APN-130(V) is an advanced Doppler system for measuring helicopter ground velocity components. The set employs four narrow beams of continuous-wave electromagnetic energy and permits automatic hovering as well as highly accurate navigation. This system permits the Navy's ASW helicopters to operate with all-weather, around-the-clock capability, and has done much to advance this particular art in other parameters. ■

RYAN REPORTER

MAY-JUNE/1962



About the Cover: Welded strips of paper-thin foil gauge aluminum create an intriguing design. The honeycomb structure is actually part of a sun harnessing satellite solar concentrator framework. (Article, page 26).

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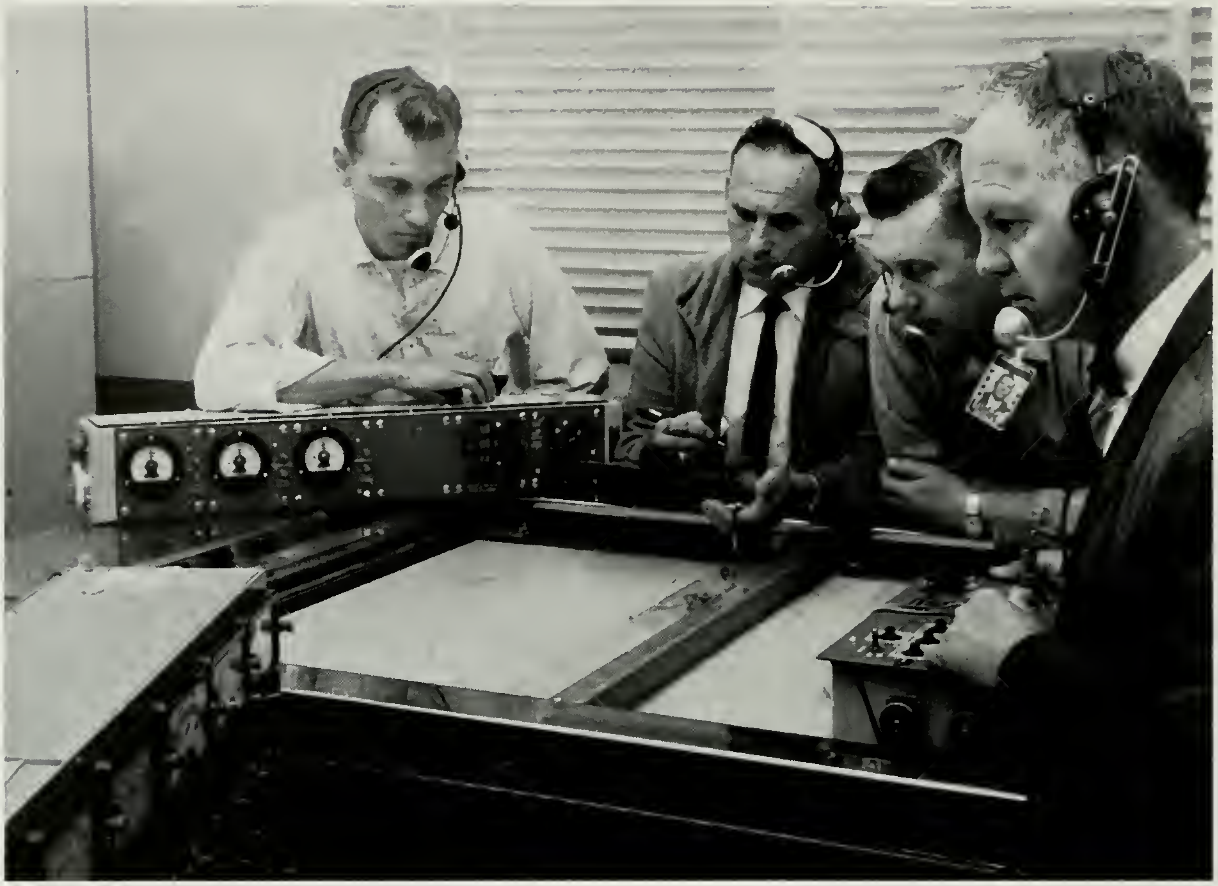
NAVY vs. Q-2C at PMR

Navy challenges new enemy.

The Navy's surface-to-air and air-to-air missiles have a new enemy, and although the surface and air units have just begun to encounter it, scientists and technicians at the Naval Missile Center, Pt. Mugu have been studying the air-borne threat for more than a year.



At ground control, Pt. Mugu, Bob Lake, plotting board operator, Woody Moldenhauer, Ryan Representative, Emile LaPointe, range facility control officer, and George Peterson, Ground Support Branch, Aerospace Operations Department, remotely control the Q-2C on its "enemy" mission.

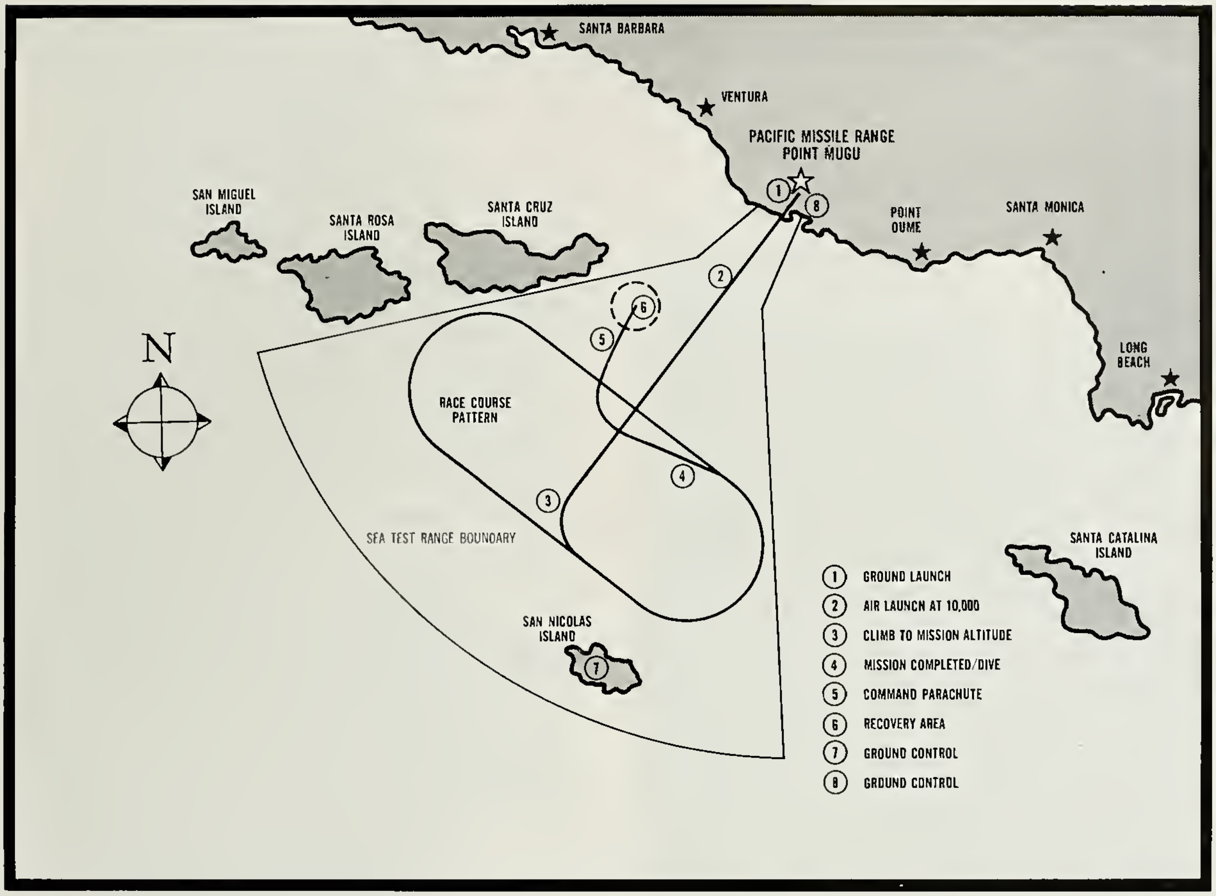
Commander E. G. "Casey" Callas at the controls of the P2V-5FD, completes his check-off list before getting airborne for a Q-2C mission on the inner sea test range at Pt. Mugu.

THE ENEMY—the Navy Q-2C Ryan Firebee jet target missile, is 23 feet long, with a 13 foot wingspan. Powered by a Continental J-69-T-29 turbo-jet engine, it possesses all the electronic elusiveness, speed and maneuverability of swift modern jet fighters.

The Pt. Mugu team, under the direction of the Bureau of Naval Weapons, is conducting a series of exhaustive shakedown tests to determine how the Ryan Q-2C, with all its enemy stand-in characteristics, can best serve the Navy in modern missile training. Further, the Pt. Mugu team will establish fleet handling and repair procedures for the Q-2C.

The Navy recently ordered several hundred Q-2C's and has already assigned them to training functions in both the Pacific and Atlantic fleets.

The Q-2C in the fleet will replace the KDA-4 Firebee target, is larger, faster and more maneuverable than its predecessor, and through its complex electronic heart is a more realistic target. The target can be either air or ground launched, can fly at speeds of more than 600 miles per hour,



at altitudes above 50,000 feet and for durations of more than an hour. It has achieved a radar-measured altitude of 59,800 feet and has flown for 77½ minutes above 50,000 feet. It has achieved a maximum single full power flight duration of 98.38 minutes and regularly demonstrates speeds of Mach .95.

NMC's Shakedown Team

At Pt. Mugu the Ground Support Branch is headed by Lieutenant Commander Bill Haff, and his civilian engineering advisor, George Peterson. The crew of specialists is a part of the Naval Missile Center's Aerospace Operations Department, under the direction of Commander Rex Gage.

Discussing the Q-2C tests, Lieutenant Commander Bill Haff said, "a target is essentially a package of hardware and instrumentation which must simulate as nearly as possible the enemy threat, from the standpoint of aerodynamic performance and real or apparent size. It must also be capable of carrying instrumentation that can determine the effectiveness of a missile system."

"Our tests are designed to develop functional

Technician at the Ground Support Branch of the Aerospace Operations Department at the Naval Missile Center, Pt. Mugu packs a Q-2C parachute.

At PMR, the Ryan Q-2C is the target for almost every weapon in the Navy arsenal. Here an F3H Demon takes a crack.

Navy enlisted men monitor the Q-2C from control stations in the P2V-5FD. At PMR the Q-2C is either air or ground controlled.

Technician from the Naval Missile Center's Target Department, works over a Q-2C. The department provides targets for all Pacific Missile Range customers.

data on the Q-2C for our operating air and surface units", George Peterson said. "To do that we are thoroughly testing every component of the target then equating our findings to the total capability of the target system. So that we may furnish complete data to the fleet, we are continuing to test and record our findings on every procedure from target launch through flight, recovery, decontamination and repair of the 'bird' 'til it's back on the ready line for another flight."

BuWeps Monitored

"The test and evaluation data is coordinated through the Bureau of Naval Weapons with the Naval Air Development Center," Peterson said.

In the past year the Q-2C's flight characteristics, launch procedures, radar augmentation, and recovery procedures have been studied. Its flotation characteristics, and decontamination procedures also were carefully studied and documented. Utilization of various electronic evasion techniques, radar augmentation, and infrared devices were also tested to establish operating parameters for fleet units.

A target department crew mates the Q-2C to the P2V. The department provides the Firebee to fleet air and surface units engaged in training exercises on the sea ranges at PMR.

Commander "Casey" Callas and his civilian advisor check over target requirements before a mission. Callas says operating the target department demands close liaison with other commands.

Other details studied included the observation of on-station time, tracking instrumentation, miss-distance scoring equipment, flight path accuracy, and over-all system reliability. Included in this evaluation is augmentation work, technical support, and provisions for incorporating all Navy ancillary equipment. Liaison between the Navy and Ryan has been extremely close, and has resulted in the Navy's rapid acceptance of the Q-2C.

Targets for Missiles

Located in another sector of the vast Pt. Mugu complex is the first Navy operational unit to fly the Ryan Q-2C target, the Naval Missile Center's Target Department, skippered by Commander E. G. "Casey" Callas. An operational support group, the department is responsible for providing targets to Pacific Missile Range users who may be engaged in research and development, test and evaluation programs, or contractor development tests. Targets are also provided to fleet surface units engaged in training exercises on the sea ranges at PMR.

The Bureau shake-down tests required close cooperation between the two Pt. Mugu units—the target department launches the Q-2C from their P2V-5FD aircraft and the Ground Support Branch controls the bird from a ground site at Pt. Mugu.

In operational flights of the target, the target department controllers perform the remote control functions either from the P2V or a ground control site.

In addition to the operation of aerial and surface targets, the department conducts target flight evaluation programs, and incorporates special instrumentation and devices where a non-standard target is required. Their target inventory is comprised of eight aerial-powered targets, three non-powered and three surface targets, including the Q-2C, F9F, the KDA-4, KD2R5, and the World War II patrol bomber, the P4Y-2K.

Pt. Mugu target operations are conducted on the inner and outer sea test ranges, and control of the powered targets is performed either from Pt. Mugu, San Nicolas Island, or from the launch and chase aircraft.

Lieutenant Commander Bill Haff (left), George Peterson (right) and a technician from the Ground Support group ground-check the Q-2C with a basic system checkout console.

In a typical air launch from the P2V-5FD, the Q-2C's engine is started at 10,000 feet and the countdown to release continues until the target is launched. Standard engine run time for an operational Q-2C before launch is four to five minutes. Once the target has been dropped from the wing, a remote controller either in a ground station at Pt. Mugu, or in the launch aircraft, guides it into a race track course between San Nicolas Island, and the Santa Cruz, Santa Barbara Island chain, about 50 miles off the coast of Pt. Mugu. Exact mission profile is determined by what "enemy" role the Q-2C has been assigned to play.

Mission completed, the remote controller will return target to the recovery area and command chute at approximately 20,000 feet. A giant 81 foot parachute allows the target to drop slowly into the ocean where a helicopter or recovery boat is standing by to pick it up and transport it back to Pt. Mugu, for a thorough decontamination and repairs. One Q-2C at Mugu has had 17 such flights.

Commander Callas said that in conducting target operations on the range, the Target Department maintains close liaison with other commands engaged in the research and development, test and evaluation missile programs, fleet training, or special programs which require the adaptation of a target to perform a function which cannot be carried out by a manned vehicle.

Pt. Mugu

Pt. Mugu, located on the coast approximately 55 miles north of Los Angeles, is the headquarters of the Pacific Missile Range, the third and largest national missile range. The Naval Missile Center is commanded by Captain K. C. Childers, Jr. ■

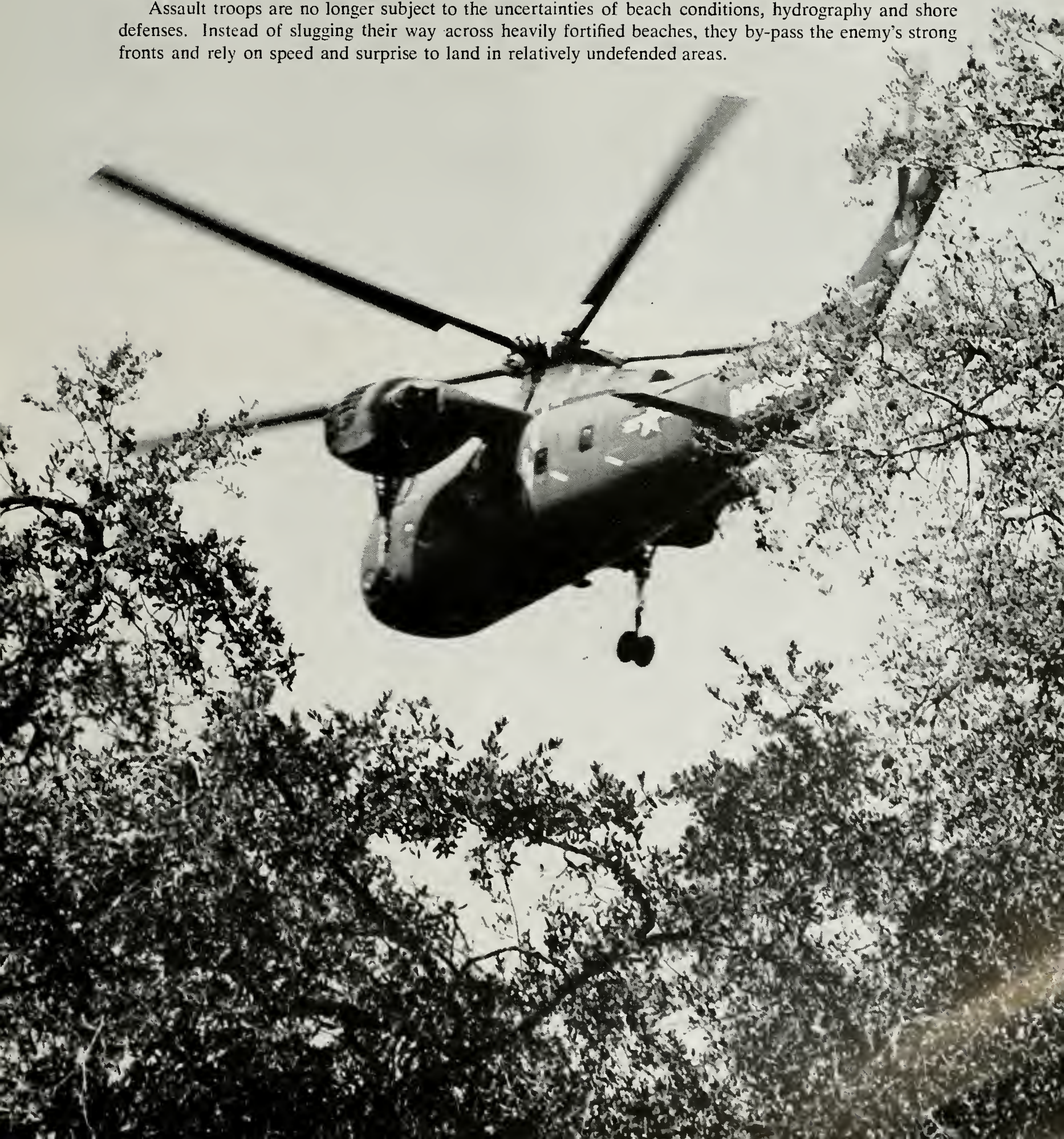
Following a rough mission, thorough decontamination and repair, the Q-2C is re-assembled and checked before being assigned to another mission. Here technicians conduct engine run-up tests. Note air scoop and screen.

At Pt. Mugu, utilization of electronic evasion tactics, radar augmentation and infrared devices were tested to establish operating parameters for the Q-2C in the fleet.

TACTICAL MOBILITY

THE TRADITIONAL PORTRAIT of green-clad Marines storming a palm tree-lined beachhead in waves of amphibious landings is past history. Highly mobile helicopter and vertical envelopment battle concepts are the plan of the day—and the future.

Assault troops are no longer subject to the uncertainties of beach conditions, hydrography and shore defenses. Instead of slugging their way across heavily fortified beaches, they by-pass the enemy's strong fronts and rely on speed and surprise to land in relatively undefended areas.



Striking from an off-shore carrier in highly mobile helicopters, troops executing vertical envelopment tactics are the plan of the day—and the future.

THE ASSAULT FORCE strikes the combat area from an offshore carrier task group with surface and air might under a heavy concentration of fire power. In this new mobility concept—vertical envelopment—the carrier provides a mobile platform for the helicopter force, which in turn airlifts troops and supplies into and around the battle area.

The Marines have taken to the air, not at 10,000 feet, or even 1,000 feet, but at tree-top level, or better still between hills, trees and other terrain that would provide cover. They are exploiting the helicopter to achieve a new order of tactical mobility.

Similarly, today's ultra-modern Army includes the sky cavalry, a highly mobile force with crushing fire-power capable of striking anywhere in the world within hours rather than weeks. Such mobility is possible only through the air. The Army now has fixed wing and rotary wing aircraft for tactical mobility.

The Army's mobile units flying within the concealment of ridge lines, ravines, wood lines, and other terrain features are provided the protection of obscurity which has always made the ground the soldier's best friend.

Armed transport and reconnaissance helicopters skimming along at tree-top level—under skilled pilots, provide only a ghost for a target.

Tree-Top Surveillance

Precise target acquisition is necessary if maximum usage is to be made of today's tremendous fire power. Well planned observation and surveillance are essential for both combat and logistics missions, many of which must be carried out at tree-top level.

But despite the general flexibility of the helicopter as a tactical and logistics air weapon, to be completely effective it must have an automatic, self-contained navigation system to enable it to operate over all types of terrain in any kind of weather.

Reliance on visual navigation frequently limits the mission. If the target is hidden by fog or low clouds, the field commander loses his air capability. The pilot, finding his target obscure, must select an alternate destination and determine its range and bearing accurately and quickly. Reliance on time-consuming manual computation reduces his effectiveness and impairs his safety.

To be tactically competent, a navigation system must be able to operate independent of ground radio beacons, have no minimum altitude limit, must be adaptable to all speeds, from the forward speeds of conventional aircraft to the hovering requirements of VTOL and the negative

Helicopters can spot deliver weapons or supplies in instantaneous response to the field commander's request.

Ground units have the capability of precise air movement of heavy weapons and cargo to strategic points in and around the battle area.

speeds of helicopters. They must also provide cruise to hover transition capabilities with pinpoint accuracy.

Ryan Doppler navigation equipment was developed to provide an increased flexibility for helicopter operation within the combat area. Rotary wing aircraft utilizing the capability of these sets, can navigate with complete independence from previous restrictions.

Work Independently

Ryanav Doppler systems are completely self-contained and do not rely on radio aids, true airspeed, or wind estimates. They automatically and continuously determine and display heading speed, drift speed, and vertical speed, providing an automatic means for the pilot to keep his aircraft on course. The systems include the capability for ground position computing and indicating equipment, and course and distance computing and indicating equipment.

Ryanav systems utilize the Doppler principle formulated by the Austrian physicist Christian Doppler, in 1842. This principle is applied to navigation by measuring the Doppler frequency shift of microwave energy. To provide a microwave coupling from the aircraft to the ground, the energy generated by the C-W Doppler set is concentrated into two or more narrow beams of radiation which are directed symmetrically outward and toward the earth. The incident energy is dispersed or scattered, by the "roughness" of the terrain and a portion of the scattered energy is received by the Doppler sets antenna.

With beams directed either fore or aft, the apparent frequency of the reflected energy is either higher or lower than the frequency of transmission because of the component of aircraft velocity relative to the ground in the direction of the beam axis. The frequency difference, actually a spectrum of frequencies, lies in the audio frequency band. The center frequency of the spectrum is proportional to a component of aircraft speed. The higher the aircraft speed—the larger the frequency difference.

The ground velocity data obtained with the Doppler set is the basic output from which other vital navigation information is generated. It can be directly integrated to provide ground miles, or it may be used as a navigational computer, along with true heading information for the determination of the north-south and east-west components of aircraft velocity. If desired the north-south and east-west speed data can be integrated automatically to obtain the north-south and east-west distances traveled, which in turn can be converted to the latitude and longitude coordinates of the

As mobile carriers, helicopters flying within the concealment of ridge lines and ravines, provide only a ghost for a target.

aircraft's present position, the best course and shortest distance can be computed and displayed automatically.

Ground speed also may be combined with air speed for automatic determination of wind speed and wind heading. Accordingly, Doppler navigation sets, which provide navigation without reference to wind data, actually permit automatic computation and display of wind speed and wind direction.

A universal navigation set which incorporates these Doppler techniques, is the Ryanav IV "A". It is lightweight, accurate, and reliable. This new system provides a continuous navigation and hovering capability for helicopters and fixed wing aircraft. It operates over any type of land or sea, in any kind of weather without the aid of ground radio stations, wind instruments, or true airspeed data.

Rotary wing aircraft can concentrate and pinpoint their fire-power.

The Ryanav IV "A" provides electrical outputs of heading velocity, drift velocity, vertical velocity, ground speed, ground track, drift angle, true heading, and east-west, north-south distance traveled. Visual displays include an indicator showing ground speed and ground track, or wind speed and wind heading; a hovering indicator showing heading velocity, drift velocity, and vertical velocity.

Outputs are provided for tie-in with plotting boards and other position indicating equipment, course and distance computing and indicating equipment, and terrain clearance radar.

In a vertical envelopment operation, lift off from a carrier deck, airborne rendezvous, and landing within a predetermined enemy location, require exacting navigational skill and precise timing. Furthermore, helicopters must rely on extremely low altitude flight for protection.

Ryan Doppler navigation sets are available to meet these demands of the modern helicopter. Based on years of experience and thousands of flight hours, these navigational systems provide the most advanced concepts for present day aerial navigation. Versatile and easy to maintain, they promise to be a valuable addition to assist the helicopter in meeting its operational and environmental requirements. Equipped with Ryanav systems, air mobile units can be more effective in the exploitation of combat power, to achieve—Tactical Mobility. ■

NASA PROBES SLIP-STREAM V/STOL

By William P. Brotherton

A Ryan V/STOL research aircraft—the VZ-3RY Vertiplane—is performing valuable research in low speed flight at NASA's Ames Research Center, Moffett Field, California. Developed for the U. S. Army to evaluate the deflected slip-stream principle for V/STOL flight, the Vertiplane completed two years of flight before being turned over to NASA, in February, 1960.

Since then, the VZ-3RY has completed 35 flights, under the direction of Howard L. Turner, NASA Project Engineer, to explore the conditions existing when an aircraft flies at low speeds. This engineering knowledge is important to the designer of V/STOL aircraft, where a good proportion of the performance may be in the low speed regime, but is also necessary for the engineer working with high performance, even supersonic, aircraft. In these machines, the need for positive control at the low speeds required for take-off and landing becomes vital.

Ryan first announced the Vertiplane in mid-1956 when a contract for fabrication of the aircraft was disclosed by the Army and the Office of Naval Research.

Prior to the NASA flight test program the aircraft had flown in excess of 5,500 feet, at speeds of over 110 knots and as slow as 26 knots. Approximately 200 hours of various ground and wind tunnel tests had been successfully completed in the program in addition to flight testing.

The Army Vertiplane contract followed extensive engineering by Ryan, the Air Branch of the Office of Naval Research and the National Advisory Committee for Aeronautics. Previously, Ryan completed the first tests and studies of slipstream principles with full scale equipment for the Office of Naval Research.

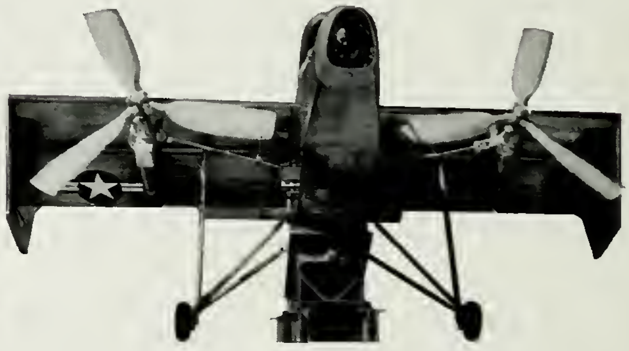
NASA pilots Fred Drinkwater and Bob Innis have developed a good deal of engineering data from their flights with the VZ-3RY, related to the low speed area. They have flown the aircraft at speeds down to 15 knots. They have descended at rates of 1600 feet-per-minute at idle power settings. They have determined the stall boundaries of this deflected slipstream configuration and find that the aircraft stalls in a conventional manner.

The rates of descent are higher than that which an H-23 helicopter can achieve in autorotation. Turner believes the aircraft may be capable of making landing approaches, descending at 1000 feet per minute and 40 knots. One of the questions which he is pondering: How to make best use of this capability, tactically?

Study Unique Design

One of the major areas of exploration, which NASA-Ames is pursuing with the VZ-3RY, is ground effect. The deflected slipstream design, as well as the tilt-wing configuration and others, is a self-disturbing aircraft type which produces adverse ground effects when the plane is close to the runway. With the VZ-3RY, this effect becomes significant at low speeds when the wheels

Enroute by ship from San Diego to Moffett Field, the Ryan Vertiplane was first announced in 1956 by the Army and the Office of Naval Research.



Successful in establishing the deflected slipstream principle for achieving V/STOL flight, the Vertiplane is now being used for a broader, more significant role in hands of a well qualified NASA-Ames research team.

are within a few feet of the runway.

As the aircraft approaches the runway, it appears that a turbulent wake begins to billow out ahead and cause some loss of power and control as it passes back through the propellers. This phenomenon can often be observed when a helicopter lands in a dusty field.

Another area for exploration by Turner is the problem which most V/STOL aircraft encounter in take-off and landing operations. For these maneuvers, the pilot must reduce power, which concurrently reduces control of the aircraft. Turner believes that some system must be developed which will provide constant control power regardless of throttle setting.

This subject is becoming more timely as progress is made in low speed aircraft design. Today, a number of V/STOL and Boundary Layer Control aircraft can be flown at speeds below which they can be satisfactorily controlled.

NASA-Ames research with the VZ-3RY is primarily interested in the STOL area and secondarily concerned with data from the VTOL regime. For that reason, the pilots have not attempted to hover the Vertiplane. Good level flight transitions have been made, from 80 knots to 27 knots, with ease and without any substantial changes in trim or power settings. Smooth transitions from flaps-up cruise to flaps-down conditions (prior to hovering) have been easily accomplished.

It is possible, in Turner's thinking, that too much emphasis is being placed upon hovering capability in V/STOL applications. Ninety-five per cent of the missions which most V/STOL aircraft may be called upon to perform can be achieved without hovering. Even the helicopter, which has this characteristic, usually makes a horizontal STOL-type take-off and landing. At almost any site, conditions will permit a short run before take-off or landing. We should be careful not to compromise performance by designing for a capability which may not be needed.

Developed for Army

The Vertiplane was developed for the Army in response to the need for a medium speed, liaison, reconnaissance and utility type which can operate from terrain without runways. It is powered by an 785 horsepower Lycoming gas turbine which drives two propellers, mounted on wing pods. The salient feature of the plane is the large retractable wing flaps which extend far below the trailing edge of the wing.

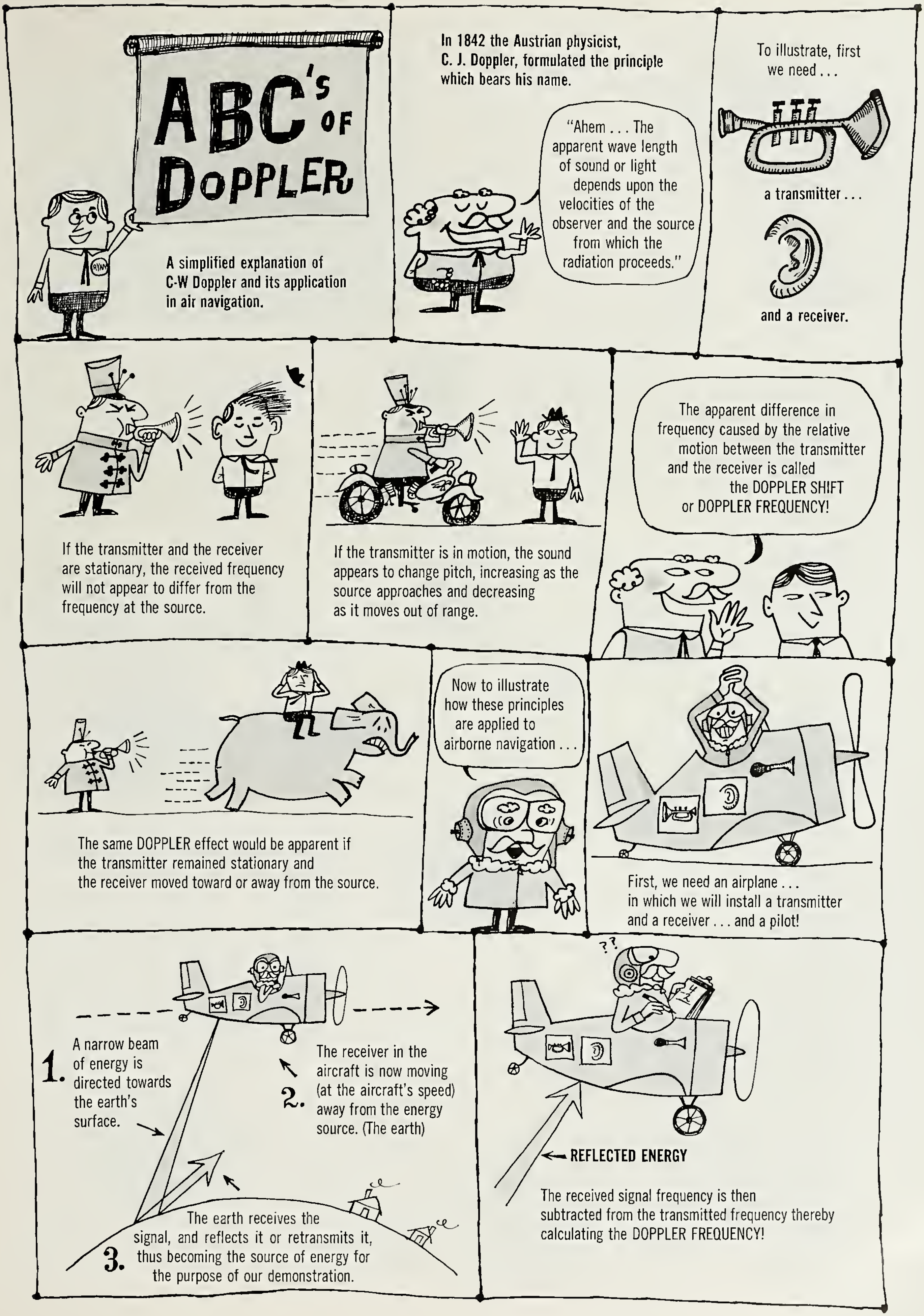
When extended the flaps bend the propellers' slipstreams downward and provide vertical lift for take-off, hovering and landing. For transition to forward flight, the flaps are retracted and the slipstreams flow horizontally.

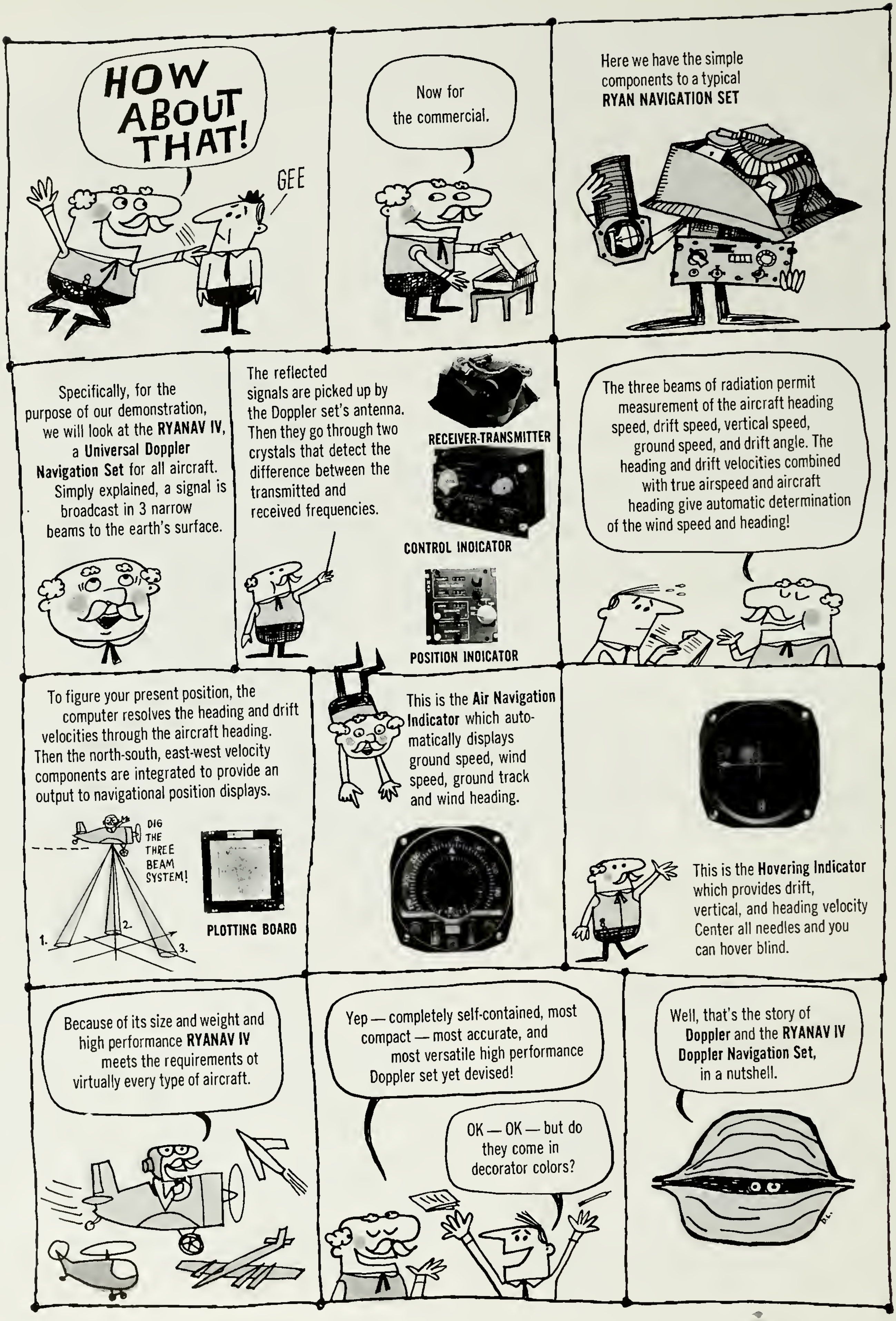
At Ames Research Center, NASA team of (l. to r.) pilot Fred Drinkwater, crew chief Lawson Williamson, and project engineer Howard L. Turner, discuss the operating characteristics of the VZ-3RY.

Turner is optimistic about the potential of the deflected slipstream principle for future commercial applications because it provides V/STOL performance without complex, experimental mechanisms. Propellers and flaps are well proved devices. He also feels that other systems, such as boundary layer control, may prove to be very promising in commercial operations. The Vertiplane's ability to take off in one to two plane lengths is a feature which will be very desirable to have in feeder aircraft which could serve small communities and operate from tiny sites in larger cities.

Turner is pleased with the progress which he and his staff are making in their use of the VZ-3RY as a research tool. He estimates that they will continue to fly the aircraft for another year in their experiments. He would like to have an opportunity to put it back in the huge 40-by-80 foot wind tunnel at Ames and test it as a means for obtaining closer coordination between flight and wind tunnel test data.

Successful in establishing the deflected slipstream principle for achieving V/STOL flight, the Vertiplane is now being used for a broader, more significant role in the hands of a well qualified NASA-Ames research team. Much of the knowledge gained from this effort, which will provide a greater understanding of low speed flight, will be provided in a report on the VZ-3RY, which is being prepared by Howard Turner for early distribution. ■


ABC's OF DOPPLER
RYAN
A simplified explanation of C-W Doppler and its application in air navigation.
In 1842 the Austrian physicist, C. J. Doppler, formulated the principle which bears his name.
"Ahem . . . The apparent wave length of sound or light depends upon the velocities of the observer and the source from which the radiation proceeds."
To illustrate, first we need . . .
a transmitter . . .
and a receiver.
If the transmitter and the receiver are stationary, the received frequency will not appear to differ from the frequency at the source.
If the transmitter is in motion, the sound appears to change pitch, increasing as the source approaches and decreasing as it moves out of range.
The apparent difference in frequency caused by the relative motion between the transmitter and the receiver is called the DOPPLER SHIFT or DOPPLER FREQUENCY!
The same DOPPLER effect would be apparent if the transmitter remained stationary and the receiver moved toward or away from the source.
Now to illustrate how these principles are applied to airborne navigation . . .
First, we need an airplane . . . in which we will install a transmitter and a receiver . . . and a pilot!
1. A narrow beam of energy is directed towards the earth's surface.
2. The receiver in the aircraft is now moving (at the aircraft's speed) away from the energy source. (The earth)
3. The earth receives the signal, and reflects it or retransmits it, thus becoming the source of energy for the purpose of our demonstration.
??
REFLECTED ENERGY
The received signal frequency is then subtracted from the transmitted frequency thereby calculating the DOPPLER FREQUENCY!



HOW ABOUT THAT!
GEE
Now for the commercial.
Here we have the simple components to a typical RYAN NAVIGATION SET
Specifically, for the purpose of our demonstration, we will look at the RYANAV IV, a Universal Doppler Navigation Set for all aircraft. Simply explained, a signal is broadcast in 3 narrow beams to the earth's surface.
The reflected signals are picked up by the Doppler set's antenna. Then they go through two crystals that detect the difference between the transmitted and received frequencies.
RECEIVER-TRANSMITTER
CONTROL INDICATOR
POSITION INDICATOR
The three beams of radiation permit measurement of the aircraft heading speed, drift speed, vertical speed, ground speed, and drift angle. The heading and drift velocities combined with true airspeed and aircraft heading give automatic determination of the wind speed and heading!
To figure your present position, the computer resolves the heading and drift velocities through the aircraft heading. Then the north-south, east-west velocity components are integrated to provide an output to navigational position displays.
DIG THE THREE BEAM SYSTEM!
1.
2.
3.
PLOTTING BOARD
This is the Air Navigation Indicator which automatically displays ground speed, wind speed, ground track and wind heading.
This is the Hovering Indicator which provides drift, vertical, and heading velocity Center all needles and you can hover blind.
Because of its size and weight and high performance RYANAV IV meets the requirements ot virtually every type of aircraft.
Yep — completely self-contained, most compact — most accurate, and most versatile high performance Doppler set yet devised!
OK — OK — but do they come in decorator colors?
Well, that's the story of Doppler and the RYANAV IV Doppler Navigation Set, in a nutshell.

The French firm, Compagnie Francaise Thomson-Houston, was the subject of conferences recently between Robert C. Jackson, Ryan President, at right, and French officials. At left, Andre Labarthe, noted French scientist, publisher, and editor, who is Director General of Ryan's European Bureau at Paris; and in center, Rene Millett, French Consul General at Los Angeles.

French Firm To Produce Ryan Navigators

RYAN AERONAUTICAL COMPANY and one of Europe's largest firms of its kind, Compagnie Francaise Thomson-Houston, recently announced signing of an agreement under which Ryan Doppler radar navigational equipment will be produced for the European market.

The agreement gives Thomson-Houston rights for sale and manufacture of Ryan automatic navigators for both fixed wing and rotary wing aircraft use. Ryan has developed and is producing for the U.S. Navy and U.S. Army such equipment to meet the special requirements of the two services in more than 25 types of aircraft.

Ryan's entry into the increasingly important European market was hailed in San Diego by Dr. Andre Labarthe, Director General of the company's European bureau at Paris, and one of France's most noted publishers and scientists.

Dr. Labarthe, editor and publisher of the French magazine, "Constellation," which has world wide distribution, was among the early leaders of the Free French movement in World War II, serving as Chief of Armament and Minister of Information for the French Government in Exile in England.

In addition to his current interests as a journalist, scientist, and painter, Dr. Labarthe has headed Ryan's activities in Europe since establishment in 1960 of an office in Paris, where he is assisted by Colonel Alain G. Jourdan, Director of the Paris bureau.

Dr. Labarthe played a major role in successful conclusion of recent negotiations resulting in an agreement between Ryan and Compagnie Francaise Thomson-Houston, of Paris, under which Ryan-Doppler automatic radar navigational equipment will be produced for European customers.

Thomson-Houston is one of Europe's largest producers of a great variety of electrical and electronic products for both the civilian and military markets.

Dr. Labarthe foresees a major market in Europe for the Doppler navigation equipment, in which specialized field more than 14 years' development has made Ryan the world's foremost producer.

He also envisions promising opportunities in Europe for Ryan's explosive forming techniques for shaping space age metals—another field in which Ryan has been a pioneer.

"The rate of growth annually of the European economy is now several times that of the United States," Dr. Labarthe commented.

"Europe is rapidly becoming one of the most important customers for all kinds of goods manufactured in the United States, and the purchasing potential is increasing at a faster rate than that within the United States."

Within the European market, France is a prime mover, he pointed out.

"What is decided today in Paris is not only a go-ahead sign for France but for all of Europe, as far as choice of products is concerned. That is why French interest in the Ryan Doppler navigation systems is so significant. Ryan already is a well-known name throughout Europe because of acceptance in France."

In conference with Ryan executives, Dr. Labarthe is accompanied by Nicholas G. DeRachat, of Washington, D.C., international marketing consultant for Ryan ■

The Flexible Wing Army

Artist's concept of Ryan's Flexible Wing system for unmanned towed gliders capable of mutiplying normal cargo carrying capacity of Army aircraft. Under new Army contract, Ryan will conduct detailed design leading to fabrication and testing of Flexible Wing test vehicles capable of carrying heavy payloads.

New Contract Exploits Flexible Wing Concept

A NEW VERSION of the unique Flexible Wing system for unmanned towed gliders capable of multiplying the normal cargo carrying capacity of Army aircraft will be designed by Ryan Aeronautical Company in a Phase 1 contract awarded by the Army Transportation Research Command, Ft. Eustis, Va., Robert C. Jackson, Ryan President, announced recently.

The contract is a follow on of studies conducted by Ryan recently for the Army, indicating that use of a Flexible Wing with air cargo delivery systems may offer substantial advantages over present techniques.

Ryan engineers in the new contract will conduct a detailed design which will lead to fabrication and testing of Flexible Wing test vehicles capable of carrying heavy payloads as they are towed behind an Army helicopter.

Ryan studies to date have shown that the Flexible Wing glider may be able to lift as much as six times the normal lifting capability of the helicopter, thereby greatly expanding usefulness of such conventional vehicles. The payload would be delivered by the Flexible Wing, following release, in a gentle glide to a prescribed area, under radio control from the aircraft or the ground.

All types of supplies, weapons and fuel could be airlifted in this manner to provide speedy logistics support to Army units in the field. Payloads of as great as 13,000 pounds could be towed by a Sikorsky H34 helicopter, utilizing a Flexible Wing, according to previous studies.

The new contract is another of the numerous applications proposed for the Flexible Wing in manned and unmanned, powered and glider-type vehicles. Ryan built the world's first Flexible Wing manned, powered flying test bed to demonstrate functional and aerodynamic characteristics. In contrast with conventional aircraft containing rigid metal-covered surfaces, the Flexible Wing is of flexible, plastic-coated material attached to a keel and leading edge members to form an arrow- or V-shaped, kite-like surface.

After successful completion of an intensive flight test program at Brown Field, near San Diego, by Ryan for the Army Transportation Research Command, the flying test bed was shipped to the National Aeronautics and Space Administration's facility at Langley Field, Va. There it underwent wind tunnel tests to confirm and correlate data obtained in the actual flights.

Among other Flexible Wing engineering studies conducted by Ryan for various agencies is one for NASA on its adaptability for recovery of the first stage booster of the Saturn space vehicle. ■

For space rendezvous, a system to chart a collision course.

ROSSENA

A space age helmsman!

by Dr. Karl Undesser
Manager, Astronics

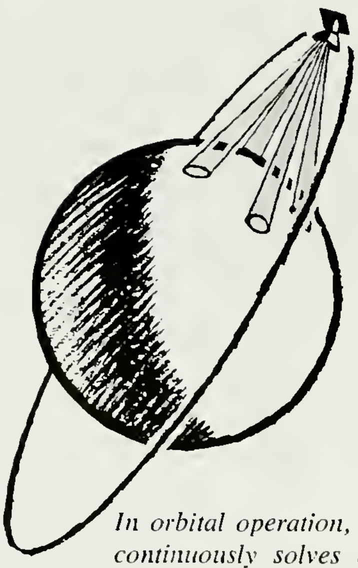
SPUTNIK I opened the space race in 1957. Since then, Explorer, Vanguard and many other space vehicles have appeared on the horizon.

Why are major world powers competing for prestige in the race? There always seems to be an adequate answer, matter of fact a few reasons could be cited.

But regardless of the political motivations for space research, each satellite and space vehicle tossed into space eventually must earn its keep and perform a meaningful and important mission. The development costs involved in boosting a satellite into orbit or sending a space vehicle to the vicinity of Venus are too vast to afford the mere luxury of a satellite just aimlessly orbiting the earth, the moon or perhaps Venus.

How to navigate a space vehicle -

The author: Dr. Karl Undesser



In orbital operation, Rossena continuously solves equations stimulated by the repetitive range and Doppler inputs.

Space vehicles must perform a specific mission, and to do so scientists must know their exact location, heading and velocity. Simply, the vehicle must have the capability to be guided to those locations in space which are to be explored, inspected, helped, or threatened.

Present space vehicle guidance and control systems are earth bound, or if self-contained in the vehicle, become dangerously inaccurate after long periods in operation.

To solve this space age navigational riddle, Ryan has designed and patented a versatile self-contained space-borne navigation, guidance and control system—Rossena.

The Rossena system is an orbiting satellite navigational system, which determines continuously and without assistance the longitude and latitude of the orbiting vehicle in which it is installed. It is capable of highly accurate local vertical determination, yaw error sensing and vehicle alignment in the orbital plane, and will compute instantaneously orbital parameters without any accumulative errors.

Navigational Aid

Rossena can be used for navigational aid satellites, for self-navigation, for rendezvous operations, for evasive maneuvers, for re-entry, for terminal guidance and landing operations. In manned orbital test flights, Rossena monitors satellite location and heading, and correctly reenters the vehicle for a landing at a pre-selected landing site.

In military space missions, Rossena enables the vehicle to go through evasive maneuvers, without being lost in the void of space, then allows it to resume course and finish its assigned mission.

For space rendezvous and intercept, Rossena provides the intelligence and accuracy to initiate the necessary trajectory transfers to insure a collision course. Rossena could determine the flight path of the highly elliptical orbit of a vehicle approaching the moon, could determine the point in the trajectory to change the elliptical orbit into a moon orbit, could then provide the self-navigation to a desired orbit (possibly polar or circular) and, finally, the descent and landing maneuvers.

In actual rendezvous and docking missions, around the earth, moon, or other planets, the system will provide the necessary vehicle dis-

that is the question!

tances, closing rates and relative angular positions.

In a pure scientific role, the system, while orbiting around a planet such as Venus, can determine the planet's rotation sense and rate, and rotation axis in addition to the planet's shape and surface characteristics.

As a strict navigational aid, a Rossena equipped satellite, orbiting the earth, can plot accurately the location of islands and land masses in relation to each other, and provide navigational latitude and longitude coordinates to aircraft, ships and other satellites.

As a self-contained system, for the orbiting mode of operation, Rossena has four basic components:

(1) *a 4 beam Doppler radar constituting the basic system input sensor.*

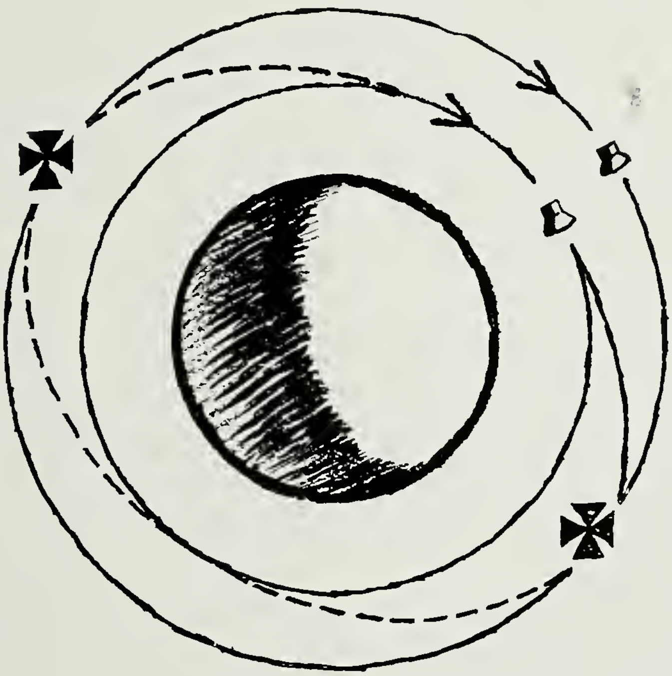
(2) *a stabilization subsystem to control the attitude of the vehicle and thereby align the four radar beams in a prescribed fashion, utilizing the range data of the radar subsystem.*

(3) *a computer subsystem, to derive the necessary command control signals and to solve continuously or periodically, a set of system equations to determine instantaneous orbital parameters and inherently connected system outputs.*

(4) *a power supply subsystem, to satisfy the power requirements of the various subsystems. Solar power will act as the recharge agent.*

In orbital operation, Rossena continuously solves equations stimulated by the repetitive range and Doppler inputs, enabling the system to furnish the vehicle position and ephemeris at all times without accumulative errors.

Although Rossena employs a Doppler radar, it differs from conventional Doppler radar navigational systems. The system equations are simultaneous equations and not integral equations as in conventional Doppler navigators. The output is significantly different in that it contains no errors which integrate with time because the system equations are not integral equations. ■

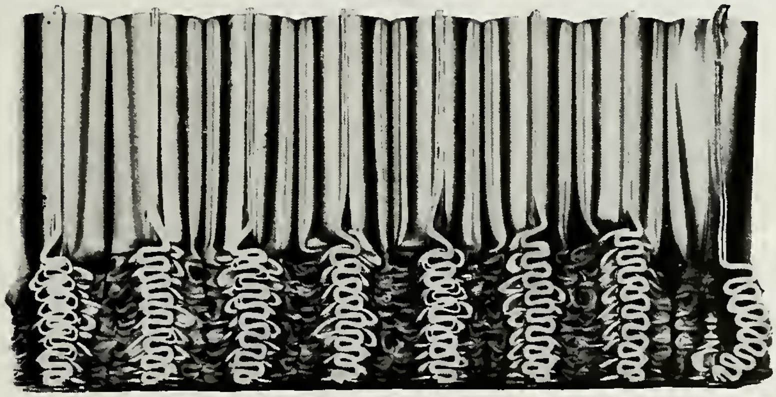


RYAN
ORBITING
SATELLITE
SELF-CONTAINED
NAVIGATIONAL SYSTEM

For space rendezvous and intercept, Rossena provides the intelligence and accuracy to initiate the necessary trajectory transfers to insure a collision course.

Ryan meets demanding schedules in fabricating . . .

SPACE AGE



STRUCTURES

THE UNIQUE PROBLEMS encountered in penetrating outer space impose special burdens on engineering and manufacturing organizations engaged in the design and production of structures that can "live" in this new environment.

Flexibility of approach to solutions is a prime requisite—because in tackling space age structures, standard fabrication techniques no longer provide the certainty of correct answers.

In the development of solar concentrators, solar cell panels, radar reflectors, radar altimeters, velocity sensors, lunar landing systems, impact structures, and missile components, Ryan Aeronautical Company engineering and production staffs have become familiar with sudden shifts in program schedules and the increasing demands for speed in meeting requirements of space probes and orbital missions.

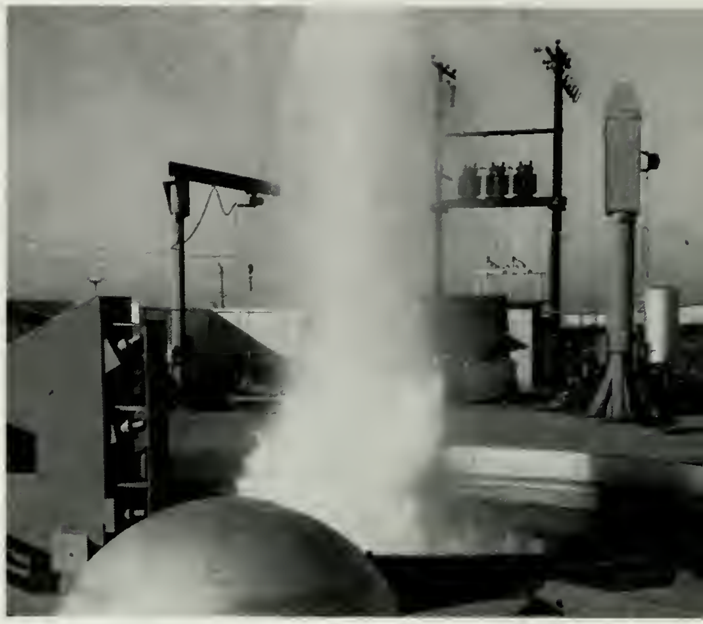
Fast reaction time in producing custom-built, high-quality, low-weight units for space vehicles is paramount.

This was recently exemplified when exigencies of a space project called for a quick switch in the production by Ryan of solar cell panels. One project was stopped, another went into high gear to meet delivery schedules that would mesh with a programmed planetary probe. And when this order was completed, it was discovered that more electrical power would be needed for the mission. With the pressure intensified, the cells were returned to Ryan for modification in the face of a looming deadline.

"Constant change has become a way of life in the space structure business," a Ryan engineering executive observed. "We must be organized to give rapid service while performing careful engineering analysis and critical control of manufacturing methods.

"Over-all systems capability is essential in coping with today's complex needs of government agencies and scientific organizations."

To meet these demands, the diversification which has highlighted Ryan's 40 years of fabrication history is now focused in the field of space structures.



Ryan explosive forming techniques smash tough metals into space age shapes.

Harnessing the Sun

Energy will be captured from the sun by Ryan solar panels built for the National Aeronautics and Space Administration's Mariner R, slated for an Atlas-Agena Venus space probe. Thousands of photoelectric cells were mounted on the specially designed aluminum panels to convert radiant energy into electric power for the scientific tasks of the instrumented vehicle.

Other solar panels have been designed and built in a developmental contract for the Mariner B, which will operate ultimately with the Centaur in Mars and/or Venus missions, and for a satellite which will serve as a navigational aid.

A new structural concept in which an aluminum skin is stabilized by continuous corrugations attached by resistance welding, was developed by Ryan to combine low weight with high strength and reliability characteristics.

Solar panels convert light energy directly to electric power. Another means of corralling the sun's rays is by use of a solar concentrator, which focuses the energy into a boiler to drive a conventional generator—a method which has advantages for long durations at high power requirements. Ryan has built a quarter-scale model of such a parabolic mirror for a solar mechanical engine; the next step will be construction of full-scale concentrators for actual use in space.

Design concepts in the construction of solar panels have emphasized thermodynamic efficiency. To operate at peak effectiveness, solar cells must be kept reasonably cool; Ryan structures have proven excellent radiators. The ability to dissipate heat becomes particularly critical in such planetary probes as that to Venus. Ryan configurations present large areas of radiating surface; at the same time, highly reflective surface finish of the materials achieve maximum emissivity.

In developing the solar concentrator, Ryan has acquired experience adaptable to the design of the large antennas which space craft will carry for communication and tracking in deep space probes.

The parabolic surface of the concentrator can be applied to the antenna dish, which is geometrically similar. Mechanically, Ryan has successfully tackled the problem of storage during launching followed by deployment in space. The solar concentrator consisted of 36 blade sectors which, when folded into position between the satellite payload and the power unit at launching, assumed a compact cylindrical shape. Such a packaging and deployment system would have distinct advantages for antennas.

Ryan has performed extensive studies in overcoming the problem of forming parabolic shapes in extremely light gauge materials, where difficulty is encountered in maintaining contours and a smooth surface finish is a necessity.

Explosive Forming

Explosive as well as stretch forming techniques are utilized in shaping space age metals. Ryan is one of the nation's pioneers in the explosive forming field. Its production and experimental facilities utilize water-filled tanks, ranging in diameter from 5 feet to 25 feet; small charges of ex-

The sun's energy will be captured in this solar reflector shown in early stages of fabrication at Ryan

plosive are detonated in the tank, into which the raw material to be shaped is placed in a die. The explosion forces the water against the part into the shape of the die to create the part in milli-seconds, contrasted with much slower speeds of more conventional forming machine methods.

Missile bulkheads and huge radar reflectors—the latter aluminum mirrors 78 inches in diameter and 22 inches deep—have been formed by "blasting". For a rocket fuel tank, Ryan used a 40-ton concrete die, one of the largest of its kind in the world, to explosively form a pie-shaped "gore", one section of the elliptical dome.

Ryan has performed a wide range of studies on impact structures, which could be used on instrumented packages and manned vehicles to absorb the shock of lunar and return-to-earth landings.

In addition to the obvious advantage of such structures to enhance survival of personnel and instruments in the critical terminal phase of a space mission, they will enable a reduction of power which would be required for "feather" landings.

Shock dissipating devices, fabricated of steel and aluminum, have shown great promise in the Ryan tests at high velocities. Various configurations have been studied to determine the maximum amount of energy absorbed per pound of weight.

Ryan's experience in developing a self-deployable solar concentrator can be directed toward the intriguing new field of automatically erectable structures in space. Launched from earth in a compactly folded package, an entire space laboratory, for example, could be erected in orbit by hinging of tubular sections into the desired shape.

Two of NASA's major space vehicles, Saturn and Surveyor, will be equipped with Ryan Electronics' radar altimeters, and the Surveyor also will carry Ryan Doppler velocity sensor equipment.

The Saturn radar system is designed to record altitude measurements up to 250 miles by measuring the traveltime of a single radar pulse transmitted from the vehicle to the ocean and reflected back to the vehicle.

New Frontiers

Other Ryan studies involving the use of electronic devices are also aimed at solving such problems as rendezvous terminal guidance, antisatellite terminal guidance, satellite vertical reference, gravitation control and communication antennas.

Ryan today is the world's largest producer of jet target systems (Firebee series) for the armed services, and is in the forefront of such developments as V/STOL aircraft, Flex Wing applications, and Doppler automatic navigation systems for fixed-wing aircraft and helicopters. Ryan aircraft, from the "Spirit of St. Louis" to the Navion; from the PT-22 Army Air Corps primary trainer to the Navy Fireball, first all-jet carrier-based plane; and from the Army Air Corps pre-World War II Dragonfly to the Air Force X-13 Vertijet, world's first all-jet VTOL, have all blazed new air trails.

Now the challenge of distant space is beckoning Ryan to new achievements. ■

A Record Smashing Army 124-E Firebee shattered its own record and set a new all-time endurance and altitude mark for this type of free-flying target at White Sands Missile Range, New Mexico, on May 17.

The 124-E flew 1 hour and 52 minutes, of which 1 hour 47 minutes was powered and 5 minutes was glide prior to parachute recovery. A new altitude record in excess of 61,000 feet was achieved, and a new record of endurance at high altitude was set when the Ryan Firebee flew 84 minutes at 55,000 feet or above.

The flight was performed under direction of the Ryan crew at White Sands, headed by J. E. Young, base manager. J. C. Rhea, flight engineer, controlled the mission. The previous mark set earlier this year, was 1 hour, 45 minutes, 20 seconds, including 99 minutes powered flight, and 5 minutes 40 seconds glide.

The 124-E is the most advanced production model of the Ryan family of Firebee jet targets and is a special Army configuration of the Q-2C, being produced in large quantities for the Navy and Air Force.

The Army reached another major milestone at White Sands recently when they conducted their 300th Firebee flight. Since 1959 the accelerating Army target drone program has supported Army Ordnance research and development of surface-to-air missiles. Dedicated efforts of Ordnance personnel, working closely with highly skilled Ryan technicians, have resulted in many other achievements, including capability to simulate formation flight by using miniaturized formation flight equipment; and provision for electronic countermeasures to confuse the missilemen.

A Systems Dynamics and Simulation Building — Ryan's newest facility — is nearing completion in San Diego. The 6,000 square foot structure will find major use in connection with the development of the Ryan Vertifan concept, in which turbojet engines and submerged wing fans are used to obtain thrust for both horizontal and vertical flight. Ryan has been engaged in the application of this concept to V/STOL aircraft since 1955.

First major assignment will be flight simulation of the VZ-11 fan-in-wing V/STOL research aircraft for the Army Transportation Research Command being designed and built by Ryan under contract to General Electric. An instrumented cockpit and airplane hydraulic and control system mockup are connected to the Ryan simulator system. Later, two flying prototypes will be produced to demonstrate capability of vertical take-off, transition to conventional flight and flying at high speeds. Lift fans horizontally submerged within the wing and driven by the exhaust of two G.E. J85 engines will provide lift for vertical take-off and hovering.

In the simulator building, a test pilot will be able to "fly" an airplane from a cockpit fully equipped with controls and instruments. He will face a "wrap-around" screen depicting terrain and providing a sensation of movement although the cockpit remains stationary in the darkened room.

Results of the flight simulation will enable Ryan engineers to evaluate the airplane flight characteristics and to optimize flight performance and airplane control systems before the first flight of the prototype airplane.

Another major feature of the new structure is a hydraulic laboratory, which will determine system response, reaction to loads, and other capabilities of components, which must meet demanding specifications before they are installed in the simulator.

A "clean room" will be provided to eliminate all contaminants from the sensitive components before they are placed in the hydraulic system. Cleansing operations will include the use of ultrasonic equipment, in which the parts are subjected to high frequency vibrations through a special liquid.

A Ryan Firebee, flown by the Aerospace Operations Department at the Naval Missile Center, Pt. Mugu, was recently the victim of an interesting numbers game. Engine mechanics, checking the Firebee serial numbered "2317", after a recent mission noted that the engine time had been clocked at exactly 23 hours and 17 minutes and that the drone—affectionately called "Bessie" had completed its 17th hop on the Pacific Missile Range. In honor of the occasion, Pt. Mugu civilian employees Ray Hardquist (left) and George Peterson (right) strategically place a decal indicating the 17th flight.

A tape processing console which will slot Mylar 35mm tapes for 13-channel time programmers, has been developed by Ryan. The console cuts hours from former manual methods of tape preparation. Major components of the console are a tape punch, a tape reader, and two associated, motor-driven, synchronized tape transports. The console features a 13-key keyboard input for verification and punching. Numerical lampbanks display the keyboard entry, enabling the operator to double check entries before the tape is actually cut. Original tapes can be cut by selective keying from a time-code chart.

REPORTER NEWS

In the cockpit of the U. S. Army VZ-11 mock-up now being designed and fabricated by Ryan, G. W. Rutherford, Ryan Vice President, Operations (left) and Dave Cochran, General Manager, G.E. Flight Propulsion Lab, (right) hear Hugh Starkey, Ryan VZ-11 Project Engineer and John Peterson, Ryan Vertifan Program Manager explain cockpit control functions. Under contract to General Electric and the U. S. Army Transportation Research Command, Ryan is designing and building two fan-in-wing VTOL VZ-11's to be flight tested in mid 1963.

A Product Field Support Activity was recently announced by Ryan, and with the announcement it was disclosed that Paul W. Gill, Captain, USN (ret.), and former Comptroller of the Bureau of Naval Weapons, would manage the new support group. He was most recently Overhaul and Repair Officer at the North Island Naval Air Station, San Diego.

Gill's support group will provide field support for Ryan products in use at military bases, and Gill will supervise Ryan base operations, such as those under way with Ryan Firebee targets at White Sands Missile Range, N.M. for the Army, and Roosevelt Roads Naval Station, Puerto Rico, for the Navy.

A member of the 1939 class at the U. S. Naval Academy, Gill retired recently after a 27-year Navy career. In his postgraduate education, he attended the Harvard Graduate School of Business Administration, and Massachusetts Institute of Technology, from which he received the Master of Science Degree in Aeronautical Engineering.

The Royal Australian Navy has placed a third order for Doppler ground velocity indicators. The contract calls for installation of Ryan AN/APN-97A sets in Westland Wessex helicopters, and follows previous orders for larger quantities of similar equipment on which deliveries are nearing completion. The AN/APN-97A functions primarily as a hovering indicator for helicopters. It provides the manual or automatic means for the pilot to maintain his aircraft in a precise position under all conditions of visibility. It is in operational use by U. S. Navy ASW squadrons, and helicopters also used by the Marine Corps, Coast Guard, U. S. Army, and by certain units in Britain and the Netherlands.

Two Hardy Firebee jet drones, given up for lost, have been recovered from the Gulf of Mexico in remarkably good condition after long periods of floating in the sea.

Crews of the 4756th Drone Squadron at Tyndall Air Force Base, Fla., were marvelling at the water-tight integrity of a Ryan Q-2C which had been afloat a record breaking 21 days, when word was received of another Firebee that had drifted in the Gulf's choppy waters for a new record of 35 days. Both birds were discovered by fishing boats, towed to port and turned over to the Air Force.

The first Q-2C was launched April 12. Three weeks and 200 miles from where it completed its target mission, it was sighted off Tarpon Springs, Fla. Subsequently, a Q-2C which was launched April 11 was found by another fishing boat exactly 5 weeks later off the coast of Cedar Key, Fla.

The equipment compartments of both Firebees were found relatively dry, with virtually no corrosion effects, thus enabling salvage of considerable gear. In both instances, engine trouble in retrieval boats and heavy seas prevented immediate recovery efforts by Air Force retrieval boats in the recovery area following target missions.


Craftsmen conquer heat shrugging metals.

ONE OF THE AEROSPACE INDUSTRIES ANCIENT arts—welding—has experienced many innovations in recent years, but modern technology involved with the design and production of manned and unmanned spacecraft, super muscular rockets, atomic power and sun capturing solar devices, has prompted metallurgists and welding technicians to new frontiers in the art of stitching metals together.

Hard to shape, tough, heat resistant refractory and reactive metals and their alloys tungsten, molybdenum, tantalum, columbian, hafnium, titanium, zirconium and beryllium as well as paper thin foil gauge materials all present their interesting and sometimes unique problems in the welding process.

Aluminum flux dip brazing, short arc guns and a new Ryan joining process called Molectrobond are taming tough metals.

At Ryan, metallurgists and technicians with years of experience are applying new techniques, and equipment to the task. Ryan introduced resistance welding in the manufacturing of double contoured airframe structures. It is the world's leader in resistance welding of titanium. Ryan technicians also spent seven years on a highly specialized program in resistance welding of microgage materials — .0005 inch — for missile and space vehicle components.

Achievements in fusion welding have been equally significant, and techniques and equipments developed by Ryan have been adopted throughout the industry.

Ryan has developed many special electric resistance welders. These include multi-head spot welders for attaching layers of thin gauge materials wrapped around a copper cylindrical mandrel and new methods for welding foil gauge exotic metals to materials of any thickness—a technique of immense service in spacecraft construction.

TAMING TOUGH METALS

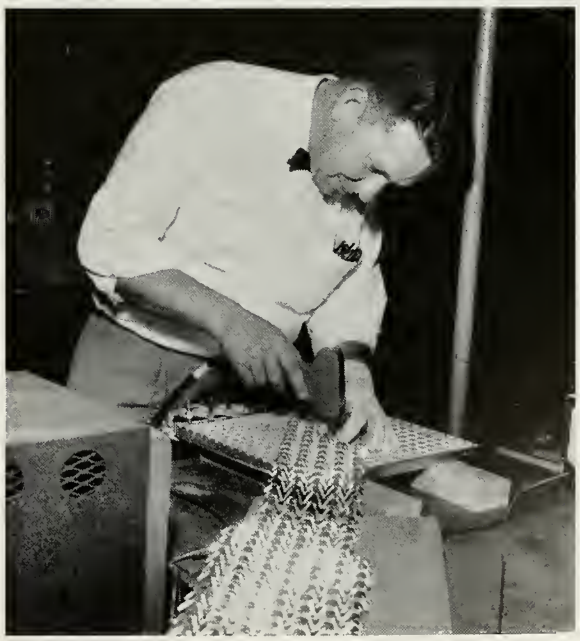
Flux Dip

A new wrinkle in joining is employed in the production of aluminum alloy wave guides used in Ryan's Doppler navigator antennas. Parts to be joined together are actually dipped in a molten flux bath. The aluminum flux dip brazing process offers many advantages over manual torch brazing. Some of the most apparent are uniformity of results, ability to braze thin sections, ability to braze thick and thin sections in one assembly, and the ability to braze complex assemblies, while minimizing distortion.

In the dip brazing process, the detail parts are degreased in an alkaline cleaner, deoxidized and air-dried. The detail parts are assembled by staking, pinning, spotweld tacking or fusion weld tacking as required by the nature of the assembly. Filler material, brazing alloy in the form of wire, foil or powder slurry is applied, then the fixture is placed in a pre-heat oven for 15 to 20 minutes at 1000°F.

Following pre-heat, the assembly is dipped in the molten flux bath at about 1100°F—immersion time depending on the mass of the part—some-

For a sun harnessing solar concentrator Ryan technician fabricates portion of reflector petal from paper thin foil gauge aluminum.



Molectrobond, a resistance welding technique was developed by Ryan specifically to join refractory, dissimilar cold worked and heat treatable materials. Weld power and pressure are virtually unrestricted in the unique new method.

Exhaustive laboratory analysis of welding techniques supports all prototype and production welding programs. Technician examines cross-section of titanium resistance weld.

times ranging from a few seconds to two or three minutes. After immersion the assembly is removed from the flux and allowed to cool to approximately 600°F. Then immersed in a hot quench (200°F) and rinse tank to remove the flux carried over from the immersion in the molten flux bath. Finally, a hot water bath, and a neutralizer immersion follows before the assembly is hot water-rinsed and air-dried.

Dip brazing is one of the most practical means for joining aluminum parts which may be fabricated from brazeable wrought or extruded alloys and those casting alloys which will withstand the brazing temperatures. In general, the wrought and extruded forms of 1100, 3003, 6061, 6062, 6063, 5052 and the casting alloys C-612, 40E and in some cases A-612 may be dip brazed in any combination.

Paper Thin Aluminum

Resistance welding of paper thin, foil gauge aluminum presents an interesting challenge, when compared to thin gauge steels and titanium. More welding energy is required since aluminum is an excellent conductor, as well as faster follow-up of weld pressure. Proper cleaning and handling, surface condition and resistance, and surface contamination are important considerations in producing desired weld strength in thin aluminum.

The resistance welding of foil gauge aluminum ranging in thickness from .0005 to .016 in many varied combinations and degrees of hardness have been successfully accomplished. This knowledge and specially designed equipment was used in the fabrication of a 10-foot solar reflector. Skin thickness on the petal like structures were of .008 and .010 5005-H38 aluminum with a highly polished surface to which was welded .004 and .005 1235-H18 and 3003-H14 grill and lattice work.

Other foil gauge aluminum parts have been joined by resistance welding using alloys including 2014 - 2024 - 3003 - 5005 - 5052 - 6061 and 7075 in all gauges to .016 and hardness from dead-soft to full hard.

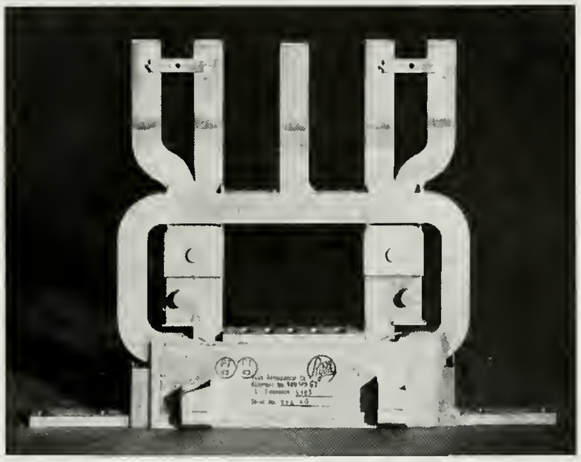
Short Arc

Short arc welding with a hand-held mechanically fed gun provides controlled welding at high speeds. Its main advantages are the ability to weld sheet metal in a range of thicknesses .030 to .040, using low heat input, a very small weld puddle, a continuously fed fine wire thus permitting welds in all positions and with very little distortion of the parts.

Operating in the range of 12 to 21 volts at 30 to 125 amps, the arc short circuits dozens of times per second and produces a small weld puddle pinpointing the location of arc heat, while the low heat to speed ratio holds distortion to a minimum. The unit uses 0.030-inch diameter wire, although 0.020-inch diameter wire works well on material in the low end of the thickness range. The continuously fed electrode permits more welds per day per man.

Short arc welds can be made in all positions, on all types of joints and is compatible with all common metals including carbon steel, stainless steel and aluminum. Welding time with the short arc can be reduced as much as 80%. Precision is aided by the reduction and sometimes elimina-

In new flux dip brazing process critical aluminum alloy assemblies are joined together in a molten flux bath after special preparation.



The several parts of this intricate wave guide, for a Ryan Doppler navigator antenna, were joined together with flux dip brazing process.

tion of distortion problems.

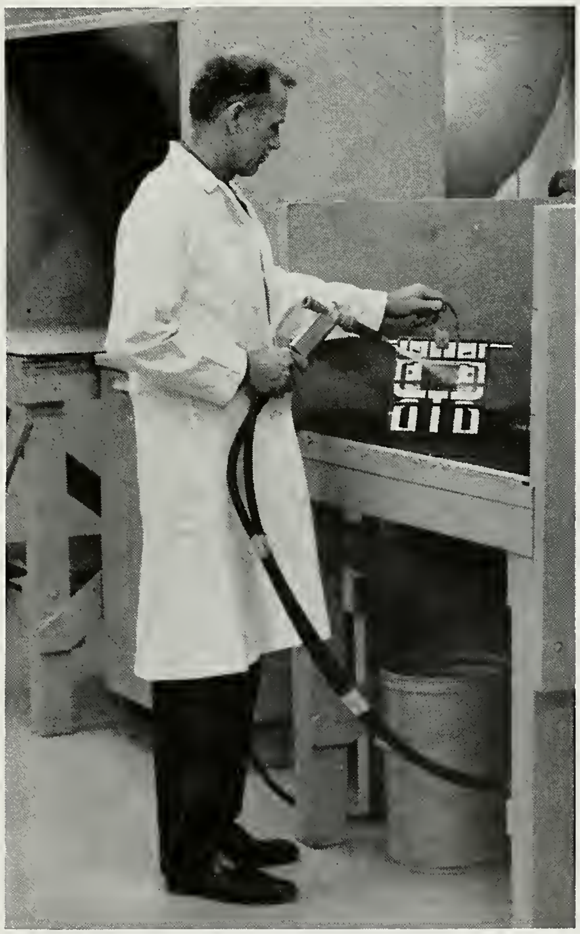
Molectrobond

Molectrobond, a new joining technique developed specifically by Ryan in the resistance welding family permits welding with a minimum of degradation or change of parent material characteristics.

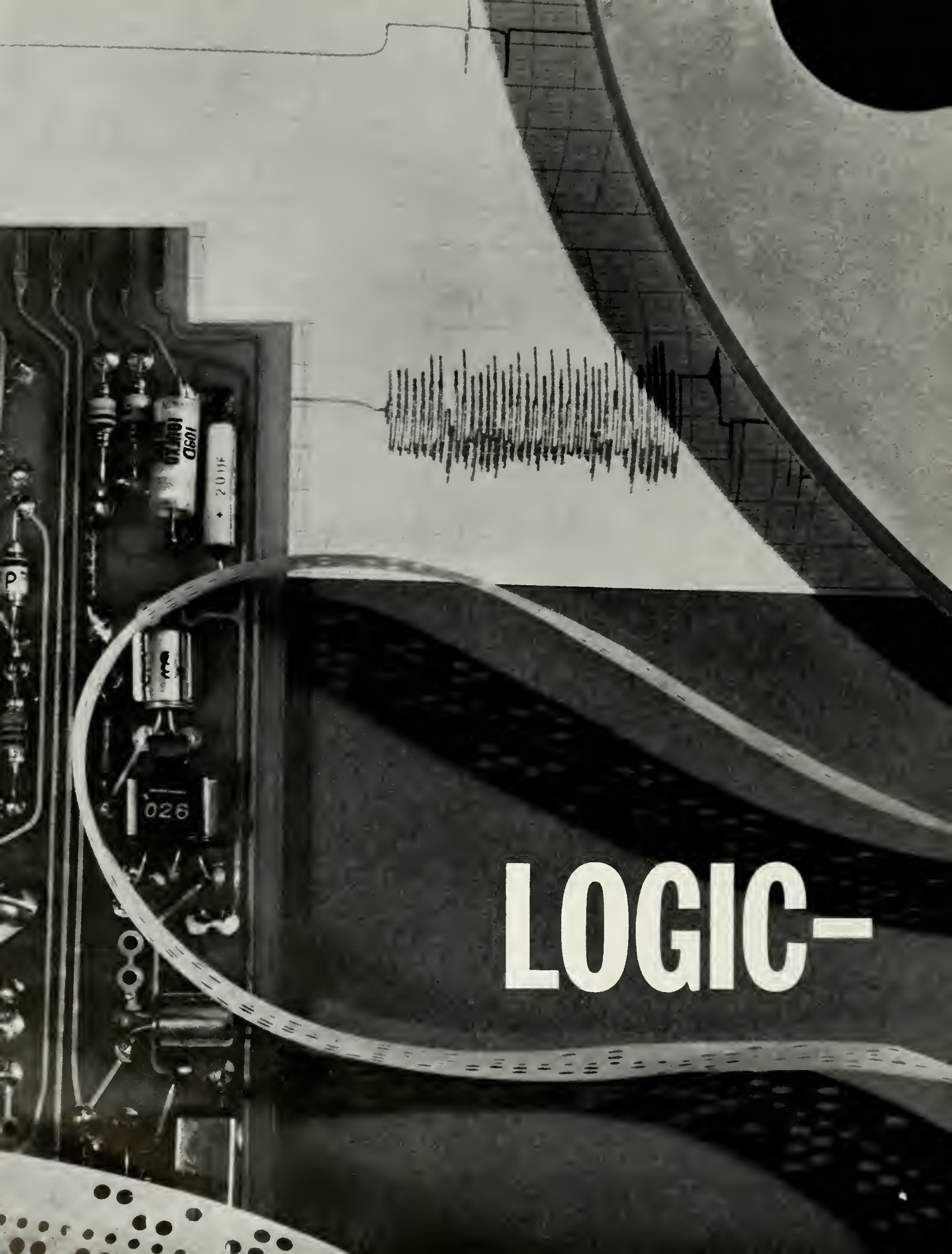
The equipment and techniques have been developed specifically to join refractory, dissimilar cold worked and heat treatable materials, with a minimum of disturbance in the properties of the parent material, and reduction of electrode sticking problems.

Developed by Ryan metallurgists and welding experts, the Molectrobond machine has a 36″ spot weld throat. Weld power and pressure are essentially unrestricted in the unique new machine.

One of the keys to Ryan's successful leadership in welding, is its outstanding welding research program and its welding laboratory completely equipped with the services of chemical, metallurgical and physical test facilities. Ryan's welding programs include many new advancements—the reduction of strength degradation in welding; the welding of dissimilar metals and the development of the highest reliability welds in virtually all weldable materials. These projects are laying the framework for tomorrow's welding technology. ■



Completing the flux dip operation, completed parts are given a hot water bath, and a neutralizer immersion, before being hot water rinsed and air dried.



LOGIC—

MACHINES with phenomenal "memories" and lightning speed have been installed in the new digital computer center at Ryan.

One is an IBM 1410 electronic data processing system to process engineering, manufacturing, and financial information for management and operating reporting; the other will provide engineering calculations. Both are digital computers.

The computer center is air-conditioned and includes a level of humidity required by the magnetic tape processing units.

The data processing system is an all-transistorized IBM 1410, equipped with 20,000 characters of core storage memory in a "black box" only 10 inches wide, 10 inches deep, and 6 inches high. Space is available for installation of another "box" to double the memory capacity when needed.

Human-originated programs and data are introduced into the processing system and the machine assembles the data by use of programs to prepare the desired reports at a maximum printing speed of 600 lines per minute—four times faster than the IBM 407 tabulator previously utilized.

Not only is the IBM 1410 speedier, but it can also perform at one time many more complex types of calculations than the combination of the IBM 407 tabulator and the IBM 604 calculating punch machine. At a later date, additional components of magnetic tapes, random access, and an IBM 1401 computer will be added to the system.

A seemingly endless maze of wires, the memory heart of the IBM 1410 data processing system has a capacity for 20,000 characters of stored information.

A FUNCTION OF MEMORY

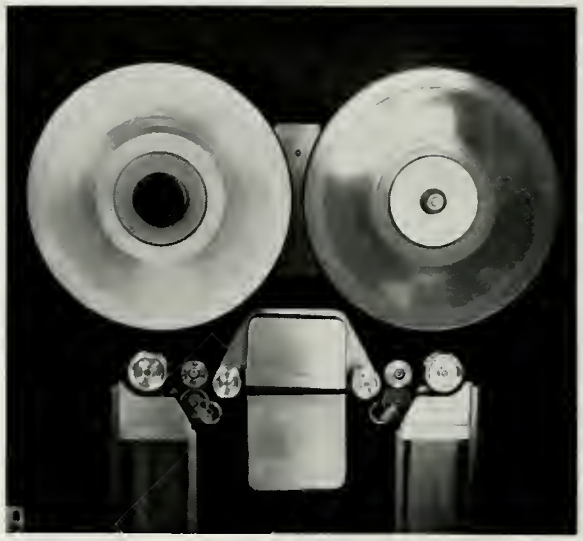
The new computer will permit consolidation of engineering, manufacturing, and financial information into one file. In the past, such data has been maintained in several files.

The new equipment will provide management and operations with a more complete picture of the current situation.

The other major feature of the computer center is an IBM 704, which will complete engineering calculations.

The 704 utilizes cards and magnetic tapes to feed data and programming into its core storage, and it is estimated that its calculations for engineers will be performed from 30 to 100 times as fast as with previous equipment. It will also enable engineers to accomplish more complex, sophisticated calculations.

A unique feature of the attractively designed computer center is the accessibility to cabling and power conduits beneath the floor. Two-foot square Vinyl tile blocks can easily be lifted by suction cups to permit inspection and to add additional cables when more components of the system are required. Each set of four blocks has jacks which can be adjusted to assure an exact level base for the computer machines. ■



Instant data with lightning speed.

Utilized as a management tool, the Ryan computer center consolidates engineering, manufacturing and financial data in one file.

Possessed by electronic hocus pocus, the Q-2C casts a spell with...

The art of self defense is a never-ending challenge, especially as regards defense against enemy aircraft and missiles — aimed at destruction.

Initial detection of a potential enemy aircraft or missile, then tracking it at tremendous closing speeds as it smashes through space in search of a target, and the ominous implications involved in performing both of these functions in adverse weather conditions dictates that defense teams be honed to razor-sharp effectiveness. The latest fad in this game of cat and mouse, played between attacking missile and defense units, is a bit of Black Box Magic, called electronic countermeasures (ECM).

To keep razor-sharp, air defense teams are training with the Ryan Q-2C Firebee jet target equipped with special black boxes, and electronic counter-measure devices as part of the target's traveling wave tube (TWT) radar augmentation system. Basically the radar augmentation device makes the 23 foot long Firebee look like a B-52 on the radar scope.

Military authorities have described the Ryan Firebee as the nation's most realistic target to maintain pilots, ground radar crews and fighter-interceptor planes at combat readiness. In the evaluation of various weapons systems including ground-to-air and air-to-air missiles, the electronic counter-measures and radar augmentation capabilities of the TWT system have been invaluable.

The Firebee TWT is housed in the target's equipment compartment and is connected by coaxial cable to antennas on the outer shell. With this active augmentation system, the Firebee meets target requirements for the Falcons, (GAR -1, -3, -9, and -11), the Genie, Bomarc, Hawk, Talos, Nike Ajax, Nike Hercules, Terrier and Tartar.

Designed and built by Ryan, the TWT system is a broad-band, high gain device with the ability to detect low level signals and amplify the signals with a minimum delay, an average of 60 db above the incoming level, while retaining the particular characteristics of the input signal such as frequency, polarization, pulse repetition rate, pulse width and scanning modulation.

The TWT radar augmenter is a one-tube microwave amplifier consisting of a single traveling wave tube and associated transistorized power supply. The traveling wave tube can amplify numerous microwave signals simultaneously over a wide range of frequencies. As installed in the Q-2C, the unit provides radar echo augmentation in various patterns by the use of specially designed antenna systems. Any incident radar signal falling within the frequency range of the TWT and the antennas will be accepted, amplified and retransmitted as a true "skin" echo with all the reflection characteristics of the specific radar type. The size of the echo can be conveniently varied by adjusting the system gain to simulate various target sizes.

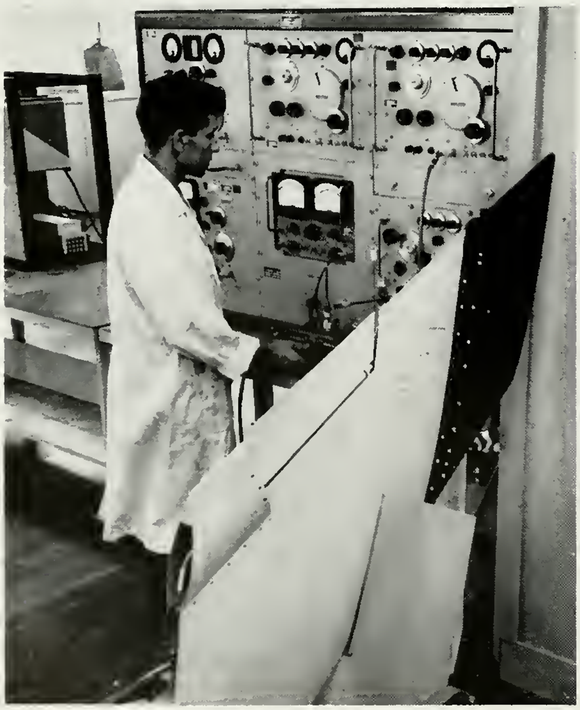
To satisfy operational requirements, TWT radar augmentation is available in the L, S, C, and X-Band frequencies. The C and X Bands are covered by one TWT, and L and S Band coverage is accomplished by separate amplifiers. Antenna systems have been designed for individual frequency bands and for dual-band operation. Augmentation is omni-directional for L and S Bands. For C and X-Bands remotely selected right or left side coverage can be provided if maximum power output is required for a given sector, or paralleled antennas can be employed to achieve omni-directional azimuth coverage. In addition, nose antennas present frontal coverage.

Early traveling wave tubes as developed initially, were sensitive high gain, wide-band amplifiers designed specifically for laboratory use. The first tubes were large with inadequate power output for radar augmentation, and in general were not rugged enough for airborne applications.

In more than four years of developing and refining the TWT system for the Firebee jet target Ryan engineers have ruggedized it and converted circuitry to solid state, transistorized configurations. Since 1959, the weight of the amplifier has been reduced from 40 to 12 pounds in the X and C band unit and from 20 to 4 pounds in the single band configuration.

27 01

Due to the relatively small physical size of the Q-2C, its radar reflectivity must be augmented to simulate the level of actual threat aircraft.

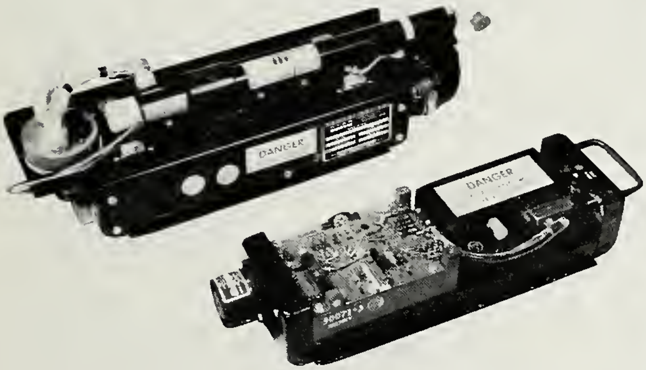


TWT systems have been installed in small helicopters to "beef-up" their radar image.

Antenna placement and design sometimes presents critical problems in various TWT installations. Elevation and azimuth coverage as well as isolation between receiving and transmitting antennas of a given system are determining factors. Substantial testing of various antenna designs is completed at Ryan's rooftop antenna range in San Diego.

In tests conducted to study Firebee antenna placement, a one-quarter scale model of the jet target is mounted on a special tower that allows rotation of the target along azimuth and elevation axes. Analysis of the tests formed the basis for the final array of multiple antennas on the target's shell.

In another radar augmentation assignment, the Ryan TWT system has been installed in small helicopters to "beef-up" their radar image. The helicopters, basically skeleton framework and cockpit, housed in a plastic bubble, return a weak radar image and can be a hazard to bustling air traffic patterns. The TWT augments the radar size of the "chopper" aiding air traffic control towers in the location, identification and track of the vehicles. ■



The TWT radar augmenter is a one-tube microwave amplifier consisting of a single traveling wave tube and associated transistorized power supply.

Installed in the Q-2C's instrument compartment, the radar augmenting traveling wave tube system is connected to surface antennas by coaxial cable.

Exhaustive tests conducted by Ryan technicians, on quarter scale and full scale Firebees, determined the location of surface antennas.

27-01

How to get maximum performance from V/STOL aircraft?

The Ryan V/STOL engineering team has the answer. With three million engineering manhours devoted to four vertical take-off research projects, Ryan is the world's most experienced and knowledgeable specialist in high speed V/STOL aircraft.

Newest and most advanced of these projects is the U.S. Army's VZ-11 research aircraft now being designed and built by Ryan. Powered by General Electric's lift-fan propulsion system, it will be capable of vertical take-off, yet cruise in normal flight at more than 500 mph. The VZ-11 concept provides maximum jet thrust augmentation for take-off *(engine thrust is multiplied 3 to 1 for vertical flight).*

In many space age areas, flexible, fast-moving Ryan is making significant contributions. Ryan is the world's largest designer and producer of Doppler navigation systems and jet target drones. Among other Ryan activities are Flex Wing applications, electronics systems for lunar landings, and structures for space vehicles.

At Ryan Aerospace and Ryan Electronics, technical and management capabilities are designed to assure compliance with the most stringent standards.

RYAN AERONAUTICAL COMPANY, SAN DIEGO, CALIFORNIA

TRI-SERVICE TILT-WING V/STOL TRANSPORT, *being built by Ryan (jointly with Vought and Hiller). Designed to transport troops, cargo and weapons, the VHR-447 will be produced to meet Army, Navy and Air Force logistical requirements.*

RYAN X-13 VERTIJET, *world's first jet VTOL aircraft, was developed under Air Force and Navy contracts dating back to 1946. This was first aircraft to demonstrate the feasibility of vertical jet take-off with transition to level flight.*

RYAN VZ-3RY VERTIPLANE, *a research aircraft designed, built and flown by Ryan for the U.S. Army and Office of Naval Research. It uses prop-jet engines and slipstream deflected by large wing flaps to achieve STOL take-off and landing.*

RYAN
AEROSPACE

RYAN REPORTER

JULY-AUGUST/1962

About the Cover: Wind tunnel tests of the Ryan designed VZ-11 provide both the setting and subject for a dramatic photograph.

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INTRODUCING THE VZ-11

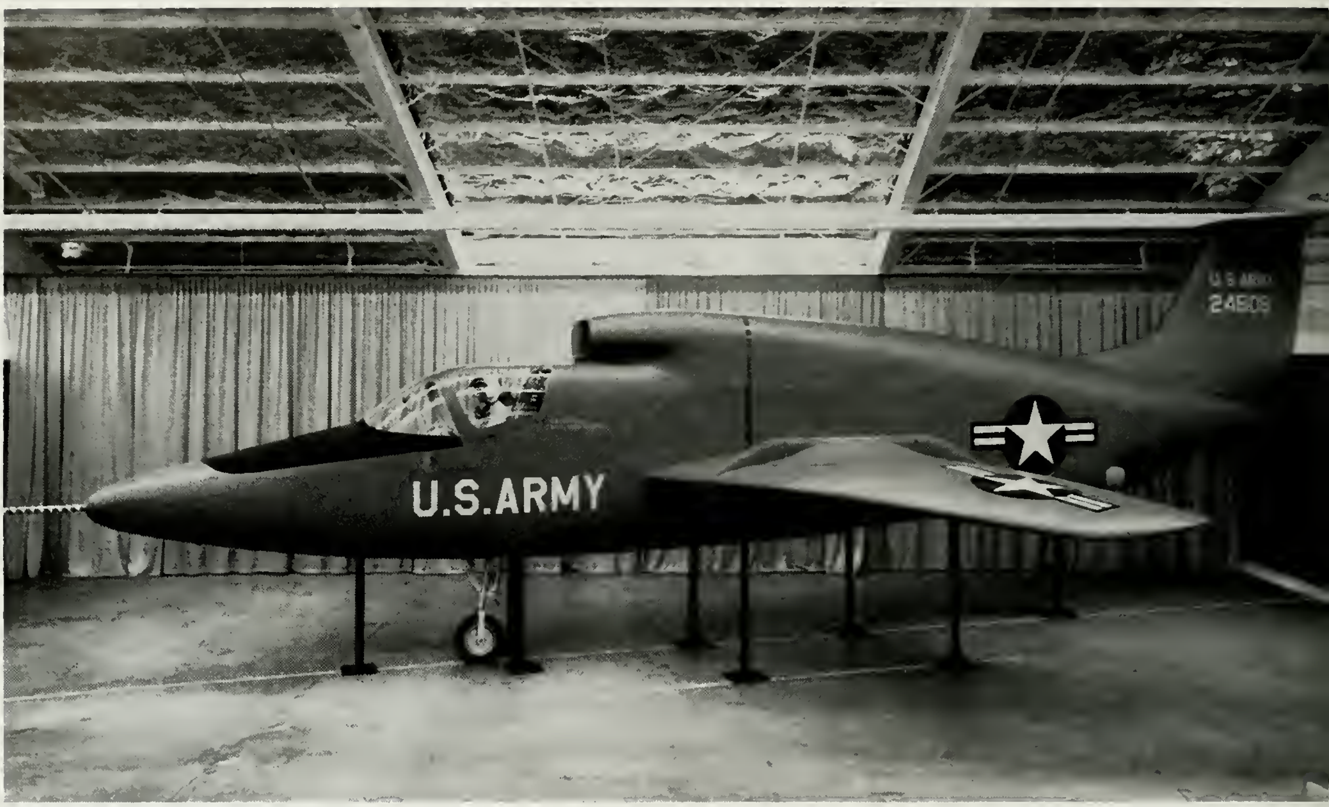
THE U.S. ARMY VZ-11 design, the world's first lift fan V/STOL aircraft, was unveiled by the Army, General Electric and Ryan at Ryan's San Diego plant August 17.

Completed on schedule, the VZ-11 mockup is a full-scale forerunner of two advanced V/STOL research aircraft which the Army's Transportation Research Command ordered from General Electric, in November, 1961, under a contract which totals $10.5 million. Ryan received a subcontract from G.E. to design and build the two fan-in-wing aircraft. First flight for the VZ-11 is planned for mid-1963.

The VZ-11 mockup demonstrates the compatibility of the lift fan vertical propulsion system with a high performance airframe configuration. This system appears to be applicable to a number of future Army aircraft.

The research aircraft will be powered by General Electric's Lift Fan system. They will be capable of taking off vertically, transitioning to conventional flight, and will fly at speeds of more

Completed on schedule the VZ-11 mockup is a full-scale forerunner of two advanced jet V/STOL research aircraft designed by Ryan and powered by General Electric's lift fan propulsion system for the Army's Transportation Research Command. Flight tests are scheduled for mid-1963.



A full-scale mockup of the Ryan designed U. S. Army VZ-11 lift fan V/STOL research aircraft demonstrates the compatibility of the General Electric lift fan propulsion system with a high performance airframe configuration.

than 600 miles per hour. The Army feels that V/STOL aircraft can make a major contribution to mobility needed for limited and general war. Such aircraft, for example, may be used for future combat surveillance or target acquisition missions, and will greatly extend the vision of Army field commanders.

Free from dependance upon airfields or other support complexes not available in remote combat areas, the VZ-11 concept blends battlefield mobility with high performance. Aircraft based upon this concept could "live with the troops," and be instantly responsive to ground commanders' requirements.

The VZ-11 concept provides unique advantages in performance and operational suitability because of inherent and engineered features. The lift fan produces two to three times more lift, for a given amount of installed engine thrust, than other high performance V/STOL designs. In the VZ-11, the thrust of the J85 jet engines is multiplied 300 per cent for V/STOL flight.

This major advantage will make possible important savings in fuel consumption and logistics support and provide greater range and payload capabilities. As a result, the VZ-11 concept is unlike typical V/STOL test beds in that it is designed to have performance which closely approximates anticipated requirements for military missions.

Basic components of the VZ-11's propulsion system are two J85 turbojet engines, mounted high on the fuselage, two five-foot diameter tip turbine driven fans submerged in the wings and a smaller fan in the nose of the fuselage.

Lift Fan Thrust

For vertical flight, diverter valves direct the jet exhaust to the tip turbines to drive the lift fans. Because the fans multiply the available thrust by 300 per cent, the basic engines can be sized for cruise conditions, and not oversized to meet vertical flight requirements. For forward flight, the diverter valves close the fans off and allow operation as a conventional jet aircraft. The nose fan is used to provide lift, pitch trim and control.

Crossover ducting between engines and fans insures that sixty per cent of the total lift will be available with only one engine operating. Under standard conditions and normal landing weights, adequate lift will be available for vertical landings with a single engine. Conventional landings can

Federal Aviation Agency officials inspect the U. S. Army VZ-11 mockup in recent technical review at Ryan's Lindbergh Field San Diego plant. The VZ-11 will be capable of taking off vertically, transitioning to conventional jet flight, and will fly at speeds of more than 600 miles per hour.

be made with a single engine under any loading condition.

The VZ-11 is designed to have outstanding control capabilities in hover and slow flight. The fan crossover duct system will provide balanced forces for attitude control as well as sixty percent of lift should one engine become inoperative. An ejection seat is installed for the pilot's safety while hovering or in high speed flight.

Major features of the VZ-11 concept are the flexibility of the system and the long history of development and testing of its components. Both factors increase the reliability of the aircraft.

For example, power transmission is accomplished by pneumatic coupling. All gear boxes and shafting are eliminated, which reduces maintenance and parts problems. The entire control for hovering and transitional flight is obtained from the primary propulsion system, which eliminates the need for auxiliary ducting and variable nozzles.

Another reliability advantage is the low speed of the main fans, which is only 2600 rpm—or about the same speed as a small-plane propeller. The relatively low velocity and low temper-

U. S. Army officials visiting Ryan from the Transportation Research Command, Ft. Eustis, Virginia, discuss and examine cockpit controls during detailed mockup review. Familiar pilot controls, ample room and good visibility are cockpit features of the Army's VZ-11 lift fan aircraft.

ature of the fan efflux, give the VZ-11 facility for flying from almost any small area.

The VZ-11 program culminates three years of static and wind tunnel testing of the lift fan propulsion concept. First tests were conducted at G.E.'s outdoor testing facility in 1959 at Evendale, Ohio. In 1960, the National Aeronautics and Space Administration built two full-scale lift fan aircraft models for test in the NASA/Ames wind tunnel at Moffett Field, California. Five test series were conducted with the lift fan installed in both fan-in-fuselage and fan-in-wing configurations and showed that lift fan powered aircraft would have good performance and transition capabilities.

Exhaustive Engine Tests

Tests also confirmed the propulsion system's mechanical integrity. These research tests have never been delayed due to mechanical failure of the lift fan system and over 300 hours of fan running time has been achieved at G.E. and NASA facilities.

Since the VZ-11 program started, scale model lift fan aircraft have been tested at various wind tunnel test locations including the David Taylor Model Basin in Maryland. These tests have provided information on the optimum design for the VZ-11 engine inlet and data on high and low speed flight performance. A similar NASA fan-in-wing full-scale wind tunnel model is now being tested at the Ames 40-foot by 80-foot wind tunnel facility.

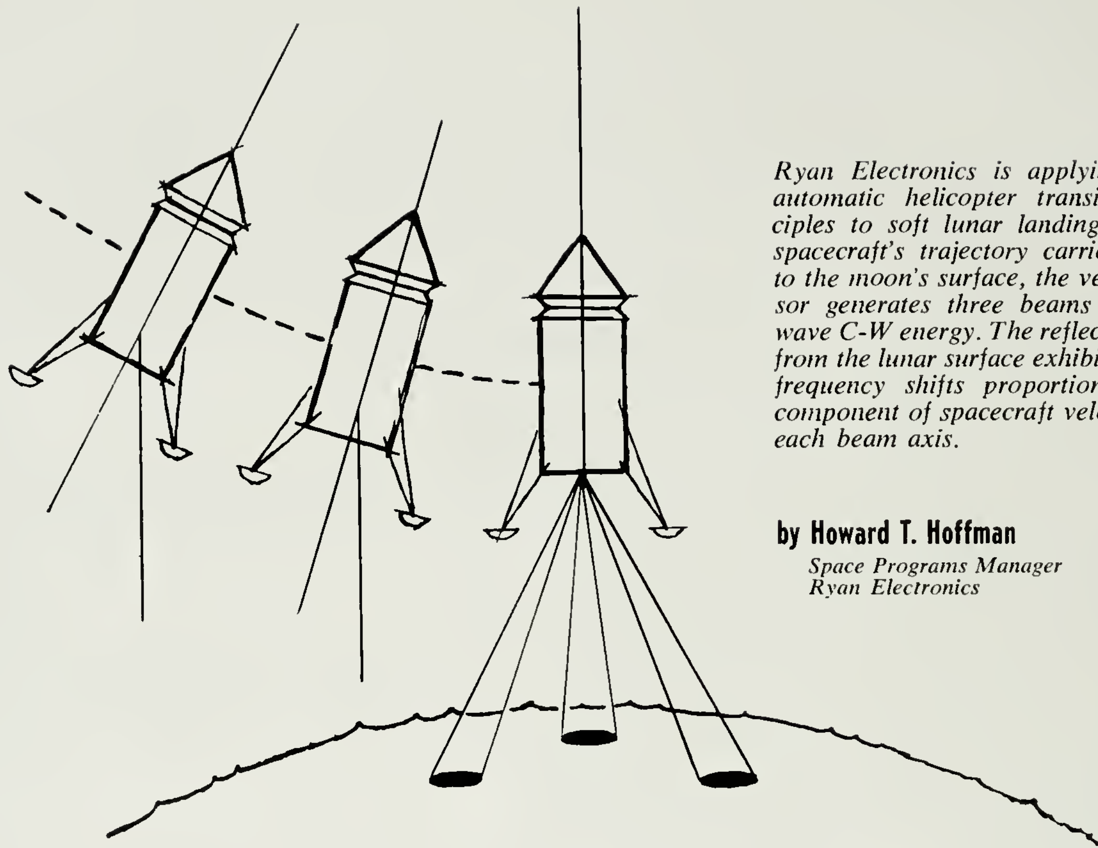
Since 1955, Ryan has been directly engaged in studies of V/STOL aircraft utilizing the basic fan-in-wing concept and has completed a U.S. Air Force contract to develop the parameters for well matched fan propulsion system and airframe configurations. This work led to the Ryan proposal which was selected as the winning design in the VZ-11 design competition. Over the years, Ryan has accumulated a unique backlog of three million manhours of V/STOL engineering experience in developing four major V/STOL aircraft and participating in the design of a fifth.

In addition to program funding by the Army, the VZ-11 is being actively supported by NASA and the U. S. Air Force. Wind tunnel facilities at NASA/Ames will be used to test one of the VZ-11 airplanes and a free-flight scale model of the aircraft will be tested at NASA/Langley. The Air Force is supplying the G. E. J85 turbojet engines and the diverter valves for the program.

Upon completion of the scheduled flight program, two VZ-11 airplanes will be delivered to the Army for evaluation of the concept's compatibility with Army operational requirements. ■

Ryan technicians examine the VZ-11 nose fan which provides lift for trimming and pitch control during fan supported flight. Note the engine air intakes located high on the fuselage to minimize debris ingestion when the aircraft is operating from unprepared runways.


LUNAR LANDING RADARS
A cushion for man's first fledgling steps on the moon.
Early lunar exploration will depend, to a great extent, upon the ability to soft land a payload on the surface of the moon. Precise measurements of altitude and vehicle flight attitude may well be the key factors that will spell success or failure. Ryan Electronics is currently under contract to design and fabricate Doppler sensors and radar altimeters for the Surveyor and Saturn programs.



Ryan Electronics is applying proven automatic helicopter transition principles to soft lunar landings. As the spacecraft's trajectory carries it close to the moon's surface, the velocity sensor generates three beams of microwave C-W energy. The reflected energy from the lunar surface exhibits Doppler frequency shifts proportional to the component of spacecraft velocity along each beam axis.

by Howard T. Hoffman
Space Programs Manager
Ryan Electronics

Because of proven accuracy and high reliability, radars such as those described in this article may play an important role as man soft lands his first space vehicle on the moon. Their function will be that of providing signals to a spacecraft control system for altitude, attitude and rate of descent control.

The automatic flight control system in helicopters provides functions analogous to those required for a soft lunar landing system. The helicopter control system permits automatic course, automatic hover, and of main interest, automatic flight path and velocity control during transition from cruise to hover mode. A Doppler velocity sensor and a radar altimeter provide outputs to the helicopter automatic stabilization equipment which permits this automatic transition.

During cruise a constant ground speed and altitude are maintained. Upon command, automatic transition is initiated and the helicopter follows a pre-programmed velocity-altitude profile to reach the hover condition.

The automatic transition requires helicopter velocity and absolute altitude information which is compared to programmed values in the automatic stabilization equipment. The helicopter's attitude, direction and thrust are then accurately controlled during the maneuver. A spacecraft making a soft lunar landing will require the same inputs and perform a similar automatically controlled operation.

In lunar applications, the radar altimeter will provide signals to the spacecraft control system for altitude and rate of descent control. It must continuously measure the slant range from the spacecraft to the lunar surface.

The Ryan Doppler velocity sensor outputs in spacecraft coordinates will be supplied to the spacecraft control system where the horizontal components will be used to align the thrust axis parallel to the velocity vector, and the vertical component will be used for rate of descent control during the final terminal approach. In the system described here, the radar altimeter and the Doppler velocity sensor are combined into one equipment. Both the altimeter and the sensor employ C-W Doppler.

In its function, the Doppler velocity sensor generates three narrow microwave beams of C-W energy toward the lunar surface, [oriented as shown above.] The reflected energy from the lunar surface captured by the antennas exhibits Doppler frequency shifts proportional to the component of spacecraft velocity along each beam axis. The three resulting Doppler shifts, which completely define the spacecraft velocity, are detected, measured, and converted into three mutually orthogonal velocity components in spacecraft coordinates. Horizontal components of velocity are used to align the thrust axis with the velocity vector continuously during the approach to the lunar surface. The vertical component is used during the final terminal approach in the altitude-velocity control system.

Two antennas fixed mounted to the spaceframe radiate the three Doppler beams and the single altimeter beam. The detection of the Doppler frequency on each velocity sensor beam is accomplished by heterodyning the received energy with a portion of the transmitted energy.

A special microwave technique is used to determine if the Doppler shift is above or below the carrier frequency.

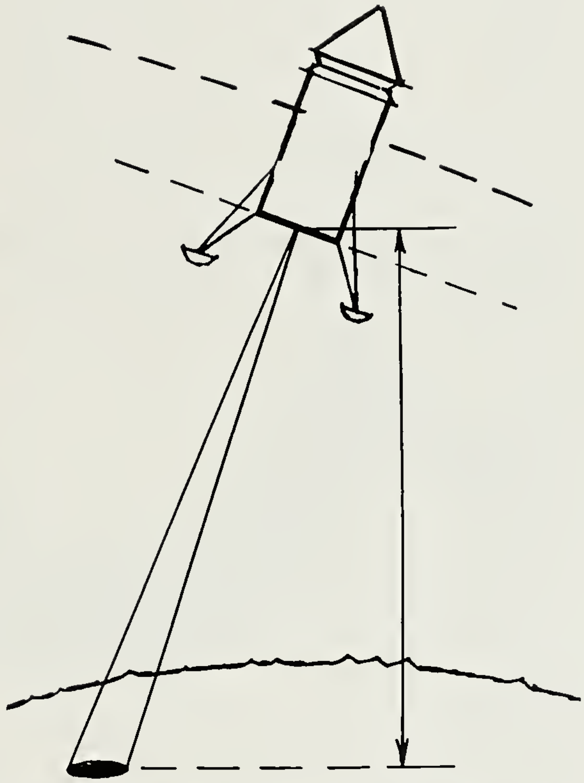
The detected signals are at low level and are amplified in the Doppler amplifer to bring the inputs from the microwave mixers up to a convenient signal level to be processed by the frequency trackers. The tracker rapidly sweeps the band of expected Doppler frequencies, to acquire and to track the center of power of the Doppler spectrum.

As in Ryan Doppler systems, the tracker provides an output at an intermediate frequency plus or minus the Doppler frequency, depending on the Doppler sense. The tracker function is to increase the signal-to-noise ratio of the Doppler signal by eliminating noise not in the tracker bandwidth.

The sums and differences of the Doppler frequencies are obtained to generate frequencies proportional to the spacecraft velocity components (V_x, V_y, V_z). These arithmetic operations are performed in the frequency domain so that accuracy in the horizontal components V_x, V_z will be retained. The arithmetic operations are performed in balanced modulators still retaining the sign sense.

The resultant frequencies proportional to V_x, V_y, V_z are converted to dc voltage and used in the spacecraft flight control system. The conversion process involves a coherent zero crossing counter and averaging circuits which provide a positive or negative dc output depending upon the sense of the velocity component. Smooth operation is provided through zero velocity on each component so that the control system can null the horizontal velocity components.

The radar altimeter continuously measures the slant range from the spacecraft to the lunar surface



The radar altimeter continuously measures the slant range from the spacecraft to the lunar surface during the final approach to the landing. The altimeter transmits a single beam of FM-CW energy parallel to the roll axis of the spacecraft.

during the final approach to the landing. The altimeter transmits a single beam of frequency-modulated continuous wave energy parallel to the roll axis of the spacecraft. The reflected energy from the lunar surface exhibits a range frequency shift from the transmitter frequency. The range signal is used by the spacecraft flight control system to provide altitude control on the main spacecraft. Appropriate range marks are also provided as required.

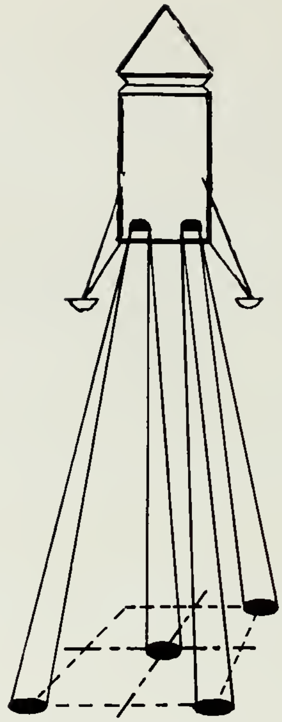
The radar altimeter transmits a single microwave beam toward the lunar surface utilizing a space duplexed antenna. This antenna is located within one of the Doppler velocity antennas. The transmitter is frequency-modulated and the FM microwave signal is fed to the transmitting dish of the antenna, which directs it into a beam whose axis is parallel to the roll axis. The radar return from the lunar surface to the receiving dish is delayed in time proportional to range along the beam. The radar return is continuously heterodyned with a sample of the transmitted signal, and the difference in frequency signal is used to establish the slant range to the surface.

Prior to acquisition, the frequency search circuit is scanning the predetermined range interval. As the spacecraft descends into this interval, a range signal will be received. Upon the acquisition of this signal, the range scanning is stopped; and it is determined whether or not signals are present in the discriminator bandwidth during both the modulator upsweep and downsweep. If so, the system will pass from the acquisition mode to the operational mode, range tracking will begin, and the reliable operate signal be present.

Range marks as required are generated by voltage decision circuits as the range voltage reaches the proper voltage levels.

The Doppler sensor and the altimeter will accommodate large angles between the moon verticle and the roll axis of the spacecraft. This is made possible through the inclusion of special logic circuits within the trackers. This logic also provides for side lobe effect supression.

Special considerations — the lunar landing radars are subject to a wide variety of radically changing environmental conditions. They commence during checkout and count-down and continue through the launch, midcourse and terminal phases of the mission. The equipment must be capable of being biologically sterilized internally by exposure to a temperature of 125°C for 24 hours and must be able to withstand exposure to ethylene oxide gas for 8 hours for external surface sterilization.



Two antennas, fixed mounted to the spacecraft radiate the three velocity sensor beams and the single altimeter beam. The three velocity sensor beams demonstrated in the geometry above, are directed to the outward angles forming imaginary triangle base lines, while the altimeter beam forms a 90° angle with the lunar surface.

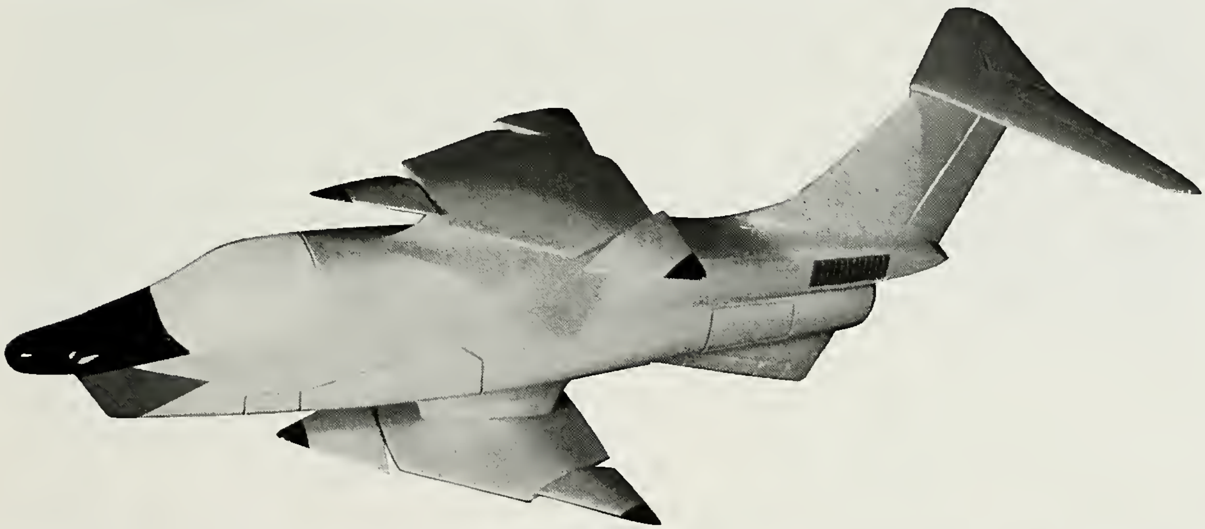
Obviously, reliability is of prime importance since the success of the entire lunar mission may depend on operation of the lunar landing radars. Reliability surveillance must be 100 per cent throughout the pre-design, design and development, fabrication and testing of the radars to ensure operational reliabilities of 0.9986 or better.

Aside from the severe environmental and reliability requirement, weight and size are critical considerations. Lightweight materials and components must be utilized and high density modules, and advanced packaging techniques evolved to meet a completely new standard of installation, operational and maintainability requirements.

While the Ryan system described here is not intended for any particular application, it is adaptable for almost any space mission, planetary or return-to-earth landing. It is adaptable to earth orbit, lunar orbit, or direct launch techniques. To illustrate the approach and technique employed rather than a specific system, exact numbers and precise details have intentionally been eliminated. However, Ryan Electronics is currently under contract for the design, development and manufacture of space radars similar to the system outlined in this article. ■

ROTATING DELTA WING

VTOL



A NEW CONCEPT in VTOL (vertical take-off and landing)—the turbojet delta wing Heliplane—has been patented by Peter F. Girard, Ryan Project Engineer, Special Projects, after seven years of "off and on" study.

Internationally noted as the test pilot of the Ryan X-13 Vertijet, world's first pure jet VTOL, and the propeller-driven VZ-3RY Vertiplane, Girard has created a design which theory shows to be more efficient than present turbojet aircraft in the hovering condition, and which is capable of transition to supersonic speeds.

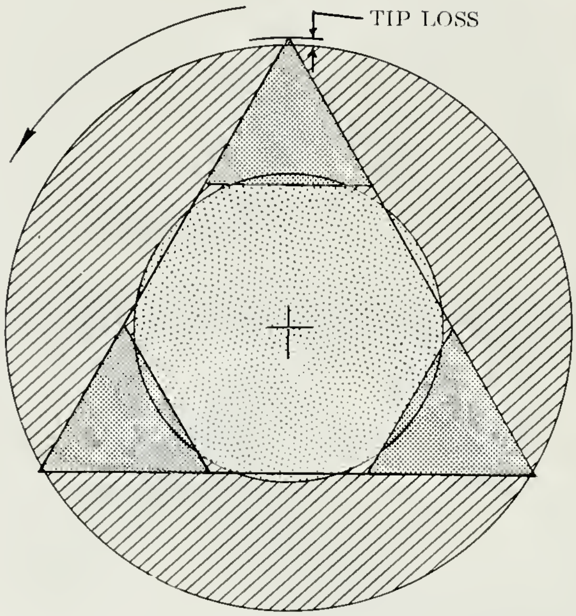
The Heliplane consists of a somewhat conventional body and tail group, to which are attached two rotary, delta-shaped wings, one above and the other below the fuselage.

Exhaust from the single jet engine is diverted to an auxiliary turbine (similar to the Pratt and Whitney geared J-60 system), which drives a shaft connected to a single gear box for contra-rotation of the "rotor-wings" in vertical take-off and landing, and in low horizontal speed and hovering.

The wing rotation is stopped in cruising flight, during which the Heliplane operates as a conventional delta wing turbojet aircraft. The stopping of the wing rotation is feasible because of the delta planform of the wings, which produce much lower levels of vibration and transients during transition than the straight tapered conventional planform.

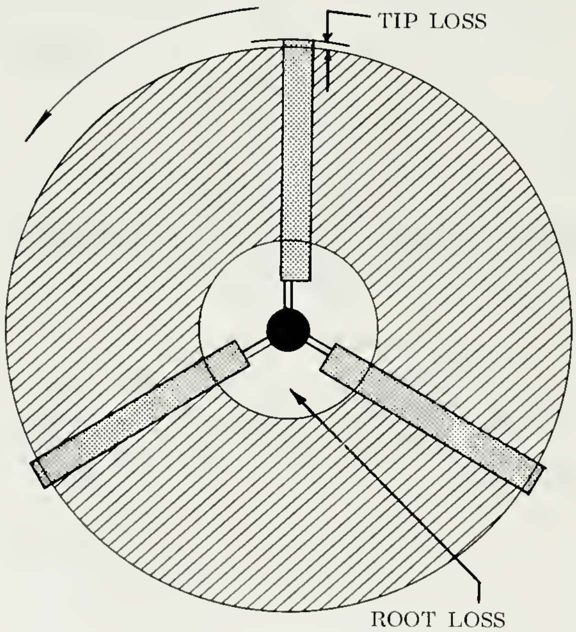
Directional control in the VTOL mode is provided by diversion of exhaust gases through ports in the aft end of the fuselage. This technique can

Heliplane—yet another approach to VTOL.



DELTA HELIPLANE

Heliplane designer, Pete Girard, was the first man in history to fly a jet VTOL aircraft—the famed X-13 Vertijet. Rising vertically on a column of jet exhaust, the aircraft would transition for level flight, then return to a vertical attitude to land on a ground service trailer. Girard has flown all types of aircraft from B-24's to flying boats, jet fighters to helicopters.



HELICOPTER

In the efficient Heliplane, the delta wing will produce lift by the direct action of the movable wing tips, as well as lift produced by the pressure difference between the upper and lower wing surfaces induced by the action of the wing tips. Conventional helicopter rotors suffer some tip and root loss in their lift action.

also be employed for anti-torque in those configurations employing only one wing.

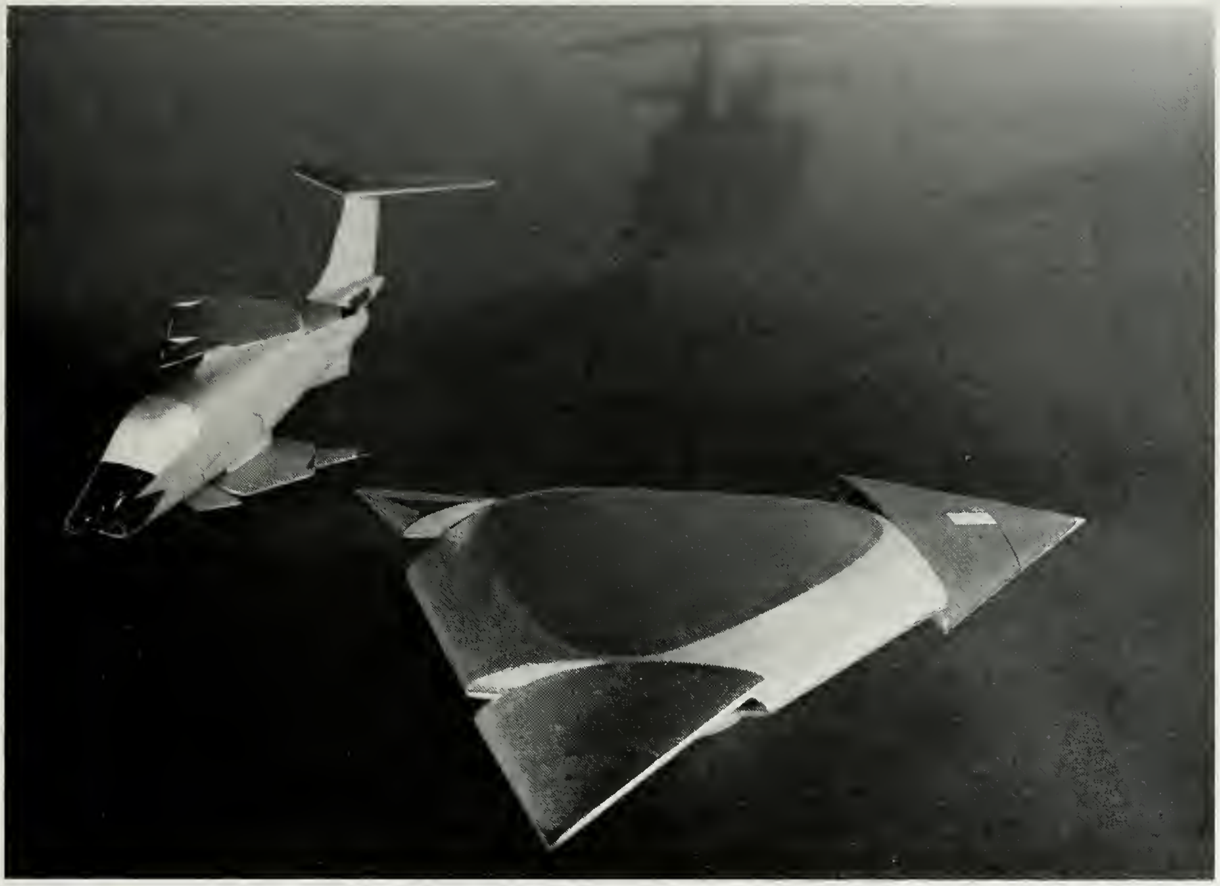
"This is an entirely different approach to VTOL," Girard explained. Previous popular methods have depended on either 'hanging' on props or rotors, or support of pure or augmented jet exhaust before conversion to wing lift for cruising flight.

"The wing contributed little more than dead weight and a place to mount the power plant when the craft was in the hover mode.

"The Heliplane uses the delta wings for support in both hovering and forward flight, and requires no helicopter-type rotor, propeller or other special device for support during hovering flight.

"Movable tips on the wings serve as the lifting rotor system, for hovering and low speed flight, as well as the longitudinal and lateral control systems, as they are provided with means for both collective and cyclic control. Lift is also produced by the wing center section due to the induced differential pressure across this section.

"In any type of VTOL operation, low downwash velocities are highly desirable in order to avoid ground erosion and dust and debris problems. A most significant feature of this approach is the very low downwash velocities possible. The



The aircraft's principal feature is a rotating delta wing with movable wing tips. Each of the three wing tips is movable about an axis lying approximately in the wing chord plane and along a line joining its vertex and the center area of the wing.

high flexibility in the choice of disc loadings makes this possible. Disc loadings as low as 25 pounds per square foot are feasible, even for very high subsonic speed aircraft."

The delta wings are equilateral triangles which Girard believes will demonstrate remarkable aerodynamic characteristics. Theoretical analyses have shown hovering figures of merit as high as 74 per cent (the average helicopter has a figure of merit of approximately 70 per cent).

Having obtained the patent and built models of the Heliplane. Girard is now constructing a model of the wing in his home workshop to perform hovering tests of a quantitative nature as a check on the results of theoretical analyses.

"The widely spaced coaxial wing configuration provides beneficial stability characteristics, and the delta shape has proven itself in high speed flight," he said.

"The particular arrangements of these rotating wings will give the aircraft improved dynamic stability in pitch and roll in hovering and low speed flight. No artificial stability augmentation is required as is the case in many other VTOL concepts.

"Longitudinal and lateral control are inherently quite powerful. Because of the 'rigid rotors,' the craft will possess a wide center of gravity range, and handling response will be of the velocity type rather than the less desirable acceleration type found in most helicopters.

"Because of the coaxial arrangement which eliminates need for anti-torque correction with power change, the handling qualities will be further improved.

"Due to the moderate disc loading possible, hovering flight performance will be good and can be made to approach that of the helicopter.

Girard, whose patent was obtained with the assistance of Ryan's legal staff, sees the Heliplane as being extremely well suited for the role of a high speed observation VTOL aircraft. ■

OPERATION OSCAR

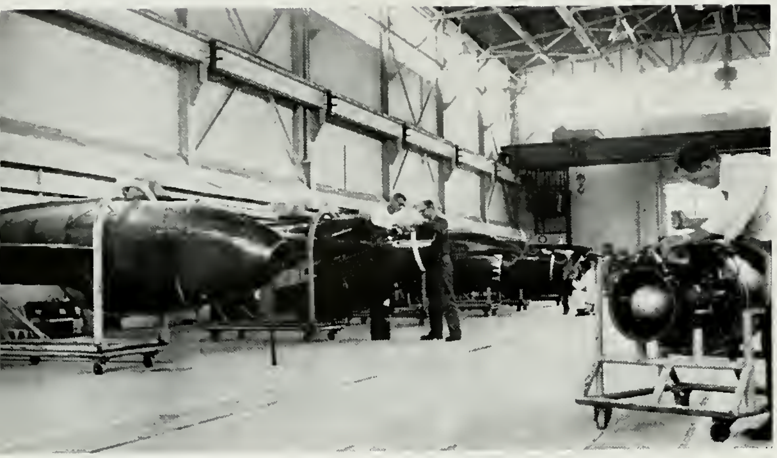
"Range Control – this is Operation Oscar; at my mark the time will be X minus five minutes."

HALF A DOZEN MEN clustered about a pair of plotting boards in a heavily instrumented station at the White Sands Missile Range hear the instructions and pass along, via an extensive radio net, commands to missile launch sites, radar control outposts, and other control and safety monitoring stations. "Operation Oscar"—code name for Ryan Firebee flights at the Army Missile range—is underway.

At least six times a week Operation Oscar takes over the range to fly the versatile high-speed Ryan Firebee jet target for Army, or Navy missile research and development programs at the desert site, under program management of the Army Missile Command, Redstone Arsenal, Alabama.

"At my mark, the time will be X minus three minutes." Jack Young and Jim Rhea, Ryan men in charge of the Firebee operation, move like a well drilled team into a series of split second operations. Jack at the Firebee remote control box checks his circuits and in turn the plotting table. Jim Rhea, via radio link with the Firebee launch site two miles away, commands "Start Engine"—and Gene Graeber calls back "Roger". A few seconds of silence and Gene is back on the line with "there's a light on the engine", indicating the Firebee's powerful turbojet is running up to full power.

"This is Operation Oscar—X minus 90 seconds," and again commands are passed, instruments checked between the control station, launch site



Ryan target service technicians are headquartered in a spotless hangar where rows of Ryan Firebee targets stand in various stages of readiness.

During Ryan Firebee flights, personnel at the White Sands ground control station fix their attention on Ryan base manager Jack Young, gesturing over the Firebee remote control box.

and radar outposts. "Six—Oh" the project director snaps. "Four—Five". "Three—Zero"—Silence, then the countdown continues.—"Ten, Nine, Eight, Seven, Six, Five, Four, Three, Two, One—LAUNCH—.

Across the hot desert, with a beautiful burst of orange and red flame from the JATO, the dayglo colored Firebee lurches into the sky and streaks in a climb for a rendezvous as the target for one of a possible half dozen surface-to-air missiles being evaluated and perfected on the White Sands range.

At the launch burst, the target control plotting board springs to life, and a series of tiny dots, charting a staccato line on the board, indicate the track of the Firebee across the sky.

At the far end of the control room, tension builds as the missile crew talks through a similar countdown, and the distant horizon reveals a white smoke trail as the missile blasts off to seek out the fleet jet target.

The operation—a typical one—is backed by efforts of thirty top-notch Firebee field experts, the Ryan contractor service team assigned to WSMR.

4,000 Miles of Desert

White Sands, 4,000 square miles of desert, located in the heart of New Mexico, is the busiest and biggest all-land missile and rocket test center in the Western Hemisphere. It is the only overland test center of the three national missile ranges, and is operated for the Department of Defense by the Army.

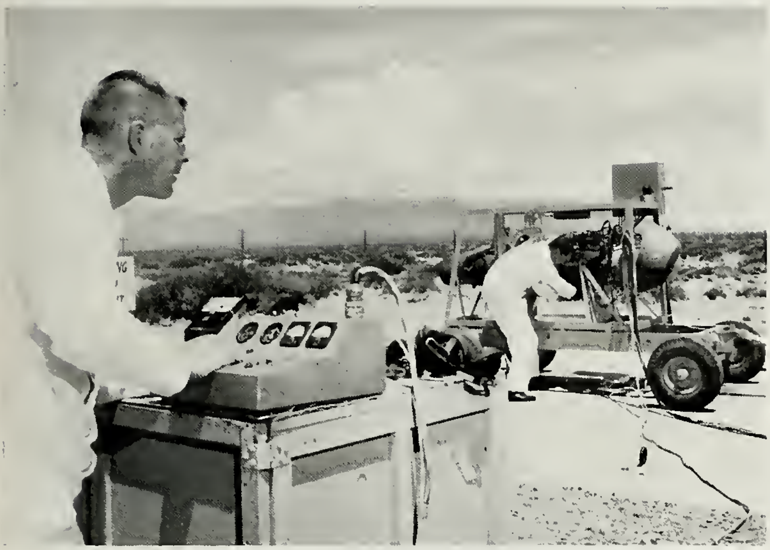
In July 1945 when White Sands was established, then designated White Sands Proving Grounds, the site was not much more than sand and sage. The location was adopted because of the wide open space necessary to missile tests. Ideal climate and year-around cloudless skies permit the ultimate in optical tracking and photographing of missiles in flight.

The range was established on July 9, 1945. Seven days later, early in the morning of July 16, man touched off his first atomic explosion at a barren spot known as Trinity Site, in the heart of the uprange missile impact area. In September 1945, the Tiny Tim, adapted to simulate the WAC Corporal, streaked into the desert sky.

17,000 Population

From that tentative beginning, when the physical plant of White Sands Missile Range covered only a patch of the entire 4,000 square mile range area, and its buildings seemed pitifully temporary, the desert test center has bloomed to a population of nearly 17,000 civilian and military technicians and scientists working on missile programs for the Army, Navy and Air Force.

Four years after its birth—on February 24, 1949, White Sands gave man his first real, though momentary glimpse of outer space when a V-2 and a WAC Corporal teamed up in a Bumper Project firing to soar 250 miles high. 65 V-2 rockets, captured during World War II and shipped to the desert site for research were fired between April 16, 1946 and June 28, 1951.



At desert engine run-up stand, Ryan technicians tune a J-69 turbojet for a demanding Firebee target mission.

Jack Young, Ryan base manager and Captain Lowell D. Twitchell, Army liaison officer assigned to the Firebee program, discuss a mission beside the versatile Army 124-E Firebee.

This July, White Sands' role as a major missile range was even more emphasized when Major General J. Fred Thorlin announced plans for extended testing programs for the Army's Sergeant and Pershing vehicles. The test programs will include firings of the missiles from off-range launch sites at Blanding, Utah and Fort Wingate Ordnance Depot, New Mexico for Pershing and Datil, New Mexico for Sergeant. The missiles will strike impact points within the boundaries of White Sands range. General Thorlin said the program marked the first time such extended use had been made of the heavily instrumented White Sands facility.

Under Base Manager

Headquartered in a spotless hangar where neat rows of Firebee targets stand in various stages of readiness, the Firebee team is directed by Jack Young, an eight-year target program veteran. Respected by fellow missilemen, the Ryan crew has earned the responsible title as a "can do" outfit. They maintain "B" Station where the Firebee is ground launched, and where the launch team has achieved an enviable record of reliability, with more than 350 ground launches in the logbooks.

During Firebee flights, assigned personnel at "C" Station huddle respectfully around Jack Young and flight engineer Jim Rhea to watch the exciting progress of the mission.

In the total White Sands program the Ryan contractor operated service team is carving a performance record that other missile teams will be hard pressed to match.

The Ryan team is currently averaging six

Major General J. Fred Thorlin, seventh commanding general in the 17-year history of the White Sands Missile Range, assumed command of the desert range in mid-July and voiced optimism about the future role of WSMR.

"The achievements of White Sands personnel in missilery have been most impressive," he said.

"As the first of our three great national missile ranges, White Sands has a long tradition of excellent performance in United States defense and space efforts. There appears to be every reason for optimism as we look to the future."

At White Sands he succeeds Major General John G. Shinkle, commanding general since June 1960.

A Ryan Firebee jet target rests on its launcher beside an 80 ft. rail launcher, where the Firebee was first ground launched in late 1959.

flights per week on the White Sands range, and some weeks the count will go to over ten. Dual launches to perfect a flight target formation system keep the crew on its toes as one bird roars off the launch pad to be followed by a second only sixty seconds later.

Statistically, the operation is part of Target Missile Projects, Systems Test Division, Ordnance Mission at the sprawling desert facility. A twenty-two man Army staff, under the direction of Capt. Lowell D. Twitchell works with the Ryan team to coordinate Ryan activities with other range and logistics activities on the base.

The Ryan Firebee jet target was first introduced and flown at White Sands in 1949. Firebees supported the maiden firings of the Nike Ajax, and since then have supported every surface-to-air missile development on the range. In August 1959, the Firebee program was stepped-up when the XM-21 was first ground launched in a program supported by twelve contractor target specialists.

Perfected Ground Launch

The White Sands team has been credited with perfecting the Firebee ground launch system, beginning first with rail launches from a set of 80 ft. rails, then later the zero-length ground launch system. Perfection of a towed target, "TOWBEE", concept in conjunction with the Army's advanced Ryan 124-E target program, is now underway calling for cooperation between the White Sands complex and nearby McGregor range near Ft. Bliss, Texas.

The 124-E Firebee can be ground launched at White Sands, and flown to McGregor range for extended missions. On such missions, Young and Rhea in direct radio contact will begin a countdown, and at the proper count, Young at White Sands will click his remote carrier off and Jim Rhea at McGregor will snap his carrier on. The countdown continues for five seconds while Rhea commands the Firebee to turn. If the target responds, Rhea maintains control, otherwise

Alone against the morning sky, the Firebee soon will be surrounded by technicians preparing it for an assigned target mission. Firebees were first flown at White Sands in 1949.

Young will resume control of the target, until a proper transfer can be made.

To maintain the heavy schedule of weekly launches required of the White Sands Ryan team, George Leonard, the Ryan chief mechanic; and Harley Eastman, electronic leadman, keep their crews on their toes. Young said the excellent record maintained by the Ryan team is a result of the superb ability of his crew, all trained veterans.

The training of the Ryan crew is best exemplified by their backgrounds. Leonard, a leadman mechanic, is a 14-year employee of Ryan. He worked with the Firebee in programs at Marietta, Georgia; Eglin, Holloman and Tyndall Air Force bases; including two William Tell meets, before reporting to the White Sands Missile Range.

Leadman electrician Eastman, a ten-year Ryan employee, has worked with Firebees at White Sands, Holloman Air Force Base, and the Naval Missile Center, Pt. Mugu.

Base Manager Young was a member of the first operational Firebee jet target squadron at Yuma Air Force Base and took part in the testing of the Navy XKDA-2 Firebee in 1954. Flight engineer Jim Rhea is a Firebee service veteran and, along with Young, was a member of the first Firebee squadron. ■

RYAN AWARDED FIREBEE CONTRACTS TOTALING MORE THAN $1.3 million - to supply airframe spare parts for Navy Q-2C Firebee jet targets.

One order -- totaling $840,500 will support Navy's portion of a contract announced earlier this year for several hundred Q-2C's. This earlier contract assured continuing production of this latest model Ryan Firebee through 1963.

Second contract calls for $489,000 in spares to support production of Navy Q-2C Firebees currently being built at the San Diego plant.

RYAN RECEIVES NEW CONTRACT TO EXPLOSIVELY FORM aircraft radar antennas at the company's explosive forming facilities.

New contract is for approximately $250,000, and was awarded Ryan by the Dalmo Victor Company, division of Textron, Inc., Belmont, California. Nearly 2,000 of the aluminum reflectors, which are installed in nose of military aircraft as part of radar equipment, have been built by Ryan at its explosive forming plant since it went into operation in 1960.

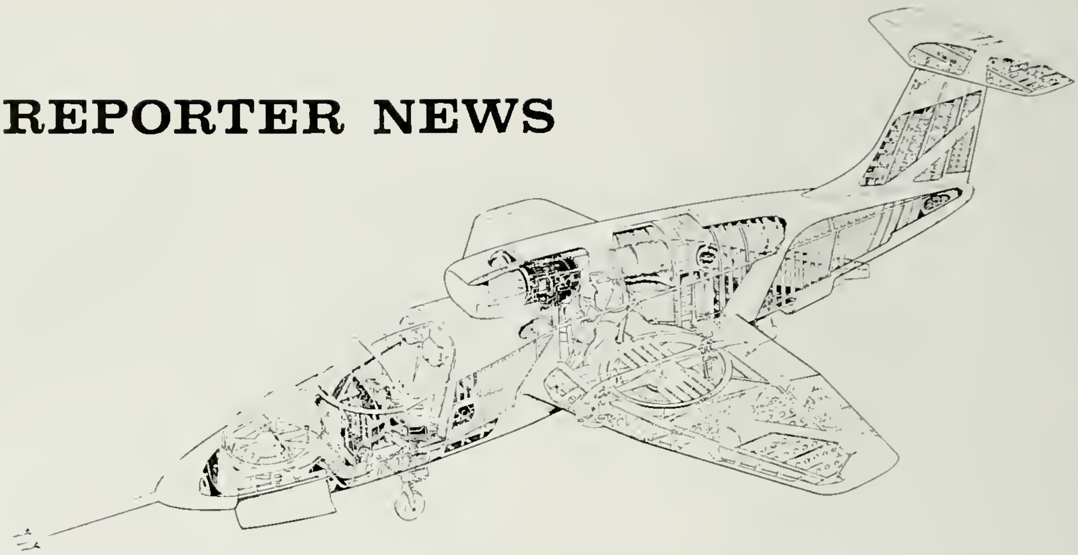
RYAN IS CONDUCTING FIREBEE OPERATIONS FOR ATLANTIC Fleet units - at the Roosevelt Roads Naval Station, Puerto Rico, under a year-long contract from the Bureau of Naval Weapons.

Under the Navy contract, first of its kind awarded to Ryan, Ryan personnel provide Q-2C target missions for surface-to-air firings of shipboard anti-aircraft missile crews, and air-to-air firings by fighter-interceptor aircraft of the Atlantic Fleet.

FIREBEE TARGET SERVICE CAPABILITY EXTENDED AT WHITE Sands Missile Range, New Mexico, by the U.S. Army.

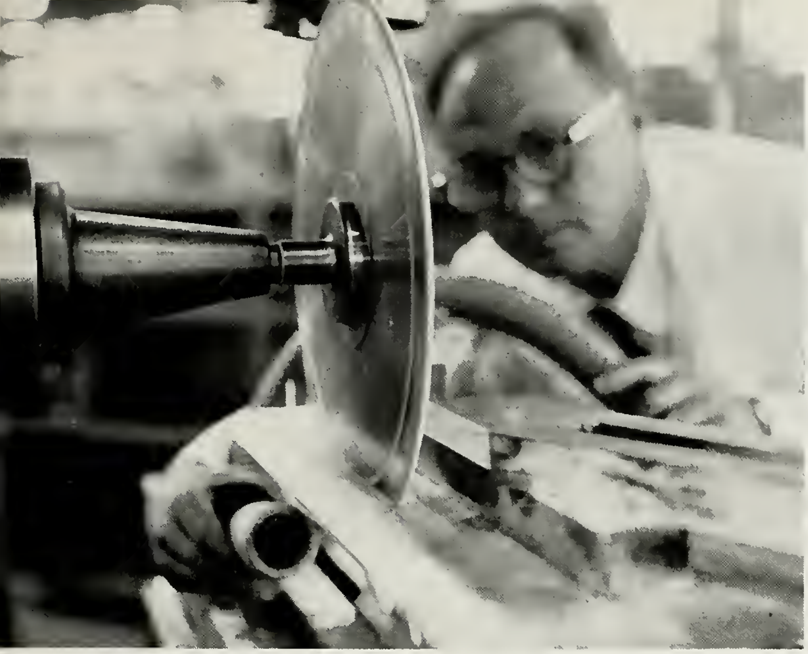
A contract for more than $850,000 has been awarded by the U.S. Army Ordnance District, Los Angeles, authorizing the Ryan flight crew at White Sands to perform all necessary Firebee flight services for the 1962-63 fiscal year. About 30 Ryanites are stationed at the desert range, where the Army has been conducting ground launchings of Firebee jet targets - in support of surface-to-air missile programs - since 1959.

REPORTER NEWS



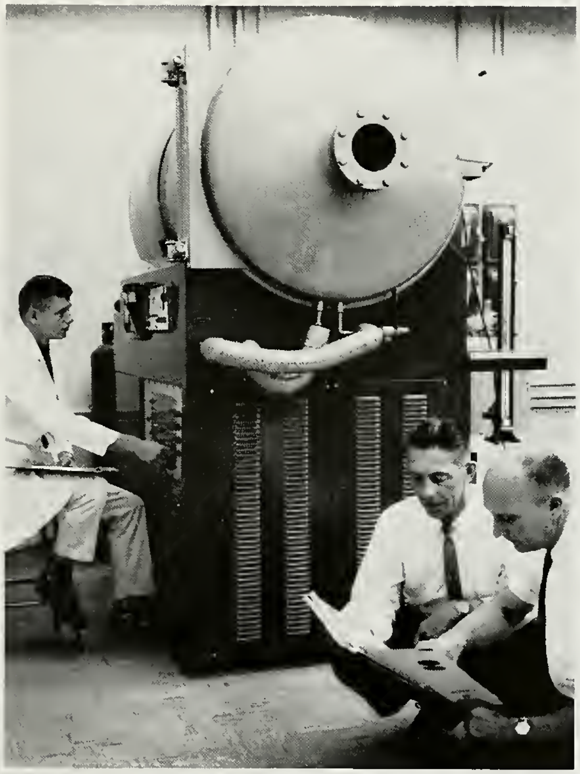
A Dramatic Cutaway illustration of the U. S. Army's VZ-11 lift fan research aircraft which the Ryan Aeronautical Company will design, build and flight test under contract to General Electric and the Army, reveals the unique wing and nose fans that power the aircraft for vertical take-off. Combining the advantages of hovering with high speed performance, this concept employs the thrust from fans submerged in the wings for vertical take-off and landing, and normal horizontal thrust from its two J-85 jet engines for conventional flight. First flights for two VZ-11 aircraft are scheduled for mid-1963.

Plucked from the Atlantic Ocean, Astronaut Scott Carpenter is hoisted aboard a Navy Sikorsky HSS-2 helicopter equipped with a Ryan Electronics APN-130 Doppler navigation system. The automatic Doppler equipment helped pinpoint Carpenter's location after his Project Mercury capsule, Aurora 7, landed 200 miles from the designated recovery area.

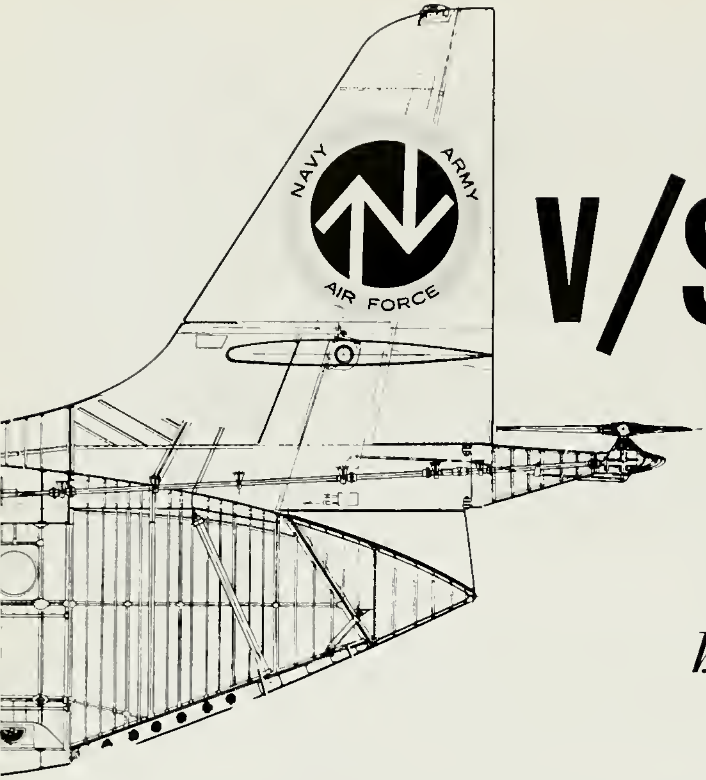


To Solve a plastics cutting problem, Ryan industrial engineers used a standard metal cutting mill equipped with a high speed head and standard stock diamond cutter to slash 40 hours plastic machine time to 4 hours. The technique was used to create a close tolerance splice for a Ryanav navigation system radome. The second piece was machined in two hours and engineers predicted production cuts could be completed in five minutes—floor-to-floor. The head can be used on standard mills, planers and Bullards to cut fiber glass or honeycomb, with diamond cutters or valve stem cutters.

The World's Champion floating Firebee gets a coat of paint in Hawaii after floating 13 months and 3 days in the Pacific Ocean. The target, was "shot down" off the California coast on the Pacific Missile Range on May 3, 1961. Scratched from Navy records as lost, it drifted nearly 2400 miles before being picked up June 6, 1962 by the fleet oiler, USS Chemung, 150 miles southwest of Oahu Island.



New "Deep Space" chamber is checked out by Ryan engineers after its installation in the Environmental Test Laboratory at Ryan Electronics. The high vacuum thermal space simulator evaluates equipment designed for space vehicles under conditions encountered in leaving the earth's atmosphere, traveling or orbiting in space, and on re-entry.

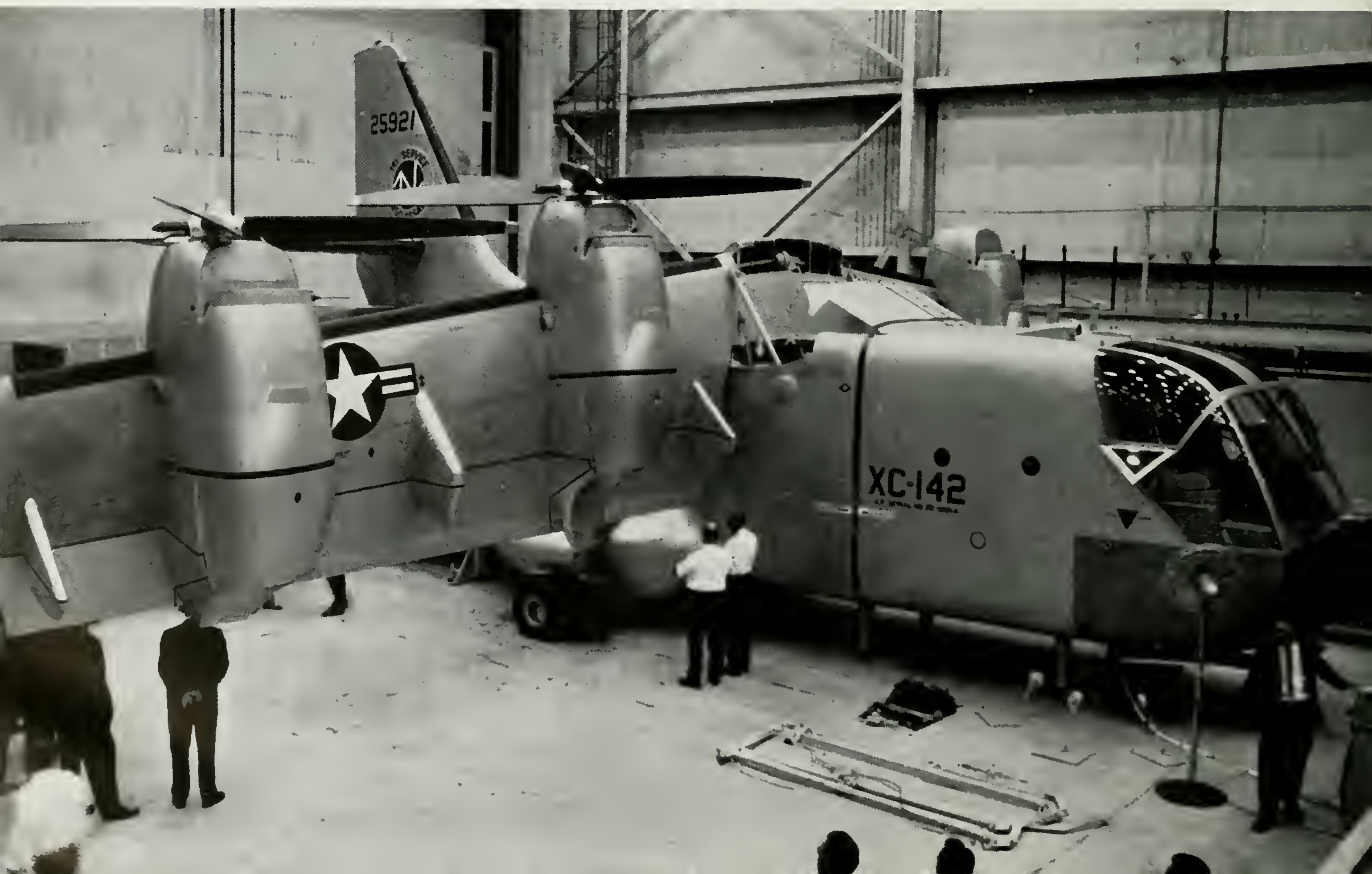


V/STOL—XC-142

by D. H. Williams
Tri-Service Program Manager
Ryan Aerospace

The marriage of helicopter mobility and aircraft speed becomes reality!

Air Force, Navy and Army officials are joined by Federal Aviation Agency, British Ministry of Aviation and Canadian Defense Research Board representatives in examining the full-scale mockup of the XC-142. The mockup is the forerunner of five full-scale tilt-wing V/STOL transports.



THE VITAL KEY TO SUCCESS for the military forces of today is mobility—intra-theatre mobility. Men, machines, supplies — everything needed to insure success of land, sea, or air operations—have to be able to move fast and go almost anywhere on short notice.

To aid in this complicated mission, the three-company team of Vought, Hiller and Ryan were selected early this year to furnish the military with an experimental transport capable of taking off and landing vertically, in all types of weather, and in all types of terrain. Obviously, these three companies were not just chosen at random. They were chosen because they could draw upon years of experience in V/STOL aircraft design and construction.

The XC-142 Tri-Service Transport is the result of this combined effort — answering the Defense Department's problem of providing tactical and logistics transportation to any place in the world.

The Vought-Hiller-Ryan team will develop and fabricate five of the experimental vertical and short take-off and landing airplanes to investigate procedures and techniques associated with V/STOL transport operations in the 1965-1970 time period.

Mockup Review

A complete full scale XC-142 airplane, cockpit, and cockpit lighting mockup was recently demonstrated for the military services by the Vought-Hiller-Ryan team. The extreme interest in the aircraft and its importance was evidenced at the mockup demonstration, held at Vought's Dallas, Texas plant, by the large number of U.S. Air Force, Army and Navy attendees, plus representatives from the U.S. Federal Aviation Agency, British Ministry of Aviation, and Canadian Defense Research Board.

Emphasizing the effectiveness of the Vought-Hiller-Ryan team, no major changes in concept or design were suggested by the U.S. Air Force, Army and Navy tri-service customer. Only a few minor changes, in the interest of standardization and maintenance simplification, were requested.

The XC-142 Tri-Service Transport is a V/STOL aircraft that will swiftly transport troops, supplies, and equipment from assault ships or airfields into unprepared areas under all weather conditions. Employing a unique tilt-wing enabling it to takeoff and land vertically or in short distance, depending on the terrain, the transport can fly 200-300 miles — fully loaded — at a cruising speed of 250-300 knots. The cargo compartment

The XC-142 is a V/STOL aircraft that will be able to swiftly transport troops, supplies and equipment from assault ships or airfields into unprepared areas under all-weather conditions.

holds 8,000 pounds of equipment or supplies, or 32 combat-ready troops. Used as a "flying hospital," it can carry as many as 24 litter patients.

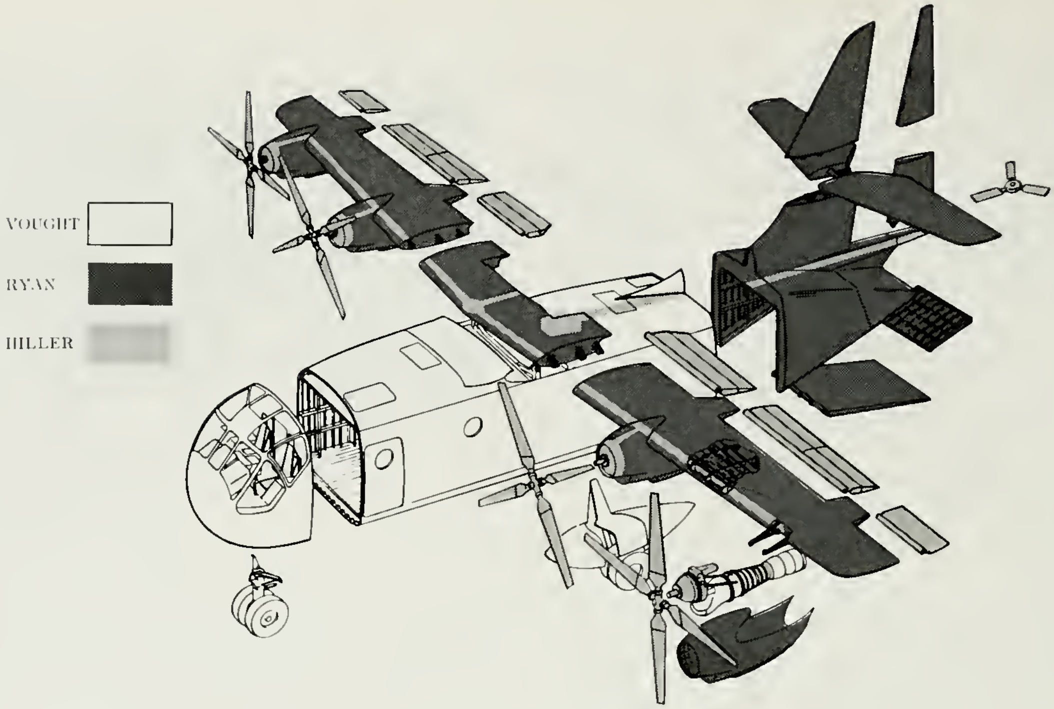
Design features of this transport will make it the most versatile and mobile aircraft in the military service. Major design emphasis has been placed on mission flexibility, performance, flying quality, reliability and growth potential. Control and stability efforts have been toward a safe simple, integrated system compatible with existing hardware wherever possible, with fail-safe arrangement, and with automatic back-up application in critical areas.

The plane's four T-64-GE-6 engines drive four conventional fifteen and one-half foot, four-blade propellers and a horizontally-mounted eight-foot tail rotor. Safety features include a system of cross-shafting connecting all four engines and tail rotor. Over-riding clutches are provided so that the plane can remain aloft with a minimum of two engines in operation. Dual synchronized wing tilting actuators provide "fail-safe" reliability.

A mechanical integrator linkage that transmits cockpit control motions to the proper control surface as a function of wing incidence is a unique feature of the XC-142's flight control system. A dual four-function stabilization system gives the transport stability during IFR flight, hovering, and transition. The hydraulic system is used for engine starting, power control, and stabilization, as well as utility and emergency systems operation.

Tilt Wing

The wing is mounted on the fuselage at four points and will tilt through an angle of 100 degrees, allowing the XC-142 transport to hover in a tail wind. The wing has full span, double-slotted flaps with the aft outboard sections operating independently as ailerons. The horizontal tail



In the joint contractor program Ryan will design and construct the aft fuselage section, including tail surfaces, engine nacelles and wing panels. Vought is the system manager and Hiller will design and fabricate the power transmission systems.

is a single movable unit, shaft-supported on two bearings by the vertical tail.

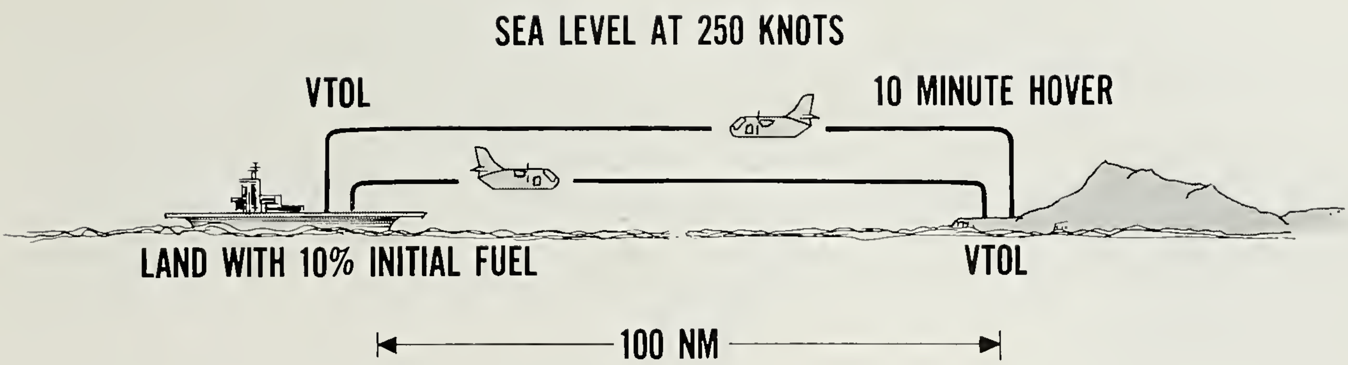
Structure of the fuselage is semi-monocoque, composed of bulkheads, frames, skins, longerons and stringers, all built to allow for maximum cargo space throughout the length of the plane. Usable internal area of the cargo-troop compartment measures 7½ feet wide, 30 feet long, and 7 feet in height.

To facilitate cargo loading, the fuselage is only three feet from the ground with the undersurface lowering to form a ramp. Loading can be accomplished via this ramp, located at the rear of the plane, or through a forward side access door. Heating and ventilating facilities maintain an environment compatible with personnel and cargo requirements.

Three primary generator systems and an emergency generator comprise the electrical supply. In normal conditions, only two primary systems operate at one time.

Aiding in normal flight during all types of

Mockup review officials asked for only minor standardization and maintenance simplification changes in the basic aircraft design. Unique features of the transport will make it the most versatile and mobile aircraft in the military service.



Navy-Marine Assault Mission

weather conditions are the de-icing system, a fully powered flight control system, stabilization system, automatic switching in event of generator failure, and instrumentation for IFR.

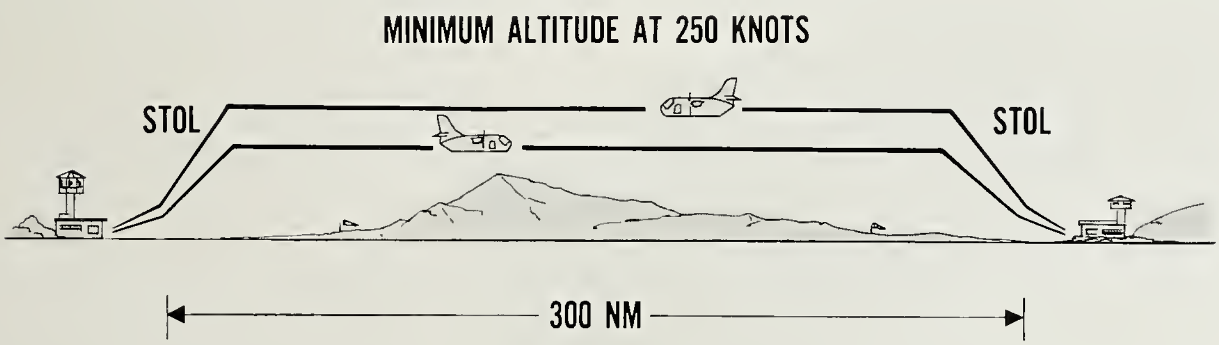
Two bladder-type cells in the top of the fuselage hold the fuel, which flows from a sump in the forward cell to dual cross-shaft-driven booster pumps, then into engine inlets. An auxiliary cargo compartment tank can be installed for ferry missions.

The XC-142 transport's cockpit configuration and instrumentation makes maximum use of available space by providing side-by-side pilot and copilot seating, with the crew chief seated behind the cockpit's center pedestal.

Maximum visibility — down angle of vision in particular — is a key requirement in vertical take off and landing. Cockpit instrumentation displays in the XC-142 are arranged to give adequate scanning without compromising this necessary external visibility requirement. A control stick is used for precise maneuvering in hover and low-speed forward flight, and a collective control lever provides altitude control during hovering.

The problem of U.S. Air Force, Army and Navy intra-theater mobility is a challenging one — develop a tactical and logistics transport incorporating the V/STOL advantages of a helicopter with the speed of an airplane; make it versatile enough to operate from all kinds of landing areas or vessels in all types of weather — yet economically feasible, giving high performance at low cost.

The success of the recent XC-142 Tri-Service V/STOL Transport mockup demonstration indicates that the Vought-Hiller-Ryan industry team is well on its way in helping solve this problem, making intra-theater mobility a reality. ■



Army-Tactical Transport Mission

HELO FLY-IN

Ryanav system returns home aboard sub-seeker.

27 01

EMPLOYEES AT RYAN'S manufacturing facility in Torrance, California were thrilled recently by the landing of a giant Sikorsky HSS-2 twin turbine jet helicopter inside the grounds at the plant. The purpose of the "fly-in" was two-fold —first to let the employees see how the Doppler navigation equipment they produce is installed and used in one of the free world's most important anti-submarine warfare weapons, and secondly to coincide with a plant inspection tour by a group of U.S. Navy officers. Among these were Captain F. R. Roberts, Commanding Officer, NAAS Ream Field, and Captain G. W. Okerson, BuWeps Representative in San Diego.

The helicopter, flown by Lt. D. E. Cooley, was from Squadron HS-10 based at Ream Field located a few miles south of San Diego. Also aboard was the squadron's commanding officer, Cdr. A. E. Monahan.

Ryan officials and Navy officers toured the Torrance electronics manufacturing facility following the HSS-2 fly-in. The group included (l to r) A. E. Svitil, Torrance Factory Manager; Fred Rathert, Assistant Operations Manager-Torrance; A. Auerbach, Director-Manufacturing Programs; Commander A. E. Monahan, Commanding Officer HS-10; Captain F. R. Roberts, Commanding Officer, NAAS Ream Field; and H. L. Fontaine, Ryan Vice President, Manufacturing.

Self-contained Navigator

The HSS-2, which is the world's largest and fastest amphibious helicopter, is equipped with Ryan Electronics' AN/APN-130 Doppler navigators. These sets are a key part of the HSS-2's anti-submarine warfare system. It is completely self-contained and gives the HSS-2 an all-weather, day or night operational capability.

The AN/APN-130 is a high performance Doppler navigator which automatically and continuously measures and displays heading speed, drift speed, and vertical speed without the aid of ground based radio, wind estimates, or true air speed data.

With the AN/APN-130 in the HSS-2, the pilot can command a fully automatic maneuver from normal cruising through transitions in both speed and altitude to a hover.

The HSS-2 is designed to operate from carriers and can be airborne within five minutes of an alert. With Ryan Doppler, it can hover for extended periods while dipping its sonar to detect submarines. The helicopter carries explosives to kill submarines once they are detected. ■

Ryan Electronics technicians inspect the Ryan AN/APN-130 Doppler navigator installation in the Navy HSS-2 anti-submarine warfare helicopter.

How to navigate over unknown enemy terrain?

27-01

Over strange jungles, deserts, mountains, seas—the most practical answer to aerial navigation yet devised is the new Ryanav IV Doppler Navigator developed by Ryan Electronics.

Without outside navigational aids, the self-contained, accurate and reliable Ryanav IV makes possible precise all-weather navigation of Army, Marine and Navy (anti-submarine warfare) helicopters. This system also has universal application to a broad spectrum of fixed wing aircraft, ranging from V/STOL to supersonic types.

World leader for 15 years in the design, development and large-scale production of Doppler navigators, versatile, fast-moving Ryan is also making significant contributions in other space age areas.

For example, Ryan is building the newest concepts in vertical take-off aircraft. And today, as for years past, Ryan is the major supplier of advanced jet target drones for all the Armed Services. Among other Ryan activities are Flex Wing applications, electronic systems for lunar landings, and structures for space vehicles.

Your inquiry is invited concerning these and other capabilities of Ryan Electronics and Ryan Aerospace in the design, development and fabrication of space age products.

RYAN AERONAUTICAL COMPANY, SAN DIEGO, CALIFORNIA

TACTICAL AIR MOBILITY *requires low-speed, low-altitude operations which depend upon precise navigation. Ryan Doppler Navigators are uniquely suited for these missions because of freedom from low-altitude limitations.*

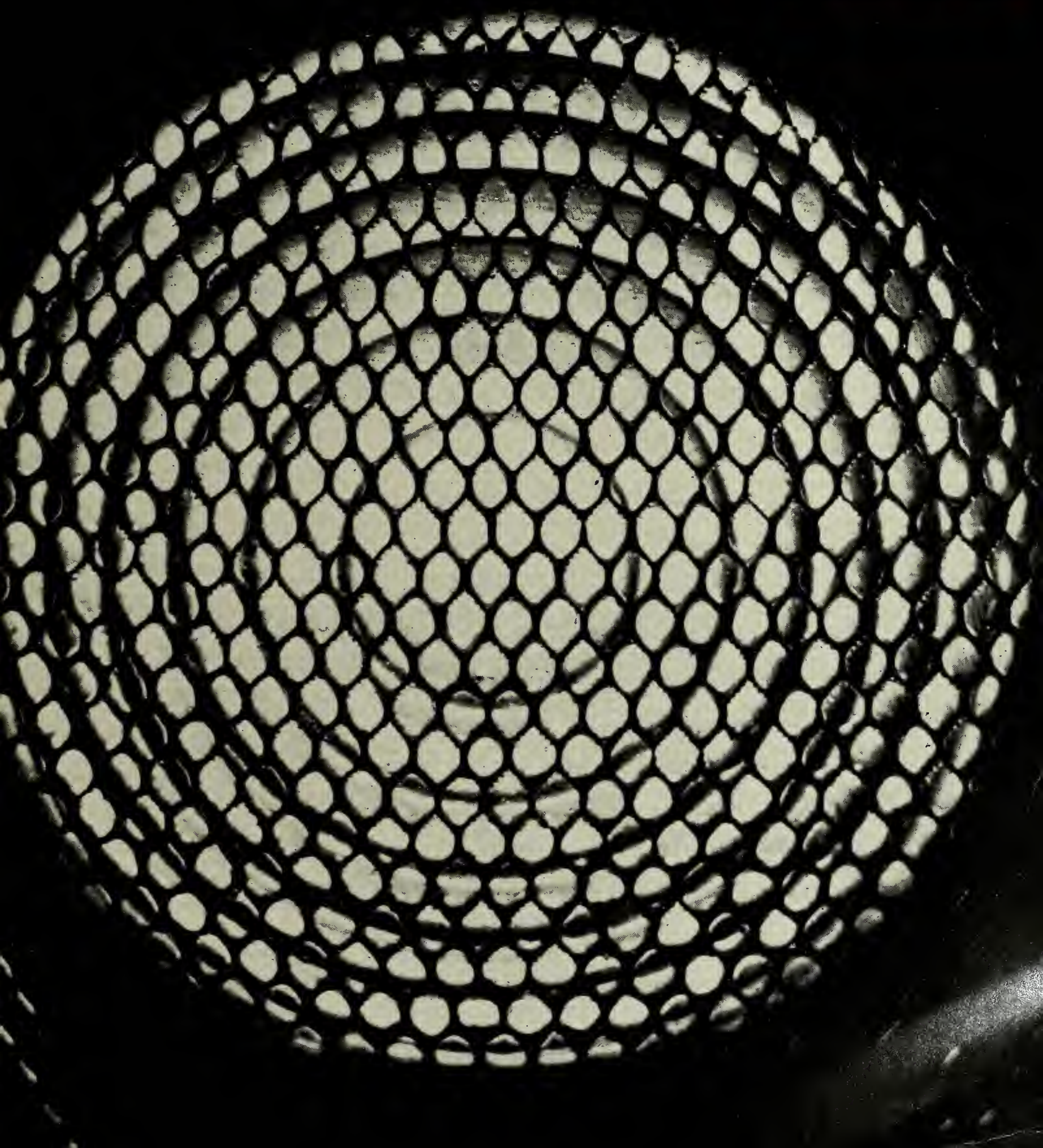
ANTI-SUBMARINE WARFARE. *Ryan pioneered the application of Doppler to Anti-Submarine Warfare missions and is the principal supplier of this equipment for both rotary and fixed wing aircraft in the United States and abroad.*

"ON THE DECK" *navigation at supersonic speeds can now be successfully achieved with the new Ryanav IV Navigational System with capabilities ranging from zero speed to 2000 knots at altitudes from take-off to 70,000 feet.*

RYAN
ELECTRONICS

RYAN REPORTER

SEPT.-OCT./1962



RYAN REPORTER

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About the Cover: Light forms a dramatic pattern behind the epoxy cover of a Ryanav IV antenna, to simulate the continuous wave Doppler effect in an intriguing cover photo. (Article, page 18.)

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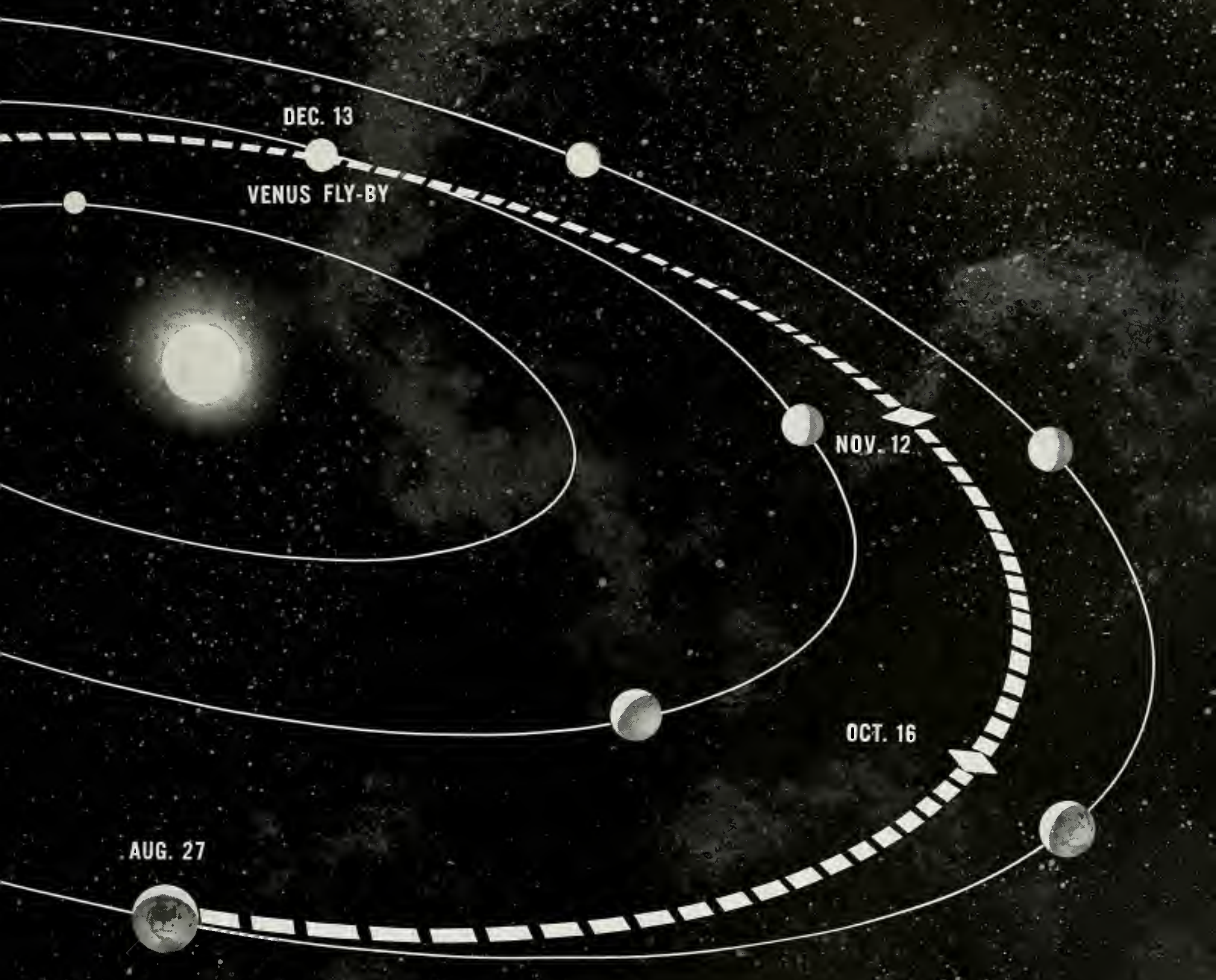


to Venus and beyond...

In August National Aeronautics and Space Administration scientists took the longest stride yet attempted in the nation's space program—they launched the 447 pound Mariner II spacecraft atop an Atlas-Agena B vehicle on a 191 million mile journey to the vicinity of the planet Venus.

September 4, a planned midcourse correction was carried out from the Mariner control station at the Jet Propulsion Laboratory in Pasadena, and the flight path of the spacecraft is now predicted to carry Mariner II within several thousand miles of the planet in December.

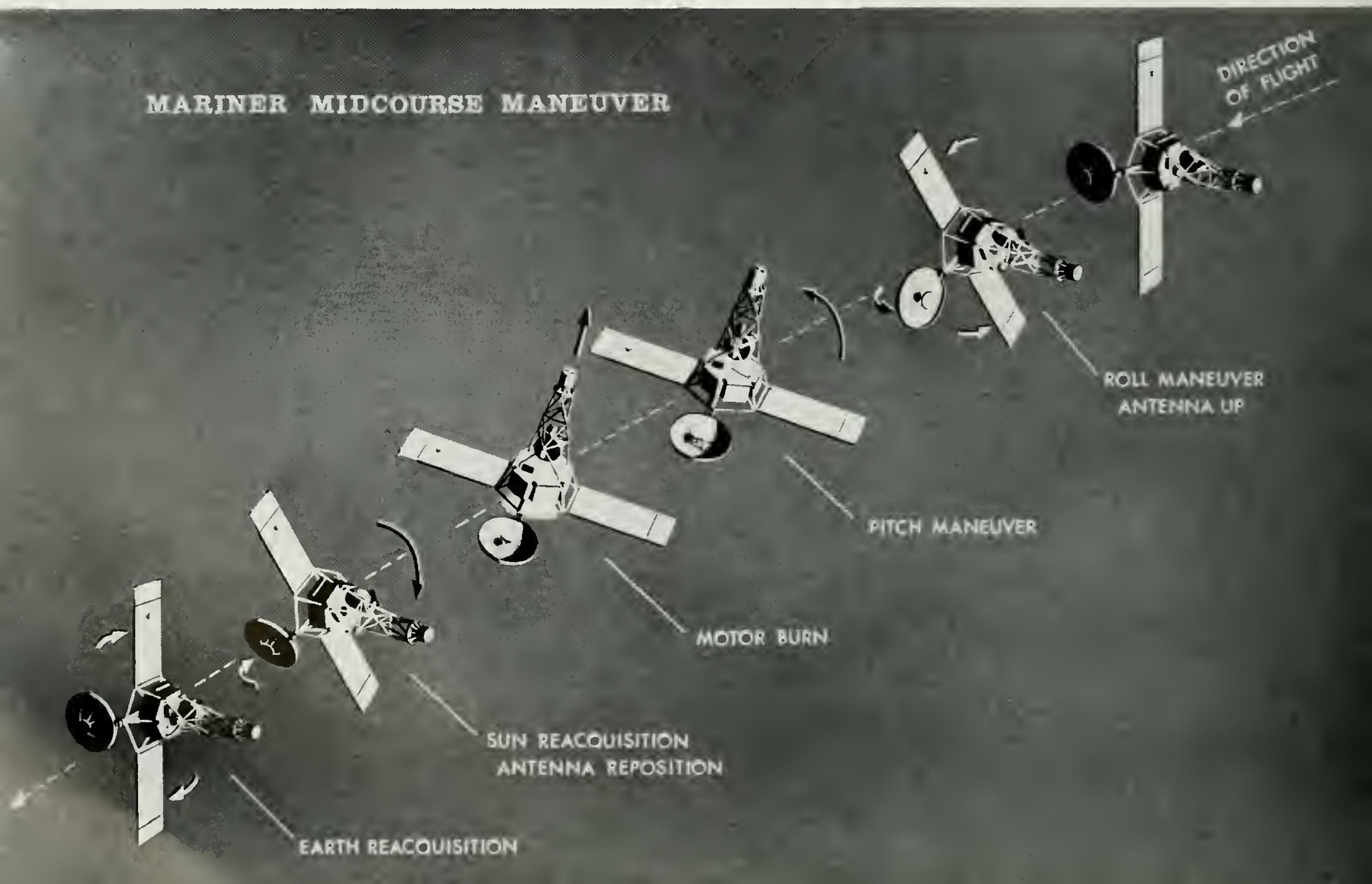
Fred D. Kochendorfer, Mariner program chief in the NASA office of Space Sciences said "Mariner II has already demonstrated that the United States has moved forward in the development of a controllable spacecraft."

Aboard Mariner, two rectangular-shaped solar panel structures are the first Ryan-built assemblies ever to penetrate the darkness of outer space. A vital component of the spacecraft, the panels each are 29½ inches wide and 60 inches long.

The panels were designed and fabricated for the Mariner program under a contract to the California Institute of Technology's Jet Propulsion Laboratory. Ryan began the design of the panels in August 1961 and fabrication began in September, and signify Ryan's growing emphasis on projects with space applications. W. M. "Mac" Cattrell was project engineer on the program under the direction of Wes Vyvyan, Design Engineering Manager.

According to Cattrell, the panels were designed to incorporate low weight, high strength, and heat dissipating characteristics. To meet these requirements a spotwelded corrugated aluminum structure, to which a thin aluminum skin was attached, was selected. "For this mission", Vyvyan said, "this structure is considerably lighter than honeycomb, and it has the thermal characteristics allowing efficient solar cell performance. Specifications called for vibration tests on the completed panels to simulate launch conditions. To prevent overheating and to maintain solar cell efficiency, the undersides of the panels were coated with a special black coating to promote cooling."

At launch, the hinge-mounted panels were folded up alongside the spacecraft. In space, exactly 44 minutes after launch, explosive pin pullers holding the solar panels in their launch position were detonated to allow the spring-loaded solar panels to open and assume their cruise position. In this configuration the span of



the Mariner craft is 16.5 feet. A command antenna for receiving transmission from earth is mounted on one of the panels. The tip of each panel supports nozzles used to orient the vehicle toward the sun.

Ryan's first Mariner program proposal was made in January 1961, and the first contract was received in March 1961.

To transport the delicate assemblies JPL provided several panel trucks with custom-built bodies. Ryan designed and built tubular structures to mount the panels in the trucks.

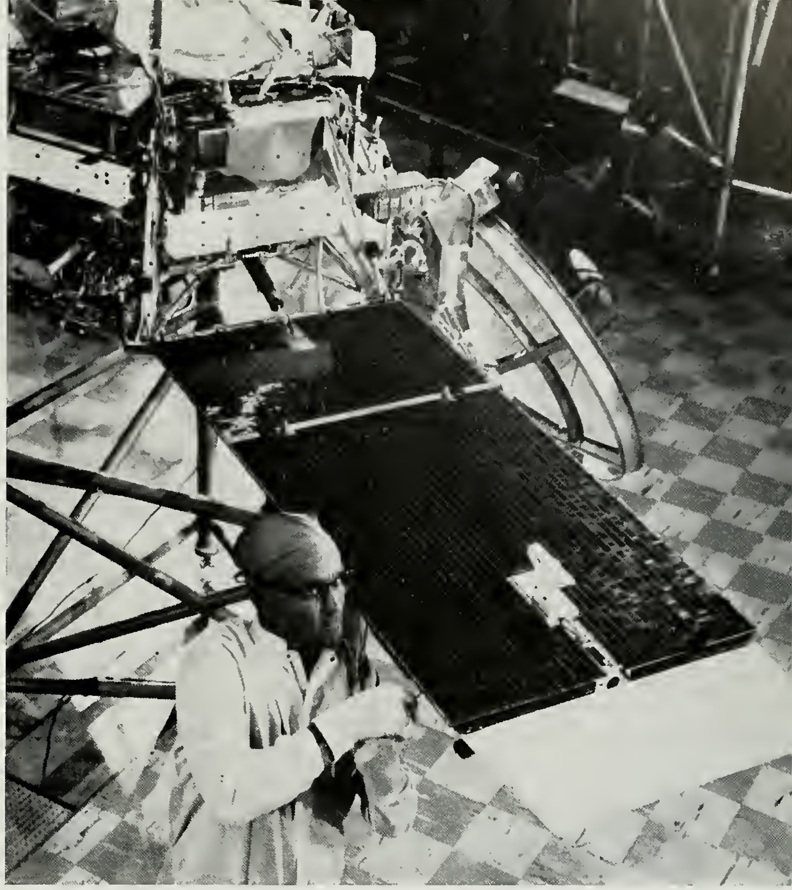
Mariner II carries six experiments, two of which will make measurements at close range as the spacecraft flies by Venus and communicate this information over an interplanetary distance of 36 million miles. Mariner is to determine: (1) the planet's surface temperature and atmospheric details, (2) any fine structure of the cloud layer, (3) changes in planetary and interplanetary magnetic fields, (4) charged-particle density and distribution in space and near Venus, (5) the density and direction of cosmic dust, and (6) the intensity of low energy protons from the sun.

Scientists over the centuries have accumulated relatively little true data on Venus. Our closest planetary neighbor, Venus is in an orbit between the earth and the sun. Traveling at the speed of 78,300 miles an hour, the Venusian year is approximately 225 days. Its average distance from the sun is 67,200,000 miles.

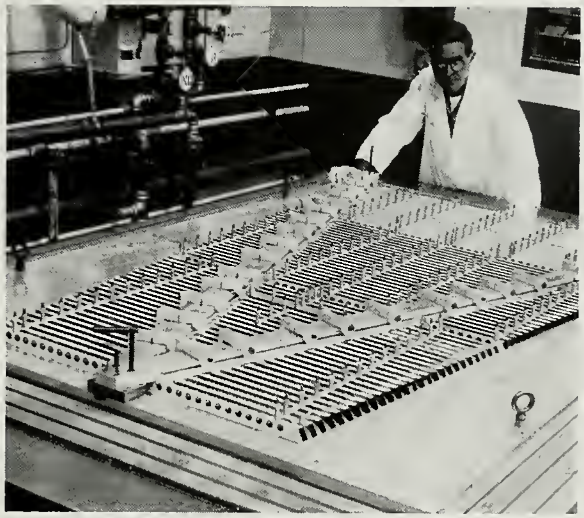
Venus has been referred to as the earth's twin. It has an estimated diameter of 7800 miles, as compared to 7926 miles for the earth.

Spectographic studies seem to indicate that the Venus atmosphere contains carbon dioxide and nitrogen, but probably little free oxygen or water vapor. Measurements taken in the infrared region of the electromagnetic spectrum indicate that temperatures of minus 38 degrees F. exist somewhere in that atmosphere. The microwave regions, however, show temperatures of 615 degrees F. at or somewhat near the surface.

The surface temperatures, however, are still in doubt. Scientists are not in agreement as to the altitude from which these temperatures emanate. One theory holds that a Venusian ionosphere, with thousands of times the electron density of the earth, gives the impression that the planet is extremely hot. Another explains that the high temperatures are due to a "greenhouse" effect in which the sun's energy is trapped beneath the dense clouds. A third theory holds that the surface of Venus is heated by friction produced by high winds and dust clouds. ■



Ryan-built lightweight solar panels, which support thousands of tiny photoelectric cells, are adjusted on Mariner II spacecraft at JPL in Pasadena, California.

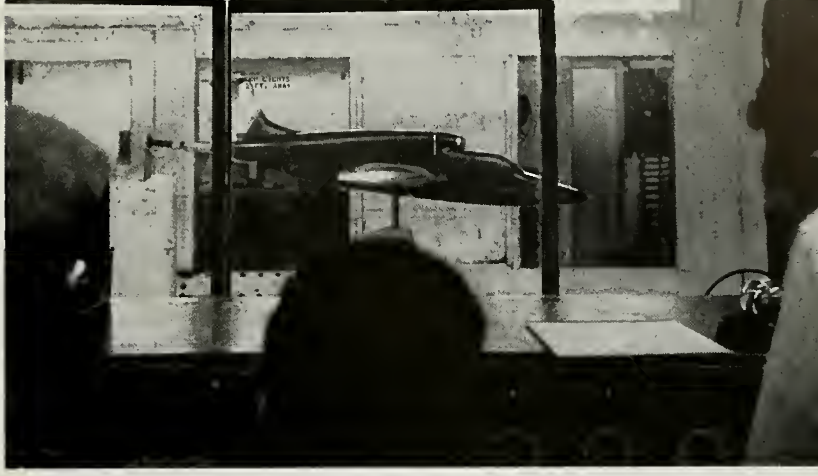


The panels were designed to incorporate low weight, high strength, and heat dissipating characteristics. Ryan selected a spotwelded corrugated aluminum structure, to which a thin aluminum skin was attached.

Full scale U.S. Army XV-5A wind tunnel model tests at NASA's Ames Lab typify Ryan's intensive testing program.

TUNNELS MOMENTS FORCES & XV-5A*

*formerly VZ-11



Ryan Aeronautical Company, in the design, construction and flight test of the U. S. Army XV-5A, is conducting an exhaustive wind tunnel test program on the dramatic new jet fan-in-wing VTOL.

Ryan engineers adjust a XV-5A test model on an external balance in the low speed tunnel.

The full scale wind tunnel test model clearly shows the wing fan propulsion system in a hovering configuration, butterfly doors open. Ryan is designing and building two XV-5A research aircraft under contract to General Electric who is also providing the lift fan propulsion system.


726430

V/STOL BY VERTIFAN

by John M. Peterson
*Assistant Chief Engineer,
Aircraft Development
Ryan Aeronautical Company*

THE RYAN VERTIFAN (fan-in-wing) concept can be applied to suitable V/STOL missions to increase our military posture at costs which are conceivably lower than the costs of operating today's conventional aircraft weapon systems.

Since 1955, Ryan has been directly engaged in studies of V/STOL aircraft utilizing the Vertifan concept. In this work, Ryan completed a U.S. Air Force contract to develop the parameters for well-matched fan propulsion system and airframe configurations.

Prior to work with the Vertifan concept, Ryan had amassed an extensive background (nearly 3 million man-hours) of V/STOL engineering experience. This was gained in the development of the YO-51 pioneer Army STOL aircraft, the VZ-3RY deflected slipstream research aircraft for the Army and the X-13 Vertijet, world's first jet VTOL aircraft, for the Air Force. In 1961, Ryan focused this experience to produce a proposal which was selected as the winner of the U.S. Army VZ-11 V/STOL research aircraft design competition.

V/STOL AIRCRAFT SPECTRUM

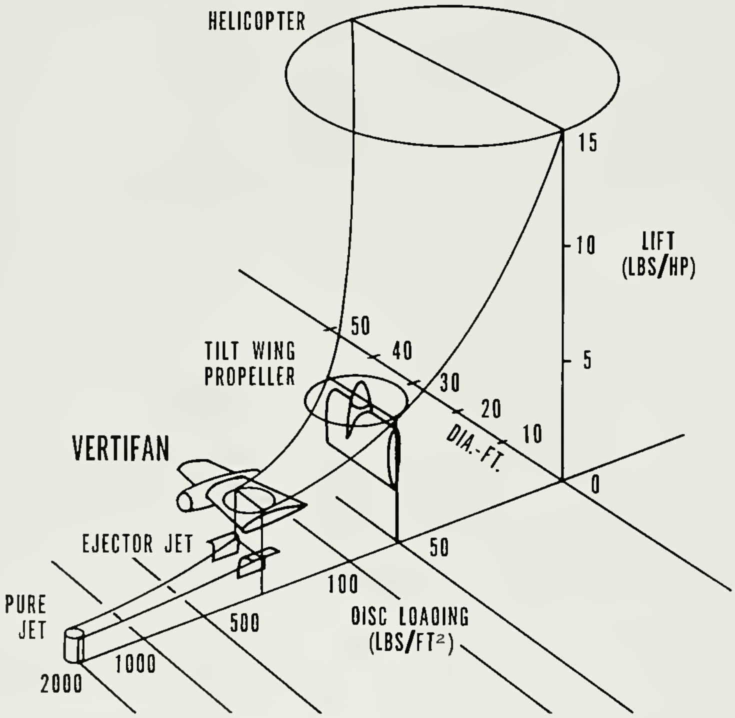


FIGURE 1

V/STOL Aircraft Design

Vertical lift, as applied to aircraft, is obtained by accelerating a mass of air to some finite velocity. The resulting thrust (lift) is equal to the product of the mass flow of air and the velocity to which it has been accelerated; i.e.,

$$T = wV$$

T = thrust (lbs)
w = mass flow (slugs/sec)
V = velocity (ft/sec)

All vertical lifting aircraft are based on this principle. In terms of vehicle design, helicopters produce lift by accelerating a very large mass of air to a relatively low velocity per unit time. Propeller type VTOL aircraft accelerate a smaller mass of air to a higher velocity per unit time, and so on through to jet propulsion systems which accelerate a very small mass of air through their compressor increasing the energy level by adding fuel and burning to create a very high exit velocity. Therefore, to provide a given amount of lift, each system accelerates a certain mass of air to a finite velocity per unit time, the product of which is identical for a given amount of lift for each type of vehicle.

A criterion for the selection of a propulsion system for a given amount of lift is to define efficiency.

Work per unit time (power) expended on the vehicle, is a measure of efficiency. This can be defined as:

$$P = TV/2$$

P = power (ft lbs/sec)
T = thrust (lbs)
V = velocity (ft/sec)

however, $T = wV$
therefore, $P = \frac{1}{2} wV^2$

Thrust can be obtained with infinite combinations of mass flow and velocity while the power expended on a vehicle is a function of the velocity squared to which the mass of air has been accelerated. Since mass flow (w) varies linearly while velocity (V) varies as the square, velocity is by far the most critical variable. Further, since helicopters accelerate the air mass to a very low velocity (on the order of 50 ft/sec), and non-afterburning jet engines accelerate the air mass to a very high velocity (on the order of 1700 ft sec), it can be seen that the energy expended by a jet VTOL vehicle far exceeds that of a helicopter.

Figure 1 provides a spectrum of V/STOL aircraft lifting systems. This is a general curve and shows relative rotor diameters, efficiency in terms of lift per horsepower (horsepower of the jet lift vehicles is the power being expended on the vehicle; i.e., $P = \frac{1}{2} wV^2$) and disc loading (lift divided by the rotor area). As shown here, the helicopter is the most efficient lifting device. However, the quest for more speed during cruise has led to the other V/STOL concepts.

In general, the systems on the right hand part of the curve represent low speed vehicles and speed increases towards the left to the point where jet engines occur, at which point the speeds obtainable can be either high subsonic or supersonic.

In all cases, lift is provided in excess of the gross weight of the vehicle to obtain VTOL. In the cases of the unloaded rotor and the helicopter, the total installed power for vertical flight is utilized for cruise also. In all other cases, except the Vertifan system, more power (or thrust) is installed in the aircraft for VTOL and hovering than can be efficiently utilized during cruise. Of the latter systems, the Vertifan system alone utilizes power (thrust) installed for cruise to provide hovering power by multiplication of jet engine thrust through the use of a fan.

Vertifan Concept

Ryan Vertifan aircraft utilizing fan-in-wing propulsion systems represent a very efficient and unique approach to V/STOL.

In this system the jet engine exhaust is directed by a diverter valve to impinge on turbine blades mounted on the periphery of a fan submerged in a wing parallel to the chord plane. Doors above the fan and vanes below the fan are opened to a vertical position for vertical take-off and hovering.

During transition from hovering to normal flight, the lower vanes slant aft deflecting the slipstream for forward acceleration. When normal flying speed is reached the vanes close, leaving a high-speed airfoil—the exhaust being diverted from the fan to straight thrust for conventional forward flight.

For vertical take-off engine thrust is diverted to the fan to provide lift in excess of the gross weight of the aircraft. For forward fan supported flight the lower vanes are deflected aft. When normal flying speed is reached, the vanes are closed and the exhaust is diverted to straight thrust.

In landing the vanes are opened and thrust is again diverted to the fan. The fan slipstream is directed forward to slow the aircraft to a hover. A gradual reduction in lift lowers the vehicle to the ground.

To take off with an overload the fan slipstream is directed aft immediately to produce accelerating

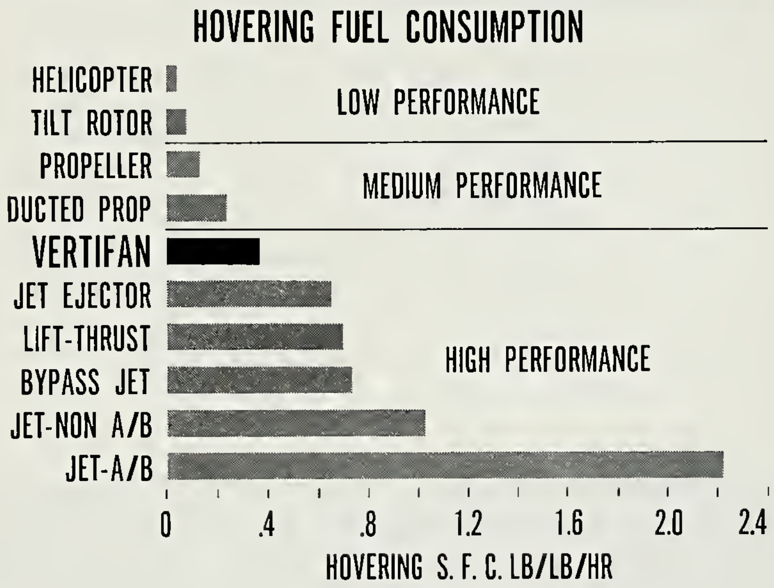


FIGURE 2

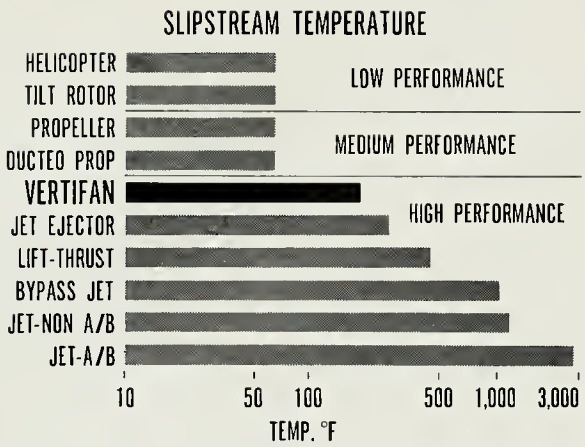


FIGURE 3

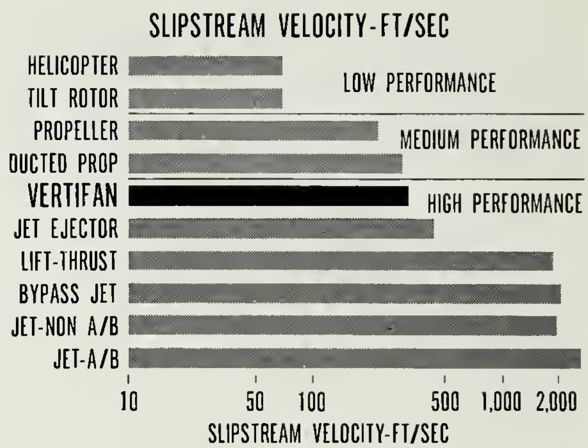


FIGURE 4

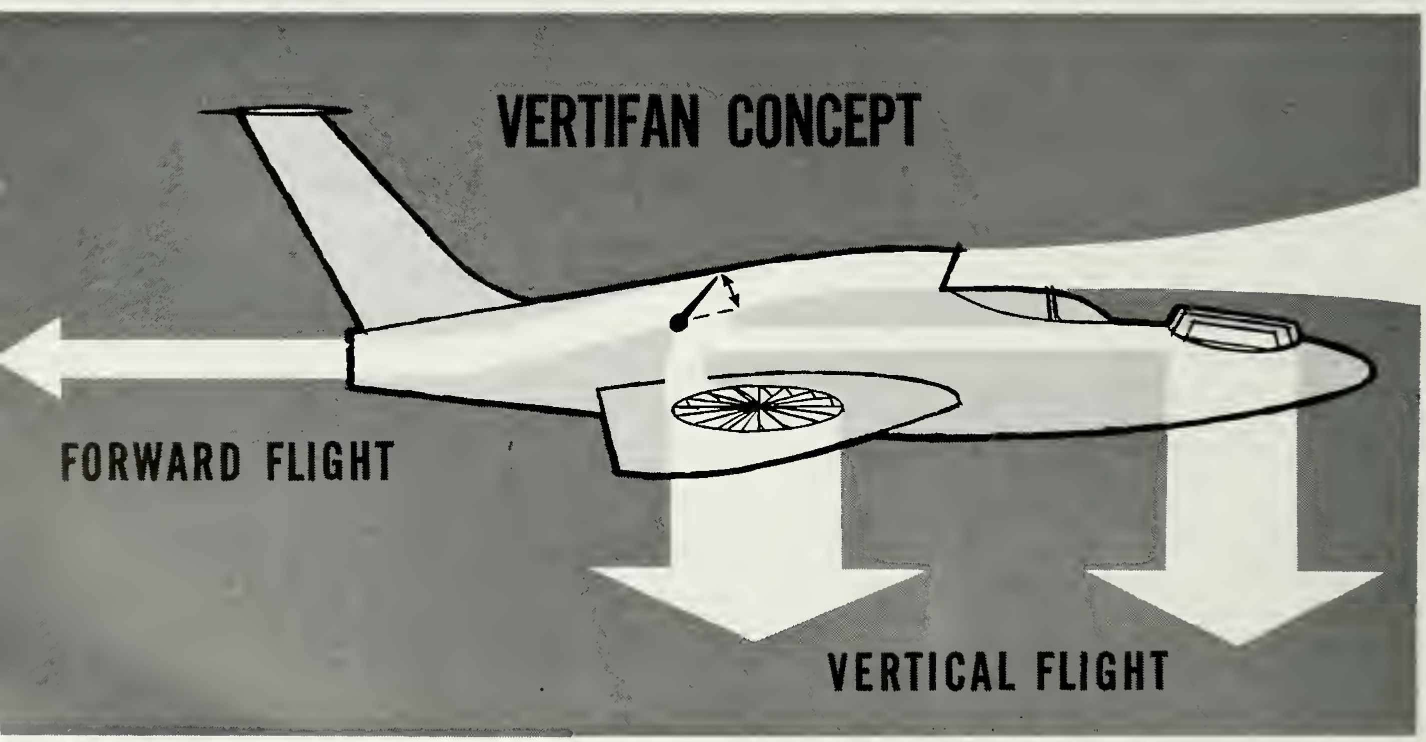
and lift force vectors. As the aircraft accelerates down the runway, the combination of lift produced by the wings and fan allows short take-off distances.

Transition to and from normal flight is similar to VTOL operation.

Figure 1 compares specific V/STOL propulsion systems in terms of hovering efficiency and disc loading. As noted in this figure, there is a significant break in obtainable efficiency between mechanical accelerators and jet accelerators. The Vertifan system represents a completely unique V/STOL system having high speed jet performance during cruise while maintaining a hovering efficiency associated only with mechanical accelerators.

Figure 2 points up the economy of fuel consumption during hover as compared to other V/STOL systems.

With respect to ground erosion, figures 3 and 4



define slipstream temperature and velocity of various V/STOL systems.

In addition to the qualities already mentioned there are several unique characteristics of Vertifan propulsion systems with respect to military weapon systems.

The basis on which the concept is built is that the jet engine thrust installed in the aircraft is matched to the airframe for its cruise mode, whether high subsonic or supersonic, and the fan is sized for VTOL. An actual multiplication of thrust is obtained by the fan which can produce a lift anywhere from 120 per cent to 400 per cent of the engine thrust. This allows the aircraft designer to size the aircraft engine for cruise rather than vertical take-off.

Of further interest, the entire power transmission is accomplished through ducting the exhaust of the basic jet engine eliminating all gearboxes and shafting for primary power transmission.

Elimination of gearboxes and shafting results in reduction of maintenance. Logistic problems are minimized by the low fuel consumption and the inherent high reliability of the ducted gas power transmission system.

V/STOL vs. STOL

Within the state-of-the-art of aerodynamic design, the aircraft designer must adjust thrust-to-weight (T/W) ratio, aspect ratio (AR), wing loading (W/S) and maximum coefficient of lift (CL_{max}) in order to obtain a specified take-off distance for any given STOL aircraft requirement. With these parameters identified, the final performance of the resulting aircraft is largely a function of empirical data applied in a logical sequence, over which the designer has little control.

Vertifan aircraft, requiring little installed jet engine thrust for true V/STOL operation as well as little dependency on wing area for take-off, is highly competitive with STOL-only aircraft designs, not only with respect to design parameters but complexity as well.

When all aspects of STOL aircraft design are summed together, including increased thrust-to-weight ratios, increased aspect ratio and/or wing area, increased control power and overall increased weight and complexity, little difference can be found between STOL-only and V/STOL Vertifan aircraft designs.

In addition, Vertifan aircraft enjoy a basic advantage over STOL-only aircraft in that, when only limited take-off and landing areas are available, Vertifan aircraft can operate with design payloads in VTOL or STOL modes, as desired, under broad variations of altitude and temperature. ■

ABOUT THE AUTHOR

Author John Peterson (standing) discusses the Vertifan program with project engineer Paul Hayek. Peterson first conceived the Vertifan principle in 1955 as a new method of combining vertical take-off and landing characteristics with high speed forward flight. The Air Force then recognized the value of his findings by award to Ryan of a preliminary aircraft design study contract. Peterson played key roles in the design of the world's first jet VTOL aircraft, the Ryan X-13, and the Army-Navy VZ-3RY Vertiplane, an experimental deflected slipstream STOL aircraft. For his Vertifan efforts, he recently received the San Diego Junior Chamber of Commerce Aerospace Award. He has been with Ryan since September, 1953.

Flex Wing – A Space

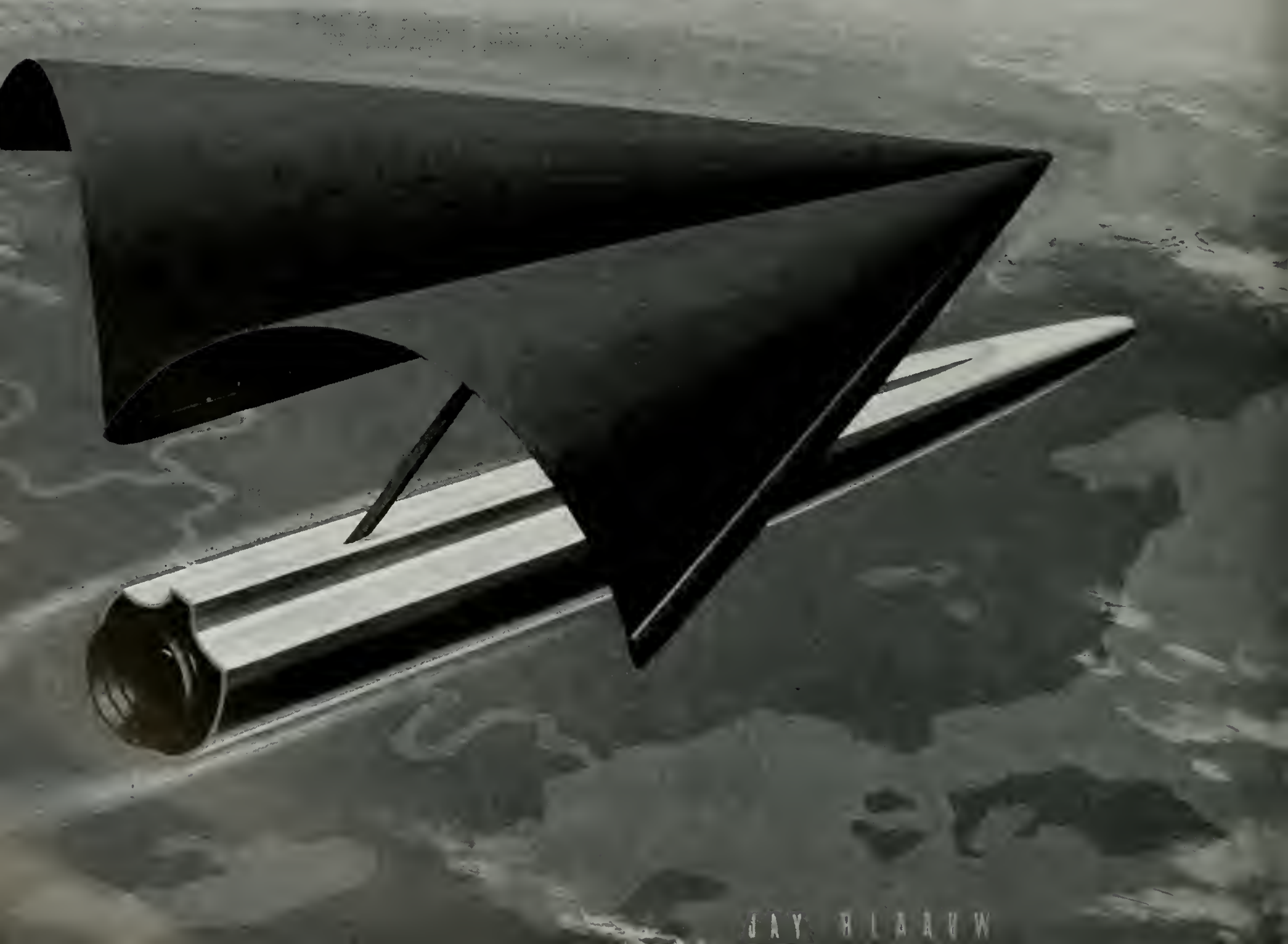
As awesome as the scientific discoveries in the penetration of space and probing of the planets is the staggering financial burden of man's newest explorations.

The development and successful launching of one space vehicle made possible by complex skills and fabrication techniques represents an unprecedented astronomical arithmetic.

One-shot missions may become a luxury of the Space Age. Recovery of vehicles from orbital velocities for repeated re-use would appear essential in the technology of rocketry.

Over and above the economic factor — and probably paralleling it in significance — is the desirability of controlling re-entry from orbital velocities in order to accomplish pinpoint landings at predetermined ground locations. As manned voyages into space become more frequent, man's return to pre-set land areas (— rather than in the broad expanses of the ocean, requiring far-flung and costly Fleet rescue operations, and expensive, time-consuming decontamination—) will become a built-in requisite of the mission. And recovery intact of instrumented packages, with their precious scientific records, would provide independence from total reliance on telemetering.

Ryan Aeronautical Company's pioneering in the application of the Flex Wing concept has led to studies of structures, erectible in space, to provide a lifting re-entry from orbit of a wide variety of space vehicles. This is in contrast with the present ballistics re-entry requiring either extremely critical heat shielding or resulting in destruction of devices and vehicles which, in the present state of the art, must be considered expendable.



Age Glider

The flexible wing, conceived by Francis M. Rogallo of the National Aeronautics and Space Administration, already has achieved unique status in the development of new military logistics techniques. In slightly over two years, Ryan — in cooperation with NASA, the U.S. Army Transportation Research Command and the Marine Corps—has participated in more programs aimed at practical applications of this concept than any other company in the United States.

The world's first manned test vehicle, built by Ryan, wind tunnel tests and NASA data have demonstrated the flexible wing's inherent stability characteristics and light loading capability. These advantages, combined with the extremely low cost of fabrication, have established the flexible wing's potential in the recovery or delivery of large and small packages, in drone surveillance, and other military applications. Now the employment of flexible winged structures, erectible in space, for increasingly sophisticated missions, bear careful consideration.

Unlike the conventional wing composed of a rigid skin covering a forming structure, the Ryan erectible wing is composed of a membrane of flexible material which is attached to the two leading edge members and the vehicle body.

The vehicle body and the two side members, or leading edges, which may be either rigid or inflatable construction, are joined at the foremost point to define a triangular envelope. The edges of the flexible membrane are continuously attached to the leading edges and the body. The wing system is joined to the vehicle by rigid structural members.

The flight trajectory is controlled by proper displacement of the center of gravity of the vehicle with respect to the center of pressure of the wing by a simple shift of the payload capsule. Roll control is achieved by differential movement of the leading edge sweep angle. Although emphasis is placed on the center of gravity shift type of control, aerodynamic controls can also be provided to solve some of the problems that may be encountered.

The light wing loadings — of 2 to 6 pounds per square foot — would accomplish controlled lifting re-entries from orbital velocities of approximately 18,000 miles per hour. In contrast with the erectible wing, the wing loadings of comparable rigid wing re-entry configurations are approximately 25 to 30 pounds per square foot.

Light wing loadings also assure low landing velocities, enabling the astronaut or ground controller to exercise considerable discretion during the approach and landing phase to assure accurate touch-down. Landings of 30 to 40 knots can be anticipated (the Ryan Flex Wing manned test bed consistently landed at 30 knots).

A major advantage of the erectible wing is its adaptability to use of currently available structural materials, despite the exotic environment to which it would be subjected. Because energy is decayed at extremely high altitudes, maximum temperatures experienced would be about 1800 degrees F. Such stagnation temperatures are well within the limits of existing materials, obviating the need for ablative coating, cooling systems, etc.

In contrast with fixed wing configuration or a ballistic re-entry, temperatures would remain so low that only a small volume of air in the vicinity of the erectible wing would be ionized. Thus, direct communication can be maintained with the vehicle at all times during trajectory, eliminating long periods of silence such as occurred during the re-entry of Astronaut Scott Carpenter.

It appears that the membrane of the wing would be of metal foil or coated wire mesh, with ceramic or glass fiber cloth under a silicone coating also offering solutions to the materials problem. The flexible wings which Ryan has built to date under government contracts for operation solely at subsonic speeds and within the atmosphere are of rip-stop nylon, coated with Mylar plastic, a material similar to that used in the Echo space balloon or dacron with polyester coatings.

Folded and stored for the launch and orbital segments of a space mission, the erectible wing would be integrated completely with the vehicle and would pose no dynamic problems on the launch booster which are associated with rigid wing configurations. Wing erection would be exercised automatically from a clock reference

Sometimes employing sailmaker's techniques, Ryan craftsmen on hands and knees fabricate a space-age glider.

stored within the vehicle, synchronized with respect to ground time reference continually corrected from the ground during orbital flight.

The erectible wing's package cover during launch and orbit would consist of the leading edge of the wing using typical aircraft construction and known design techniques.

Rather than considering the wing as an attachment to the space vehicle, it would be fully integrated into the system to realize the best characteristics of the wing. For example, a manned capsule would be inside a fuselage suspended from the wing; an Atlas-size booster would be designed so that its tankage would in effect become the fuselage carrying the fuel, with the tankage thus incorporating the wing.

Retrorockets for escape from orbital velocity would be in the fuselage, in which the payload is housed.

Landing speeds would be so low that a skid attached to the fuselage could be effectively employed.

In the welded corrugated members of the erectible wing's structure, existing high temperature materials, such as Rene 41 nickel alloy, would be employed. The wing leading edge consists of a welded corrugated structure supported by the erecting spreader bar and the wing apex hinge point. The erecting spreader bar provides bending rigidity for the wing loads.

Wing erection from the stored position would be accomplished by movement of the spreader bar along the erection track. The system is electrically actuated and driven on command. Manual override deployment is possible, if desired, through the wing keel.

Fuselage and payload capsule structure would be composed of longerons and frames with a corrugated structure skin. The lower fuselage longeron would serve also as the landing skid, thus eliminating heavy weight conventional gear.

On a typical space mission, at conclusion of orbital flight, ground control would begin with the vehicle oriented to a pre-determined angle in the orbital plane. Wing erection would then be commanded and the retrothrust for orbital departure initiated.

The retrothrust would provide a decay velocity, resulting in a re-entry angle of less than minus 2 degrees. Attitude control during these maneuvers would be provided by a jet reaction system, and would remain in continuous operation until fuel expenditure. As penetration occurs, aerodynamic forces increase, permitting effective center of gravity control.

Re-entry, down to a velocity of about 10,000 feet per second, would be automatically controlled by the autopilot in response to the temperature controller. The deceleration period from 10,000 feet per second to lower velocities occurs within the last 2,000 miles of range, during which portion of trajectory the angle of attack can be modulated by the control station for pinpoint landings. Banking during the re-entry maneuver would provide for landing site selection of up to 700 nautical miles.

During the final glide phase, the vehicle would be within the vicinity of the landing area and at an altitude of about 200,000 feet. Correction for

This Ryan Flex Wing is made of rip-stop nylon, coated with Mylar plastic, a material similar to that used in the Echo space balloon.

wind effect during descent would be accomplished by changes in trim angle of attack. Descent time of up to 1½ hours, during the final glide phase, would provide considerable time for ground control to position the actual landing.

Although initially, the test system would be proved with ground controls, an advanced navigation system ultimately would allow the astronaut to govern his own landing maneuvers.

A broad spectrum of uses for the erectible wing is envisioned. In operational applications, the wing could recover vehicles utilized for:

Geophysical measurement data, mapping areas on "spy in the sky" missions.

Astronaut training, which could be performed in recoverable two-man vehicles. At present, most training prior to orbital missions is essentially confined to the ground.

Satellite inspection to determine whether a space vehicle's mission is friendly or inimical to the national security.

Establishment of criteria evaluation of precision descents from orbit.

Recovery of boosters and manned capsules.

In technological investigations, the expendable wing could be employed in:

Assembling of astro-biophysical measurement data and returning such information to the ground for study.

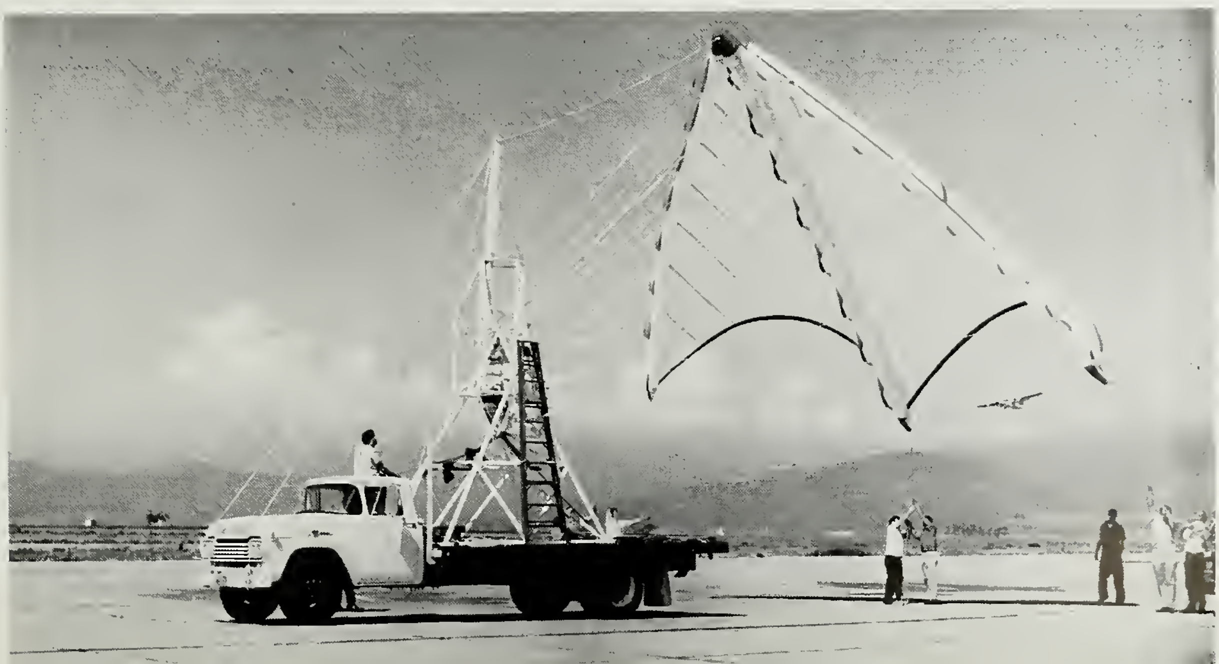
Sub-systems evaluations.

Evaluation of lifting re-entry criteria at escape velocities.

Escape from space stations.

The growth potential for expandable wings erectible in space to recover vehicles from orbit appear limitless. ■

The subject of intensive study by Ryan, the Flex Wing is capable of light wing loadings from 2 to 6 pounds per square foot.



3-IN-1 NAVIGATOR

by C. N. Bates
Technical Assistant to Chief of Advanced Design Ryan Electronics

WHAT does a "second generation" self-contained automatic Doppler navigator look like? The answer to this question has recently been unveiled by Ryan Electronics, San Diego, California, in the form of the Ryanav IV, which operates from zero to more than 70,000 feet altitude, and the first "universal" Doppler navigator suitable for all types of aircraft. Military pilots are by now familiar with the Ryan "first-generation" Doppler sets such as the AN/APN-122(V), used in a great variety of fixed-wing aircraft, and the AN/APN-97 and AN/APN-130(V) sets for rotary-wing aircraft.

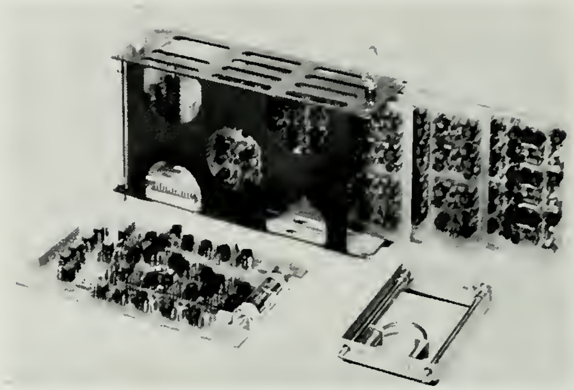
Compared with these first generation Doppler sets, the Ryanav IV has realized a host of improvements measured by every yardstick of equipment design. For example, the Ryanav IV permits one system, in two basic versions, to meet the navigation requirements of all types of fixed- and rotary-wing as well as V/STOL, aircraft. It also meets the specialized hovering and stabilization requirements characteristic of rotary-wing aircraft.

Since the first part of an attack mission may be performed at high altitudes and over water, the 70,000 foot altitude capability of the Ryanav IV is of great importance in establishing generous operating margins. After arriving at a point of increasing exposure to the possibility of radar detection, a low level approach may be initiated, with complete assurance that the Ryanav IV will continue to provide full accuracy no matter how low the pilot chooses to fly. Steering and distance information is still available and the accurate ground speed and ground track outputs of the Ryanav IV may be employed to drive a roller-map display corresponding to the aircraft's present position with respect to a pre-selected ground track. This type of display greatly simplifies the location and identification of landmarks and course-change points during the low level approach, as well as the target and weapon release points during the final delivery maneuver. The availability of Doppler-derived wind speed and direction can also simplify the trajectory corrections required for accurate delivery of the weapon.

In ASW operations, precise navigation plays one of the most crucial roles in assuring that the

Down on the deck in a zero visibility condition, this helicopter pilot relies on his Ryanav system to provide precise position information in ASW operations.

complex and interdependent operations of a task force will result in a high probability of kill. For the airborne elements of the task force, the Ryanav IV can provide the pilot/navigator with a continuous display of his present position, in terms of latitude and longitude and/or miles traveled north-south or east-west from some initial reference point. It can display, during the entire operation, the aircraft's ground speed and drift angle, as well as the speed and direction of the prevailing wind with an accuracy never before attainable. With the flick of a switch, it can display course and distance information or steering information, to one of several targets or to a return base. At the same time it is keeping track of the aircraft's course and position in general coordinates; it can drive a pictorial display stabilized against local coordinate reference to provide navigation of pencil-point accuracy for ASW search and trapping patterns.



The Ryanav IV features subassembly "modules" which perform complete system functions. They can be removed and replaced rapidly for convenience in testing and maintenance.

Building Block Design

The Ryanav IV Doppler Navigation Set consists, in its basic form, of two principle units: a lightweight Receiver-Transmitter producing three radar beams, and a compact Converter-Computer which processes the Doppler return to provide ground speed and drift angle. It also contains a Control-Indicator that controls the equipment operation, and a Ground Speed/Drift Angle Indicator for visual reference.

A major feature of the equipment is the use of subassembly "modules" which perform complete system functions and which may be removed or replaced rapidly for convenience in testing and maintenance. Equally important, however, this "building-block" approach permits additional functions to be added for special applications. For example, one system contains computer modules to handle a complete navigational problem, in-

Ryan navigators provide navigation data with pencil-point accuracy for ASW search and trapping patterns.

cluding outputs and displays of present position and course-and-distance to either of two destinations or base. In addition, a wind computer module is included which automatically compares ground speed and air speed to derive wind speed and direction. In other applications, the set is designed to be compatible with separate navigational computers and displays, including dead-reckoning computers and various types of pictorial displays.

The Ryanav IV is the first truly universal Doppler navigation set having broad applications to a wide range of operational requirements.

A typical example of a fixed-wing application is the low level attack mission. In this usage, the Ryanav IV supplies position data for an associated Latitude-Longitude Navigation Computer display. In addition to displaying present position continuously during all phases of the mission, the Navigation Computer computes and displays course and distance information to alternate destinations or to base on a Bearing-Distance Indicator. The indicator shows "ground track made good" on a moving card, and bearing to target by means of a pointer against this card, so that the difference between the pointer and the fixed marker is steering error. Making good a desired course simply requires zeroing the steering error by aligning the pointer with the fixed marker.

One of the technical keys to the design of a "universal" Doppler navigator set lies in the exclusive use of continuous-wave (C-W) radar techniques for transmission and reception of microwave energy. This technique makes it possible to achieve the highest possible efficiency of utilization of the microwave energy (theoretically 100 per cent) for maximum high-altitude capability, and yet operate down to essentially zero altitudes without loss of sensitivity or accuracy.

The high utilization efficiency comes about because the unmodulated C-W transmission does not waste valuable radar energy in unwanted signal sidebands, which always result when the transmitted energy is modulated in any way. The extremely low altitude capability is also a result of C-W transmission, since there are no altitude "holes," at altitudes where the period of the modulating signal corresponds to the round-trip transit time of the ground-reflected energy. The first of these "holes" represents a minimum altitude limitation, since the energy returns before the transmitter can be turned off and the receiver turned on.

Another design feature essential to the use of a universal Doppler navigator on all types of aircraft lies in the development of a small, lightweight, yet extremely rugged, fixed antenna that can be contoured for flush mounting in practically any aircraft fuselage. Since the antenna is fixed, operation under large pitch and roll angles is not limited by radome cut-out area or antenna gimbal limits, as would be the case if the antenna were stabilized. The fixed antenna is also more rugged and reliable and therefore better suited to withstand the severe environment loads often inflicted during carrier operations. ■

To back up the extensive engineering effort Ryanav systems must pass exhaustive tests in Ryan Electronic's ultra-modern environmental test laboratory.

RYAN LOGS OVER $1 MILLION IN NEW ELECTRONICS BUSINESS for Doppler automatic navigators, test equipment and spares from customers in the United States and Japan. Nissho Pacific Corp. has awarded Ryan Electronics a series of orders totaling $650,000 for AN/APN-122(V) navigation sets used in fixed-wing aircraft; AN/APN-97 and AN/APN-130(V) sets for installation in helicopters; and test equipment.

Contracts aggregating $400,000 also have been received from Grumman Aircraft Engineering Corp. for AN/APN-122(V) spares to service Ryan Electronics navigator sets being installed in carrier-based Navy aircraft.

NAVY GROUND LAUNCHES FIRST Q-2C JET TARGET ON THE PACIFIC Missile Range. Navy missilemen at the Naval Missile Center, Pt. Mugu, staged the first Navy ground launch of a Q-2C Firebee jet target, Friday, September 21. It was the Navy's first attempt to ground launch the high performance target. Remotely controlled from San Nicolas island off the California coast, it reached an altitude of 45,000 feet and flew 44 minutes before the target's parachute recovery system allowed it to drop into the ocean where it was retrieved by boat. Previously the Q-2C had been air-launched from P2V mother planes.

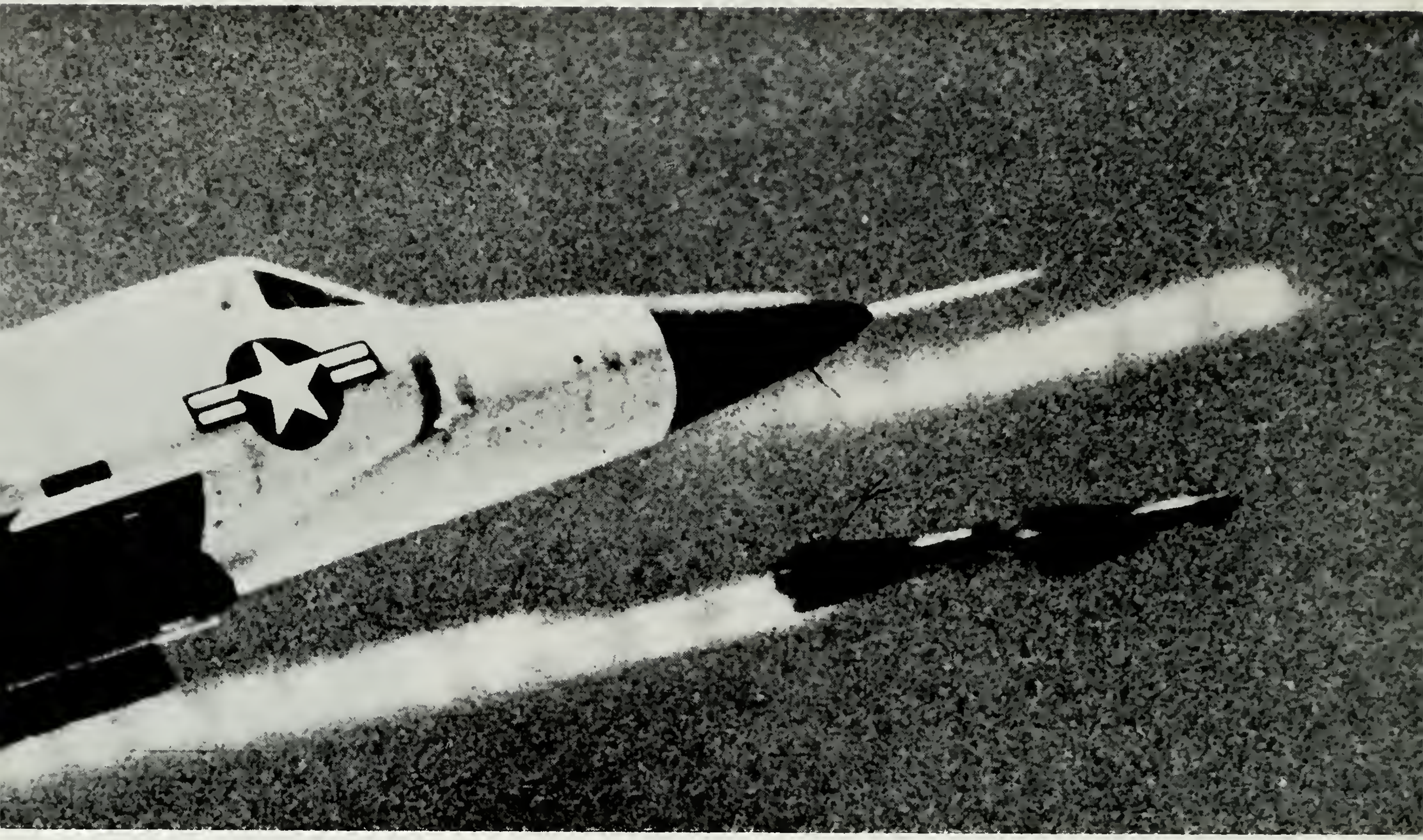
RYAN TO EXPLOSIVELY FORM SATURN C-5 ROCKET BULKHEADS following award of a $630,000 contract by the Marshall Space Flight Center, Huntsville, Alabama. Ryan will form a large number of aluminum segments to be assembled at Huntsville into domed bulkheads 33 feet in diameter. Design work on construction tools is now under way at the Ryan plant in San Diego.

RYAN DEMONSTRATED VERSATILITY IN EXPLOSIVE FORMING recently with production of prototype parts for a tank artillery piece. The unit is a bore evacuator for a 155mm rifle. The part which fits over the gun barrel near the muzzle is designed to evacuate smoke and gas from the barrel after each shot is fired simultaneously with the opening of the breech. Made of 5/8 inch stainless steel, the evacuators are fabricated in one piece by the explosive forming process.

RYAN FIREBEE SETS LOW ALTITUDE MARK in a record flight at the White Sands Missile Range. The remote-controlled Q-2A Firebee streaked over the desert floor at an elevation of only 280 feet above the terrain. The Firebee maintained its record low for several minutes, during which it was the target for Army missile-firing crews.

Celebrating the organization's 40th anniversary in September, T. Claude Ryan (at the controls of the mockup of the U.S. Army XV-5A) preferred to look ahead rather than dwell on past accomplishments and predicted a "real revolution in aviation with the advent of VTOL's." He said the coming era will see development and assembly line production of new vertical take-off and landing aircraft. Four different VTOL aircraft have been born at Ryan, including the YO-51 Dragonfly, the X-13 Vertijet, the VZ-3RY Vertiplane and the U.S. Army XV-5A, world's first fan-in-wing jet VTOL. Ryan is also teamed with Vought and Hiller in the design and production of the tri-service XC-142 transport for the Army, Navy and Air Force.

First Navy ground launchings of the Ryan Q-2C Firebee jet target at the Naval Missile Center, Pt. Mugu are paving the way for installation of ground launch facilities at two other Pacific Ocean launch sites. The new capability will be added at the Naval Ordnance Test Station, China Lake, and at the Naval Air Facility, Naha, Okinawa. Previously Navy Firebees had been air launched from P2V mother planes. Use of the ground launch technique is expected to increase the operational availability of the target since it will now be possible to get the Firebees into the air under certain minimum weather conditions.



ANG MINUTEMEN SQUARE OFF

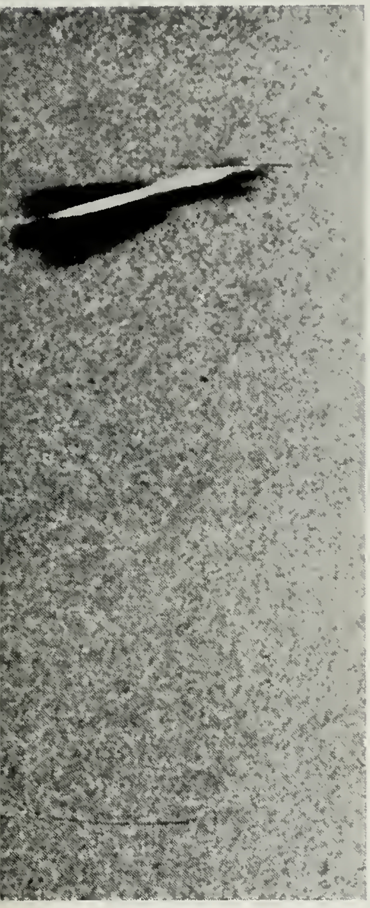
FOURTEEN of the nation's top Air National Guard pilots dropped their sleek F-102 interceptors onto Tyndall Air Force Base, Florida last month to do battle with the Ryan Q-2C Firebee jet target.

The setting for the friendly war against the jet fast target was the National Guard's 1962 Ricks Trophy Event, held annually in honor of the late Major General Earl T. Ricks, former Air National Guard Chief.

After four days of exacting competition involving hot firing runs with Falcon missiles against the Firebee target, and dry runs against the B-57 jet bomber—with a couple of navigation problems thrown in for good measure—one pilot was destined to receive the Ricks trophy. Approximately 200 team members from the Air National Guard were involved in the event.

The Q-2C Firebee jet target is the newest, most versatile member of the Ryan family of Firebee targets, and is currently the primary aerial target for the most modern weapons and weapons systems of the Air Force, Navy and Army. A high performance, remotely controlled jet aircraft, the Q-2C can fly at speeds of more than 600 mph, over 61,000 feet, and has flown for 1 hour and 52 minutes before parachute recovery.

In the air, the Firebee has the high perform-

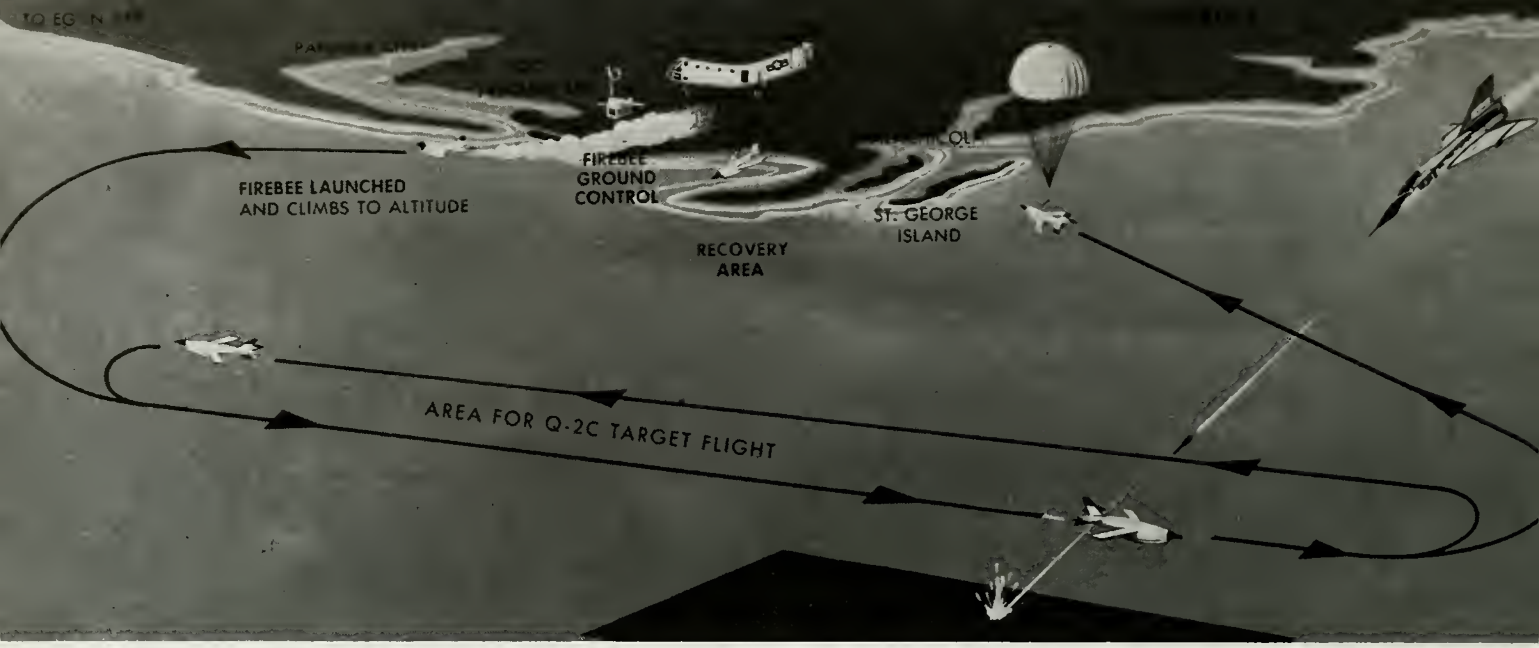


In a realistic combat environment at Tyndall AFB, Florida, determined Air National Guard pilots manned F-102 fighters to kill the Ryan Q-2C Firebee. Below: Air Force technicians rig the Q-2C for ground launch.

AINST RYAN Q-2C

ance and stamina to stay on the firing range for numerous combat-type interceptions. Equipped with special electronic scoring devices, the Firebee instantly registers hits and misses with an accuracy of a few feet, on ground station scoring recorders.

With unique Ryan-developed radar augmentation equipment the Firebee can "blow-up" its radar reflective image and look like a large bomber on radar detection scopes and their associated tracking systems. Other special devices make the Firebee compatible with a wide variety of radar and infrared guided missile systems and responsive to a broad range of interception and



Ground launched from Tyndall AFB, the Ryan Q-2C's flew a racetrack pattern over the Gulf of Mexico. Q-2C's were targets for Falcon-armed, F-102 fighter interceptors.

attack situations.

The Ryan Firebee is the only free-flying jet target to be designated as the target for a military weapons meet—pioneering in this field at the Air Force's Project William Tell in October 1958. In 1959, Firebees were the exclusive jet targets at both the Air Force's William Tell and the Navy's Operation Top Gun. In October 1961, the Q-2C was again the enemy stand-in at the Air Force's weapons meet, William Tell, 1961.

Sponsored by AFA

The Ricks Trophy Event is traditionally scheduled to coincide with the annual convention of the Air Force Association — sponsors of the Ricks Trophy—which was held this year in Las Vegas, Sept. 18-23.

The Ricks event was a planned combination of operational exercises and speed flights to determine the top combat ready team among its F-102 units. Participating in the 1962 event were: the 112th Fighter Group Pittsburgh, Pennsylvania; 114th, Sioux Falls, South Dakota; 125th, Jacksonville, Florida; 147th, Houston, Texas; 149th, San Antonio, Texas; 154th, Honolulu, Hawaii and the 159th, New Orleans, Louisiana.

To gain top scores, each unit had to keep in readiness to scramble on each phase of the competition within minutes after receiving instructions from Air Defense Command umpires.

"Rules of the event were designed to test the capability of ground crews and aircraft controllers as well as the pilots", Major General W. P. Wilson, Deputy Chief of the Air National Guard, said.

Crewmen study the Ryan Q-2C from the ground launch bunker, moments before the jet fast target is boosted into the Florida sky by an 11,000 pound thrust JATO bottle.

Ricks top pilot, Captain Earl A. Mead of the 146th Fighter Interceptor Squadron, Pittsburgh, Pa., in the saddle of his F-102 fighter interceptor. He scored 7600 points out of a possible 8600.

Pittsburgh ANG Wins

In the competition, a hot shooting Pittsburgh, Pa. team out-fired a challenging Jacksonville crew by mere percentage points, before the teams left Tyndall for Las Vegas to collect prizes and acclaim from General Wilson and the AFA gathering.

Captain Earl A. Mead of the Pittsburgh unit won the coveted Ricks trophy. He scored 7,600 points out of a possible 8,600. His percentage basis enabled him to edge out Captain Wallace Green of the second place Jacksonville, Fla., 125th interceptor squadron, who scored 8,000 out of a possible 9,600. Captain Mead's percentage was 88.3, while Captain Green's was 83.3. Hawaii's red-hot 199th fighter interceptor squadron, flying borrowed F-102 interceptors, placed third in the seven team competition.

Final scoring, computed on the basis of actual hits compared against perfect scores, gave Pittsburgh the winning 88.37 per cent mark. Florida collected 83.6 per cent. Hawaii had 79.64 per cent. The islanders shaded, by one per cent the 147th from Houston, Texas, which had 78.64 per cent. Houston, cool in early stage of the event, warmed up at mid-week to give the top three a few anxious moments as the meet approached its climax.

The 149th Fighter Group, Texas ANG, San Antonio, was fifth with 69.79 per cent. A 69.27 per cent mark put the New Orleans, La., 159th in sixth place, and the Sioux Falls, South Dakota 114th, dogged by bad luck, ran last with 64.05 per cent.

Capt. Wallace Green, of the Jacksonville, Florida ANG, receives a Ryan Firebee "kill" plaque from Maj. Gen. W. P. Wilson, Deputy Chief of the Air National Guard Bureau. Capt. Green scored two direct hits.

Following the final missions, Thursday, Sept. 20, the F-102 teams and ground support personnel scrambled for Kirtland AFB, New Mexico. The lead aircraft from each team flew to Las Vegas Friday morning with Major George C. McCrory, Pennsylvania team captain, leading the way.

Capt. Wallace Green of the Florida ANG was the only pilot of the 14 to score direct air-to-air missile hits on the Q-2C target. Splashing Q-2C's on both Tuesday and Wednesday, he was described by fellow pilots as having "the best pair of hands" in the meet. At Las Vegas he was awarded a handsome Firebee kill plaque, sponsored by Ryan and presented by General Wilson. ■

At the Tyndall ground control site, (l to r) Sgt. E. C. Page, plotting board technician, Captain Frank Garcia, and Lt. Richard Veit, remotely control the Ryan Q-2C Firebee and vector the defending F-102's into position against the "friendly" enemy.

How to power Venus-bound space probes?

Ryan Aerospace is producing lightweight solar panels which will support thousands of tiny photoelectric cells to harness the sun's energy in space. The cells will generate the electrical power needed for the controls, experimental and communications systems of Venus space probes and earth satellites. 27-01

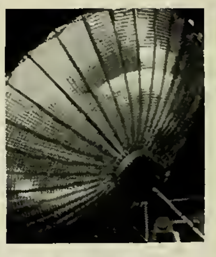
With broad experience in systems management, Ryan engineers are developing power systems, communications systems, and advanced space structures to meet the requirements of space vehicle programs. These capabilities are geared to *fast reaction time* in keeping with the demands of planetary orbits and sudden shifts in program schedules.

Flexible, fast-moving Ryan is also making significant contributions in the areas of V/STOL aircraft, Doppler sensing and navigation systems, and Flex Wing applications. And Ryan is the world's largest producer of jet target systems for the Armed Services.

Your inquiry is invited concerning the total capability of Ryan Aerospace and Ryan Electronics in space age design, development and fabrication.

RYAN AERONAUTICAL COMPANY, SAN DIEGO, CALIFORNIA

HIGH-ALTITUDE *radar altimeters for the Saturn launch vehicle, lunar landing spacecraft, and high-speed hydrofoil ships are among the advanced electronic guidance and communications systems now being created by Ryan Electronics.*



FOLDING SOLAR MIRRORS *can provide a source of power for space vehicles. This model, 10 feet in diameter, was completely engineered and fabricated in just a few months by Ryan scientists, engineers and highly skilled metallurgists.*

MAGIC LINK *between space vehicles and earth is the Antenna which makes possible two-way communication. Ryan is developing lightweight, precision Space Antennae, capable of withstanding both launch and space environments.*

RYAN
AEROSPACE

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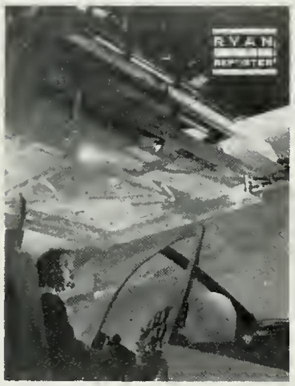
RYAN REPORTER

NOV.-DEC./1962



About the Cover: At the controls in Ryan's unique Flight Simulation Laboratory, Lou Everett, Ryan engineering test pilot is surrounded by a panoramic screen. The point light source projector and transparency overhead is tied to an analog computer.

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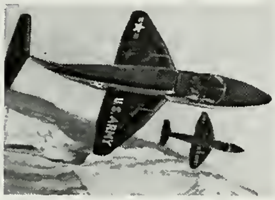
CINERAMA SIMULATOR

Ryan shatters engineering barriers with a unique new Flight Simulation Laboratory.

Wrap-around screen provides realism

RYAN engineers and test pilots can now "fly" new vertical take-off and landing aircraft, and even "land" space vehicles on the moon, without leaving the confines of a unique 6,000 square foot building at the company's Lindbergh Field main plant in San Diego, California.

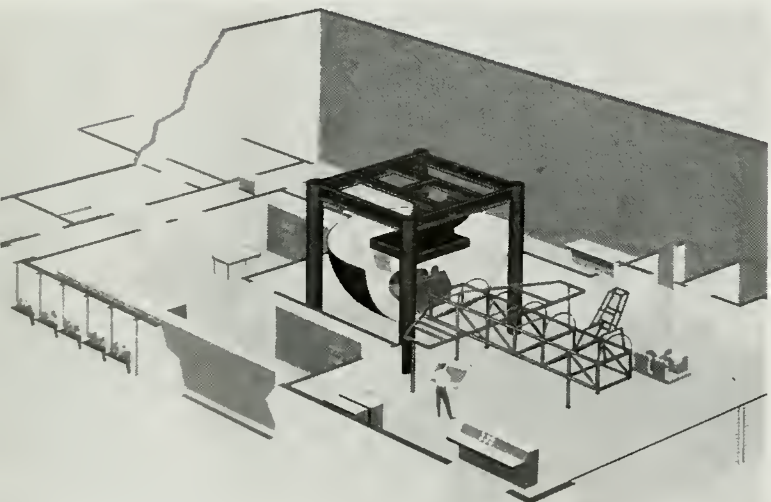


The building, a new Flight Simulation Laboratory, is now being readied to fly the Ryan-General Electric-U. S. Army XV-5A fan-in-wing V/STOL research aircraft, but the laboratory can be programmed to simulate the flight, take-off and landing performance of any aerospace vehicle, be it either completed hardware or drawing board concept, including moon landing spaceships.

In the simulator, the pilot at the controls of an aircraft or spaceship faces a panoramic wrap-around screen. A projector system tied to an analog computer transmits through a transparency an extremely sharp, detailed, realistic representation of a land or moonscape on the screen in color, and although the pilot in his cockpit remains stationary in the darkened room, he experiences a sensation of movement as he responds to the simulated flight situation.

Ryan test pilot Lou Everett described his reactions to the simulator as "so realistic I could almost feel acceleration." He said the simulator is probably the most advanced system for exploring the techniques of vertical take-off and landing. "The simulator for the first time gives the pilot peripheral vision—so important to maintaining reference in VTOL take-off, transition and landing operations." Everett, a veteran Ryan test pilot, has flown Ryan's unique X-13 Vertijet, the world's first jet VTOL; the VZ-3RY Vertiplane, a Ryan V/STOL aircraft utilizing the slipstream approach to take-off and landing; and Ryan's versatile Flex Wing flying test bed.

The control hardware in the cockpit is connected to a real-time analog computer. As the pilot takes action with the control stick, rudder pedals and power settings, the control surface motions and their associated dynamics are fed into the analog computer, which has the airframe equa-



Analog computer and recorder, cockpit simulator, hydraulic clean room and hydraulics laboratory are some of the functional components incorporated in Ryan's Simulation Laboratory.

In the simulator, the pilot at the controls of an aircraft or spaceship faces a panoramic "wrap-around" screen. A projector transmits a detailed representation of the Earth or a moonscape.

hat'll make you sick . . .

tions of motion mechanized, as a "mathematical model."

The relative motions obtained from the computer equations are fed into the projector, which in turn presents the relative motion of the aircraft on the three-dimensional screen, evoking from the pilot typical flight control responses as he observes the screen. Thus, the control system can be tested and evaluated continuously under varying conditions with no danger to the pilot, as would exist in actual test flights.

Engineers and test pilots will be able to determine performance of the aircraft's various systems, and effect improvements without leaving the ground.

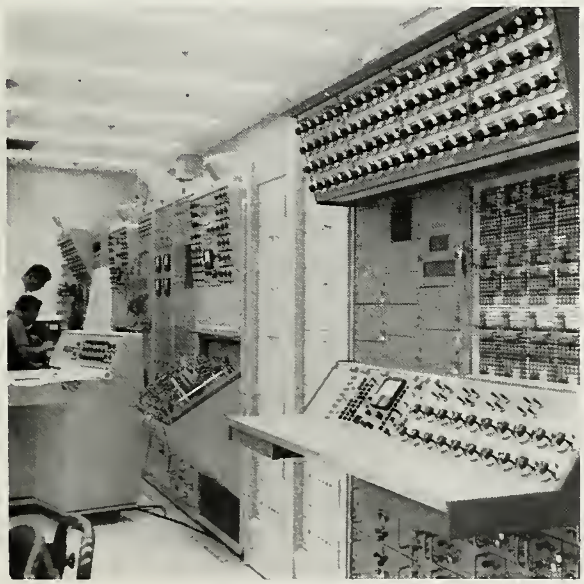
The Ryan flight simulation laboratory incorporates mathematical, physical and visual aspects. A mathematical model of the proposed aircraft or space vehicle dynamics system is first determined and mechanized on the simulator's analog computer. The mathematical model consists of a set of simultaneous non-linear differential equations incorporating appropriate boundary conditions and values of various design parameters. The expected behavior of the vehicle or system appears as the solution of these mathematical equations.

Certain physical elements replace parts of the mathematical model as they become available during the later stages of the actual aircraft development cycle. Operation efficiency of these actual physical elements can be measured by substituting them into the simulated flight in place of their mathematical counterparts.

The visual display adds further realism to the physical simulation. It permits visual evaluation of the simulated flight, and familiarizes engineers and test pilots with characteristics of existent and non-existent vehicles. For the pilot, it generates control response appropriate for the simulated flight conditions.

The engineer or test pilot in the cockpit is partially surrounded by a dynamic terrain and sky screen which provides a hemispherical view in color. The projected moving image responds not only to his control movements, but also to the various simulated load restraints which are continuously integrated by the computer. The visual results of the equations of motion continually projected on the screen are the result of pitch, roll and yaw movements of the flight vehicle combined with the earth coordinates.

If required, wind or gusts may be introduced



In the Ryan laboratory an analog computer interconnected with cockpit controls simulates yaw, pitch and roll characteristics as well as earth coordinates.

The visual display adds further realism to the physical simulation. It permits visual evaluation of the simulated flight, and appraisal of existent and non-existent vehicles.

For Ryan engineers, the Flight Simulation Laboratory is an important design tool used to shakedown aerospace vehicles still in the design stage. From preliminary design and mathematical models of non-existent vehicles, Ryan engineers are able to accurately predict and evaluate flight characteristics.

during any dynamic test flight, but all other factors are based on results of the pilot's movements and the dynamic response of the vehicle's components.

An important feature of the laboratory is its interconnected hardware simulator. This unit incorporates hydraulic, electrical and control components to simulate various aircraft subsystem performance characteristics. Examples of such simulation within the hardware simulator section are engines, aerodynamic surfaces, flight control servos and other components as required by the evaluation procedure.

A large high-bay area and access doors provide accommodations in the laboratory for the flight-ready aircraft if desired for complete systems test and checkout prior to actual flight.

At Ryan, the Flight Simulation Laboratory represents a dramatic new design tool to explore not only the techniques of vertical take-off and landing, and moon landing, but the system is being considered for other design studies. Ryan engineers say the laboratory can be used to study among other things conventional subsonic and supersonic aircraft; helicopters and ground effect machines, remote controlled drone systems; and rendezvous and docking operations for spacecraft. ■

An important feature of the Ryan laboratory is its interconnected hardware simulator, incorporating hydraulic and electrical components to simulate various subsystem performance characteristics.

Kaleidoscope '62

A dynamic year of Ryan activity and progress, offers an opportunity in the following pages to recap the highlights of 1962.

For Ryan Reporter readers, this presentation will be a handy reference to Ryan's activity in aerospace and electronics.

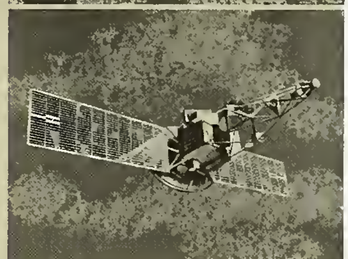
Keyed to Ryan's spectrum of capabilities, the events that made news in '62, are the launching pad for a dramatic future at Ryan.

V/STOL AIRCRAFT

ELECTRONIC NAVIGATION

TARGET/DRONE SYSTEMS

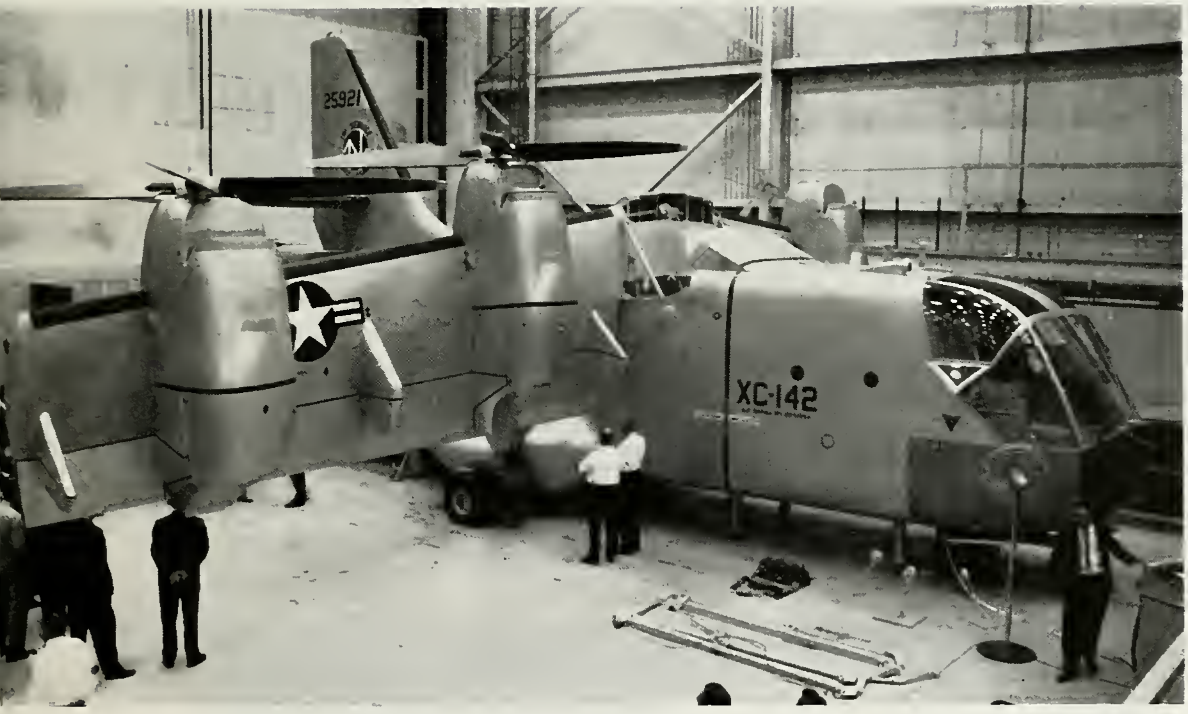
SPACE STRUCTURES



AIRFRAMES/COMPONENTS

FLEX WING VEHICLES

KALEIDOSCOPE '62



In Tri-Service Mockup Review

TILT-WING XC-142A INTRODUCED

The XC-142A, being developed for all three military services by the veteran industrial team of Ryan, Vought and Hiller has passed a major checkpoint.

A "life size" mockup of the V/STOL transport, designed to take off and land vertically in all types of terrain, yet achieve speeds of more than 300 miles an hour in level flight has been inspected by a board of Air Force, Army and Navy officials at the Ling-Temco-Vought plant in Dallas, Tex., and passed review with no major changes in concept or design.

Ryan is designing and building the aft fuselage section including tail surfaces, the engine nacelles and the wing panels.

The three-firm team was awarded a contract last January to develop and fabricate, for the Department of Defense, five of the experimental V/STOL airplanes and to investigate procedures and techniques with such operations in the 1965-70 time period. First flights for the aircraft are scheduled for March 1964.

At Ryan — World's First

XV-5A LIFT FAN MOCKUP UNVEILED

The world's first lift-fan V/STOL aircraft, the U. S. Army XV-5A (formerly VZ-11) was unveiled recently at Ryan's San Diego plant in a press showing co-hosted by the Army, General Electric Company and Ryan.

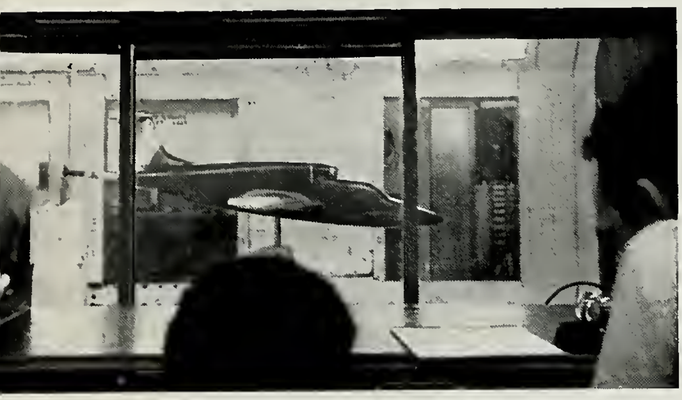
The news corps saw the XV-5A mockup, completed on schedule as the full-scale forerunner of two advanced V/STOL research aircraft which the Army's Transportation Research Command ordered from G. E. in November 1961 under a $10.5 million contract.

Ryan received a subcontract from G. E. to design and build the two fan-in-wing aircraft. The first flight for the XV-5A is planned for mid-1963.

The aircraft will be capable of taking off vertically, and transitioning to conventional flight, then fly at speeds of more than 600 miles per hour.

The Army feels that V/STOL aircraft can make a major contribution to mobility needed for limited and general war. Such aircraft, for example, may be used for future combat surveillance or target acquisition missions and will greatly extend the vision of Army field commanders.

WIND TUNNELS PROVE V/STOL CONCEPT



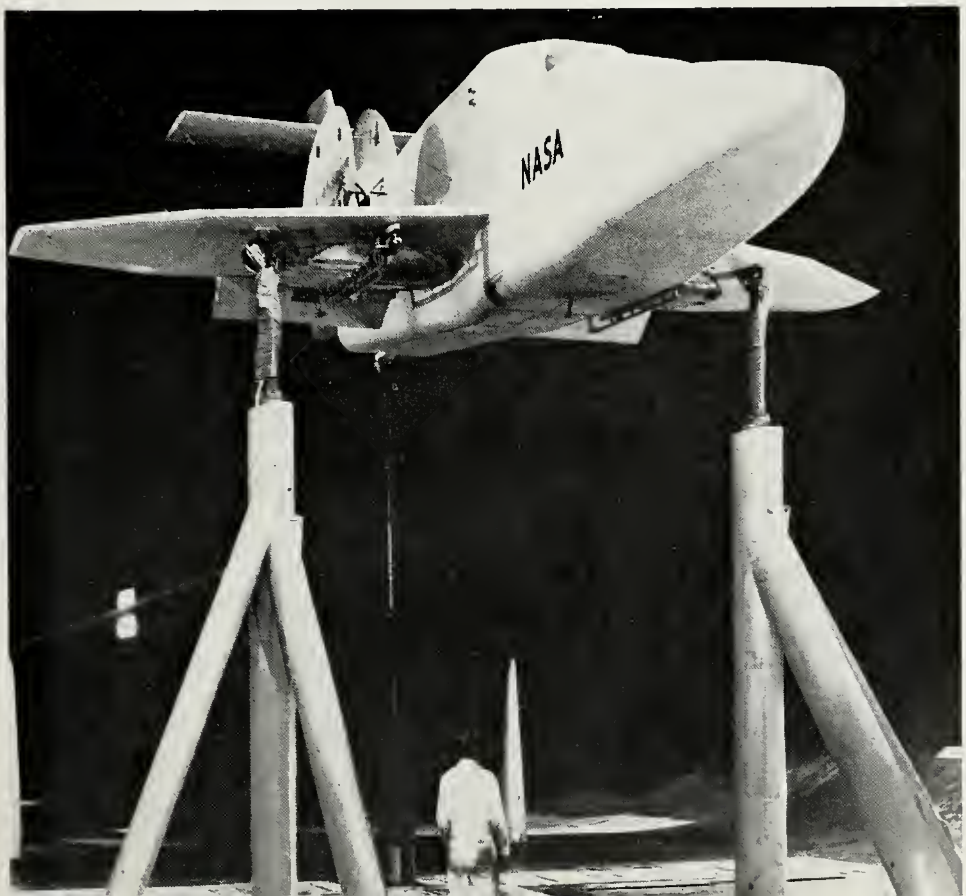
Ryan/G.E./NASA

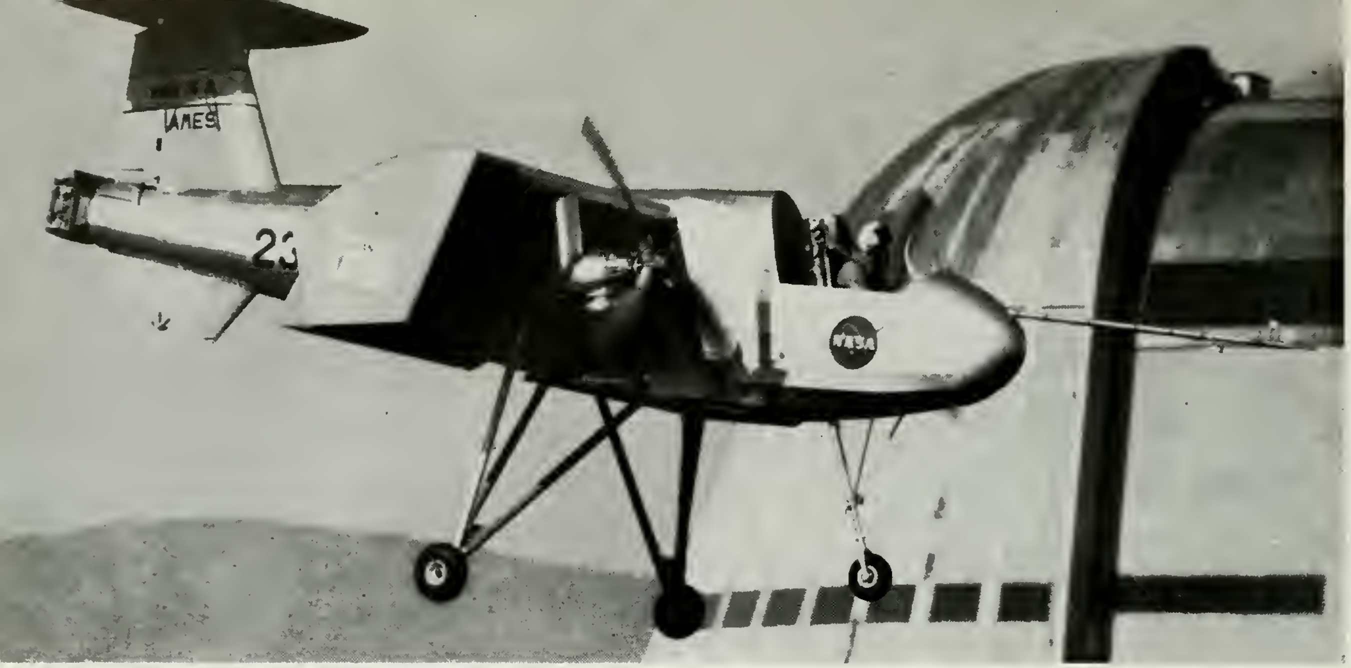
Team In Tests

Nearly a thousand hours of wind tunnel tests have proved the XV-5A lift-fan approach to turbojet V/STOL flight. More than 340 hours of full-scale wind tunnel testing has been completed on the propulsion system by General Electric and the National Aeronautics and Space Agency. Ryan has completed over 600 hours of wind tunnel testing of three scale models of the configuration which have proved the efficiency of the basic design.

NASA's Ames Research Center, Moffett Field, California, has recently completed the first phase of its tests which include simulated step-by-step flight operation from take-off through transition.

Tests were conducted at wind tunnel speeds of from zero to 120 knots and with lift fans operating up to full power at 2640 rpm. Results of the full-scale tests have confirmed the aerodynamic and configuration design of the lift fan V/STOL aircraft and previous XV-5A small scale tests conducted by Ryan and G. E.





In Low Speed Flights

NASA FLYS RYAN VZ-3RY VERTIPLANE AT AMES

More than 30 flights have been made by NASA in its research program with the Ryan VZ-3RY Vertiplane at the Ames Research Center, Moffett Field, California, since the plane completed its testing in the San Diego area. The V/STOL research aircraft is developing valuable data in the low speed flight regime for the NASA agency.

Developed for the U. S. Army to evaluate the deflected slip-stream principle of V/STOL flight, the Vertiplane completed two years of flight before being turned over to NASA, in February, 1960. The Ryan Vertiplane is the only aircraft of its kind in the United States.

The NASA flights have been made by pilots Fred Drinkwater and Bob Innis, in a program under the direction of Howard L. Turner, project engineer. The plane has been flown at speeds as low as 15 knots, and it has descended at rates of 1600 feet a minute at idle power settings. The rates of descent are higher than an H-23 helicopter can achieve in autorotation.

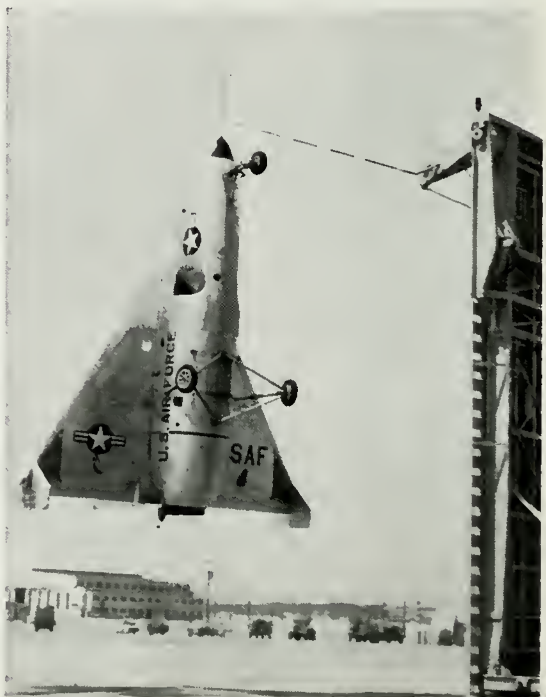
The NASA program is designed to explore the conditions existing when an aircraft flies at low speeds. This engineering knowledge is important to the designer of V/STOL aircraft, where a good proportion of the performance may be in the low speed regime, but is also important for the engineer working with high performance, even supersonic aircraft.

X-13, XV-5A Major Factors

RYAN V/STOL HOURS MOUNT NOW EXCEED 3 MILLION

Adding substantial data to its already mounting backlog of V/STOL experience, Ryan since 1955 has been directly engaged in studies of vertical take-off and landing aircraft utilizing the basic fan-in-wing (Vertifan) concept, and has completed a U. S. Air Force contract to develop the parameters for a well matched fan propulsion system and air frame configuration.

In the past 20 years, Ryan has accumulated an unsurpassed V/STOL engineering experience of three and one-third million manhours.



Proving High Reliability

TESTS SHOWCASE RYANAV IV

Extremely high reliability of Ryan Doppler automatic navigation systems has impressed European military and civilian aviation officials as a result of recent tests in France.

The demonstrations of the equipment capability occurred over a two-month period at military test bases at Bretigny, south of Paris, and at Istres, on the Mediterranean seacoast.

KALEIDOSCOPE '62

The Ryanav IV, Ryan Electronic's "second generation" self-contained navigation set, was tested in a Sikorsky HSS-1 helicopter built under license by Sud-Aviation of France, one of Europe's foremost aircraft manufacturers.

During the total flight time of 46 hours, not a single navigation failure was reported in land missions out of Bretigny and sea flights out of Istres.

Ryan navigation sets, adaptable to fixed wing aircraft and helicopters, automatically and continuously measure and display heading speed, drift speed and vertical speed, without the aid of ground stations, wind estimates or true air speed data.

For AO-1 Mohawk

ARMY ORDERS RYAN NAVIGATORS

A contract has been awarded Ryan Electronics by the U. S. Army Signal Supply Agency for Ryan radar navigation sets for use in the Army's AO-I Mohawk aircraft.

Ryan Electronics is the largest producer of Doppler navigation equipment for both fixed-wing and rotary wing aircraft. These automatic navigators are in quantity production for a wide variety of military aircraft and helicopters, reconnaissance and attack aircraft, airborne early warning and certain special purpose aircraft.

Applying Proven Techniques

RYAN ELECTRONICS TURNS TO SPACE

Ryan Electronics is applying proven automatic helicopter transition principles to soft lunar landings, and is currently under contract to design and fabricate Doppler sensors and radar altimeters for the Surveyor and Saturn programs.

Major development programs include the Model 517 radar altimeter and Doppler velocity sensor for spacecraft landing control operations, and the Model 520 high altitude altimeter for the Saturn launch vehicle.

The development of the Model 520 altimeter has provided considerable experience in the design of altimeters for reliable high altitude operation—up to 250 miles above the earth's surface. High density plug-in modular construction of electronic circuitry was a major design consideration.

The Model 517 radar altimeter and Doppler velocity sensor, intended to provide outputs for accurate control of a lunar spacecraft approach and landing mission, utilizes a Ryan developed integrated Doppler radar altimeter.

French Licensed

TO BUILD NAVIGATORS

Ryan Aeronautical Company and one of Europe's largest firms of its kind, Compagnie Francaise—Thomson-Houston, have announced the signing of a license agreement under which Ryan Doppler radar navigation equipment will be produced for the European market.

The agreement gives Thomson-Houston rights for sale and manufacture of Ryan automatic navigators for both fixed wing and rotary wing aircraft use.

Elsewhere in the free world, Ryan navigator sets have been installed in British, Australian and Japanese aircraft.

Thomson-Houston produces a great variety of electrical and electronic products for both the civilian and military markets. It is one of Europe's leading producers of electrical appliances for the home, and of telephones and telephone equipment.

Ryan foresees a major market in Europe for the Doppler navigation equipment. Europe is rapidly becoming one of the most important customers for all kinds of U. S. goods.

In Project Mercury

NAVIGATOR LOCATES ASTRONAUT

Ryan Electronics Doppler automatic navigation equipment helped pinpoint Astronaut Scott Carpenter for the rescuing helicopter after he landed 200 miles from his designated Project Mercury recovery site.

Domestic, Foreign Contracts

CUSTOMERS ORDER RYAN DOPPLER

Ryan Electronics will supply Doppler automatic navigation sets and spares under six contracts finalized recently with domestic and foreign customers.

The contracts call for delivery of a quantity of navigation sets and spares to Grumman Aircraft, Lockheed, the U. S. Navy, Japan and Australia.

Ryan Electronics Doppler navigation systems are the most widely used of their type in the world, and are in service with 25 different types of domestic and foreign aircraft.

Q-2C FIREBEE PRODUCTION EXTENDED

Continued production of Q-2C Firebees, the world's most widely used free flying jet target missile, was assured at Ryan through 1963 with award of a contract for $7,373,496.

The order is for more than 200 of the transonic missiles, of which approximately 90% will be delivered to the Navy and the remaining amount going to the Air Force.

The production order issued in early 1962 is the fourth in a series dating back more than two years, and brings the total of Q-2C's, the most advanced Firebees in production, to more than 750 either delivered or on order. The high performance Q-2C's were preceded by four years' production of over 1100 Q-2A and KDA series Firebees.

Deliveries of Q-2C's began in January, 1960, and a steady stream of the remote-controlled Firebees have been coming off assembly lines at the Ryan San Diego plant.

For Ryan Firebee

SPARES CONTRACTS TOP $4 MILLION

Additions to existing contracts totaling $4.75 million have been received by Ryan for augmentation and ground support equipment, and spares for Navy Q-2C Firebee jet target missiles.

The new business calls for augmentation equipment including Ryan developed traveling wave tube systems which augment radar signals to enlarge the Firebee on tracking radar screens to sizes as large as bombers.

At White Sands

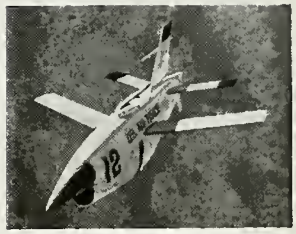
FIREBEE SETS RECORD

Shattering all previous records, an Army 124-E Ryan Firebee set a new all-time endurance and altitude mark for this type of free-flying target at White Sands Missile Range, New Mexico.

The 124-E flew 1 hour, 52 minutes, of which 1 hour, 47 minutes was glide prior to parachute recovery. A new altitude record in excess of 61,000 feet was achieved, and a new record of endurance at high altitude was set when the Ryan Firebee flew 84 minutes at 55,000 feet or above.

From Puerto Rican Firebee Base

RYAN CREW CONDUCTS ATLANTIC OPS



KALEIDOSCOPE '62

Ryan is currently conducting Q-2C Firebee target systems operations for the Atlantic Fleet at the Roosevelt Roads Naval Station, Puerto Rico, under a year-long contract from the Bureau of Naval Weapons.

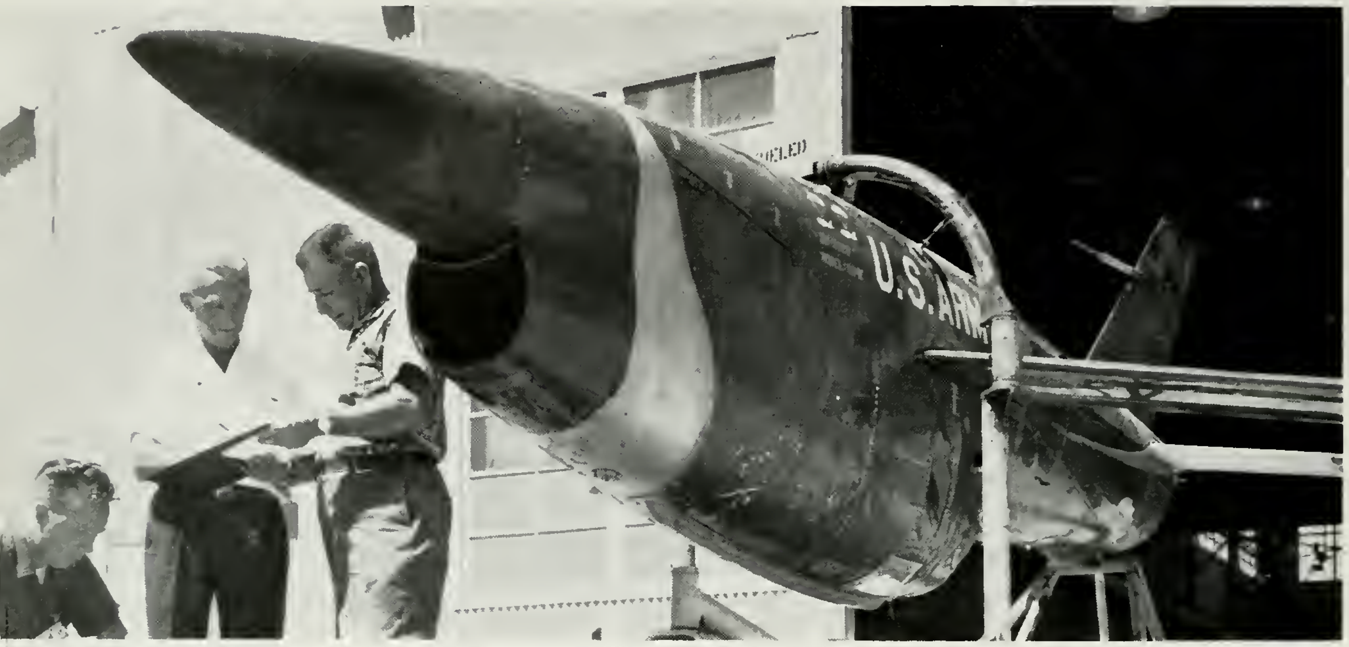
Twenty-two men under C. D. "Bud" Miller have the responsibility for target flight readiness. Miller formerly was with the Ryan crew performing similar target services for the U. S. Army at White Sands Missile Range, New Mexico.

Under the Navy contract, first of its kind awarded to Ryan, Ryan personnel provide Q-2C target missions for surface-to-air firings of shipboard anti-aircraft missile crews, and air-to-air firings by fighter-interceptor aircraft of the Atlantic Fleet.

The Q-2C, most advanced production model of the Ryan Firebee, the world's most widely used free-flying jet target, is rolling off assembly lines at the San Diego plant.

Firebee Role Puts

RYAN TEAM IN ARMY HITCH



Ryan has been retained by the Army to continue its specialized target operational services with Firebee jet drones at the White Sands Missile Range.

A contract has been awarded by U. S. Army Ordnance, authorizing the Ryan field crew at White Sands to perform all necessary flight services for the 1962-63 fiscal year.

Nearly 30 men, under Jack E. Young, are stationed at White Sands, where the Army has been conducting ground launchings of the Ryan Firebee jet target drones at an accelerating pace since 1959.

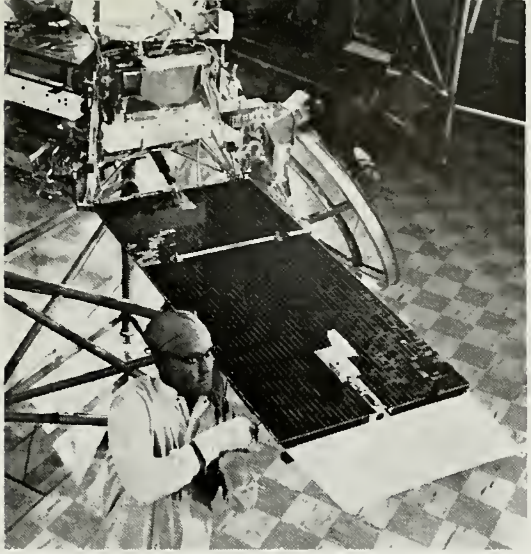
At Pt. Mugu

NAVY GROUND LAUNCHES Q-2C

A major milestone in use of Ryan Q-2C Firebees has been achieved by the U. S. Navy with the first ground launchings of the high performance jet target at the Naval Missile Center, Pt. Mugu, California.

NAVY Q-2C SPARES CONTRACTS LET

Two new contracts totaling more than $1.3 million to supply air frame spare parts for Navy Q-2C Firebee jet target drones have been awarded Ryan. One order for $850,000, will support the Navy's portion of a contract announced earlier this year for several hundred of the near sonic target missiles. The second contract, for $450,000, is for spares to support production of Navy Q-2C Firebees currently being built at Ryan.



Ryan Panels Aid

MARINER II VENUS SPACE PROBE

Ryan solar panel structures built for Cal Tech's Jet Propulsion Laboratory in Pasadena, California are aboard Mariner II, as this remarkable space vehicle probes the cloud curtain of the mystery planet Venus.

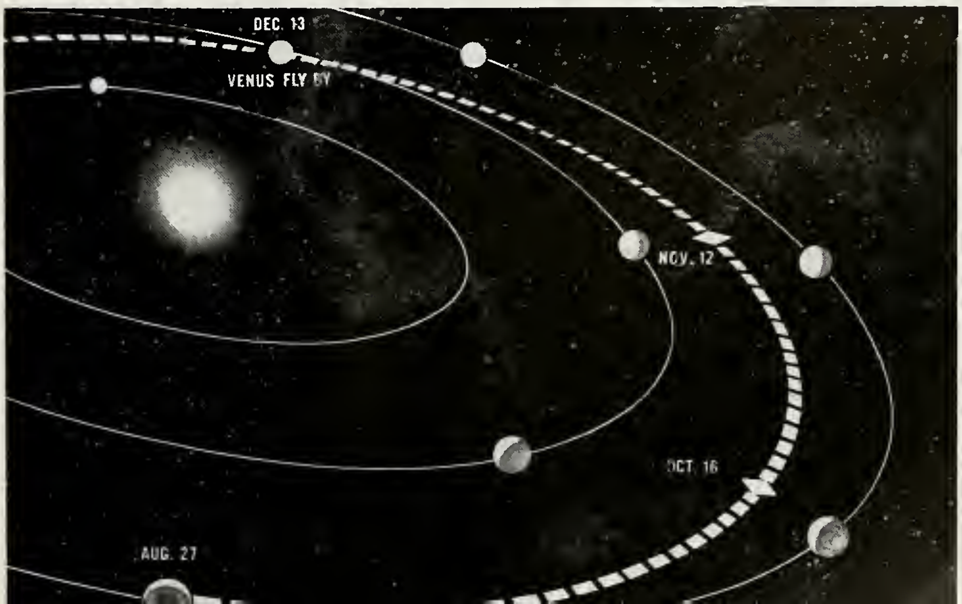
The solar panel structures, 29½ inches wide and 60 inches long, support 9800 photoelectric solar cells to collect energy from the sun and convert it into electrical power for the critical research, communications and command functions of the spacecraft.

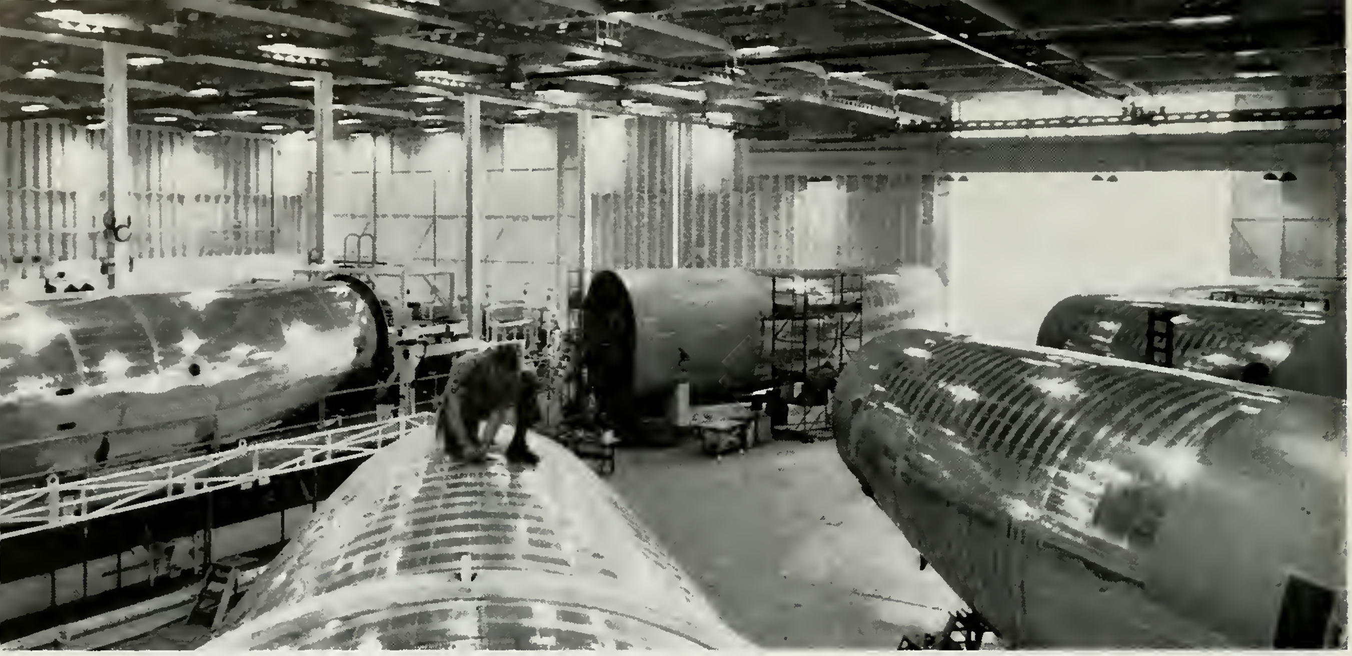
These are the first Ryan-built assemblies ever to penetrate the blackness of outer space, and indicate Ryan's growing emphasis on projects with space applications.

A new structural concept developed by Ryan combines low weight with the high strength and heat dissipating and reliability characteristics required of the panels. The aluminum skin is stabilized by continuous corrugations attached by resistance welding.

To prevent overheating and to maintain solar cell efficiency, the undersides of the panels were covered with a special black coating that promotes cooling. Thickness of the coating, as a thermal consideration, was held to between one-thousandth and one and one-half thousandth of an inch.

KALEIDOSCOPE '62





Production Into 1964

MILLIONS EXTEND KC-135 WORK

Assuring production well into 1964, a multi-million dollar order has been awarded Ryan by Boeing for continued fabrication of the giant fuselage sections for America's premier aerial tanker, the KC-135.

The new follow-on order, expected to approximate $9 million, is the ninth received for KC-135 tanker and C-135 transport fuselage sections since start of this project in 1955. More than 600 of these three-ton, 40-foot sections, the largest structure ever subcontracted for quantity production in the aircraft industry, have been built in the San Diego plant.

Ryan has established a remarkable on-time production record during the life of this project, ever since the first fuselage section was rolled out of the plant late in 1955, eight days ahead of schedule. A steady stream of these mammoth structures has been shipped by rail to Boeing's Renton, Washington, plant.

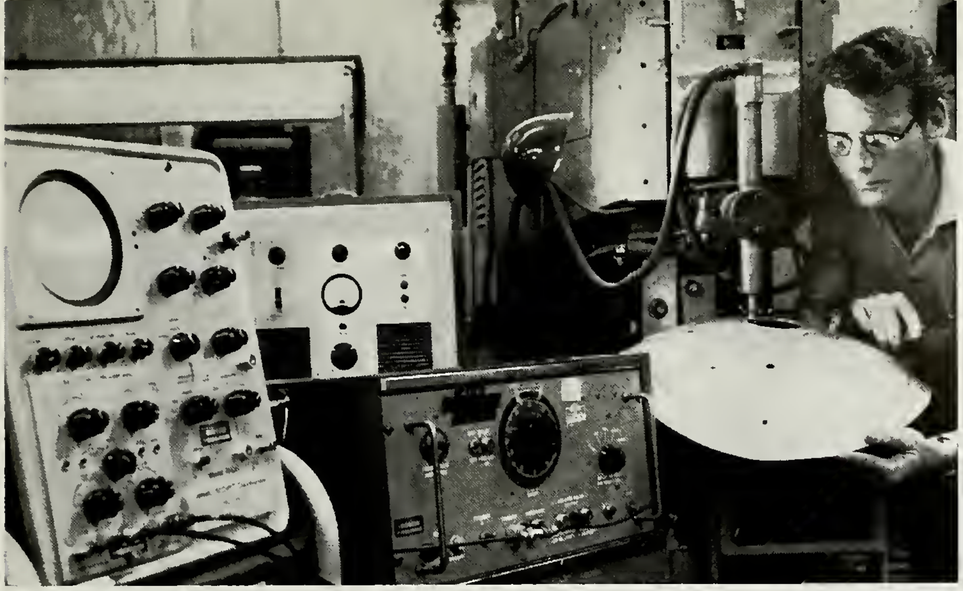
Used extensively for in-flight refueling to extend the range of combat aircraft, the KC-135 is similar in design to another famed Boeing aircraft, America's first jet transport, the commercial "707", now flying air routes throughout the world.

Air Force Awards

$2 MILLION TO RYAN FOR C-124 EXHAUSTS

Award of an Air Force contract to Ryan Aeronautical Company has been made for approximately $2 million to build exhaust manifolds for the Douglas C-124 Globemaster cargo plane.

The exhaust systems will be supplied as part of an extensive modification program for the C-124, one of the major "workhorse" logistics support planes of the Air Force. A principal feature of the program is standardization of the power pack configuration to the Pratt & Whitney R-4360-63 engine.

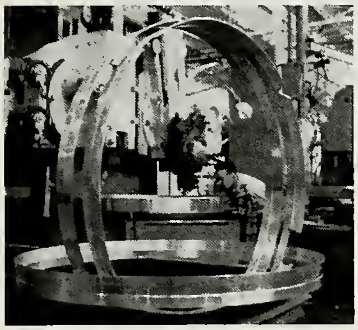


Nearly 2,000 Completed

RYAN CONTINUES REFLECTOR WORK

Continued large-scale production of aircraft radar reflectors by Ryan is assured with award of a new contract from the Dalmo Victor Company, Division of Textron, Inc., Belmont, California.

Nearly 2,000 of the aluminum reflectors have been built by Ryan.



Turret Lathes Turn

GIANT MINUTEMAN RINGS

Big vertical turret lathes are turning out missile parts at Ryan—separation rings for the Minuteman missile. Under a Boeing contract the rings, ranging from 37½ to 65 inches in diameter, are being made of aluminum alloy. The initial order calls for production of nearly 2,000 rings.

RYAN TO BLAST SATURN C-5 BULKHEADS

Award of a $630,000 contract has been made by the Marshall Space Flight Center, Huntsville, Alabama, to Ryan for explosive forming of aluminum segments for fuel compartment bulkheads in the Saturn C-5.

Ryan will build a large number of units to be assembled at Huntsville into domed bulkheads 33 feet in diameter. Design work on construction tools is now under way at the Ryan plant in San Diego.

For Army Logistics Support

RYAN DESIGNS FLEX WING TOW GLIDER

Ryan engineers are designing a unique Flexible Wing system for unmanned towed gliders capable of greatly increasing the normal cargo carrying capacity of Army aircraft.

Ryan studies to date have shown that the Flex Wing glider may be able to lift as much as six times the normal lifting capability of the helicopter, thereby greatly expanding usefulness of such conventional vehicles.

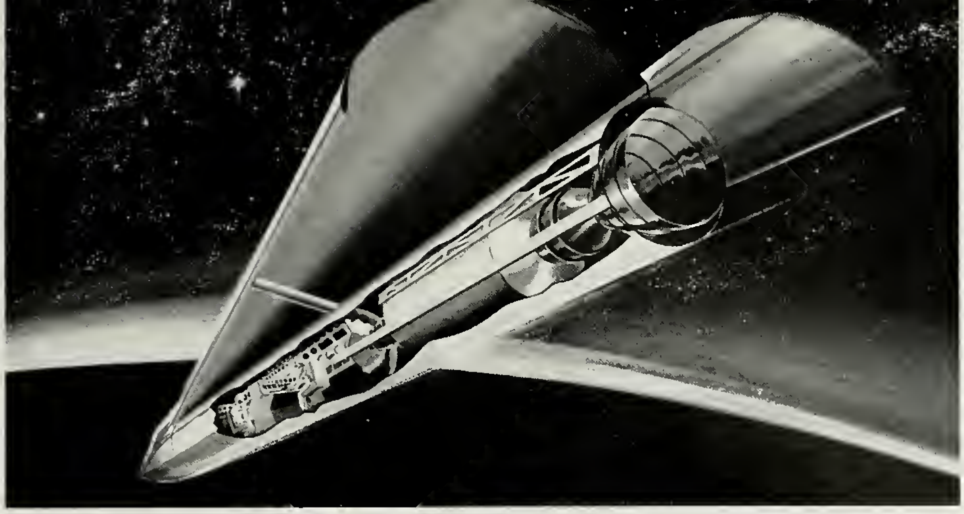
All types of supplies, weapons and fuel could be airlifted in this manner to provide speedy logistics support to Army units in the field.

Payloads of as great as 13,000 pounds could be towed by a Sikorsky H34 helicopter, utilizing a Flex Wing.

NASA "FLYS" FLEX WING TEST BED

Wind tunnel tests of the Ryan Flex Wing powered test vehicle, first aircraft of its kind in aviation history, have been successfully performed at the National Aeronautics and Space Administration's facility at Langley Field, Virginia.

Data obtained from several weeks' wind tunnel work confirmed and correlated data obtained by actual flights of the test vehicle for the Army, by Ryan test pilot Lou Everett.



On Giant Flex Wings

SPACE VEHICLE RE-ENTRY STUDIED

Ryan pioneering in the application of the Flex Wing concept led to studies during 1962 of structures, erectible in space, to provide a lifting re-entry from orbit of a wide variety of space vehicles.

Such a revolutionary technique contrasts with the present ballistics re-entry requiring either extremely critical heat shielding or resulting in destruction of costly devices and vehicles which, in the present state of the art, must be considered expendable.

Ryan engineering in the re-entry field is based on the thesis that one-shot missions are a needless luxury of the Space Age, and that recovery of vehicles from orbital velocities for repeated re-use is essential.

An analysis performed by Ryan in cooperation with the National Aeronautics and Space Administration's Marshall Space Flight Center showed that a booster development program, utilizing a flexible wing recovery system, would save the government about one-half the current booster costs.

KALEIDOSCOPE '62

RYAN FLIGHTS PROVE UNIQUE FLEX WING

Ryan's manned Flex Wing test vehicle — the world's first — completed approximately 200 test flights in the San Diego area prior to its successful performance in extensive wind tunnel tests at NASA's Langley Field, Virginia facility.

In slightly more than two years, Ryan has participated in more programs aimed at practical applications of this concept than any other company in the United States. The Flex Wing, with its broad spectrum of potential applications, holds future promise of major engineering and production activity at Ryan.

At Twenty-Nine Palms

MARINES TEST FLEX BEE

Surveillance drone applications of the Ryan Flex Wing were successfully tested by Ryan during 1962 under contract from the U. S. Marine Corps.

Test vehicles built by Ryan underwent functional and flight testing at the Marine Corps' desert facility at Twenty-Nine Palms, California, to demonstrate feasibility of a flexible wing drone for surveillance over enemy territory in support of tactical combat operations.

Launched from a portable field launcher by two Marine infantrymen, such a low-flying drone could carry photographic or television equipment to report enemy movements and positions, and could also be used as a platform for numerous other sensing systems.

CARIBBEAN ASSIGNMENT

IT WAS mid-morning when the Navy P2V Neptune eased off the Roosevelt Roads runway, tucked its landing gear, and headed for the "Alfa" missile firing area over the Caribbean northeast of Puerto Rico.

Two Ryan Firebees dressed in bright Dayglo paint hung on the Neptune's wings, and they caught the warm Puerto Rican sun as the big recon bomber banked to her assigned heading.

Aboard, three Ryan technicians joined Utility Squadron 8 crewmen. The Neptune was the launch platform for the Navy Q-2C Firebee turbojet target assigned to fly a mission for the Italian missile cruiser Garibaldi. As Puerto Rico vanished into the sea that was the distant horizon, the Ryan crew, Ed Mace, Jim Jernigan and V. J. Duncan ran through the target launch check-off sheet, readying the starboard target for action.

On the ground, Ryan base manager Bud Miller watched the P2V airborne, waved to the Ryan crew busy in the hangar, stepped into his station wagon and headed for the highest point on the

Navy Q-2C Ryan Firebees tucked under the wings of a P2V launch aircraft, catch the warm Caribbean sun.

The Ryan Firebee was the target for the Italian missile cruiser Giuseppe Garibaldi, on the Roosevelt Roads "Alfa" missile range.

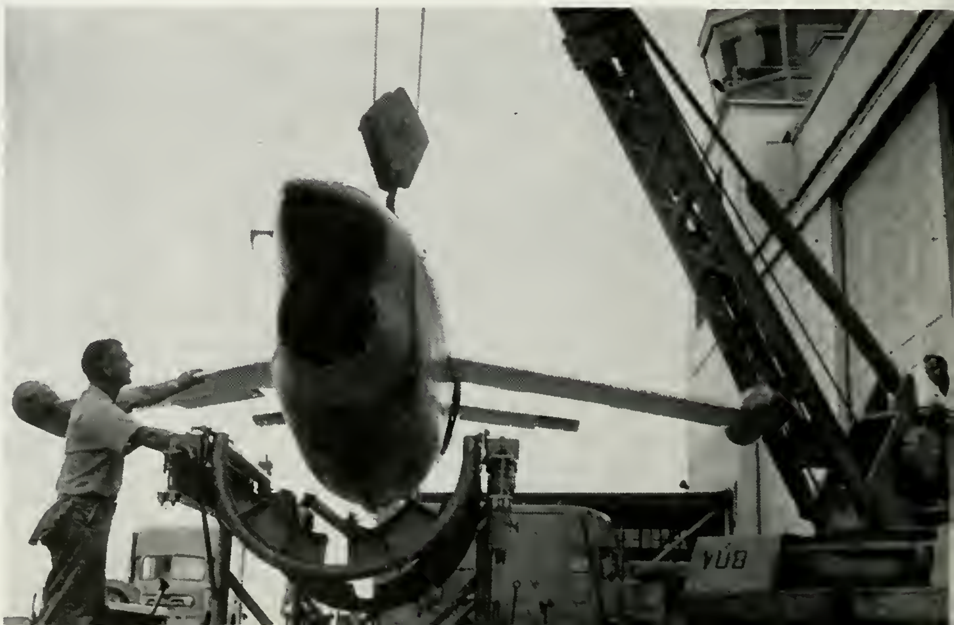
Naval station—"Echo," the control site operated by the Guided Missile Operations Control Unit (GMOCU) at Roosevelt Roads.

As he drove the winding road that cut through the thick tropical underbrush, past hangars and aircraft hidden by the dense foliage, his thoughts flashed back several days to a briefing held aboard the sleek Italian cruiser at the San Juan Naval Station. His mind rambled over the numerous details involved in working with the Garibaldi, the first Italian ship ever to fire at the versatile Q-2C. It was a typical mission, launch the Q-2C at 10,000, climb it to mission altitude, be at mission altitude in time for the first hot leg. The operation should carry the Firebee well out on the Alfa range, therefore, he'd have to save enough fuel to vector the target back to the recovery area.

At "Echo" two Ryan crewmen, Len Sinfield and Ernie Loyall were already running preliminary checks with the airborne P2V. As Miller entered the control van they were talking with Duncan and Jernigan, the Ryan direct controllers in the aircraft, performing telemetry and communications checks.

Miller eased into a seat behind the elaborate control console as Len briefed him on the P2V's progress into the range area.

Cdr. Dave Kribs, above, skipper of VU-8, prepares to take controls of a T-28 for a Firebee mission. At right, Ryan technicians George Bowie (left) and Jim Jernigan, on the "cherry picker", ease a Q-2C Firebee into its handling dolly.



Ryan base manager Bud Miller (left) and maintenance supervisor Bob Lankard discuss a mission configuration change for the jet-fast Ryan Q-2C Firebee. A demanding flight schedule requires an extensive inventory of ready targets at all times.

Meanwhile a T-28 chase and spot aircraft, piloted by Utility Squadron 8 skipper, Commander Dave Kribs, taxied off the hangar apron and headed for a rendezvous with the missile cruiser. His first objective was to fly over the cruiser, while Echo tracked his course to get a direct fix on the ship, then he'd stand by for chase and spot assignments.

As the P2V circled just inside the missile operations area, Miller called for a final remote control check, and the Firebee, still nestled under the P2V's wing, responded as green lights on the control console gave visual evidence of the telemetry reception from the jet target.

He ordered a short countdown, and the target was launched, as the plotting board atop the control console jerked to life charting the course of the Firebee as it moved out onto the firing range.

For the next hour, Miller at the remote control site guided the Firebee back and forth across the range in a race track pattern as the Garibaldi exercised its radar and missile systems in training operations against the target. Mission completed, the Firebee was vectored toward Puerto Rico and its assigned recovery area. Parachute recovery was commanded and the sleek Q-2C dropped into the ocean under a giant 81-foot parachute, where the recovery helicopter was standing by to pick it up and return it to Roosevelt Roads for a thorough decontamination and routine repair by the Ryan crew.

Miller helped the GMOCU crew shut down the control station, made a few mental notes about the mission, then headed back for the Ryan hangar.

Typical Operation

The mission was a typical operation for the twenty-man Ryan crew, the only civilian squadron on the sprawling Roosevelt Roads naval station. The Ryan team takes its orders from and is under the operational control of Commander Jack Miller and his Guided Missile Operations Control Unit at "Roose Roads," but the Ryan crew is directly responsible to the Bureau of Naval Weapons to provide Q-2C jet target service for the ships and aircraft of the Atlantic Fleet.

Ryan's partner in Firebee operations on the Roose Roads range is Utility Squadron 8. The utility group provides the supplies and necessary aircraft and pilot personnel to carry out Firebee operations, such as the P2V launch and direct control aircraft, a T-28 chase and spot aircraft, and HSS-1 recovery helicopter, and FJ-4 chase and control aircraft.

The Ryan team has been flying Q-2C's for the Navy since April on a schedule that keeps the crew jumping. Under the direction of Bob Lankard, hangar boss and maintenance supervisor, the technicians and mechanics have the responsibility for readying all Q-2C targets for flight. The team is evenly balanced with specialists directing each phase of the Firebee maintenance. Ed Mace, a target systems engineer, is also responsible for maintaining the Firebee operating radar equipment used in the P2V launch aircraft.

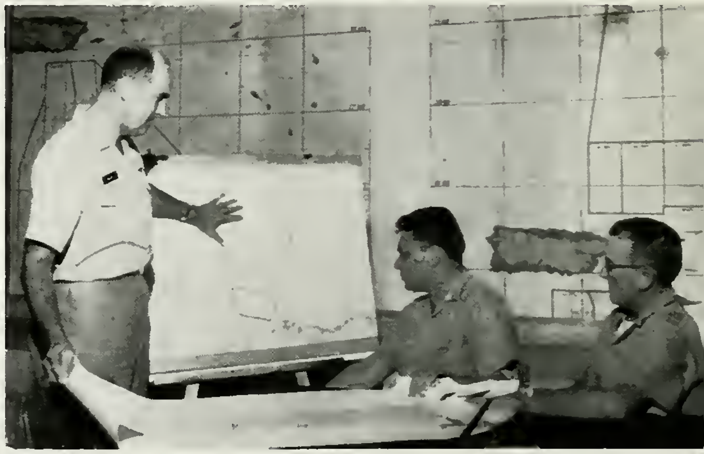
A key U. S. Navy installation in the Caribbean, Roosevelt Roads Naval Station was first commissioned in September 1944. At dedication ceremonies in May 1959, the airfield was named "Ofstie Field."

Roosevelt Roads

Roosevelt Roads was commissioned as a U. S. Naval Operating Base in September, 1944, but it had been considered as a naval base site as early as 1919. In 1955, the Chief of Naval Operations established the station as an Atlantic Fleet guided missile training center. Redesignated a Naval Station, the base was ordered to maintain and operate facilities and provide services and material to support guided missile and other operations.

A primary consideration in the selection of Roosevelt Roads was the existence of two large restricted airspace areas to the northeast and southwest of Puerto Rico, ideally suited for missile firings. The open space offered distinct advan-

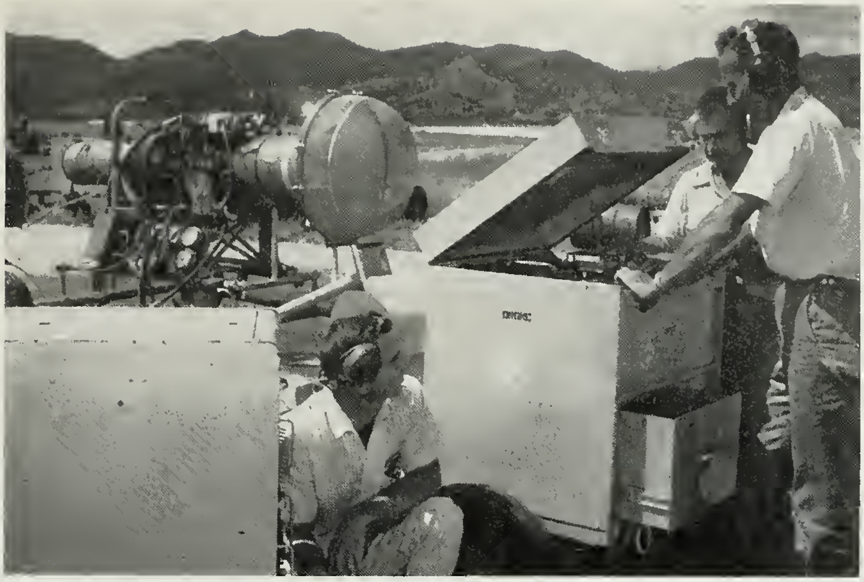
Discussing a Firebee mission, Cdr. Jack Miller, officer in charge of the Guided Missile Operation Control Unit, huddles with Ryan's Bud Miller, and Lt. Dewey Gann.



Ryan crewmen in the P2V, operate control console, in a step-by-step checkout procedure. They will launch Firebee, then direct control of the target will be maintained from Roosevelt Roads.

58-10

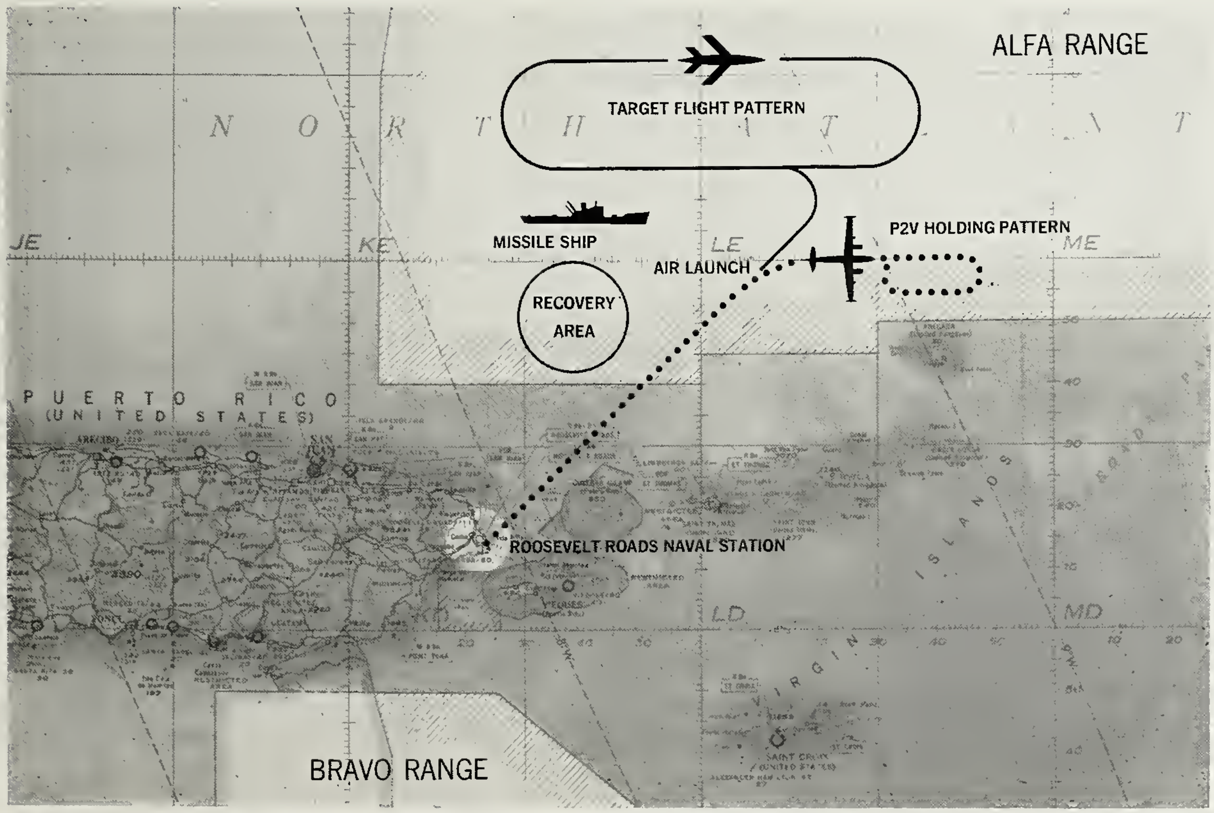
After an engine has been thoroughly cleaned and repaired, Ryan crewmen test it for efficiency. (L to R) Ryan technicians D. J. Stapp, George Bowie, and Jim Jernigan complete the engine run-up. Note screen on engine intake to prevent foreign object ingestion.



tages over potential missile sites on the Atlantic seaboard where areas are reduced in size and limited by heavy air and sea traffic. As a result, since 1957, Roosevelt Roads has expanded with a rapidity characteristic of wartime operations.

The Guided Missile Operations Control Unit was established in November 1958 to coordinate and exercise positive control of the areas used for Navy guided missile training. GMOCU skipper Commander Jack Miller, predicted an expanding role for his unit. "As our activity increases, Firebee operations should pick up tempo," he said.

The Ryan team is excited about the part it plays in maintaining razorsharp readiness in the Atlantic Fleet. Ryan Base manager Miller sums it up—"as long as they have ships, aircraft and missiles, and men to man and fire them, we're ready to fly the targets." ■



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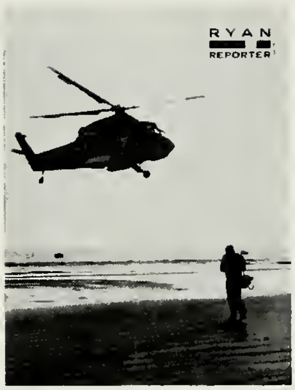
RYAN REPORTER

JAN.-FEB./1963



About the Cover: The Navy's UH-2A Seasprite, making its Pacific Fleet debut in a flight demonstration, hovers over the shimmering sand of a San Diego beach. (See article, page 18).

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HURRICANE HUNTERS

THE colorful Caribbean is one of the world's most fertile breeding grounds for hurricanes, and the men of the Navy's Airborne Early Warning Squadron Four (VW-4), stationed at the U.S. Naval Station, Roosevelt Roads, Puerto Rico, are "Hurricane Hunters." They fly the 70-ton WV-3 Super Constellation equipped with the Ryan AN/APN-122 Doppler radar navigator.

In the western Pacific, natives call similar storms "typhoons"; in the Philippines they're dubbed "baguios"; Australians call them "willies willies"; and in the Indian Ocean they're simply "cyclones."

But hurricanes, by definition, are tropical cyclones which occur in the Atlantic, Caribbean, and the Gulf of Mexico, in an area from the equator to 25°-30′ north latitude. By common agreement—among meteorologists—these disturbances are referred to as "tropical storms" until their maximum wind speed exceeds 75 miles per hour, then they earn the title "hurricane."

The mission of the Hurricane Hunters has no parallel in aviation history.

Seek out and identify hurricanes. Fly in them, determine their intensity, the direction and speed of their winds, and the speed and direction in which the storm is moving. Once they identify a storm the Hunters stay with it, and report all information to the Navy's Fleet Weather Facility in Miami, Florida.

As a unit of the joint Hurricane Warning Service, the Navy has been performing aerial hurricane reconnaissance since 1943. Patrol bomber aircraft, seaplanes, radar reconnaissance planes,

The deadly beauty of a hurricane is a familiar sight to the Navy Hurricane Hunters of VW-4. In this dramatic shot of Gracie, taken by the Hunters, note massive cloud swirls which define hurricane's eye.

anti-submarine warfare aircraft and even jet and propeller fighter planes have flown into hurricanes to collect weather information.

Although the data gathered is of great help to meteorologists in their study of storm phenomena, the more immediate role of the Hurricane Hunters is to provide civilian populations, the military services and ships at sea precise information on the path and intensity of the destructive storms.

The WV-3, "Willy Victor" as the Navy calls it, is a remarkable aircraft. Powered by four turbo-compound engines which deliver a total of 13,000 horsepower, the Constellation has the combined power of eight diesel locomotives. It cruises at 240 mph, is capable of speeds in excess of 300 mph, and can remain airborne on a weather mission for more than 18 hours. It carries a crew of 23, and the electrical power required to operate its complex electronic gear would supply an average community of 3,000 people.

"Normally when scouting a hurricane we make low level penetrations into the storm during the day, and high altitude penetrations at night," Commander Russell E. Blalack, VW-4 Commanding Officer, said.

"In a well developed storm, the aircraft may be blown sideways at three-fourths the rate of its forward motion. We buck head winds up to 150 knots, but try to maintain 200 knots air speed."

Hurricane Hunter flights sometimes span 2500 aircraft miles on average 12 hour flights.

"In the no man's land where hurricanes are born, there are no navigational aids," Commander Sidney Overall, Squadron Executive Officer, said. "Storms will clutter the search radar, and overcast conditions in the storm can hamper celestial navigation. In these situations, the pilot and crew depend on the AN/APN-122, a self-contained navigation system."

The Ryan-built APN-122 in the Super Constellation is coupled with an ASA-13 computer and a plotting board. Operating on a continuous-wave Doppler radar principle, the APN-122 develops ground speed and drift angle data and feeds it to the ASA-13. Using this information, the ASA-13 computes and displays the miles traveled by the aircraft and the route direction, together with wind speed and wind direction.

The APN-122 data, when integrated into the plotting board, will develop the aircraft's exact geographical location in latitude and longitude.

A self-contained system, the APN-122 operates on the Doppler principle, deriving from the shift in the system's transmitted and corresponding reflected-received radar energy, the ground speed and drift angle data.

"With the APN-122," Commander Overall continued, "we can obtain instant wind speed and direction while flying into a hurricane's eye. Because of the constantly changing and violent nature of hurricane winds, this is important."

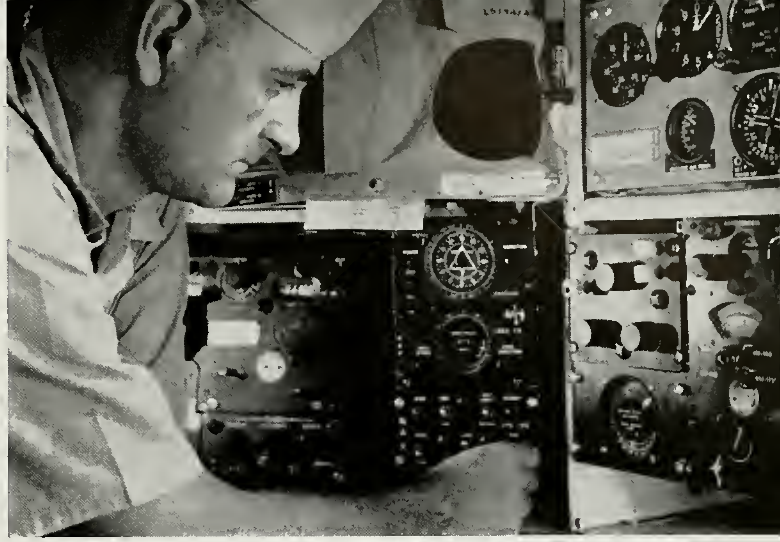
To obtain this "instant information," the APN-122 determines the ground speed and ground direction of the aircraft. This data compared to the true air speed of the aircraft develops the difference as a function of air speed and direction.

"Because the APN-122 requires no ground navigational aids, we can fly a pattern back and forth through a turbulent storm, plot the exact location of the storm's eye, come out and know exactly where we are," Commander Overall said.

On the long weather flights, the 23-man

One of over 30,000 radar photos taken of Hurricane Gracie by the Puerto Rico based Navy squadron. They tracked the storm for nine days.

Ryan Doppler data is utilized by the plotting board in the Hunter's aircraft. Ensign Ed Strain (left) and AC-1 T. D. Tayman plot a navigation fix.



At the navigation desk in the 70 ton Super Constellation, Chief Petty Officer Bouchillon monitors the Ryan AN/APN-122 Doppler navigator.

crews of the Super Connies are quite comfortable. The aircraft has sleeping accommodations and a complete galley where a machinist or a radar man —doubling in brass—can whip out a complete steak dinner.

Hurricane reconnaissance has undergone radical changes in the past three years. Weather information which once took days to acquire, can now be obtained in one VW-4 meteorological flight.

Conditions in an area greater than 200,000 square miles can be viewed with one sweep of airborne radar. One Navy weather flight can provide weather information on an area encompassing 1,500,000 square miles.

When not chasing hurricanes, VW-4 assumes a role similar to that of other Navy Airborne Early Warning Units. During the Cuban Crisis it monitored shipping in the Caribbean area. In the past it has participated as part of the recovery group for Project Mercury.

In June the Hurricane season will return to the Caribbean. The seven aircraft, 400 enlisted men and 60 officers of Airborne Early Warning Squadron Four will be ready for action.

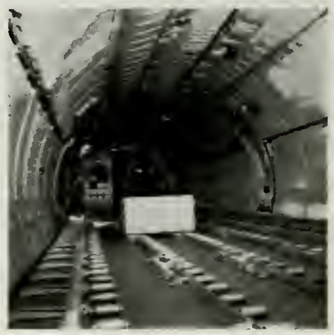
When you read about that first hurricane of the season—named Angie, or Alice, or Agatha—you'll know VW-4 was on the job! ■

The Hurricane Hunters are responsible for covering the entire Caribbean area in search of tropical storms. Flights sometimes span 2500 aircraft miles on average 12 hour flights.

WE stood in the crew's compartment of the giant C-135B jet transport on the flight line at Travis Air Force Base and looked aft. You'd have thought we were standing in a bowling alley.

To the right, through the huge side loading door of the fuselage, we could see an odd looking truck loaded with pallets of cargo, jockeying into position.

"We use the Air Force 463L cargo system," the loadmaster, a sergeant, was saying. "These individual standard-sized cargo pallets are specially designed to fit the C-135. With this equipment and that MK loader out there we can load this aircraft with 82,000 pounds of cargo in fifteen minutes." The truck began to growl, pushing cargo into the transport on a self-contained conveyor belt. We didn't believe him—fifteen minutes later we did!



Up forward, the pilot and co-pilot along with the chief engineer were progressing through the check list. Outside it was cold — 30 degrees, one of the flight line mechanics had said earlier. "This load is headed for Japan," the pilot turned his head. "We'll stop in Hawaii—it will be warm there."

Travis Air Force Base is about 48 miles northeast of San Francisco. It's the home of Western Transport Air Force (WESTAF), and the Military Air Transport Service (MATS). Two WESTAF units, whose common denominator is the turbofan-powered C-135B jet transport, are based here—the 44th Air Transport Squadron, and the 1512th Organizational Maintenance Squadron.

Someone said the Travis site was picked because it would never be foggy. As we left the aircraft and walked toward the 44th's offices, it was cold—and it was foggy.

GLOBAL WEIGHTLIFTERS

Boeing builds the C-135B, a cousin to the KC-135 jet tanker, and the commercial Boeing 707.

Ryan Aeronautical Company is a major subcontractor to Boeing on both the KC-135 and the C-135. Ryan recently received a follow-on contract for aft fuselage sections for the KC and C-135s. The $9 million order was the ninth received for the sections, the largest aircraft structure ever subcontracted in the aircraft industry. Ryan has built and delivered more than 600 of the three-ton, 40-foot sections since 1955.

Inside a green cement building that housed the offices of the 44th, it was warm. Phones rang and men in blue uniforms shuffled in and out of offices. It was smoky. In the hall several framed color photos of the C-135 decorated the walls.

"Let's talk in here," said Captain Bob Jaxtheimer, public information officer, pointing to a conference room. "I'll round up some of our people."

Moments later Lt. Col. Bernard Hartnett, the 44th's skipper; Lt. Col. John Sherwood, their Chief of Standardization; and Lt. Col. Harold J.


MATS
12669
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MATS C-135's evacuated military dependents from Guam after typhoon Karen ravished their homes in late November.

Ryan will continue to produce the aft fuselage section for both the KC and C-135 under subcontract to Boeing.

Zwiefel, the operations Officer, stood in the doorway.

"We got our first C-135 last March," they said. "Major General Glen R. Birchard, the WESTAF commander, brought the first airplane in from Boeing. In fact, he brought in the first two aircraft. For a while we thought only the general would get to fly the airplane. Now we have seventeen; they're great!"

"In April, one of our airplanes smashed seven existing world's records and established three new ones. Previously, the records had been held by the Soviet Union—we called the operation "Swiftlift." The records were set in two hops at Edwards Air Force Base on the 17th. In the morning we carried 30,000 kilograms (roughly 60,000 pounds) to 47,171 feet, topping the Soviet records of carrying the same weight to 43,047 feet. That afternoon the aircraft carried the same payload over a closed 2,000 kilometer (1,250 miles around the pylons) closed course at 615.81 miles per hour flying over 20,500 feet. The Soviet record for the same weight was 596.4 miles per hour."

The trio seemed proud of the squadron's accomplishments with the C-135 in recent months.

Lt. Colonels Sherwood, Hartnett, and Zwiefel of the 44th Air Transport Squadron discuss a MATS C-135 mission. Based at Travis AFB, their tasks are global in scope.

Major General Glen R. Birchard, Western Transport Air Force commander, directed Berlin Airlift operations. During World War II he flew 400 combat hours in B-24's and B-29's.

"Last May, Major General Birchard flew an air evacuation mission from Yokota Air Base, near Tokyo, to Travis in nine hours and three minutes. In October we carried Marines and supplies into the Naval Base at Guantanamo Bay, Cuba. In early November we began an airlift of supplies into India to help them repel a Communist Chinese attack on their border country. In late November we airlifted military dependents out of Guam after typhoon Karen had ravished the island."

"We transport cargo, troops and supplies from points anywhere west of the Mississippi to bases as far away as Saudi Arabia," Lt. Col. Sherwood said. "We make regular runs to Hawaii, Alaska, the Philippines, Japan, Bangkok and other destinations in the Far East. Somewhere, 24 hours a day, we have an aircraft airborne."

What were some of the events surrounding the Cuban airlift? "We'd rather you get those details from WESTAF," they agreed. It was late— we could do that tomorrow.

Next morning, we stopped to see the senior maintenance officer at the 1512th Maintenance Squadron and picked up a guide. Across the ramp we could see half-dozen huge steel hangars. One big barn had all but swallowed a C-135. Only its great tail structure remained visible.

Inside, a dozen mechanics were pulling a post flight inspection. The crew chief, an enlisted man, stood off to one side, clipboard in hand discussing a problem with his assistant. His responsibilities were nearly as massive as the 134-foot long, quarter million pound monster he mothered.

We left the hangar and drove past the flight line where half dozen C-135's sat waiting. "These are cocked and ready for assignment," the guide said.

Back in the maintenance office, Chief Master Sergeant Patrick Wolf gave us a rundown on the C-135. "It can transport 126 fully-equipped troops, approximately 80,000 pounds of cargo, a field hospital, or 44 litter and 54 ambulatory patients to any spot in the world in no more than 20 hours. We maintain the aircraft and reconfigure the interior for assigned missions. They're good — we figure each one of our 17

Air Force maintenance crew chief and assistant discuss post flight inspection of a quarter million pound C-135. Ryan built aft fuselage section extends through hangar doorway.

airplanes averages five hours flight time per day."

Later, Lt. Col. Jim Zicarelli, Director of Information, met us in his office at WESTAF headquarters. We went up to General Birchard's office. General Birchard was named Commander of Western Transport Air Force in July, 1961. He flew 400 combat hours in B-24's and B-29's in the Pacific during World War II, and 40 combat hours in the Korean conflict. During the Berlin Airlift, he was director of operations at Headquarters, 1st Airlift Task Force, Germany.

The Cuban Crisis?

"Within 48 hours of notification we had airlifted a complete force of Marines from California to Guantanamo Bay, Cuba," General Birchard said as he leaned back in his chair. "It was the first real test of a new strategic airlift capability the President had asked the Air Force to create early in 1961 — and for which MATS received the C-135."

"In November, soon after the Cuban crisis, India requested United States help to repel the Communist Chinese attacks on their border country. WESTAF dispatched 44th Transport Squadron C-135's to pick up supplies and deliver them to Dum Dum Airport, Calcutta, India. The airlift, which began November 2—only four days after the initial Indian request for military aid—continued for about seven days, with eight flights every 24 hours. About 840 tons of supplies were moved."

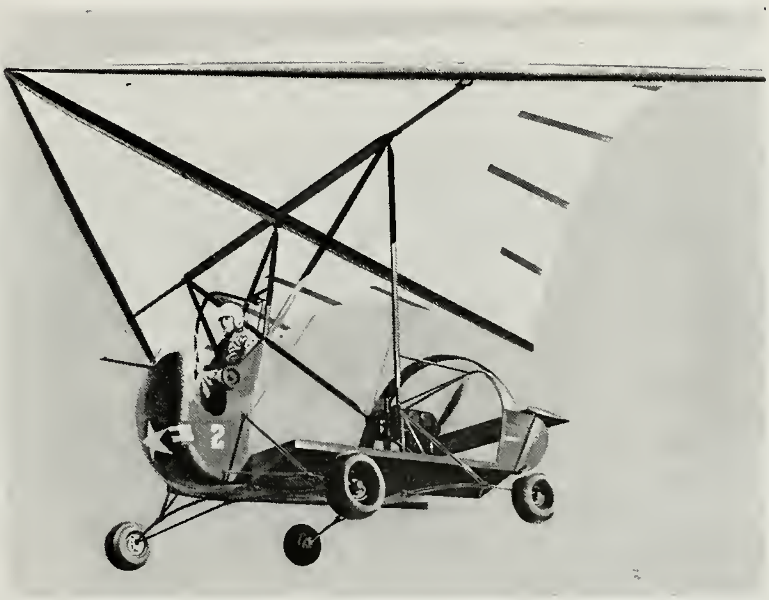
He praised the aircraft saying, "Yes, I guess you could call MATS and the C-135 an instrument of national policy. But remember, it is only an interim aircraft. Soon we will have the C-141; then with the two jet transports we'll really have a strategic airlift Sunday punch."

We left Travis a little envious. Pilots, navigators, engineers and crewmen at the 44th discussed flights to Calcutta, India, like you would a trip to the corner drug store. They keep an extra bag packed — but they fly the C-135. ■

— George Becker

(Top to bottom) On Travis flight line, special truck loads C-135 with 82,000 lbs. of cargo in 15 minutes — Pilot at controls completes check-off list — A C-135 smashed seven existing world records and established three new ones — Military supplies for India are unloaded at Dum Dum Airport, Calcutta.

Ryan Aeronautical Company has increased its total facilities in the San Diego, California area with the recent acquisition of a new 160,000 square foot plant in San Diego's Kearny Mesa Industrial Park. This expansion of capability allows the consolidation of Ryan Electronics engineering and production activities in San Diego. The new plant is located on a 30-acre site adjacent to Montgomery Field, the city's general aviation airport on Kearny Mesa.



The Army announced recently it awarded Ryan Aeronautical Company a total of $1,836,000 for three research contracts on flexible wing applications. One of the contracts called for design, fabrication and test of two Flexible Wing Aerial Utility Vehicles. Nicknamed "Fleep", the vehicle is shown in Ryan artist's concept. Other contracts called for design, fabrication and test of Flexible Wing Air Cargo Delivery Systems and Precision Drop Gliders.

By John M. Peterson
Assistant Chief Engineer,
Aircraft Development
Ryan Aeronautical Company

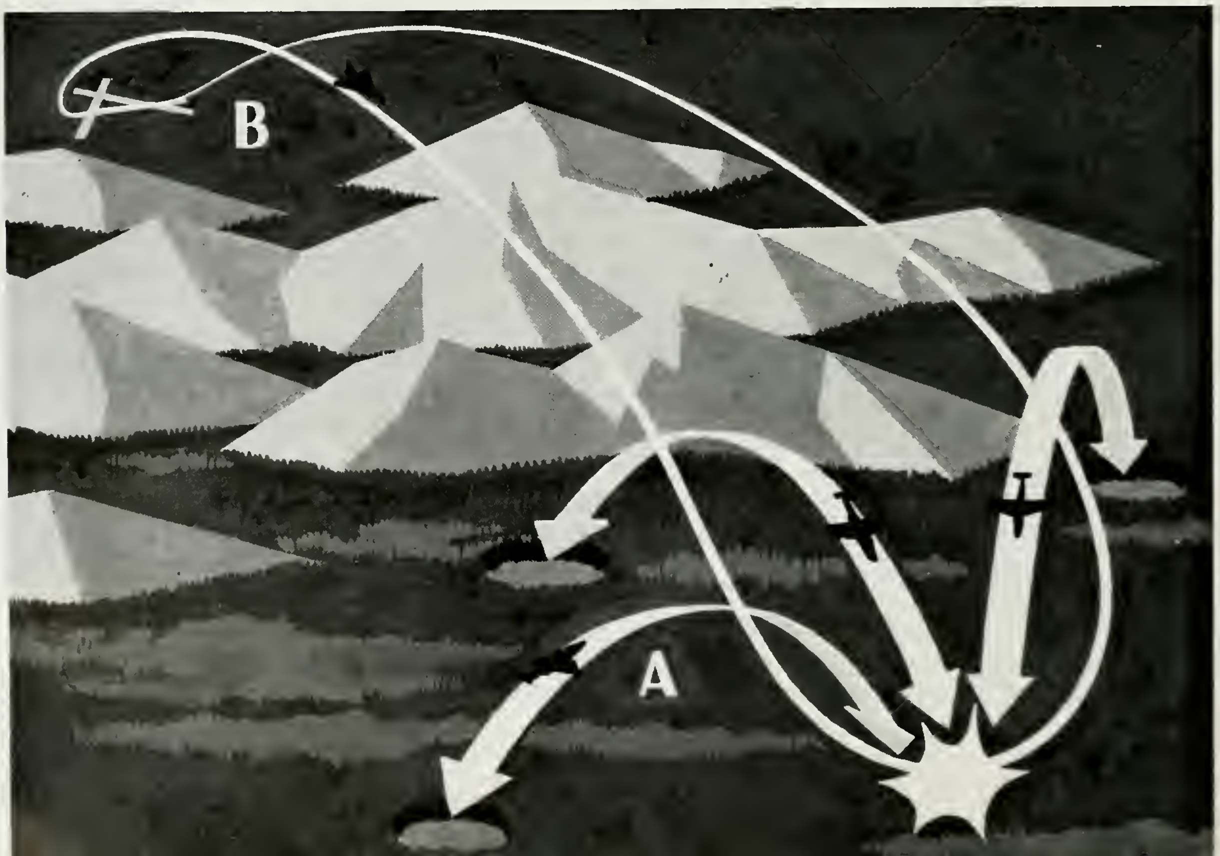
V/STOL VERSATILITY

V/STOL aircraft can be effectively utilized in global, limited and sub-limited warfare. In global warfare, with the nuclear threat, known airfields would be prime targets to reduce the opposition's capability to retaliate through aircraft carrying nuclear weapons. The ability of V/STOL aircraft to operate from hard-to-find dispersed sites would be an obvious advantage.

In limited and sub-limited warfare, the ability to operate both transport and fighter aircraft in the immediate area of conflict without building airfields is another advantage inherent to V/STOL aircraft.

There remains to be defined unique missions which can be accomplished better with V/STOL aircraft than with either helicopters or conven-

V/STOL aircraft, such as the Army XV-5A, now under design and construction at Ryan, will live with the troops. Operating from unprepared landing sites "A" in the forward battle area, as compared to conventional aircraft operating from base "B," the V/STOL aircraft will give the field commander a quicker reaction, better target location, improved communication, and greater time over the target.



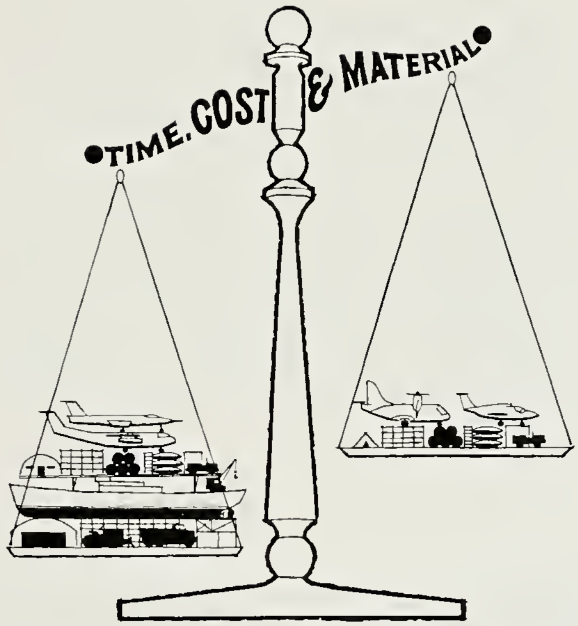
tional aircraft and preferably with advantages from both mission capability and cost effectiveness. This is not to say that conventional aircraft and helicopters will not be required, but that V/STOL aircraft can increase our military posture with an overall reduction in cost and with complete integration into existing weapon systems.

Logistic support and resupply of combat operations draws upon every type of transportation system. Trucks, trains, ships, airplanes, and helicopters all play their part in the overall transportation system — each accomplishing the portion to which they are best suited.

Helicopters are being used extensively for local distribution of material in immediate combat areas. It is apparent that the combat area could extend much farther away from vulnerable supply dumps if such distribution were accomplished by long-range V/STOL, logistic support aircraft, such as the XC-142A V/STOL transport. Another approach to the same problem would be the utilization of V/STOL logistic aircraft operating from rear bases from which conventional aircraft could operate to forward combat areas where again helicopters would handle the immediate area distribution.

Close support of ground troops and interdiction missions are presently handled by conventional aircraft operating from the nearest field available. This base may be several hundred miles away, or at any rate, a sufficient distance from the forward combat area to be comparatively invulnerable to enemy attack. Being remote from the combat area certainly improves survivability of the base, but imposes the problem of effective payloads due to the amount of fuel and navigational aids required to fly to and from the combat area. In addition, the reaction time and communication requirements of such an operation are also a problem to the military commander in the combat area.

It is interesting to note the arming of heli-



V/STOL offers reduced weapons system costs. Elimination of forward airfields alone can result in many orders of magnitude less cost than conventional aircraft weapons systems.

Ryan's Vertifan* is mobile, flexible

copters, for the close support of ground troops, vividly points out the importance that military commanders place on homogeneous support of their immediate operations.

High performance V/STOL surveillance-attack aircraft could accomplish a number of close support missions including reconnaissance, observation, fire control, command control, escort and attack missions.

These missions could be carried out in the immediate combat areas obviating long run-ins to the target from rear bases, and thereby permitting larger payloads, eliminating excessive fuel demands on the logistic supply system, and providing immediate response to changing combat situations. The missions could be carried out with the low vulnerability achieved by low altitude, high speed penetration to the target. The ability to operate from unprepared sites would allow shifting of the landing sites as often as required for survivability.

In developing the Ryan Vertifan concept, weapons systems economics was an important consideration. It has been stated that were not the costs of V/STOL so high, operational systems would have been in being long ago due to the obvious advantages inherent to the concept. In this context, criticism has been leveled primarily on reduced payloads of V/STOL aircraft and on the high costs of each machine.

The state-of-the-art of V/STOL has progressed to the point that this penalty is not nearly as severe as might be supposed. There are some conditions under which it can be shown that the

ffective and less expensive . . .

cost of V/STOL is many orders of magnitude less than the cost of conventional weapon systems.

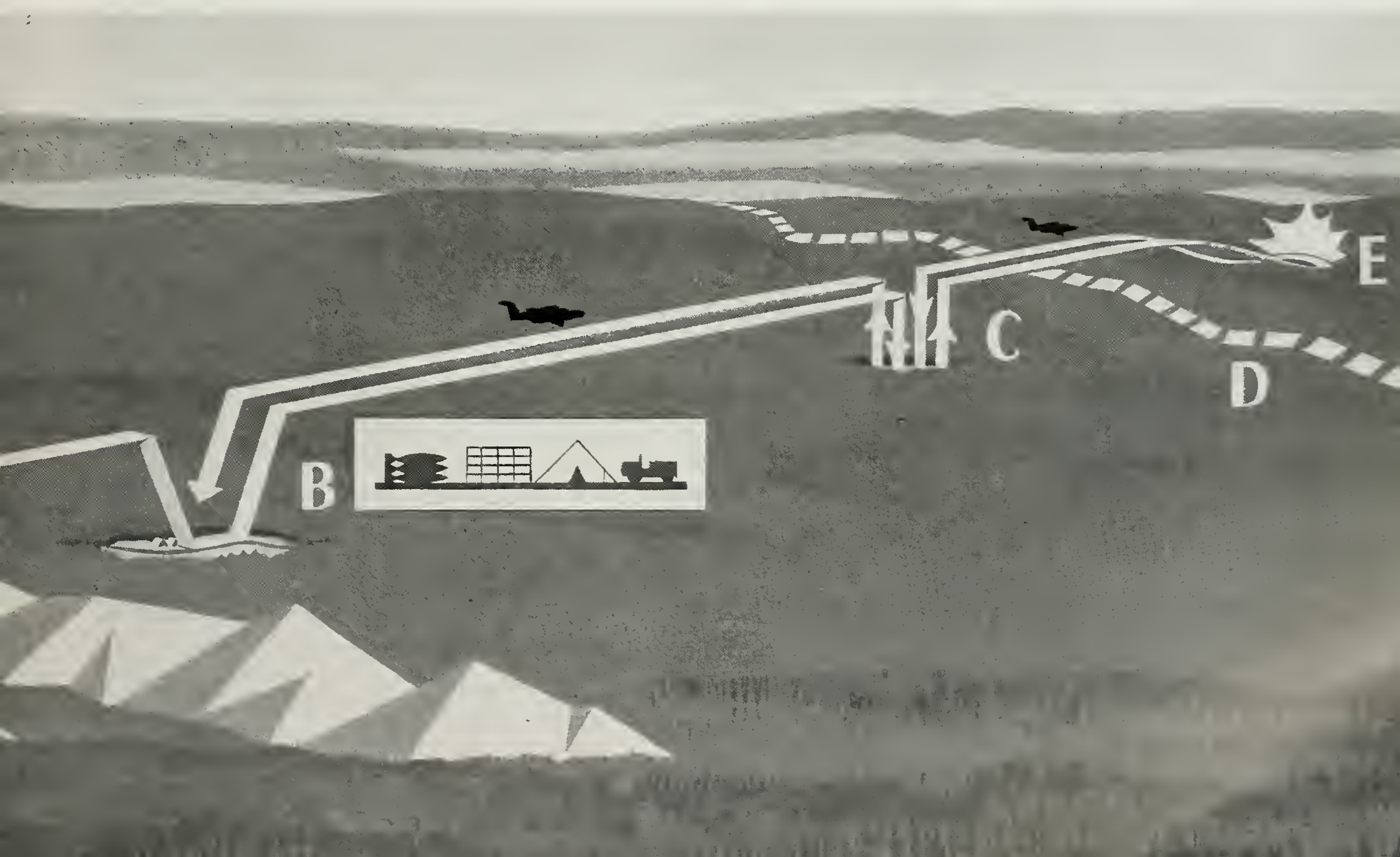
The establishment of an airfield in a remote area requires a tremendous outlay of time, cost and material. Building an airfield requires that personnel, trucks, building material and machinery all be shipped in, not to mention the logistic supplies required to support non-combat personnel in such an operation. The ultimate significance is not only in the direct cost area, but also in the vulnerable supply line required to support such an operation. In addition, the vulnerability of known airfields will probably be unacceptable in the context of any future war where short range missiles, IRBM's and ICBM's could knock out known targets almost at will. A particularly formidable threat in this area is the submarine

***Trademark**

In a typical V/STOL operation (below) the fixed airfield "A" receives conventional aircraft logistic support and marks the end ferry point of V/STOL logistic and tactical aircraft.

Soft base "B" represents a road or open field where tactical V/STOL aircraft can be refueled and supplied with weapons. Logistic V/STOL aircraft support the soft base with supplies.

Tactical V/STOL aircraft take-off from base "B" and move forward to minimum base "C" near the forward edge of the battle area "D." Then on call, the tactical V/STOL aircraft take-off vertically, fly to the target area, accomplish their mission and return to minimum base "C," for interrogation—and finally to soft base "B" for fuel and weapons replenishment. The total tactical mission from base "B" and return is unrefueled.

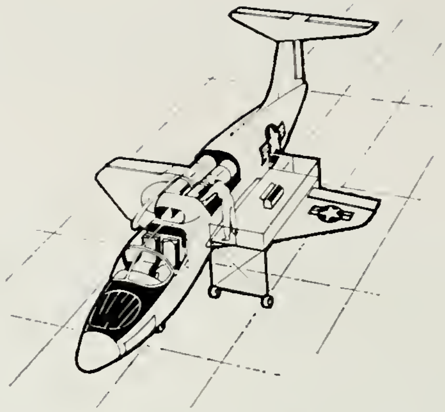


launched missile. Certainly in this context, the advantages of V/STOL weapon systems is vividly demonstrated.

Another area of V/STOL interest is anti-submarine warfare. One of the most effective localizers of submarines is the helicopter. One of the disadvantages of helicopters in this mission is the relatively short distance that they can operate away from base and the time required to arrive on the scene.

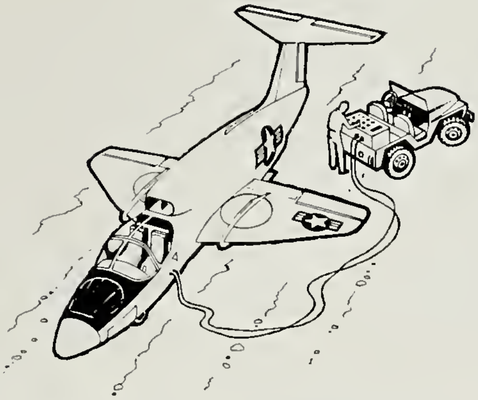
The probability of detection diminishes rapidly as a function of the time it requires for the helicopter to arrive at the initial point of contact. With the use of high speed V/STOL aircraft, either the time required to arrive at the scene could be drastically reduced or conversely the distance from base to point of contact could be greatly extended to significantly increase ASW capability.

On the subject of naval operations, there are other attributes of V/STOL aircraft which should be considered. Catapult take-offs and hook landings on aircraft carriers remain a critical maneu-



Fixed base "A" (Page 14) would provide a site for major overhaul and maintenance of the tactical V/STOL aircraft.

Under design and construction at Ryan, the Army's XV-5A incorporates the General Electric fan-in-wing propulsion system. A high performance V/STOL surveillance-attack XV-5A modification would be capable of close support missions including reconnaissance, observation, fire control, command control, escort and attack.



Soft base "B" (Page 15) provides simple "go no-go" maintenance as well as resupply of fuel and weapons.

Minimum base "C" (Page 15) is an unprepared site in the battle area, providing the field commander immediate access to air support.

ver. In addition, the amount of associated carrier machinery is large and very heavy. A considerable number of personnel are required to launch and retrieve aircraft. Of importance to an overall mission, the requirement to turn the carrier and task force into the wind demands extra time and cost.

It is probable that if these and other factors were seriously considered, a significant increase in capability of carrier operation could be achieved through the use of V/STOL aircraft.

This suggests that there could be a reduction of trained personnel required, that a greater number of aircraft and/or weapons could be carried, and a considerable reduction in cost achieved.

It is interesting to note that with 10-20 knots of wind across the deck or low catapult velocities, most V/STOL aircraft could lift off a useful load nearly equal to conventional aircraft. This is due to the STOL characteristics of such aircraft. For a Vertifan type aircraft a sample check indicates that an overload of 20 per cent can be obtained with a deck roll of 55 feet or catapult speed of 42 knots with a wind over the deck of 20 knots.

Rescue and retrieval missions are assigned to helicopters due to their unique ability to hover while operating over water or inaccessible terrain. It is obvious that this is an excellent utilization of the helicopter which has been handling this mission effectively for a long time. However, due to the limitations of speed and range of helicopters, this mission could well be supplemented by V/STOL aircraft offering greatly extended speed and range potentials.

The requirement for increased speed and range is becoming more and more important for rescue and/or retrieval missions. With the advent of recovering vehicles from space, it may in fact become of paramount importance to retrieve space capsules as rapidly and effectively as possible. Long range V/STOL vehicles might well fulfill this mission more effectively than any existing type of aircraft. With the man-in-space programs, the urgency of meeting such a requirement has been graphically illustrated by the loss of a monkey which had been successfully returned from space, and Commander Carpenter missing his landing site by many miles.

From these considerations, it is apparent that V/STOL aircraft offer significant advantages to military mission capability. Their primary features are:

1. Mobility—capable of being deployed anywhere in the world within hours.
2. Flexibility—capable of rapid response within local areas of combat.
3. Low Cost—providing reduced costs for achieving results when overall costs are analysed. ■

SEASPRITE JOINS THE FLEET!

PACIFIC Fleet carrier pilots have been adopted by a new guardian angel — the UH-2A Seasprite, a sleek jet turbine powered helicopter.

The Seasprite, built by Kaman Aircraft Corporation, joined the Pacific Fleet in January when it reported for duty with Helicopter Utility Squadron One (HU-1) at Ream Field Naval Auxiliary Air Station, near San Diego, California.

A versatile workhorse, the UH-2A is equipped with Ryan Aeronautical Company's AN/APN-130 self-contained Doppler navigation system, allowing it to operate under adverse weather conditions and at night without relying on fixed geographical navigation aids. The APN-130 permits the pilot to automatically bring the helicopter to a hover from forward flight, a capability extremely helpful to the pilot in accomplishing night over-the-water missions.

The Seasprite carries a crew of three, and can pluck from the sea nine water-logged Navy pilots or frogmen.

Since its arrival at Ream, the machine and the men who will fly and maintain it have been getting acquainted. Working a six-day week, squadron personnel under the direction of the skipper, Commander William Casey, have dedicated themselves to seeing the first Seasprites deployed with the Fleet as rapidly as possible.

Initially, the Seasprite will replace the cigar-shaped HUP helicopter in a "plane guard" role aboard fleet aircraft carriers. It will hover just off the starboard side of the flattops during an operation, ready to rush to the aid of carrier pilots who have either bailed out or ditched their dis-

The Seasprite's Ryan AN/APN-130 navigation system gets a ground check. The antenna check-out ground support equipment is strapped to the underside of the helicopter.

Lt. Art Lumley (left) and Lt. (jg) Larry Beguin in the cockpit of the UH-2A adjust the Ryan APN-130 before take-off. Seasprite will fly 150 mph.

A distinctive feature of the Seasprite is the wide chord main rotor blades with servo flaps attached on the trailing edge.

abled aircraft at sea. A normal rescue takes just a few minutes. The helicopter locates the downed flyer, lifts him from the water with a hydraulic hoist, then swiftly returns him to his ship for medical attention.

"The ability of the Seasprite to perform night rescue missions, adds a new dimension to HU-1 capabilities," Commander William Casey said. Casey, a veteran helicopter pilot with more than 1600 logged helicopter hours, is a graduate of the Naval Academy, and a former Navy helicopter test pilot at the Naval Air Test Center, Patuxent River, Md. As head of the Rotary Wing Branch of the Service Test Division there, he conducted the service suitability trials on the HSS-1, HSL-1, HR2S-1, HOK-1, HUL-1, and the HOE-1. Before assuming command of HU-1 he served as Operations Officer and Executive Officer of the squadron.

Besides deploying the Seasprite in an operational capacity in the fleet as soon as possible, Commander Casey and his squadron have been assigned the additional task of investigating the many utility potentials of the UH-2A.

As one aspect of this program, the squadron is currently conducting tests of various illumination flares to be used in night rescue work.

Regardless of what special tasks have been handed the squadron and their new Seasprites, the order of the day is training and familarization.

Last fall a team of eight squadron pilots, headed by Commander Casey, reported to the Patuxent River Naval Test Center for a fleet indoctrination and flight training program with the new helicopter. The pilots are currently busy training squadron pilots in the Seasprite.

Commander Casey, Lieutenant (jg) Larry Beguin and Lieutenant (jg) G. W. Mowery flew the first Seasprites cross-country. In separate flights, the trips averaged 30 hours, with approximately seven hours spent each day at the controls.

As a squadron UH-2A pilot Lt. (jg) Larry Beguin's day is typical. He may be scheduled for as many as four flights a day; training hops in the morning and afternoon, followed by night flights that may be designed to test night flares or develop night rescue mission tactics.

In the squadron training program, the pilots attend an intensive one-week ground training school, followed by six familiarization flights with a qualified instructor. The new Seasprite pilot will then solo and, when completely qualified in the aircraft, begin his instrument and night flying syllabus.

The Ryan APN-130 broadens the utility mission of the UH-2A with its inputs to the heart of the helicopter's stabilization system.

The Ryan Doppler system transmits four beams of continuous-wave radar energy to the surface. Energy that is reflected by the surface is detected by the helicopter's antenna and through the APN-130 is compared with the transmitted energy. From this comparison, the system computes and indicates the aircraft's heading speed, vertical speed, and drift speed, all of which are necessary to hover under instrument conditions.

Outputs from the Doppler system are utilized to determine the helicopter's directional velocity, ground speed and drift angle and are fed into the navigational plotting board and the automatic stabilization equipment.

The signals to the direction velocity indicator and the ground speed and drift angle indicator provide the pilot with visual references concerning flight conditions, with respect to the ground.

Powered by a General Electric T-58 axial flow turbo shaft jet engine, the only similarity between the UH-2A and other single-rotored helicopters is the utilization of the tail rotor for directional control.

Distinctive features of the aircraft are its compact, streamlined fuselage, incorporating a retractable landing gear system, and short, wide chord main rotor blades with servo flaps attached on the trailing edge of the blade.

When flying the Seasprite, the pilot controls only the servo flap which in turn changes the pitch of the blades. On most other helicopters, blade pitch is controlled at the propeller hub, where the entire blade rotates on its axis.

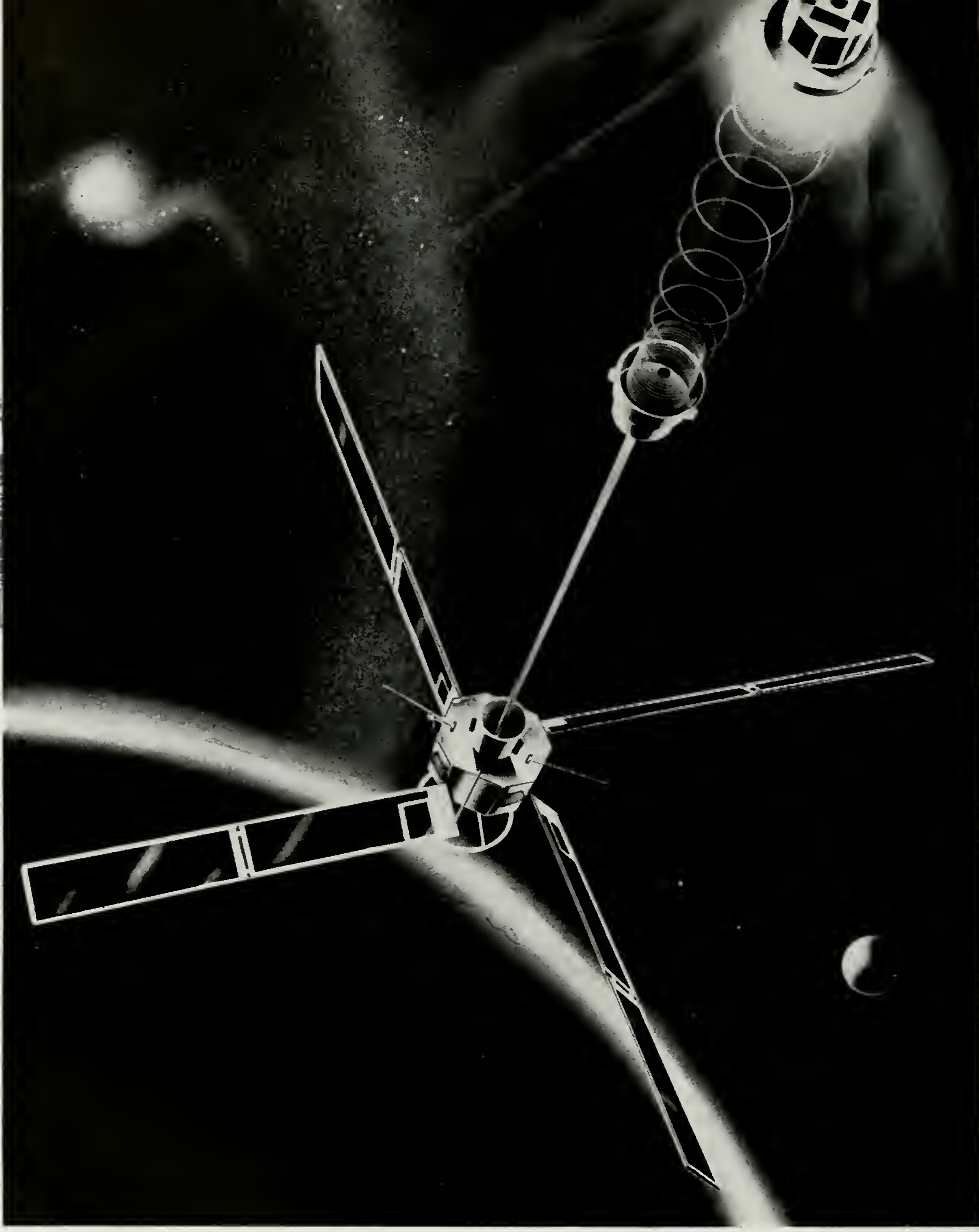
The aerodynamic result of the servo flap is a stabilized rotor system, and the elimination of stick shake and cockpit vibration normally associated with helicopters.

The UH-2A Seasprite has a maximum air speed of approximately 150 knots, and a maximum gross weight of approximately 10,000 pounds.

Helicopter Utility Squadron One, the Navy's first operational helicopter squadron, was formed in April, 1948. Detachments of the squadron provide major ships in the U.S. Pacific Fleet with helicopter service. HU-1 units are scattered over a million square mile area that stretches from Alaska to the South Pole, and from San Diego to Japan and the Philippines. Besides being based on major ships, units have been detached to LST's, Icebreakers and other small ships on special assignments.

Moviegoers will associate Helicopter Utility Squadron One with Mickey Rooney, a green top hat and the "Bridges of Toko Ri," a movie which dramatized the men of HU-1 and their service in Korea. ■

The Seasprite will add a new dimension to Navy utility helicopter missions with its capability for night rescue operations.

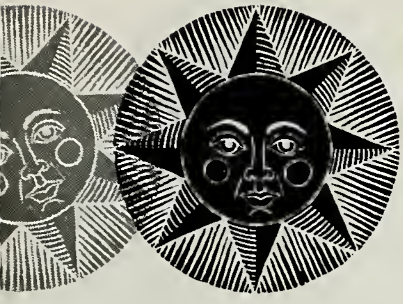


SPACE PROPELLERS

Ryan-built aluminum solar panel structures make the Navy's Transit 5-A navigation satellite look like a space-age windmill.

EIGHT Ryan-built solar panel structures, supporting 18,000 solar cells, rode a prototype of the Navy's operational navigation satellite Transit into orbit December 18 from the Pacific Missile Range, Naval Missile Facility at Point Arguello, California. The launch vehicle was a four-stage Scout rocket.

The 135-pound satellite was an octagonal-shaped body, 12 inches high and 18 inches across to which the solar panel structures were attached.



Transit 5-A was the first of two Type Five satellites slated for orbit within the next few months. The satellites will form an interim operational navigation system which will enable ships of the U.S. Navy to determine their positions day or night in any kind of weather, anywhere on earth.

Ryan Aeronautical Company built the aluminum solar panel structures under contract to the Johns Hopkins University, Applied Physics Laboratory at Silver Spring, Maryland. Development of the Transit system is being conducted by APL for the Bureau of Naval Weapons. Satellite launches are conducted by the Air Force's Space Systems Division.

The solar panel structures incorporate a new structural concept developed by Ryan, which combines low weight with high strength and reliability. The aluminum skins of the panels are strengthened by continuous aluminum corrugations attached by resin bonding and welding — a combination giving excellent resistance to fatigue during launch as well as long life under the hard vacuum of space.

In fabricating the panels, Ryan engineers selected 5050 H-38 aluminum for its strength and high heat conductivity.

The panel design provides easy access for wiring and mounting of equiment — a feature not provided by most core type structures, and prevents overheating of the solar cells as the panel dissipates heat enabling the cells to operate more efficiently, at lower temperatures.

More than 18,000 solar cells, mounted on two sides of the eight-foot long blades, collect energy from sunlight and convert it into electricity to operate the satellite's electronics devices. When the satellite is in the shadow of the earth, electrical power is provided by chemical storage batteries.

The Transit 5-A panels are so installed as to resemble propellers attached to a central body. The panels are rectangular, 10 inches wide and 96 inches long. As it travels in its orbit, the axis of the satellite points constantly toward the earth. The propeller-like solar panels, folded along the vehicle's side during launch, are deployed after boost is completed, at an angle to provide optimum usage of the solar cells.

The satellite was launched with its four double-bladed solar panels folded down over the fourth stage of the launch vehicle. The blades were held in that position by the cables of a mechanical yo-yo type de-spin device during launch. At the time of injection into orbit, the de-spin weights were deployed, unwinding the cables and freeing the blades for erection as the satellite separated from the launch vehicle.

The Navy's navigation satellite program is designed to develop and demonstrate equipment to provide a reliable operational means of fixing the position of ships anywhere in the world, in all weather conditions. The program data will also be used in determining the earth's shape to a higher degree than is now possible. The Navy's model 5-A is expected to provide data from which an improved understanding of the effects of ionospheric refraction on radio waves can be realized, and an increased knowledge of the earth's gravitational field developed. ■

Ryan engineers examine two 48 x 10 inch solar panel structures before the solar cells were added. Coupled together in space, the two became one of Transit 5-A's four 96 x 10 inch arms.

BLACK KNIGHTS
AND PHANTOM WARHORSES

BLACK Knights rode Phantom warhorses in a modern day joust on the Pacific Missile Range recently.

The Black Knights were crack Marine fighter pilots and radar intercept officers of Marine All Weather Fighter Squadron 314. The warhorses were sleek F4B Phantom II jet fighters. Their weapons — deadly Sparrow III guided missiles. Their enemy—the Ryan Q-2C Firebee jet target.

The Firebee carried into the fray only its ability to simulate the deceptive maneuvers of an aggressor aircraft.

The Marine squadron, home based at the El Toro Marine Air Station, Santa Ana, California, was at the Pt. Mugu Naval Missile Center and the Pacific Missile Range to qualify its pilots and radar intercept officers with the Sparrow III.

For the qualifications which began on Monday, January 28, VMF-314 was supported by range operating personnel at Pt. Mugu, and Navy Utility Squadron Three based at the North Island Naval Air Station, San Diego, California.

Utility Squadron Three launched the Firebee from a DP-2E launch aircraft, and the remote control of the target was performed by range personnel at Pt. Mugu.

Firebees were loaded on the launch aircraft at North Island and launched at 15,000 feet on the Pt. Mugu range. Mission altitudes ranged from 30,000 to 50,000 feet, and the versatile target reached speeds of Mach .96.

The Marines literally chased the Firebee all over the sky, and ended the first two days of qualifications with direct hits. Monday, Major Dick Robinson and 1st Lt. Pete Thigpen smashed the Q-2C with a direct hit.

Tuesday, Captain Harry Zeigler, the squadron safety officer, and 1st Lt. Ray Cushman hit the main parachute compartment of the Firebee with a Sparrow III on the first run of the day. The Firebee's recovery parachute was blown away, but the target continued to fly as several more runs were completed. Finally, Captain Tom Dumont and Warrant Officer Ed Edelen "killed" the Q-2C with a direct hit.

Wednesday, one Q-2C flew for more than an

From the North Island Naval Air Station, Navy Utility Squadron Three supported the Marine operations by air launching the Ryan Q-2C Firebee jet target.

The Ryan Firebee was the target for the deadly Sparrow III. Green-clad Marine technicians mate the missile to the powerful F4B Phantom II fighter.

hour on the range at altitudes up to 50,000 feet. Eight squadron aircraft made attacks on the target and six missiles were fired.

Formed Last Fall

The Black Knights, formed on November 1, 1962, were the first Marine Squadron to receive the powerful McDonnell F4B Phantom II. Later this year VMF-314 will become a key Marine unit in the Far East, and the Sparrow III qualifications were one of a series of training missions designed to make the squadron combat-ready.

In the week's activity, the Marines set a remarkable pace. In 4½ days they fired 35 missiles, qualifying 24 pilots and radar intercept officers. They made three direct hits on the Firebee, and during a large part of the week demonstrated the all-weather capability of the aircraft by launching, firing and recovering the F4B's—sometimes in zero visibility weather conditions.

Captain Jack Gagen, weapons training officer of the squadron, said "during the last two days of operations, weather conditions included a 300 foot ceiling and one mile visibility."

"In these conditions we launched, disappeared in the soup at 300 feet, and didn't see the sun until we reached 41,000," he said.

Serious Business

In briefings held before all missions, the atmosphere in the squadron ready room was one of "pay attention, we're going to ask questions later."

Major Hal Vincent, VMF-314 executive officer, demonstrated missions with his hands. He double-checked every detail, throwing out questions about fuel state, escape maneuvers after missile delivery, recovery and reporting altitudes.

Answers snapped back from attentive listeners in rows of leather bucket seats—always concluding with a crisp "sir." The briefing completed, Major Vincent arched his arm—"let's go."

For a few minutes the ready room looked like the fitting room of a girdle factory as pilots and radar intercept officers wriggled into "G" suits.

Outside they piled into a waiting van for a short ride to the "hot spot" where green-clad Ma-

Afterburner blazing, a VMF-314 Phantom II streaks for a rendezvous with the Ryan Firebee on the Pacific Missile Range.

Capt. Jack Gagen, VMF-314 weapons training officer indicates intercept point on plotting board for Major Hal Vincent (leather jacket) and Marine Air Group Commander Colonel Mike Yunck (extreme right).

In squadron ready room, (left to right standing) Major Hal Vincent, Warrant Officer Ed Edelen and Capt. Dick Bierhaalder confirm scoring data with (seated) Sgt. A. F. McCarthy and Pfc. D. E. Kulisek, operations clerks.

rine technicians were loading the powerful Phantom II's with Sparrow III's.

Only short minutes passed until the Black Knights were strapped in the black box laden cockpits of the Phantoms. Later, distant afterburners rumbled and the warhorses disappeared in the overcast on another all-weather mission against the Ryan Q-2C Firebee.

Commenting on the week's activity, Lieutenant Colonel Robert J. Barbour, the Black Knights skipper, congratulated his crew saying, "we're combat-ready now. We've proved the all-weather capability of this Marine fighter squadron."

Planning and coordination of fleet units in support of the VMF-314 Sparrow III qualifications was spearheaded by Lieutenant Colonel Leo Jilliski of the Commander Naval Air Force, Pacific Fleet staff, in San Diego. ■

The Sparrow III missions against the Ryan Q-2C were designed to make VMF-314 a combat ready, all-weather fighter squadron. The El Toro squadron was the first Marine unit to receive the new Phantom II.

2-7-01

OUT OF RYAN'S SPECTRUM OF CAPABILITIES: RYANAV IV

...world's first universal Doppler navigator for all types of aircraft

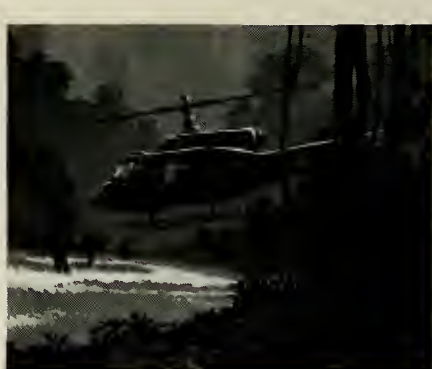
Guidepost to aerial navigation with pinpoint accuracy—this is the RYANAV IV. Reconnaissance, surveillance, observation, transportation, evacuation, close support—whatever the mission—the new RYANAV IV Doppler Navigator meets all navigation requirements of fixed-wing, rotary-wing and V/STOL aircraft from zero to 70,000 feet altitude, in all kinds of weather, anywhere in the world, *without ground stations and radio aids.*

The versatile, lightweight RYANAV IV tells the pilot *where* he is, how to get to his *destination* and return *home* regardless of flight path and altitude. This unique capability enhances mission success and reduces pilot workload.

Ryan scientist-engineering teams are also deeply involved in programs which include: creation of the newest in V/STOL aircraft, applications of the Ryan Flex Wing, advanced models of Ryan's Firebee jet target drone, lunar landing systems, space radar systems, precision antennas, and lightweight structures for space vehicles such as Mariner II, Saturn and Surveyor.

Your inquiry is invited on how Ryan's spectrum of capabilities can help solve your problems from space structures to weapons systems.

RYAN AERONAUTICAL COMPANY, SAN DIEGO, CALIFORNIA



FOR LIMITED WARFARE. Over strange jungle regions, deserts, mountains, seas, Ryanav IV is accurate, reliable and designed for ease of maintenance.

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MAR.-APR./1963

About the Cover: As the jet engine introduced a new era in aviation, our cover offers a preview of the propulsion threshold to vertical fan supported flight. Dramatized by backlighting, the cover shows a section of an XV-5A wing fan.

RYAN REPORTER

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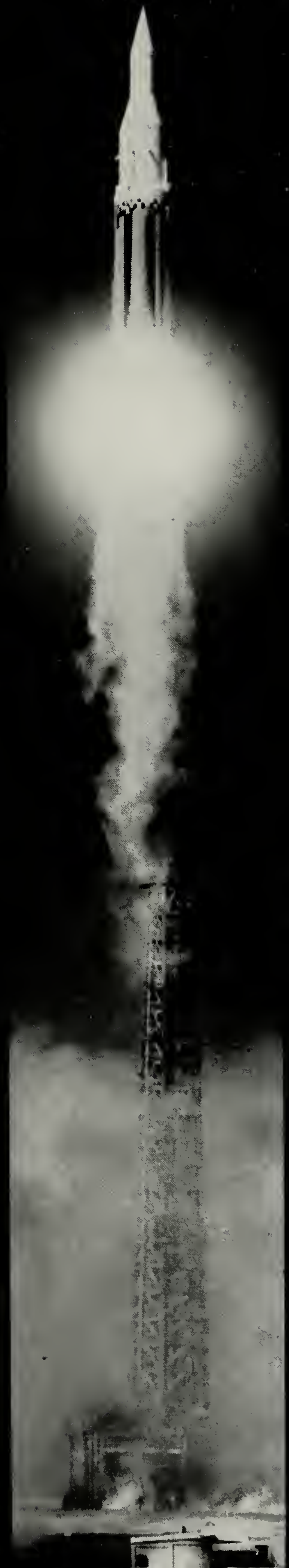
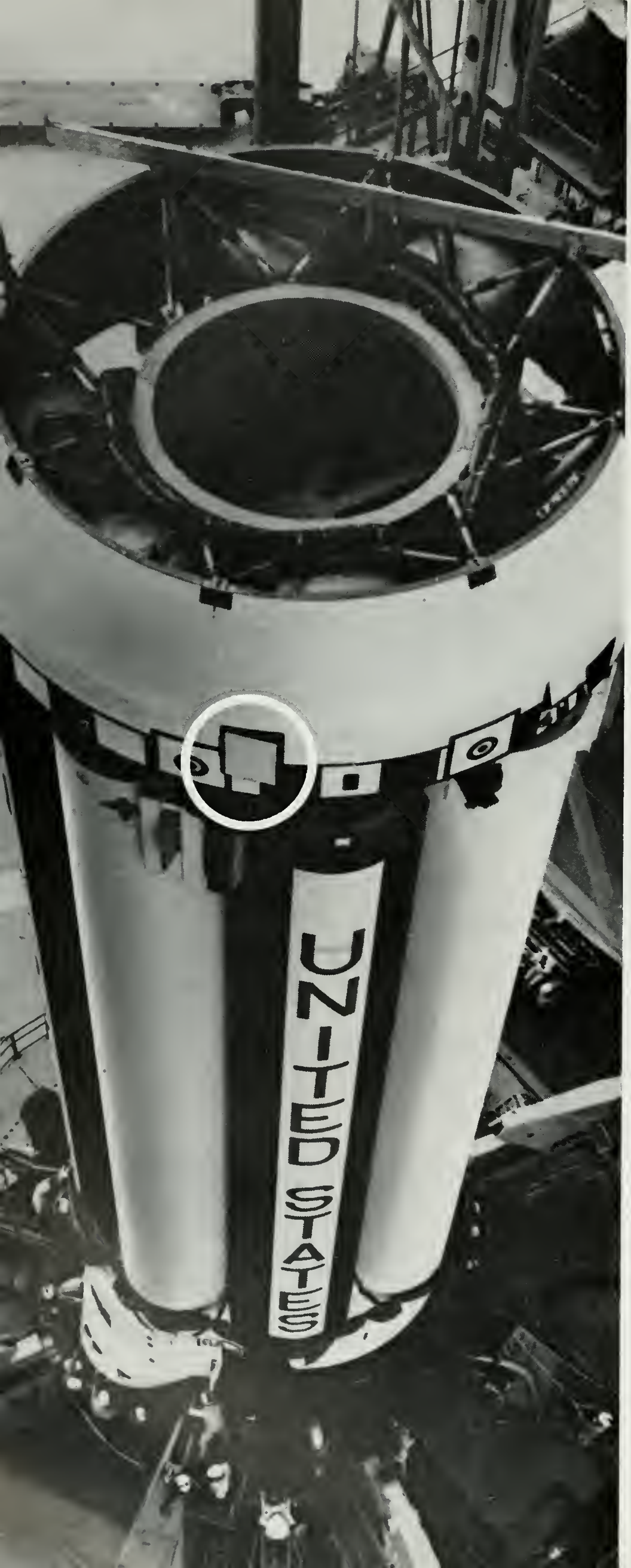


SATURN'S RADAR ALTIMETER

THE nation's first space radar altimeter designed and built by Ryan Electronics for the National Aeronautics and Space Administration, made its maiden journey into space aboard Saturn SA-4 on March 28.

The altimeter when fully developed will allow precise determination of altitude up to about 250 miles. It will be flown on Saturn I's and is expected to be used operationally on Saturn V.



The Ryan-built altimeter was mounted in the first stage instrumentation canister and connected by coaxial cable to a flush mounted planar array antenna (note circle).

Ryan Electronics received the Saturn radar altimeter contract from NASA's Marshall Space Flight Center in Huntsville in August 1961. Although the altimeter was carried in the first stage of the SA-4 Saturn vehicle, operational altimeters will be located in the Saturn instrumentation unit, immediately below the payload package.

While the SA-4 flight was similar in many respects to that of earlier Saturns, there were several significant departures. The principal addition was an experiment to confirm the "engine-out" capability which is designed into the eight engine Saturn I booster system. At 100 seconds after liftoff, an inboard engine, number five, was shut down. Fuel, normally used by that engine was cross fed into the other seven engines, extending their burning time, and thereby compensating for the loss of the inboard engine's thrust.

The Saturn SA-4 flight was the fourth in a series of ten research and development flights planned for Saturn I, the largest rocket presently being tested in the United States. By 1965, the vehicle is expected to be ready for its role in flight testing the three-man Apollo spacecraft.

The flight was the final booster-only test of the rocket. The next Saturn (SA-5), to be launched later this year, will have a live second stage and will have the capability of placing 20,000 pounds in earth orbit.

Saturn I and other Saturn vehicles are being developed under the direction of the NASA Marshall Space Flight Center, Huntsville, Ala., headed by Wernher Von Braun. The launching was conducted by an integrated team of the NASA Launch Operations Center, Cape Canaveral, and the MSFC Launch Vehicle Operations Division.

The booster was powered by eight H-1 engines developing 165,000 pounds thrust each, for a total of 1.3 million pounds. Second and third stages were inert and ballasted with water to simulate propellant weight. An inert Jupiter nose cone was the payload.

SA-4 was 165 feet tall, 21½ feet at maximum diameter, with a liftoff weight of approximately 940,000 pounds. The vehicle was launched on a path 100 degrees east of north. A smooth tilt program began at about the 10th second of flight

An altimeter to operate to 250 miles out . . .

and continued until about the 105th second when the rocket was inclined at 43 degrees from the launch vertical. It passed through the region of maximum dynamic pressure about 65 seconds after liftoff. Impact occurred about seven minutes after liftoff some 230 miles downrange. Maximum vehicle velocity was 3,650 mph.

The trajectory of this flight was somewhat shallower than on previous launches because of different assumed wind and propulsion conditions. At apex, the vehicle was 80 miles high as compared to about 85 miles on earlier launches.

The radar altimeter was developed under the direction of Jack Duggan, Deputy Chief, RF Systems Section, Instrumentation Branch, Astrionics Division, Marshall Space Flight Center.

Designed for operation from 30 to 250 miles out in space with plus or minus 100 feet accuracy, the altimeter operates through a NASA furnished planar array antenna, flush mounted on the exterior of the Saturn vehicle.

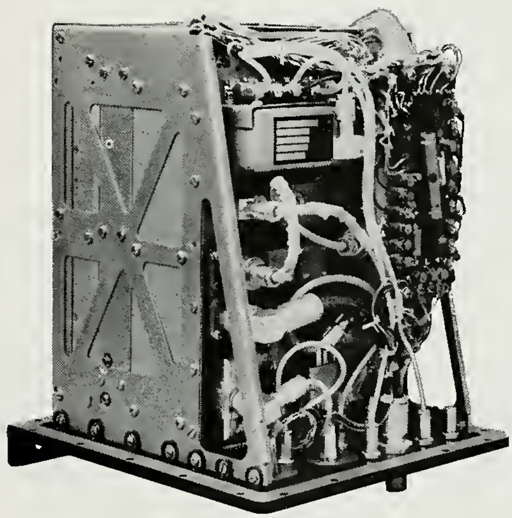
On the March 28 SA-4 launch, the altimeter system locked-on its earth target at approximately 105 seconds after lift-off as the Saturn was inclined at about 43 degrees from launch vertical. The unit tracked for 20 seconds until the vehicle's retro-rockets were fired at about 125 seconds and the Saturn began to tumble.

According to Jack Duggan "from preliminary data we estimate the altimeter tracked from about 100,000 to 200,000 feet or approximately 20 to 40 miles above the earth's surface. This was the first time an altimeter had ever operated at this altitude," he said.

Ryan designed the 25 pound altimeter in five basic modules, timer, modulator-power supply, transmitter-receiver, IF amplifier and range tracker. The altimeter depends upon accurate measurement of the time lapse between a transmitted pulse and the echo. The altimeter delivers radar altitude information to telemetering equipment in the Saturn in 18 bit binary words at a 36 word-per-second rate.

Unique Range Tracker

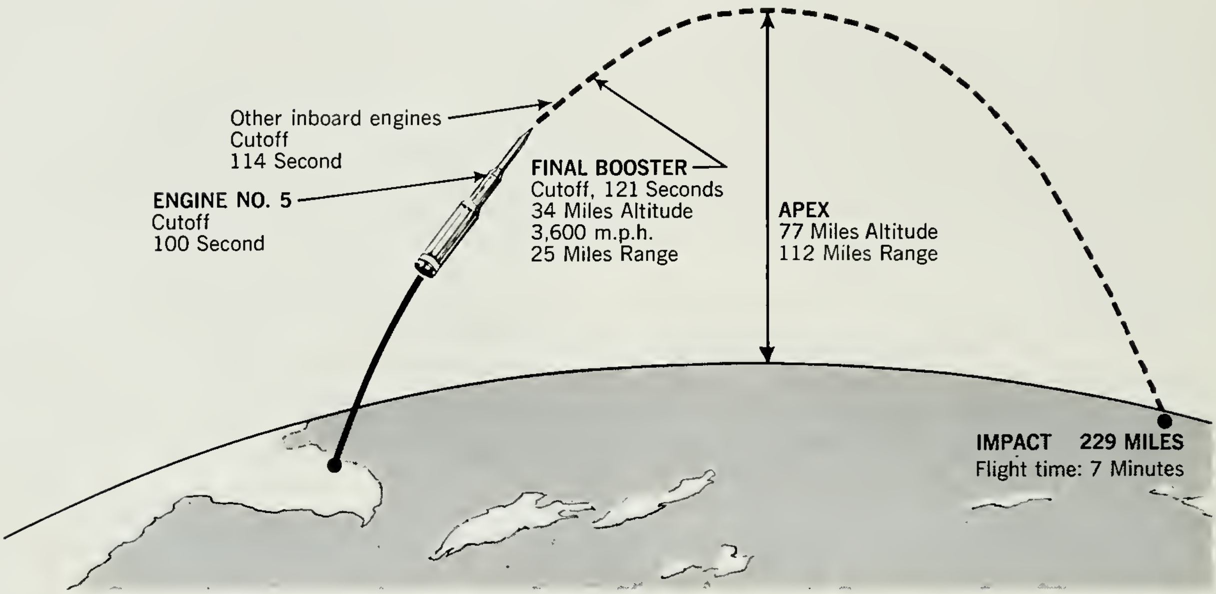
The range tracker in the altimeter is used to track a delayed radar echo and simultaneously produce a noiseless or jitter-free timer gate pulse



Weighing 25 pounds, the Ryan altimeter is designed for solid mounting in the Saturn vehicle. The unit's external package skin was designed for high heat dissipation. System features unique range tracker.

SATURN SA-4 TRAJECTORY

Saturn SA-4 traveled 230 miles downrange, and reached a maximum vehicle velocity of 3,650 mph. The Ryan altimeter locked-on its earth target approximately 105 seconds after lift-off.



to control a clock frequency. The clock frequency is counted for the duration of the time interval thus converting the pulse width to binary altitude range information.

When operational the radar altimeter will provide precise altitude data, which is particularly important when the Saturn proceeds downrange where its trajectory carries it low on the horizon making ground tracking and altitude determination difficult.

Total altimeter weight is 25 pounds, and the rectangular package measures 9¾ x 9 x 11½ inches. The system is designed for solid mounting in the vehicle and is completely pressurized at 5 psi above one atmosphere. The unit was built to withstand severe environmental conditions and large temperature variations in a low vacuum atmosphere. The altimeter's external package skin was designed to achieve high heat dissipation to eliminate internal hot spots and maintain uniform internal temperatures. A Ryan dip brazing process was used to fabricate the rectangular pressurized case.

Under NASA supervision Ryan technicians were schooled in the most advanced soldering and fabrication techniques known to the missile electronics assembly field.

On the NASA Program Ryan engineers designed special ground checkout and bench test equipment to calibrate the highly sensitive altimeter.

The Ryan altimeter contains its own solid-state power supply receiving 28 volts dc at 80 watts from the basic vehicle system and supplying internal voltages for its own operations.

From Complex No. 34

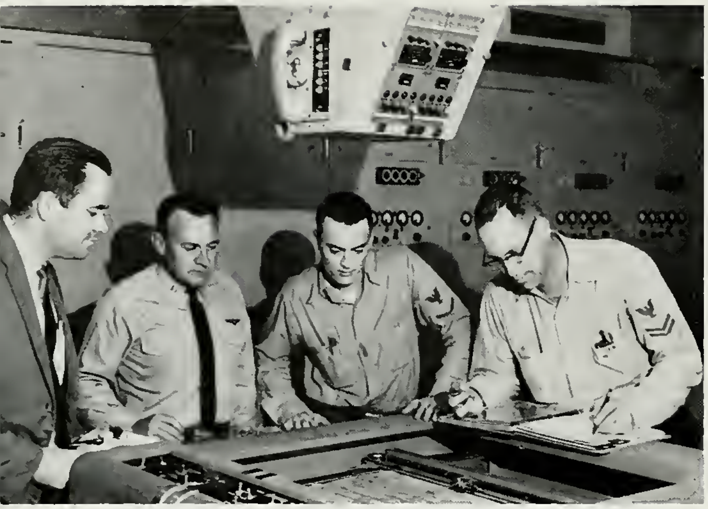
Saturn SA-4 was the fourth vehicle to be fired from Cape Canaveral's launch complex No. 34. The $45 million dollar facility located at the north end of Cape Canaveral, is a 45 acre installation, dominated by a movable structure 310 feet high and weighing 2,800 tons. The complex has a launch control center with walls 12 feet thick and a steel door two feet thick weighing 23 tons.

The Saturn V, on which the Ryan radar altimeter will be operational, will be launched from Cape Canaveral on manned lunar circumnavigation and manned lunar landing missions. ■

TARGET in the SUN

FROM sun soaked desert launch pads in Indian Wells Valley — site of the Naval Ordnance Test Station, China Lake, California — the Ryan-Navy Q-2C Firebee jet target is performing a new task in its ever increasing portfolio of Navy responsibilities. The high performance, remote controlled Firebee has become a primary target for the Navy's latest and finest surface-to-air and air-to-air missile systems.

The Q-2C was launched into its major role at the desert test facility,



Ryan rep. Dick Manceau, (left) Lt. "Scotty" Malloy, J. W. Conyers and H. V. Beal fly the Ryan Firebee by remote control.

Navy and civilian technicians ready another Ryan Q-2C Firebee for Naval Ordnance Test Station mission.

in February, when the first target was boosted off one of two new ground launch pads. NOTS was the second Navy installation to install a Firebee ground launch capability. Similar launching operations have been carried out at the Naval Missile Center, Pt. Mugu since September, 1962. Previously the Navy had air launched all Q-2C targets from P2V aircraft specially configured as launch platforms.

The Navy now has Q-2C targets in operation at Pt. Mugu, Utility Squadron 3 at the North Island Naval Air Station, San Diego, California, the Roosevelt Roads Naval Station in Puerto Rico and NOTS.

At China Lake, the Firebee is operated and maintained by the Target Division of the Naval Air Facility, a support function to the Ordnance Test Station. Captain Jack W. Hough is the NAF Commanding Officer.

Previously Ryan KDA series Firebees had flown at NOTS in support of research and development tests of Navy missile systems.

The first Q-2C was ground launched from the Ordnance Test Station on Friday, February 8, climbed to a mission altitude of 52,000 feet and flew at near sonic speeds for 49 minutes before making a routine parachute recovery. The first flight was tracked by ground radar units and by a Naval Air Facility F4B "Phantom" jet fighter.

With its Continental J-69-T-29 turbo jet engine at nearly full power, the remote controlled Firebee is boosted off its launch pad by a solid propellant JATO bottle attached in an adapter to the underside of the Firebee's fuselage. The JATO burns for 2.2 seconds, furnishing 11,300 pounds of thrust. At burnout, the bottle, together with the adapter, falls free of the drone.

Chief Warrant Officer Win Creel, a 22-year Navy veteran supervises Q-2C operations at NOTS, under the direction of Commander D. W. Knight and Commander Stan Ables, Navy Air Facility Maintenance and Operations officers respectively. Commander Knight is responsible for the maintenance repair and build-up of the targets, while Commander Ables coordinates firing schedules to conform with various missile development programs at the Naval Ordnance Test Station. The NAF target division is staffed by 38 Navy enlisted men and 15 civilian technicians.

CWO Creel, reflecting on the popularity of the Q-2C says the target has been in demand by NOTS customers almost since the first target left its ground launcher in early February. "The Firebee is almost too popular," he said.

Flight schedules have called for an average of two Q-2C flights per week and target division technicians have kept busy readying Firebees for sophisticated missions. The requirement for a target is generally issued by NOTS and weekly firing schedules are usually firmed up each Friday for the following week's activity.

A Ryan-trained, all Navy crew launches and controls the Q-2C on missions over the desert test site.

The Ryan-built Navy Q-2C is 23 feet long, is

Chief C. E. Darrah (center), completes final Firebee check with J. G. Eckholdt (left) and T. R. Herold (right).

Watchful hands guide the Ryan Firebee to its launch pad at NOTS. Assisting (left to right) are S. J. Stephens, Don Stewart, C. E. Geib and J. G. Eckholdt.

6½ feet high and has a wing span of nearly 13 feet. A high performance jet aircraft, the target is designed to fly for one hour or longer at altitudes from 300 to over 50,000 feet, at over 500 miles per hour. During flight the Q-2C is radio remote controlled, a radar beacon is employed for tracking and telemetry supplies inflight data to aid the remote control operator. Radar, infrared and visual augmentation devices are utilized to meet mission requirements. Scoring systems provide for weapon systems and interceptor evaluation. The target is recovered on the completion of the mission by a two-stage parachute.

The Naval Ordnance Test Station and its self-contained community of China Lake covers 1,198 square miles on the floor of Indian Wells Valley. It was established in 1943, primarily to provide a rocket firing area for the California Institute of Technology, then engaged in wartime rocket development.

Now described as a modern weapons forge, the Naval Ordnance Test Station is termed by officials "the Navy's largest ordnance, research and development center."

The unincorporated community of China Lake — the only completely Navy owned city in the continental United States — is a modern community with a population of 12,000.

The Q-2C Firebee is a new resident in the desert community, and its initial performances show the swift target will have no trouble earning its place in the sun. ■

Weldon Allen (left) proceeds with countdown, as CWO Win Creel observes.

Navy technician Jim Stanford connects infra-red flares on the Firebee's wing.

On NOTS launch pad, Eckholdt, Stewart and Stanford check the JATO bottle.

RYAN EXPANDS IN SAN DIEGO

Industrial complex totals 1,500,000 square feet

COMMISSIONING of a major new electronics facility by Ryan Aeronautical Company in the City of San Diego's Industrial Park, Kearny Mesa, highlights the growing importance of San Diego as a center for electronics production.

Ryan Electronics Doppler navigator production activity will be consolidated in the firm's industrial complex in San Diego, now comprising three plants with more than 1,500,000 square feet, in about one month, Robert C. Jackson, president, announced.

Proximity of Ryan's recently completed 160,000 square foot structure on Kearny Mesa to the Ryan Electronics Engineering and Research Center on Highway 395 will provide direct liaison between the engineering-developmental functions and the production facilities, he pointed out.

The new Kearny Mesa plant will comprise the most up-to-date assembly arrangement, with more than 15 assembly lines being installed in an air-conditioned, dust-free environment required to protect the sensitive components and testing equipment.

Air conditioning apparatus with a capacity of five hundred tons will maintain uniform temperature and provide humidity control. Antiseptic cleanliness of the factory area will be enhanced by waxed, smooth-surfaced tile floors, in contrast with the dust-shedding cement floors in conventional manufacturing facilities.

"The most modern flow methods of material handling and production will bring efficiency in the manufacture of intricate electronics devices to a high peak," Jackson declared.

Rapid expansion of production of Ryan Doppler navigators in the early phases of the program led to acquisition six years ago of a manufacturing facility at Torrance, California. The company's original electronics facility in San Diego, comprising 111,200 square feet of floor space on a 21-acre site on Highway 395, Kearny Mesa, became the Engineering and Research Center.

When the additional plant capacity at the City of San Diego's Industrial Park, across the highway from the Engineering and Research Center, became available, the opportunity was provided to bring together the company's electronics design and manufacturing operations in a closely integrated effort.

Ryan's new plant will have air-conditioned, dust free environment required for manufacture of precision electronic equipment.

Some functions of the Torrance plant are also being transferred to Ryan's 49-acre headquarters plant at Lindbergh Field, San Diego, where the firm's aerospace activity is centered. The large new Kearny Mesa plant and grounds, comprising 30 acres, will have certain areas available for work in the general aerospace field, as requirements for further expansion arise, in addition to electronics activity.

"Close liaison between engineering and manufacturing, made possible with commissioning of our new Kearny Mesa plant, will give Ryan Electronics an important advantage in the development and production of the complex equipment we now have under contract for space vehicles, as well as for aircraft and helicopters," Jackson said.

Utilizing Ryan Doppler navigators is a wide range of military aircraft, in the United States, Great Britain, France, Australia and Japan, including airborne early warning planes, land-based patrol bombers, attack aircraft, anti-submarine warfare aircraft, and certain specially designed planes. In helicopters, the equipment enables pilots to automatically achieve and maintain sustained precision hovering, and to navigate under zero-zero visibility.

The automatic, self-contained navigation systems provide accurate, continuous, all-weather navigation and hovering capabilities. They operate independently of ground stations, wind estimates or true air speed data. ■


TRANS-CITY

VTOL AIRLINERS

By Frank W. Fink
Vice President—Engineering
Ryan Aeronautical Company

PASSENGERS will be flying in vertical take-off and landing airliners from building tops and small pads, in the 1970s because of the swift development of practical VTOL concepts. A medium-range 500 miles-per-hour VTOL airliner is little more than a decade away.

The GE-Ryan XV-5A lift-fan and Vought-Ryan-Hiller XC-142A tilt-wing concepts are examples of this progress in the VTOL field. The XV-5A incorporates an all-jet propulsion system which provides economic cruising speeds yet does not penalize the designer in obtaining vertical flight capability.

This is due to a unique feature of the lift-fan concept in which installed power can be designed to meet optimum cruise conditions then augmented by sizing the fans to achieve required vertical thrust. In the XV-5A, only 5,000 pounds of thrust is installed and this power is augmented 300 per cent by the fans to obtain about 15,000 pounds of vertical thrust.

This important feature has significant benefits for commercial use. For the first time, it provides the airliner designer with a compatible propulsion system and airframe configuration which can perform efficiently in both vertical and horizontal flight modes.

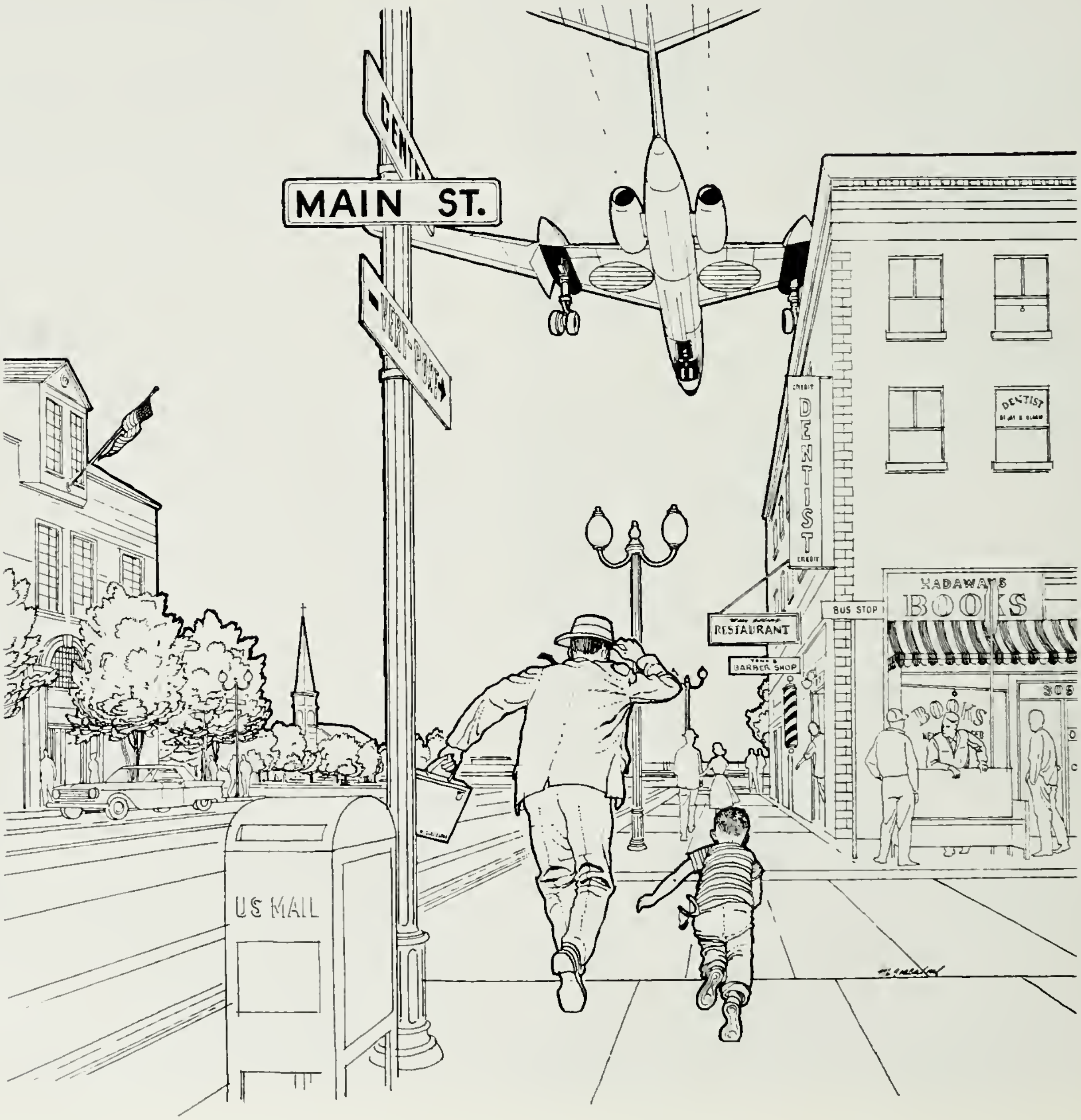
The XC-142A tilt-wing transport will be able to take off vertically or as a short-take-off conventional aircraft, with increased loads. Capable of vertical take-offs with an 8,000-pound payload, the XC-142A is the first V/STOL aircraft which is scheduled for operational evaluation. It has interesting features which are being scrutinized for commercial cargo potential.

There are several reasons why the VTOL airliner is eagerly awaited by airlines and passengers alike. First, far greater gains in reducing travel time between cities can be made today by cutting ground time than by increasing airplane speed. Second, a VTOL airliner will bring air service to hundreds of communities which either have never had it or have lost it due to the stepped up operating requirements of high speed aircraft.

It is safe to say that the subsonic VTOL airliner will be far less expensive to build than a Mach 3 aircraft. It will generate far more traffic than a Mach 3 aircraft and, therefore, the over-all cost to the passenger in the subsonic plane is bound to be less. To this must be substituted the extra cost of getting to the Mach 3 airport.

Start with present day airline transportation conditions. You can travel from Montreal to New York City by jet in one hour and 20 minutes. But you will probably have to leave your office in town one hour and 20 minutes before plane time and it could take one hour and 20 minutes from the time your plane arrives at Idlewild until you reach your destination in the middle of Manhattan—for a total of say, four hours. You could make the same trip in the same length of time with a helicopter, flying at only 100 miles an hour, if you could depart from your office roof and land on the roof of your New York City destination.

Or, let us assume that a man living in Pasa-



dena, California, wants to visit an office in Wall Street, New York. He must leave his home one hour and 50 minutes before plane time, if he is driving his own car, to reach Los Angeles International Airport. He can get a jet flight that will take him to Idlewild, New York, in another four hours and 40 minutes. From Idlewild to Wall Street by bus and taxi takes one hour and 30 minutes . . . a total of 8 hours. This time could be cut to approximately 6 hours if he were to take a helicopter at both ends of the jet flight, assuming ideal connecting schedules. However, he could also make it in 6 hours with a Vertical Take-Off and Landing transport, travelling at only 400 miles per hour, using the same heliports and without the inconvenience of making connections between three different vehicles.

Consider a two-hour ground time as a fair average for a passenger to go from the center of town to the airport and check in and to pick up his baggage at the end of the trip and get back to the center of town. Add fifteen minutes for airplane starting and taxiing time. Then, ignoring changes in speed during climb and descent, it's apparent that with an airplane flying at 100 miles per hour, it takes 6 hours and 15 minutes to make this 400-mile trip. If the airplane speed is doubled to 200 miles per hour, the time saved is 2 hours, but that is only 32 per cent of the total trip time. If the airplane speed is increased to 400 miles per hour, only an additional 16 per cent of the trip time is saved. Doubling the speed to 800 mph will decrease the time only another 8 per cent. It will be noted that increases in aircraft speed from here on out will have little effect on further reducing the time for the journey.

To look at it a little differently, if the speed of the present jets, of approximately 550 miles per hour, is used, the time for this trip would be 3 hours, of which approximately 45 minutes would be flight time. A supersonic airplane, flying at Mach 3, or 2000 miles an hour—assuming this were possible—would only decrease the time by 30 minutes. How much easier and cheaper it would be to cut 30 minutes off the ground travel time, using our present jets, than to attempt to save this time using a Mach 3 airplane. Reducing ground time can be done far more simply by the use of vertical take-off and landing aircraft, operating from several airports in a large metropolitan area. These should be located in the heart of the city and in the principal surrounding area, in locations such as the parking lots of modern shopping centers, or the roofs of buildings.

Ryan has the most extensive experience in V/STOL engineering which totals more than 3½ million manhours. This backlog of know-how dates back to the Ryan YO-51 Dragonfly, which was developed for the U.S. Army in 1940. The Dragonfly was one of the first short-take-off and landing aircraft. It employed large wing flaps to reduce take-off and landing speeds.

In 1957, Ryan unveiled the X-13 Vertijet after a ten-year period of development. This was the first jet VTOL aircraft and demonstrated the new capability in which an aircraft could be controlled and maneuvered in hovering, transition, and conventional flight by jet reaction controls.

The Ryan VZ-3RY Vertiplane was a deflected slipstream V/STOL aircraft which was designed and built for the Army and Office of Naval Research in 1959. This aircraft also employed large retractable wing flaps, like the YO-51, but in a different way. The Vertiplane's flaps are used to turn the propellers' slipstreams downward to gain vertical thrust. In conventional flight, the flaps are retracted. This aircraft is flying at NASA-Ames Research Center, Moffett Field, California, where it is used to explore the low speed flight regime.

The Ryan XV-5A lift fan research aircraft, now being fabricated for flights later this year, will incorporate much of the long experience which Ryan has gained from earlier programs. For example, the stabilization system is a direct product of the pioneering work in this field which Ryan engineers did in developing the X-13 Vertijet.

Unlike these predecessors, the XV-5A appears to have no significant disadvantages either for pilot or passengers. Undoubtedly, this will be the most thoroughly tested V/STOL concept which has been flown. More than 600 hours of wind tunnel testing of three different scale models has been completed. Over 350 hours of full-scale wind tunnel testing of the propulsion system has been accomplished without a single shut down due to system malfunction.

Predictions are often risky. An article in an 1899 issue of SCIENTIFIC AMERICAN magazine states, "The adoption of the motor car, with clean, dustless streets and odorless rubber-tired vehicles moving noiselessly over smooth pavements, will eliminate a greater part of the nervousness, distraction and strain of modern life." This prediction simply did not foresee the modern freeway.

However, it does not seem unreasonable to predict that the present military V/STOL aircraft will again be the forerunners of commercial concepts which will bring VTOL Airliners in the 1970's. ■

FLEX WING SUPPLIES

Army develops new logistics punch with Ryan Flexible Wing Air Cargo Delivery System . . .

TESTING of a unique Flexible Wing Air Cargo Delivery System by Ryan for the U.S. Army at the Army's Yuma Test Station is demonstrating feasibility of the technique to perform unmanned delivery of large quantities of cargo under combat conditions.

In the Yuma tests, the Flexible Wings are installed on the aluminum cargo containers which are loaded with ballast to simulate payloads. These units are towed at the end of a 400-foot steel cable by H-34 Army helicopters. On release of the cable by the helicopter, the Flex Wings and their cargo containers glide to a predescribed area, under radio control from the aircraft or the ground, or by automatic homing to a beacon. The Flexible Wing air cargo container can also be towed by the helicopter until ground contact is made, then detached.

Through use of such a system, the payloads of helicopters would be multiplied considerably while permitting pinpointing of controlled deliveries to ground terminal areas. All types of sup-

Tow gliders are aluminum containers with ballast tanks to simulate payloads. Ryan technician adjusts steel tow cable reel.

plies, weapons and fuel could be airlifted in this manner to provide speedy logistics support to Army units in the field.

The test vehicles have achieved a gross weight of 1100 pounds, and will eventually reach a 1500 pound capacity. The specification in the Army Transportation Research Command contract with Ryan is to develop a 1000-pound payload cargo delivery system. Ryan foresees other applications capable of delivering up to 8,000 pounds of cargo.

In contrast with conventional rigid, metal-covered surfaces, the Ryan-built Flexible Wing is of flexible, plastic-coated material attached to a keel and leading edge members to form an arrow- or V-shaped, kite-like surface.

Ryan is one of the world pioneers in application of the Flexible Wing principle, having successfully tested the first such manned, powered flying test vehicle. The Flexible Wing, with its remarkable lifting capability, is being studied as an inexpensive, highly-mobile, easy-to-maintain system that can perform missions which under more conventional means would be impractical or too costly.

In addition to the unmanned towed glider contract, Ryan is conducting work on two other Flexible Wing applications for the Army—a Flexible Wing manned Utility Vehicle, and a Precision Drop Glider system.

Contracts totaling nearly $2 million were awarded Ryan for the three projects, of which the towed glider Air Cargo Delivery System is the largest.

Two Flexible Wing Manned Utility Vehicles, nickname "Fleeps", are under construction, and an intensive testing program is being conducted with Precision Drop Gliders—containers dropped directly from aircraft, followed by deployment of Flexible Wings to carry the cargo to troops. ■

In Yuma tests Army H-34 takes up slack in tow cable and the Ryan Flex Wing tow glider moves down short runway.

Ryan Flex Wing will carry the cargo container in a gentle glide to a predescribed area, under radio control from the aircraft or ground, or by automatic homing to a beacon.

The Flex Wing glider adds greater versatility and load carrying capacity to the Army helicopter, while permitting pinpoint delivery of supplies to ground terminal areas.

The U. S. Army, Ryan, General Electric and NASA have combined forces in exhaustive wind tunnel tests to prove the XV-5A lift fan V/STOL concept. Free flight .18 scale model above was tested at NASA's Langley Research Center.

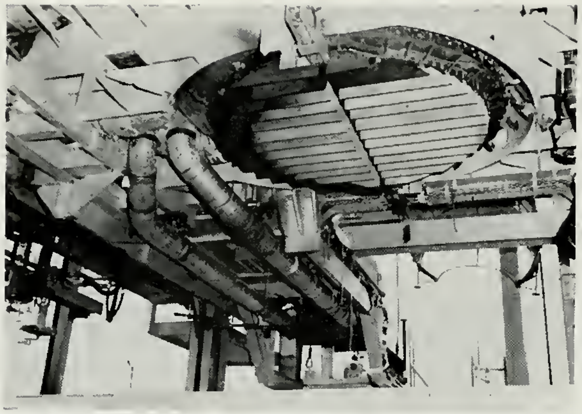
XV-5A COMPLETES TUNNEL TESTS

THE U.S. Army XV-5 lift fan research aircraft now being developed by Ryan Aeronautical Company and General Electric will be as near a perfect aircraft as wind tunnels, flight simulators and computers will permit, when it begins flight tests later this year.

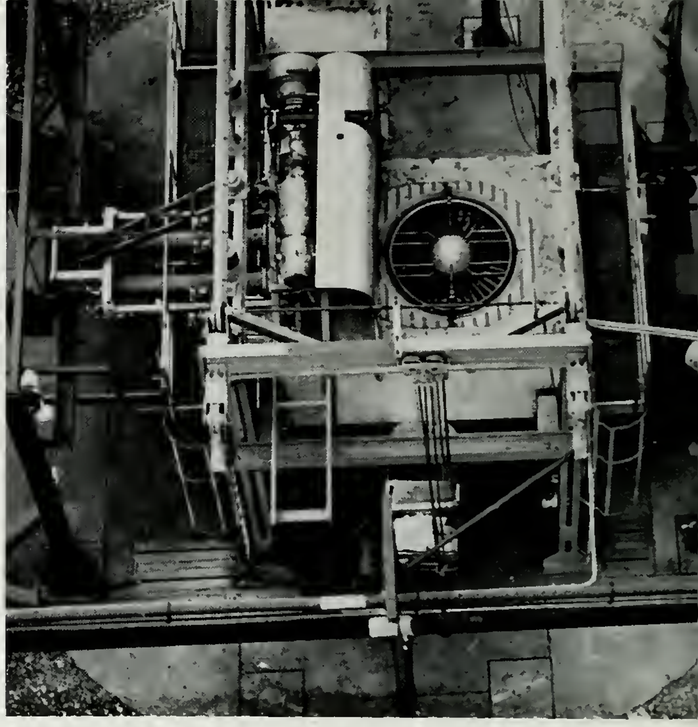
Ryan, General Electric and the National Aeronautics and Space Administration have conducted exhaustive wind tunnel testing of the XV-5A concept, the results of which have been used by Ryan and G.E. engineers in the final design of the unique aircraft. Further use of wind tunnel data will be made in actual simulated flights of the airplane in Ryan's new Flight Simulation Laboratory.

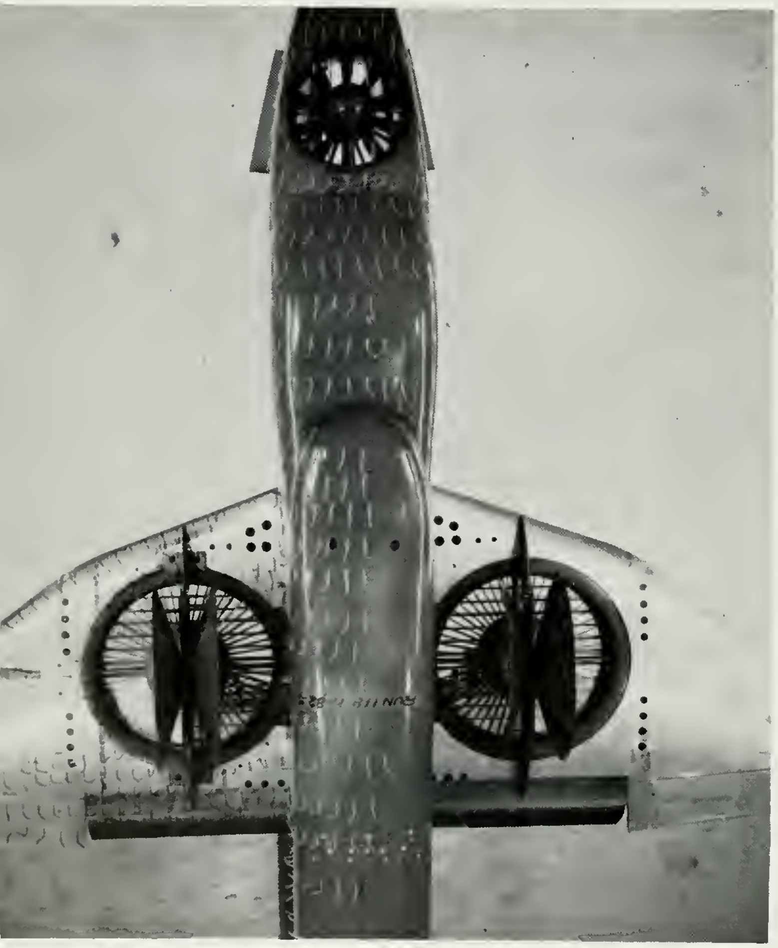
In a year-long Ryan wind tunnel testing program a wealth of data has been obtained in more than 640 hours of wind tunnel tests with fractional scale models at installations on both West and East coasts and in Texas.

Additionally, the National Aeronautics and



General Electric recently completed flight worthiness tests on the first XV-5A fan propulsion system in the GE outdoor facility in Evendale, Ohio.





In Ryan program this one-sixth scale wind tunnel model with operable lift fans was tested for low speed hovering and transition.

Space Administration has carried out an independent study of the XV-5A design in wind tunnel tests at Ames Research Center, Moffett Field, California and at Langley Research Center, Virginia.

NASA's testing of a full scale model of the XV-5A began at Ames in mid 1962, and tests of a free flight model are currently underway at Langley.

For the Army's Transportation Research Command, Ryan under contract to General Electric, is building two XV-5A aircraft which will be ready for flight tests later this year. The research aircraft incorporate powerful six-foot diameter lift-fans submerged in the wings and a three-foot fan in the nose. Two G.E. J85 turbojet engines will provide power for the fans. The airplane will be capable of taking off vertically, transitioning to conventional flight, and will fly at 500 miles per hour.

General Electric recently completed flight worthiness tests on the first XV-5A fan propulsion system in the General Electric outdoor facility in Evendale, Ohio. Included in the complete flight cycle tests were one wing fan, one nose or pitch fan and two G.E. J85 turbojets with diverter valves and all aircraft propulsion system ducting. Following the flight worthiness tests, the XV-5A fan system was completely disassembled and U.S. Army, Federal Aviation and General Electric project officials inspected the components and certified that acceptance tests could begin immediately.

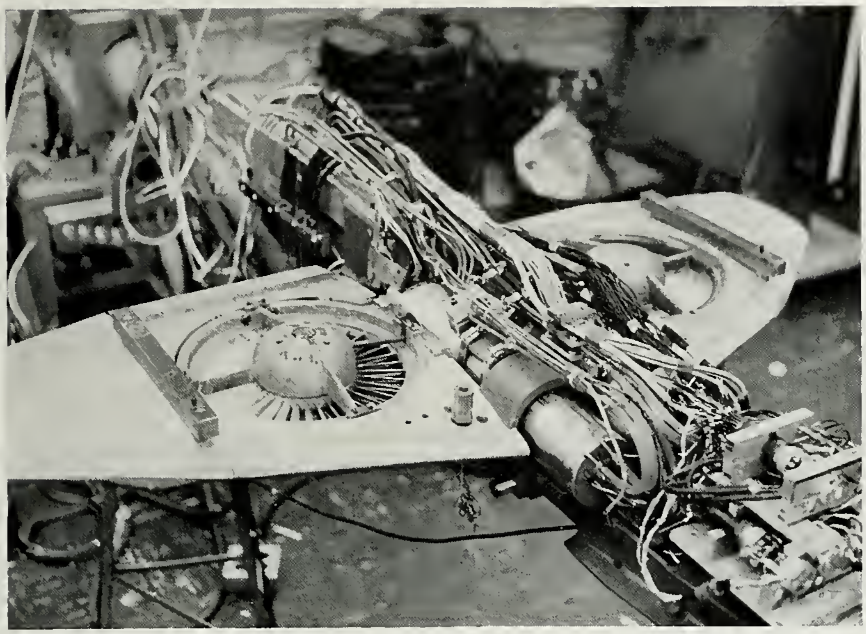


Photo reveals details of intricate test model used in exhaustive Ryan wind tunnel program on the Army XV-5A.

All wind tunnel tests in the Ryan program have been with captive models, of which four different types were built to acquire information that has resulted in optimizing the XV-5A design.

A one-fifth scale engine inlet model was tested in both low and high speed wind tunnels at the David Taylor Model Basin, Maryland, a Navy facility.

A one-eighth scale conventional horizontal model was used for low speed tests at the Convair wind tunnel in San Diego, California and performed in high speed tests at the David Taylor Model Basin, Washington, D.C.

A one-sixth scale model with operable lift fans was tested for low speed hovering and transition at the Convair wind tunnel in San Diego, and a two-thirty-fifths scale flutter model, comprising the wing and simulated fuselage, was tested at the Ling-Temco-Vought wind tunnel in Dallas, Texas.

In the full scale model tests at NASA-Ames, step-by-step flight operations were completed from take-off through transition at speeds of from zero to 120 knots and with lift fans operating up to full power at 2640 rpm.

Typical of the data developed in the series of wind tunnel tests, the NASA-Ames efforts solved two potential problems associated with vertical take off using the lift fan system.

Previous to the full scale tests, data from small scale studies showed that fan lift probably would be reduced during forward speed. Full scale model tests however proved this to be false and estab-

Fabrication of two U. S. Army XV-5A aircraft progresses rapidly at Ryan.

Full-scale wind tunnel tests were completed by NASA at their Ames Research Center, Moffett Field, California. Tests were conducted from take-off through transition at speeds from zero to 120 knots and with lift fans operating up to full power at 2640 rpm.

27 01

lished that a gain in lift would be experienced with increasing speed.

Further results of tests at the Ames Research Center indicate that careful design can reduce a potential pitch problem occurring during variations in speed. Ames engineers developed several research methods of interest to future VTOL designers. They analyzed the transition phase of the flight profile, demonstrating that rapid, controlled accelerations and decelerations in transition are possible. Conversion from fan-supported to wing-operated flight was accomplished with no altitude loss.

Both the Ames and Langley NASA studies were carried out independent of Ryan and General Electric test programs, but Ryan and G.E. officials were invited to observe and participate in the test program. Data from both NASA studies has been available to General Electric, Ryan and the U.S. Army.

Wind tunnel tests of the .18 scale free flight model of the Army's XV-5A lift fan V/STOL research aircraft are being conducted at NASA's Langley Research Center, Hampton, Virginia. The Langley free flight model has been flown in the lift fan mode at zero speed (hovering) and at forward speeds up to those representing 96 knots for the aircraft. Controlled flight, uncontrolled flight from an initial trimmed condition, and vertical take-off have been examined with the attitude control functions performed using auxiliary reaction controls.

Built by NASA-Langley, the model has a reaction control system for attitude control about all three axes in addition to fan and aerodynamic controls typical of the XV-5A aircraft. The wing and nose fan are air-driven using a rotor tip turbine and scroll much the same as in the aircraft. Each wing fan scroll is interconnected with one-half of the nose fan scroll.

An ejector installed at the gas generator inlet supplies air for the fans. Air at 150 psi is piped into the model from overhead through flexible hose and is used to power reaction controls, gyros and the ejector. The high pressure air hose and electrical leads are combined to form an umbilical and they pass into the top of the fuselage near the center of gravity.

A representation of the XV-5A wing fan exit louver mechanical mixer box is installed and performs similar to that of the aircraft. The model controls are on-off or flipper type and in most cases have automatic features. The horizontal tail and the nose fan control doors are also remotely trimmable.

First tests of the lift fan propulsion concept were conducted at G.E.'s outdoor testing facility in 1959 at Evendale, Ohio. In 1960-61 the National Aeronautics and Space Administration built two full-scale lift fan aircraft models for test in the NASA-Ames wind tunnel at Moffett Field, California. Five test series were conducted with the lift fan installed in both fan-in-fuselage and fan-in-wing configurations and showed that lift fan powered aircraft would have good performance and transition capabilities.

Tests also confirmed the propulsion system's mechanical integrity. These research tests have never been delayed due to mechanical failure of the lift fan system and over 300 hours of fan running time has been achieved at G.E. and NASA facilities.

Following flight tests, designed to absolutely prove the XV-5A concept, the two aircraft currently in production will be delivered to the Army's Transportation Research Command. ■

"A Phenomenal Airplane — the only completely new type of aircraft we have in the United States." Clair Engle (D-Calif.), a pilot himself, so described the Ryan-General Electric XV-5A V/STOL (vertical and short take-off and landing) plane during an inspection of the project at Ryan Aeronautical Company's San Diego plant. Engle, at right, is shown examining the research aircraft's controls with Hugh B. Starkey, XV-5A engineering Program Manager.

"This V/STOL has great possibilities and will become more and more important in our military plans," said Engle, a member of the Senate Armed Services Committee. Ryan is building two prototype aircraft, under contract to General Electric, for the Army Transportation Research Command, with first flight tests scheduled for late this year.

Continued Production of Q-2C Firebees, the world's most widely used free-flying jet target missile, is assured at Ryan Aeronautical Company's San Diego plant through 1964 with award of a new contract for nearly $6 million announced in Washington recently.

The order is for more than 150 of the near-sonic target missiles, of which approximately three-fourths will be delivered to the Navy and the remaining amount to the Air Force, Robert C. Jackson, Ryan President, said.

Ryan has received an additional order in excess of $700,000 for AN/APN-130 Doppler Navigator Sets, associated items and spares from the U.S. Navy Bureau of Weapons. This new business for Ryan Electronics is an add-on to a previous Navy contract.

These Doppler sets are used in SH-3A (HSS-2) ASW helicopters and also in the UH-2A (HU2K) helicopter.

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The solution to many space age problems lies within

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These notable breakthroughs by Ryan scientist-engineer teams, demonstrate proven capability to create the necessary technology and to manage every phase of new, complex systems.

- *Design, build and fly the world's first jet VTOL airplane. Then apply over three million man-hours of VTOL experience to creating such modern aircraft as the Army's XV-5A lift-fan aircraft.*
- *Take a concept like the Rogallo wing and develop a successful test-bed vehicle with broad applications—the Ryan Flex Wing.*
- *Pioneer the C-W Doppler principle into world leadership in the production of electronic navigation systems for all types of aircraft now flying or projected.*
- *Develop complete jet target systems like the famed Ryan Firebee—most widely used target jet in the free world.*
- *Design and fabricate radar altimeters, precision antennas and space structures for such advanced space vehicles as Mariner II, Saturn, Surveyor.*

From advanced astronics to the fabrication of space age metals, Ryan is prepared to assist government and industry in studies, design, development, production, and the field support of *complete* operational systems and equipment.

RYAN AERONAUTICAL COMPANY, SAN DIEGO, CALIFORNIA

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RYAN REPORTER

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JULY - AUGUST 1963 / VOLUME 24 • NO. 3

About the Cover: Conquering traditional helicopter torque problems with no-tail-rotor ease, the Dornier Do 32 is the first collapsible reaction-type helicopter in the world. Ryan will market the revolutionary machine in the United States. See article, page 14.

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FLEEP EXPRESS

For mobility, the Army looks at flying trucks

A NEW DIMENSION in Army mobility — a flying truck — was recently delivered by Ryan to the Army Transportation Research Command for testing at the Army's Yuma, Arizona Test Station.

Nicknamed "Fleep," the Flexible Wing Aerial Utility Vehicle, officially designated XV-8A, was designed and constructed by Ryan to operate out of rugged, unimproved areas where conventional airstrips are unavailable, in logistic support of combat troops. It is powered by a 220 hp six-cylinder Continental engine with fuel injection.

At the Army's Yuma Test Station, Ryan has begun "Fleep" flight tests for the Transportation Research Command.

Ryan Engineering Test Pilot, Lou Everett, takes the controls of the XV-8A—nicknamed "Fleep."

The initial "Fleep" design calls for a payload of 1,000 pounds, a 100-mile range and a take-off distance of only 300 feet. Its handling characteristics are so docile and its controls so simple that personnel accustomed only to operating ground vehicles could be quickly trained to fly and maintain the "Fleep."

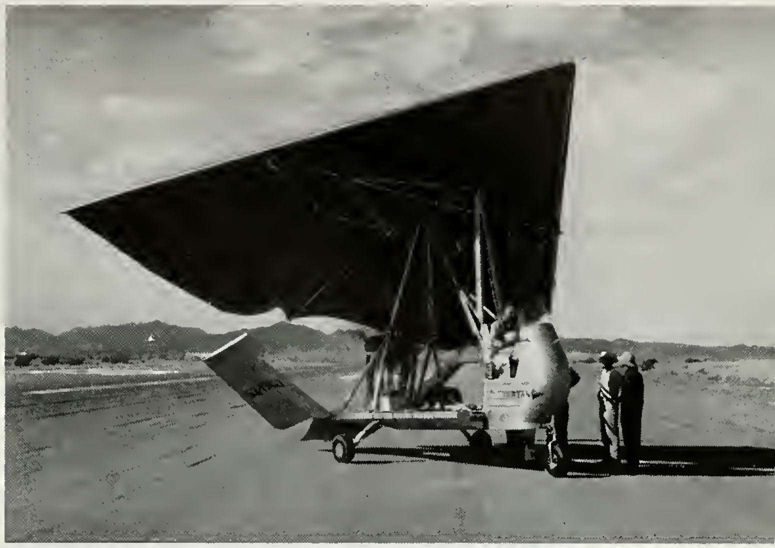
Ryan was awarded a $700,000 contract by the Army Transportation Research Command to design and fabricate two "Fleeps," to be tested at Yuma. The "Fleep" has no electrical or hydraulic system, emphasizing the extreme simplicity and ease with which maintenance can be accomplished.

Two years ago Ryan built the world's first Flexible Wing manned, powered flying test vehicle to demonstrate functional and aerodynamic characteristics. After successful completion of an intensive flight test program with the Flex Wing manned vehicle at Brown Field, near San Diego, by Ryan for the Army Transportation Research Command, the flying test bed was shipped to the National Aeronautics and Space Administration's facility at Langley Field, Virginia. There it underwent wind tunnel tests to confirm and correlate data obtained in the actual flights.

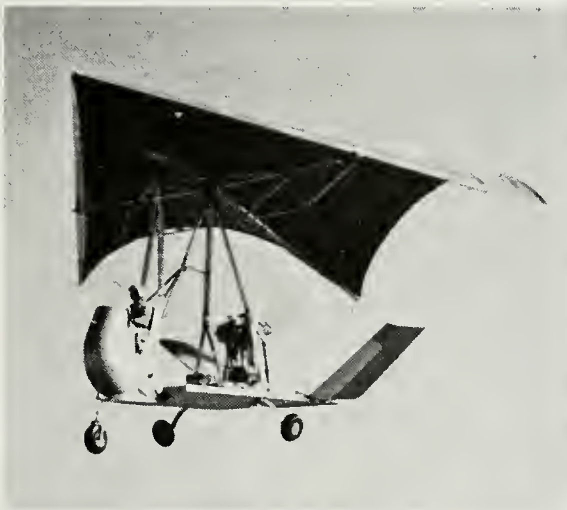
Lou Everett, Chief Engineering Test Pilot, who flew the world's first manned, powered Flexible Wing test vehicle in 1961, is flying the "Fleep" at Yuma.

After approximately 15 test flights, comprising 10 hours, to check out basic characteristics, a second phase test program is planned at Yuma, involving training of military personnel in operation of the "Fleep."

In contrast with conventional rigid, metal-covered surfaces, the Ryan-built Flexible Wing is of flexible, plastic-coated material attached to a keel and leading edge members to form an arrow- or V-shaped, kite-like surface. With its remarkable lifting capability, the Flexible Wing is being studied as an inexpensive, highly mobile, easy-to-maintain system that can perform missions which under more conventional means would be impractical or too costly. ■



Officially designated a Flexible Wing Aerial Utility Vehicle, the "Fleep" is a light STOL aircraft designed to operate out of rugged unimproved areas where conventional airstrips are unavailable.



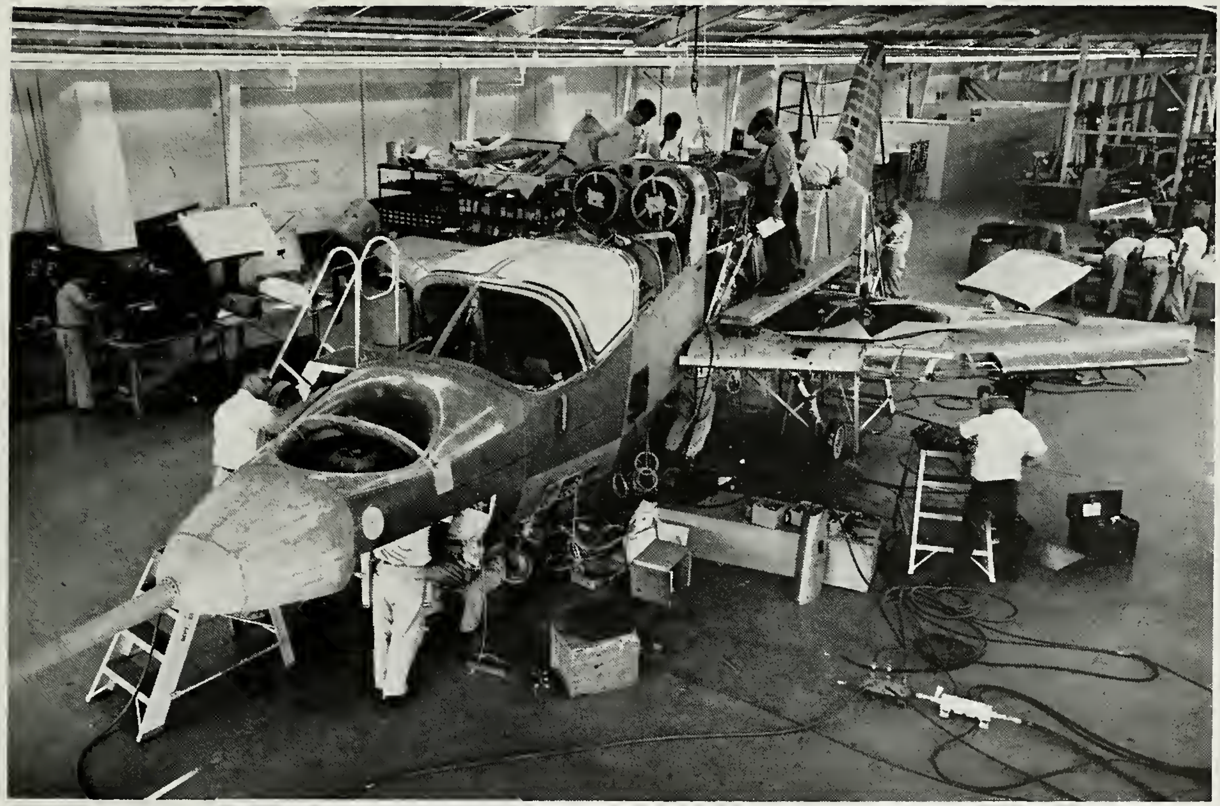
Ryan's initial "Fleep" design provides for a payload of 1,000 pounds, a 100 mile range, and a take-off distance of less than 300 feet. It is powered by a 220 hp 6 cylinder Continental engine with fuel injection.

PROGRESS REPORT

ARMY XV-5/A LIFT FAN AIRCRAFT

Ship number one moves from Ryan production hangar to static test facility.

World's first Lift Fan aircraft roll toward completion at Ryan



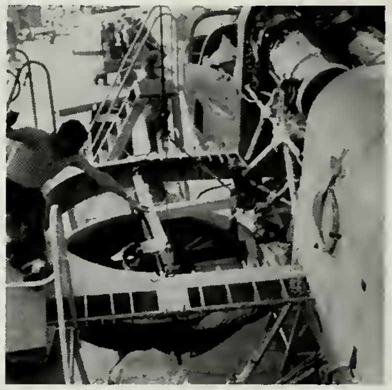
XV-5A number two begins to take final shape. This will be first aircraft to fly.

IN A well-integrated schedule, the two XV-5A lift fan aircraft which Ryan is designing and building for the U.S. Army, under contract to General Electric Company, are moving toward completion.

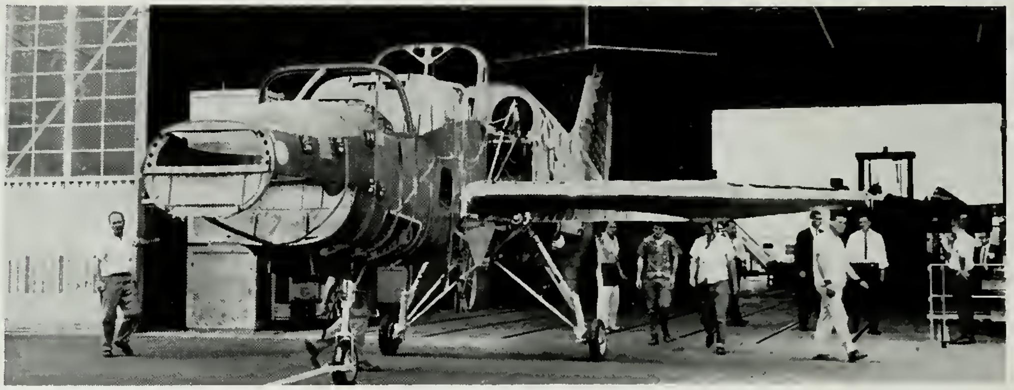
Ship number one has successfully completed its structural proof tests, ahead of schedule. Static test instrumentation is being removed. Internal systems, including the lift fan propulsion system, will be installed to complete this aircraft. Then, it will be shipped to the NASA-Ames Research Center at Moffett Field, California, for aerodynamic tests in their huge 40 x 80 wind tunnel. After that program, it will be shipped to Edwards Air Force Base.

Ship number two is being completed and prepared for ground resonance tests and engine operational tests. When completed, this aircraft will be shipped to Edwards Air Force Base for first flight tests. Meanwhile, phase one of the XV-5A simulation flight program has started in the three-dimensional Ryan flight simulation laboratory. In this work, the pilot evaluation tests will be made, using actual XV-5A control systems hardware and instrumentation. ■

(continued)



A. B.



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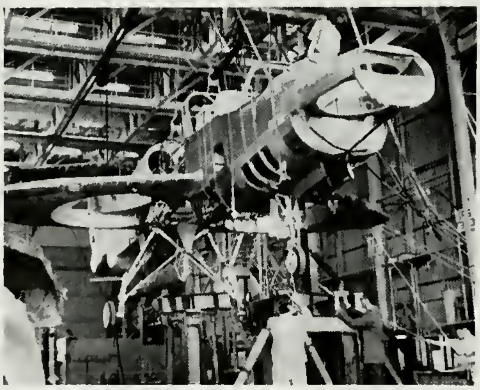
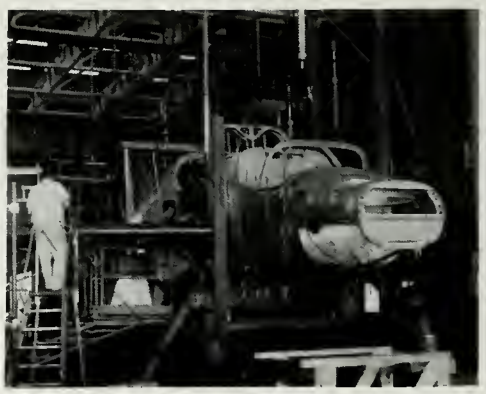
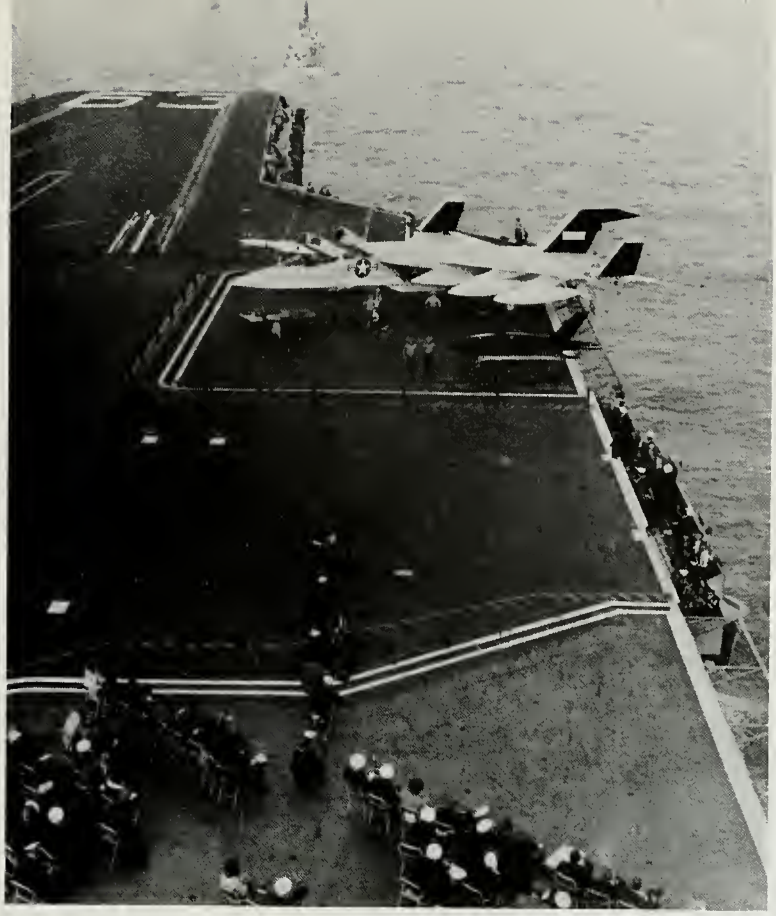


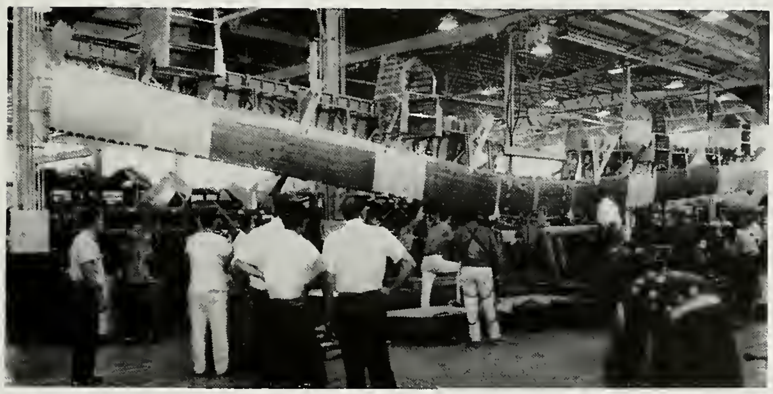


D. E.

A. *Ryan fabricates two XV-5A lift fan aircraft in San Diego plant. Horizontal stabilizer is skinned, in foreground.* **B.** *General Electric lift fan propulsion system is fitted into ship number one. Two J85 turbo-jets are shown in fuselage with lift fan in left wing.* **C.** *Ship number one is moved from production hangar to static test facility for structural tests.* **D.** *XV-5A is installed in static test fixture.* **E.** *Static tests are conducted with hydraulic loading cylinders, metals straps and rubber pads attached to wing surfaces.*

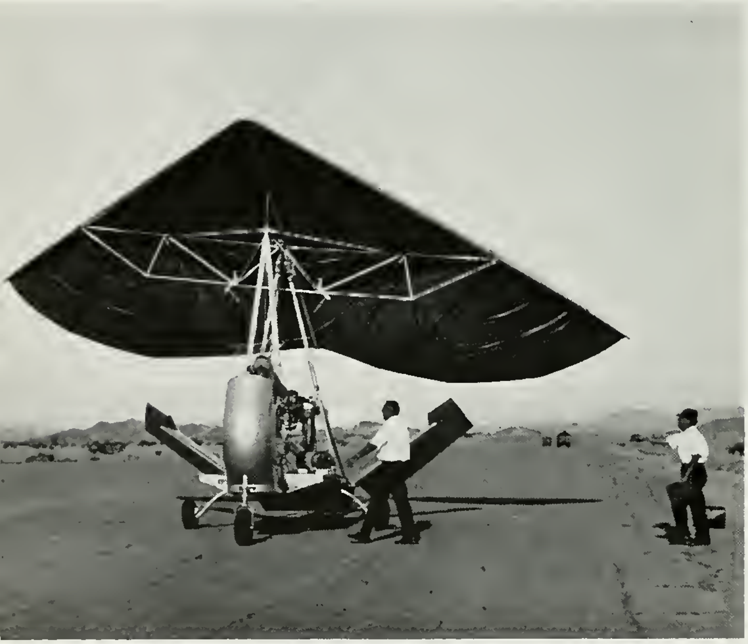


Direct hits by air-to-air missiles, which destroyed two Ryan Q-2C Firebee jet targets were highlights of a spectacular demonstration of naval power viewed by President Kennedy aboard the aircraft carrier Kitty Hawk, off the Southern California coast June 6. One Navy Q-2C was hit at its mission altitude of 1,000 feet and the other at 1,200 feet—both close to the carrier and clearly seen by the Chief Executive. During the demonstration the Ryan Q-2C Firebee was a prominent display on the carrier flight deck, forward of the President's party.



Ryan production of components for the Tri-Service XC-142A is progressing rapidly as units for the first flight aircraft near completion. In a recent photo the massive wing for the first V/STOL cargo aircraft was moved from the assembly jig to the pick-up station.

The seemingly simple, yet unbelievable Flex Wing is proving its versatility in the summer heat of the Arizona desert at the Army's Yuma Test Station. Ryan technicians are either conducting, or have completed exhaustive test programs on four Ryan-designed Flex Wing vehicles. From left to right, top to bottom: they are the Army XV-8A "Fleep" Aerial Utility Vehicle; the Marine Corps Flex Bee; the Army Air Cargo Tow Glider; and the Army Precision Drop Glider.



Braving desert heat, dotting the Arizona sky...

FLEX WINGS FLY IN YUMA TESTS

RYAN FLIGHT TEST engineers and technicians assigned to Flex Wing test programs at the U.S. Army Yuma Test Station go to work early — usually about 5:00 a.m.

The men are currently engaged in the flight test of three Flex Wing projects at the Arizona site, two for the Army and one for the Marine Corps.

Duane "Swede" Jensen, Ryan Base Operations manager explains the reasons for the early bird activity. "We try to complete our daily flight schedule while the desert is relatively cool," he said. "By noon the high temperature — ranging from 100 to 117 degrees — develops thermal layers in the air which make difficult the precise evaluation required in test work. Then, we like to complete our day's work before the heat gets too intense."

The Ryan crew has been testing the Army's new "Fleep," a unique new "flying truck" recently delivered to the Army's Transportation Research Command and Advanced Research Projects Agency for testing at Yuma. Tests of an Air Cargo Delivery glider, towed by an Army helicopter, and remote control flights of a reconnaissance drone known as the "Flex Bee" for the Marine Corps, are other Flex Wing programs currently under test. More than 130 test missions of Flex Wing Precision Drop Gliders have recently been completed by the 20-man Ryan team at Yuma.

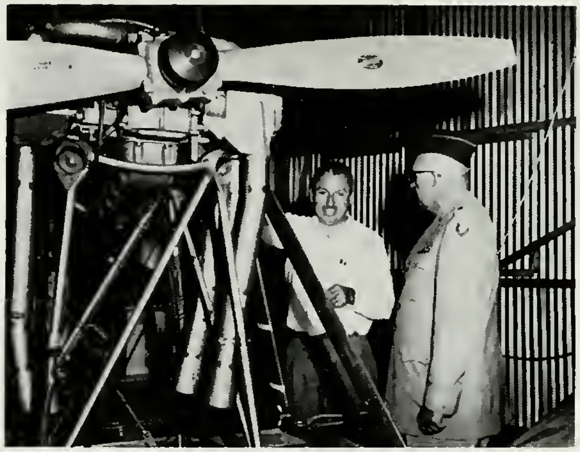
All the Flex Wing vehicles were designed and fabricated at Ryan's facility in San Diego.

Initial tests of the Air Cargo Glider began last December to demonstrate the feasibility to perform unmanned delivery of large quantities of cargo under simulated combat conditions. Taxi tests were completed by using a truck as a tow vehicle to study ground handling techniques and capability.

In January the aluminum cargo gliders were towed for the first time with the H-34 helicopter using a 400 foot steel cable. By mid-May heavy loads were being successfully towed and delivered by the system, and on May 21, during a visit by Francis Rogallo, the tow glider system carried its designed gross weight of 1800 pounds on successful launch, towed flight, and free flight to landing. Rogallo is considered the father of the Flex Wing and is currently Chief of the 8 x 10 foot Wind Tunnel, National Aeronautics and Space Administration, Langley Field, Va.

In free flight, after release from the tow cable and helicopter, the Flex Wing gliders are remotely controlled by radio command either from the ground or the tow helicopter. The gliders can home to a radio beacon on the ground, or be towed by the helicopter until ground contact is

Towed by a helicopter or fixed wing aircraft, the Air Cargo Glider will carry 1800 pounds.



Ryan engineer Pete Girard explains "Fleep" details to visiting Brigadier General Merrill B. Tribe, Commanding General Quartermaster Research & Engineering Command.

Ryan technicians fold inflatable wing into top of cargo package.

made, then detached.

An interesting capability of the glider is its ability to automatically flare in the landing sequence. As the glider approaches the ground, a sensory cable slung from its nose section makes first contact. At ground contact, an electric sensor system, sends a signal to the wing control mechanism ordering it to flare. The wing pops back, creating added drag, and the glider pancakes to a safe landing. The wing flare also decreases ground roll after the initial touchdown.

Through use of the Flex Wing Tow Glider system, the payloads of Army helicopters can be multiplied considerably while permitting pinpoint delivery of supplies to ground terminal areas. All types of supplies, weapons and fuel could be airlifted to provide speedy support to Army units in the field.

Additionally, testing of the tow glider delivery system was begun in mid-June to develop techniques of attaching the wing system to various types of cargo including small mechanized vehicles, field guns, and cargo packages.

Marine Corps Flex Bee flights began in late May, as a preliminary step to final evaluation of the reconnaissance drone system by the Marines at Quantico, Virginia. In the Yuma program, Ryan will train a crack two-man team to demonstrate the capabilities of the Flex Bee in the Quantico evaluation.

Early training flights were conducted by launching the Flex Bee from the top of a jeep. Later flights were made from a portable ground launcher. The remote controlled drone, utilizing the unique Flex Wing, has a take-off speed of approximately 45 miles per hour and will cruise 65 mph. It is driven by a 9½ hp McCulloch Go-Cart engine.

The Army "Fleep", newest member of the Ryan Flex Wing family at Yuma, is expected to complete its first phase flight test program in six to eight weeks at the desert facility. Fifteen operations are scheduled with the unique new aircraft that looks more like a huge kite than an airplane. Included in the fifteen operations are six taxi tests and nine flight operations.

In the taxi tests, maneuverability and ground control were studied to develop handling techniques and operating parameters. Slow speed taxi tests were completed at speeds up to 15 knots. During high speed taxi runs, the "Fleep" was allowed to lift off the ground and touch down before full scale flight operations began.

Taxi tests of the unique machine were conducted on the inactive runway at the Laguna Air

Facility at the Yuma Test Station. Flights were in the flight pattern at altitudes ranging from 500 to 1000 feet. Basic flight performance was studied including aircraft handling during climbs, and turns. Take-off distances at various loadings were also studied. Ryan flight test engineer Jim Maroney is directing the "Fleep" flight program.

The "Fleep" designed by a team headed by Fred Landgraf and Pete Girard, is powered by a 220 hp six-cylinder Continental engine with fuel injection.

Girard piloted the world famed X-13 Vertijet and Fred Landgraf was in charge of the design of Ryan's unique VZ-3RY Vertiplane, a huge flapped, deflected slipstream theory, short take-off and landing propeller-driven aircraft.

The Yuma Test Station is located 32 miles north of Yuma, Arizona on State Highway 95. The station boundaries incorporate more than a million acres of test area. The facility is a support function to the U.S. Army Test and Evaluation Command with headquarters at Aberdeen Proving Grounds, Maryland. Colonel James C. Taylor is Commanding Officer of the Station.

During the Flex Wing testing, the Ryan team works in conjunction with the Directorate of Air Testing at Yuma, commanded by Major James P. McDonald. Duane Oliver is the direct liaison between Ryan and the DAT function. ■

Colonel James C. Taylor is Commanding Officer of the Yuma Test Station. Prior to his assignment at Yuma he was the Senior Advisor to the 22nd Vietnamese Infantry Division, Kontum, Vietnam.

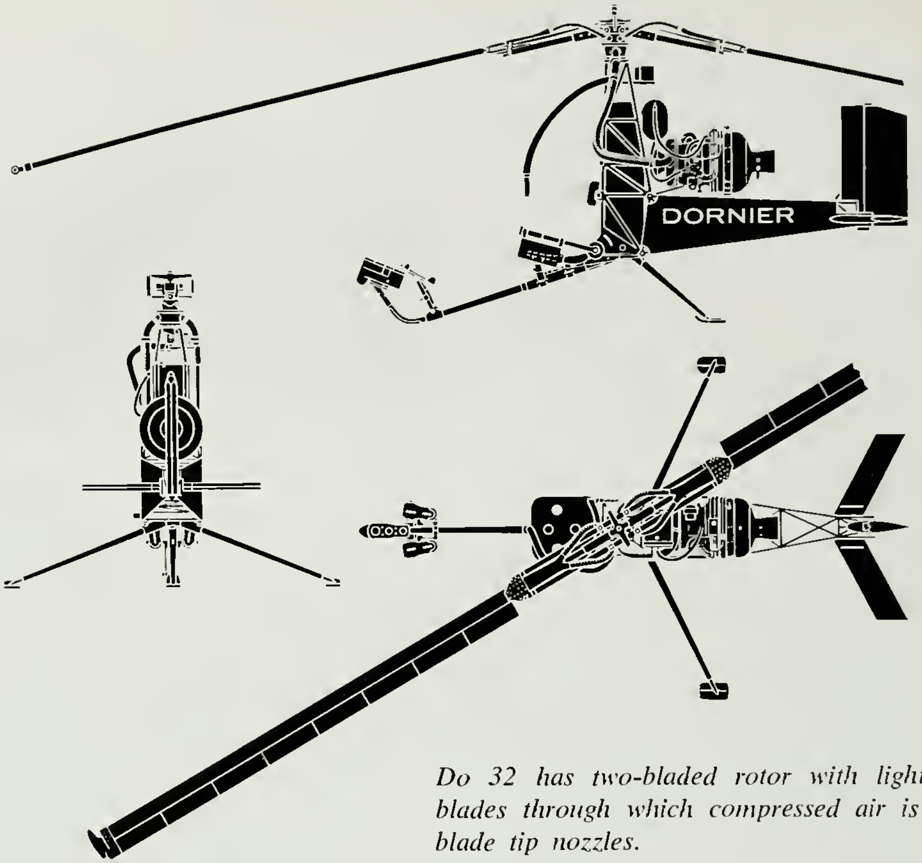
The Yuma Test Station is a facility of the U. S. Army Test and Evaluation Command. The test range is approximately 58 miles long and 54 miles wide. The station supports Department of Army programs by providing facilities and support for desert and hot weather research.

JACK-IN-THE-BOX HELICOPTER

RYAN Aeronautical Company has reached an agreement with Dornier-Werke GmbH to demonstrate, in the United States, the revolutionary new single-place Dornier Do 32 — West Germany's first postwar helicopter.

The Do 32, unveiled recently at the Paris Air Show, is the first collapsible reaction-type vehicle of its kind in the world, and the first helicopter which can be transported in a trailer serving as a take-off and landing platform. The Do 32 has no tail rotor.

In a historic meeting at the recent Paris Air Show, two of the world's aviation pioneers, T. Claude Ryan and Prof. Dr. Claudius Dornier gave their personal endorsement to an agreement that joined Ryan Aeronautical Company and Dornier-Werke in the demonstration and promotion of the revolutionary helicopter in the United States this fall. In the inset photo, Ryan with camera, shares an umbrella with Dornier, during helicopter flight demonstration.



Do 32 has two-bladed rotor with light metal blades through which compressed air is fed to blade tip nozzles.

Two of the West German-built vehicles will be shipped to Ryan's San Diego facility soon, accompanied by a Dornier pilot and mechanics, to begin a Ryan-conducted flying demonstration tour of military and government agencies.

Arrangements for the introduction of the Do 32 into this country were completed after Robert C. Jackson, Ryan president, and T. Claude Ryan, Board Chairman, witnessed a demonstration of the unique helicopter at the Paris Air Show in June, and were impressed by its performance.

"Potential uses of the Do 32 are numerous for military applications, by government agencies, and for commercial and sports purposes," Jackson said.

Military missions could include visual and photographic reconnaissance, courier duty as a "motorcycle of the air," spotting for artillery units, and flying command post functions.

Among government non-defense agencies that have an increasing need for equipment of a special character in remote areas are the U.S. Forest Service, the Department of Interior, and the U.S. Immigration and Naturalization Service.

Duties could include fire control, access to otherwise inaccessible terrain, border patrol, control of harbors and waterways, traffic regulation, accident assistance, salvage missions, and mountain and sea rescue service.

In the commercial and private field, the Do 32 could be utilized for pipe-line and high tension transmission line patrol, and for numerous private business activities.

Lou Everett, Ryan engineering test pilot, who flew the helicopter in Germany several weeks before the Paris Air Show, submitted a highly favorable report.

The helicopter can be stored in a box mounted on a trailer bed, which is easily transportable by a car to the take-off area. It can be shipped by air or sea.

In less than five minutes, the Do 32 can be assembled on the trailer, which folds down to become a "heliport" from which the helicopter performs a jump take-off.

The Do 32's principle of power transmission is new. Compressed air, supplied by a turbine driven compressor, is routed to rotor blade tip nozzles which turn the rotor by reaction without negative torque effect. Any type of fuel can be used.

The jet stream of the 100 hp turbo power plant is directed aft onto the vertical control surface. In contrast with conventional helicopters, the need for gears, clutches, free-wheeling units, shafts and tail rotors is eliminated.

The rotor rpm's are independent of engine turbine rpm's, leading to an extremely simple design in which the rotor has neither tilting linkages, nor dampers or floating hubs.

The foldable Do 32 can be stored and transported in a trailer box 12.5 feet long, 2.8 feet wide and 3.3 feet high.

Unfolded, the trailer becomes a heliport. The helicopter's center pylon is erected to vertical position and the rotor blades are unfolded.

Air compresssor hoses are connected at the rotor hub and the Do 32 is ready for flight.

Employing jump take-off techniques, pilot scoots Do 32 off trailer launching pad.

In case of engine breakdown, the compressed air is switched over automatically to autorotation. If necessary, it can also de-ice the blades.

The Do 32's maximum speed is 65 knots, and its cruising speed is 54 knots. Its operating range at cruising speed is 56 miles and its endurance without auxiliary tanks is 50 minutes.

The nationwide demonstration tour of the Do 32 will be conducted by Ryan marketing and engineering personnel, a Ryan pilot, the West German pilot and mechanics.

Historic Meeting

The Paris Air Show was the scene for a historic meeting between T. Claude Ryan, Board Chairman and Chief Executive Officer of Ryan Aeronautical Company, and Professor Dr. Claudius Dornier, founder of the famous West German company that bears his name.

Today, Dornier is senior among German aircraft manufacturers, and his firm, Dornier-Werke, is the only large German aviation firm that is still family-owned. At the age of 78, he is still eager to project new concepts, such as the Do 32. ■

In less than four minutes the helicopter is ready for flight.

INDIVIDUAL DROP GLIDER

With Flex Wings airborne troops could fly 7 miles...

ARMY airborne troops of the future may literally fly themselves to a controlled landing, following Army announcement of the completion of initial flight tests of a flexible wing individual drop glider (IDG) system. Using the flexible wing, troops can control their direction and rate of descent after jumping from aircraft.

Under contract from the Army Transportation Research Command, Ft. Eustis, Va., Ryan designed and fabricated inflatable flexible wings and instrumented full-scale dummies for testing the system at the Army Test Center in Yuma, Arizona.

The IDG wing has a 300 sq. ft. surface area and a 22 ft. keel. The leading edges and keel are made of polyester-coated dacron, and are inflated by an automatic system. In addition to off-set delivery capability and accuracy not attainable with parachutes, this system will be capable of operating in winds up to 25 mph.

An offset delivery capability of approximately one mile horizontal distance for each 1,500 feet of altitude will be attained. When the system is fully developed, for example, airborne personnel could be released at 10,000 feet altitude approximately 7 miles horizontal distance from target, and guide themselves to the objective in controlled descent.

When an airborne trooper jumps, a static line connected to the inside of the aircraft initiates deployment of the wing. After a preset time period, a compressed air bottle in the aft end of the keel is triggered to inflate the keel and leading edges.

In the test program, sponsored by the U. S. Army Transportation Research Command, instrumented dummies were remotely controlled from the ground by radio command to govern servo motors that control pitch and roll of the system during glide and landing flare.

In actual use, a soldier will be capable of controlling his direction by pulling on riser lines to bank to the right or left.

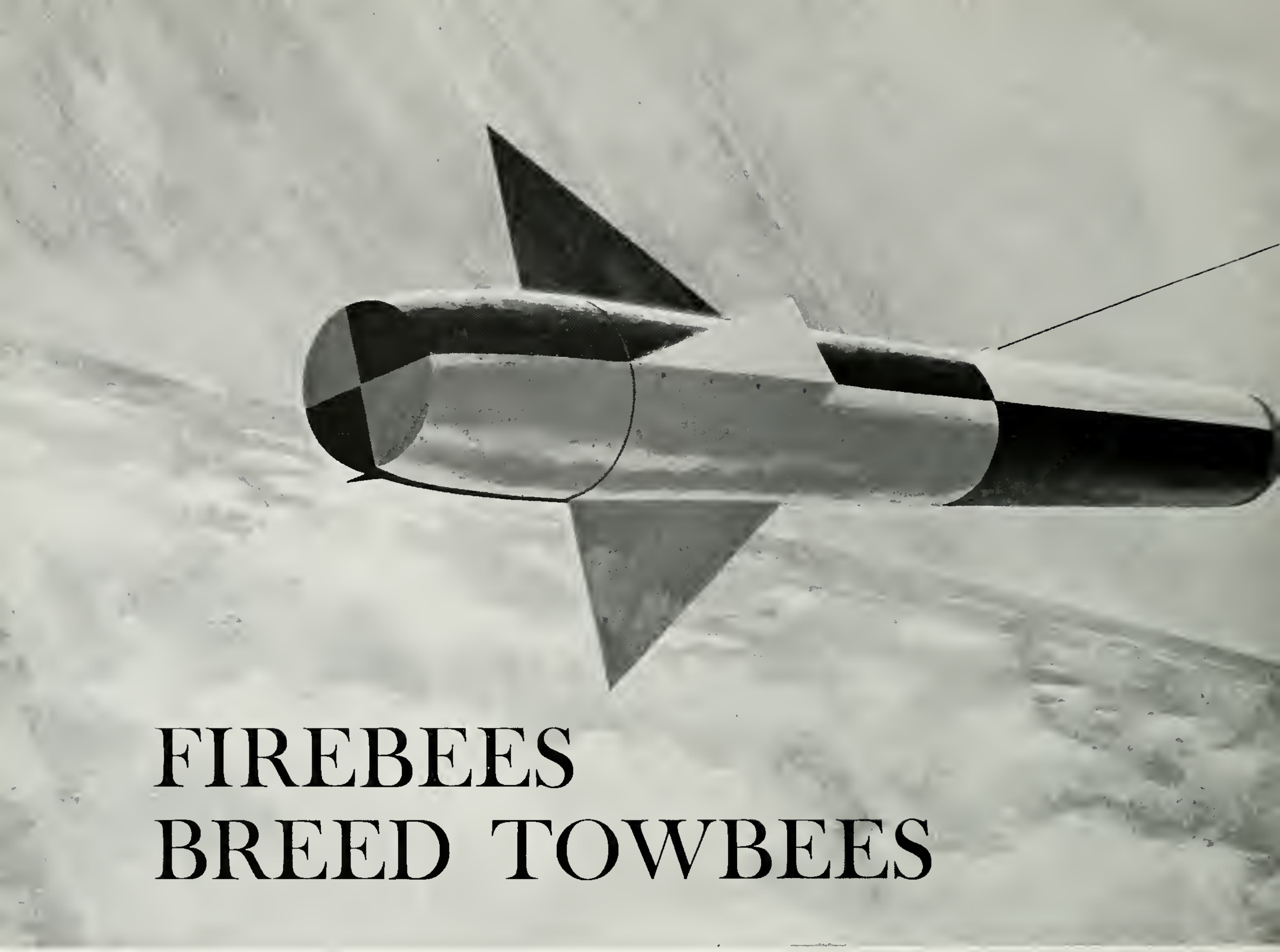
Use of the flexible wing principle to drop personnel on special missions would enable the individual to "aim" at a ground site more effectively from a far greater initial release distance than with conventional parachutes, according to M. M. McDaniel, Flex Wing Project Manager, who is in charge of the program at Ryan.

A second phase of testing is presently being carried out by the Army's Transportation Research Command at Fort Eustis, Va. These studies are being conducted to obtain further data on landing procedures and safety. "Live" tests or manned qualification is expected to begin after the Transportation Command's tests are completed.

Ryan's Flexible Wing individual drop glider program for the Army followed successful tests in the San Diego area, utilizing a half-scale model dropped from a plane at an altitude of 2,000 feet. This program is another of the numerous applications proposed for the Flexible Wing in manned or unmanned, and powered and glider-type vehicles.

Two years ago Ryan built the world's first Flexible Wing manned, powered flying test vehicle to demonstrate functional and areodynamic characteristics. In contrast with conventional aircraft containing rigid metal-covered surfaces, Flexible Wings are of flexible, plastic-coated material attached to a keel and leading edge members to form an arrow- or V-shaped, kite-like surface.

After successful completion of an intensive flight test program with the Flex Wing manned vehicle at Brown Field, near San Diego, by Ryan and for the Army Transportation Research Command, the flying test bed was shipped to the National Aeronautics and Space Administration's facility at Langley Field, Va. There it underwent wind tunnel tests to confirm and correlate data obtained in the actual flights. ■



FIREBEES BREED TOWBEES

THE U. S. ARMY 124-E/Ryan Firebee has added a new dimension to its support of Army missile development and training programs on the White Sands Missile Range.

The Army version of the remote-controlled, high performance Q-2C Firebee has been configured to pull tow targets appropriately named "Towbees."

The Firebee-Towbee system has been flight tested by a 30-man Ryan Contractor Operated Service team at the White Sands Range under the technical direction of the Army Missile Command at Redstone Arsenal, Huntsville, Alabama.

Successful firings of Army surface-to-air missiles at the Firebee-Towbee system in early April proved the feasibility of the concept and climaxed a two-year development program which was highlighted by successful flights with the Towbee in various stages of development.

Low-Cost Presentations

The Towbee concept was developed to provide the Army with high performance, lower cost targets for surface-to-air missiles. Army Missile Command target guided missile experts felt larger cost savings could result from use of expendable targets, towed by the remotely controlled parachute-recovered Firebee. The concept is similar in one respect to that in use for years in which aerial targets were trailed behind manned aircraft. Safety restrictions preclude extensive use of manned aircraft in guided missile testing, particularly surface-to-air missile firings.

A further consideration in the development of the Towbee concept was the capability of the Firebee, towing more than one target, to give surface-to-air missile crews targets in formation, a requirement long needed.

In the Army/Ryan development program two types of Firebee-Towbee operations were demonstrated in the two-year program. In early Towbee operations dating back to October, 1961, ground launched Q-2A Firebees, trailing 1800

A new cousin joins Ryan's Firebee family

feet of 1000-pound test nylon line, snatched a seven-foot long Del Mar standard Air Force tow target (MC-5) from the ground. In the successful test, the Ryan Firebee jet target picked up the target and towed it at speeds up to 400 knots and at altitudes up to 30,000 feet. No appreciable reduction in the Firebee's normal performance was noted. As the Firebee was boosted off its ground launcher, it passed over the Towbee lifting it off the ground and towing it aloft.

The early tests were believed to be the first time that a target missile had been used in such a manner.

In similar launches in April and June, 1962, Q-2A Firebees, ground launched at White Sands, towed the bomb-shaped targets in missions over adjacent McGregor Range used by Fort Bliss, Texas missile training schools. Target presentations were made on both flights, which were climaxed with a missile intercepting the tow target and successful parachute recovery of the Firebee.

The Towbee was developed as an Army expendable target. Towbees are five feet long, seven inches in diameter and weigh 35 pounds.

A series of flights, demonstrating a second Towbee concept, in October, 1962, began at White Sands, using the advanced 124-E Firebee. For these flights one Hayes TA-7 tow target was mounted on each Firebee wing tip, and two tow reels developed by Anderson Greenwood, were mounted in the Firebee equipment compartment.

The 124-E Firebee is capable of launching and sequentially towing one, two or three Hayes TA-7 tow targets. When airborne, the targets are launched from the 124-E Firebee, payed out and towed by means of a one-way reel containing 5,000 feet of steel cable.

In the early October flight, the two targets were launched and towed at 20,000 feet. The White Sands missile tracking station tracked the operation successfully and, following the last tow target jettison, the Firebee was flown to a predetermined recovery area for a successful parachute recovery.

Two more successful development flights in October and November of 1962 and one flight in January, 1963, proved the wing tip launched Towbee concept.

The aluminum Towbees, approximately five feet long, seven inches in diameter and weighing only 35 pounds each, are connected to a one-way reel inside the Firebee's equipment compartment.

As the small target drops away from the "mother" Firebee, the cable pays out for a distance of 5,000 feet (at a rate of about 1000 feet per minute). If the target is hit in a firing run, the tow cable is cut at the equipment compartment, allowing the cable to be dropped. For a second firing run, the second Towbee is released from the other wingtip.

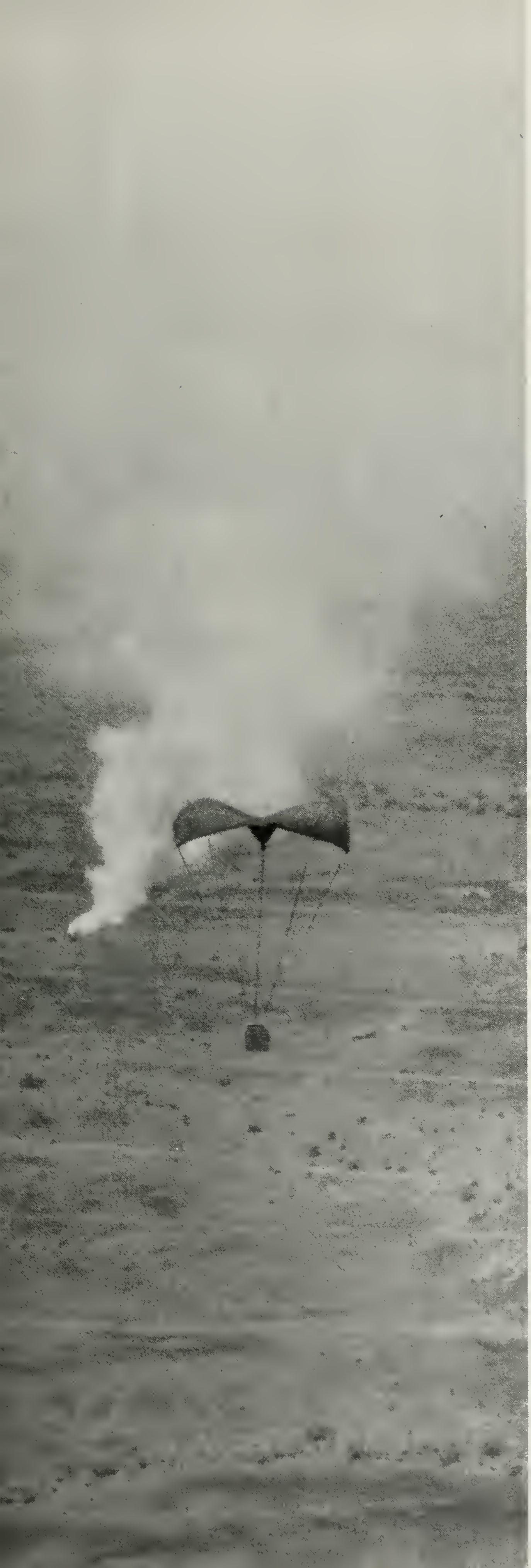
The Hayes target may be equipped with radar augmentation lenses, has the capability to carry an internally mounted scoring system, and augmentation for heat-seeking missiles. This tow target is essentially a center of gravity tow vehicle, with fixed fins for stability.

Army officials at Redstone expressed enthusiasm for the new target program. Pointing up the inexpensive target presentation aspects of the program, they said the Towbee concept extends the capability of the Ryan 124-E because the remote controlled target with Towbees allows a double or triple missile kill capability for each 124-E launch. They said formation flights accomplished by the 124-E towing more than one Towbee at one time, and its low altitude capabilities were added benefits of the Firebee/Towbee combination, which will be investigated. ■

Under the direction of the Army Missile Command, the Firebee/Towbee system was developed by Ryan at the White Sands Missile Range.

Mounted on the Firebee wingtips, the Towbees may be equipped with radar augmentation lenses, internally mounted scoring system, and augmentation for heat-seeking missiles.

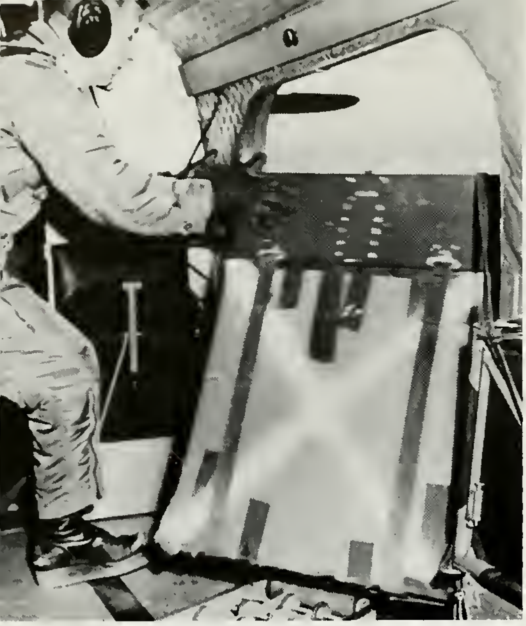
On White Sands ground launch pad, the 124-E Firebee with Towbee attached is ready for mission.



PRECISION DROP GLIDERS

PRECISION DROP GLIDERS utilizing Ryan Aeronautical Company's unique Flexible Wing system to carry large quantities of priority cargo into combat areas of limited space have been successfully tested for the U.S. Army Transportation Research Command.

To a 300 pound cargo container, Ryan technicians strap saddle containing inflatable Flex Wing and remote control equipment. At left, a Precision Drop Glider heads for impact site indicated by smoke flares in the background.



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Dropped from fixed wing aircraft and helicopters, Precision Drop Gliders have been successfully demonstrated in more than 150 missions . . .

The Precision Drop Glider is designed to "home" on a portable ground beacon, or to be remote-controlled to a pinpoint landing from the launch aircraft. As the system is launched from the aircraft, a static line initiates a sequence of operations to deploy the Flex Wing—as shown in the above series of photos. Cargo such as ammunition, fuel, food, electronic equipment, medicine, clothing, tools, and other supplies can be delivered to remote areas. In this configuration the Flex Wing has a glide ratio of 3 to 1, and makes it possible for a package dropped at 9,000 feet to fly to an impact area five miles away.

In more than 130 missions flown at the Army's Yuma, Arizona, Test Station, a high degree of reliability was achieved in landing payloads of up to 300 pounds in prescribed areas. The system is ultimately designed to deliver cargo as heavy as 5,000 pounds in large-scale tactical operations.

Army fixed wing aircraft and helicopters were used in the Yuma tests. The Ryan "Flex Wing," fabricated of extremely lightweight flexible, plastic-coated material, is folded into a compact package similar to a parachute pack and attached to the cargo container, an inexpensive, rugged cardboard box.

Launchings of the precision drop gliders were conducted at altitudes ranging from 500 feet to 9,000 feet. As the container is ejected, a static line attached to the aircraft begins a sequence of operations to deploy the "Flex Wing," which carries the cargo container to earth in a glide ratio of approximately 3 to 1.

Thus, priority cargo such as ammunition, fuel, food, electronic equipment, medicine, clothing, tools, etc., can be delivered by an aircraft flying several miles from the area of concentrated enemy firepower. From an altitude of 9,000 feet, the precision drop glider can carry cargo approximately five miles to destination.

The glider can "home in" on a portable ground beacon or can be radio-controlled to a pinpoint landing from the launch aircraft. After unloading the cargo, ground troops can use the cardboard container for fuel or shelter, and the "Flex Wing" itself is reusable. During the Yuma tests, one precision drop glider and its control system was flown on 31 missions, and several others had more than a dozen flights each to their credit.

Ryan built the "Flex Wings" and the control equipment, including radio guidance and portable beacons, from commercial grade, off-the-shelf components—making it both economical and serviceable for operations in any part of the world.

For tactical Army operations, the precision drop glider is considered adaptable to counter-insurgency and other missions where cargo must be rapidly delivered into such limited areas as jungles and small clearings.

The Flexible Wing concept offers a lightweight, large areodynamic lift surface and a simplified control system. Unlike conventional aircraft with rigid metal-covered surfaces, the "Flex Wing" is of flexible, plastic-coated material attached to a keel and leading edge members so as to form an arrow- or V-shaped delta wing surface.

In addition to the precision drop glider, Ryan's Flexible Wing is being applied to the "Flex Bee" reconnaissance drones for the U.S. Marine Corps; unmanned towed gliders to multiply payloads of conventional aircraft; aerial utility vehicles; and recovery of huge space vehicle boosters as space re-entry wings. ■

4.

5.

An altimeter on "Sea Legs"...

Hydrofoil Height Sensor

In New York Harbor, Ryan's height sensor completed highly successful tests aboard the Navy's "Sea Legs."

Sensor antenna horns in early breadboard configuration for microwave tests.

FOLLOWING a two-year development program by Ryan Aeronautical Company and the U.S. Navy's Bureau of Ships, Ryan has been awarded a contract to build radar altimeters for the Navy's new hydrofoil ship. The contract is for a limited number of service test models, which will be designed and built at the Ryan Electronics facility on Kearny Mesa, in San Diego.

The altimeter or height sensor which it is sometimes called, will provide precise "altitude" information to the hydrofoil's automatic pilot system as the high speed craft "flies" across the water at very high speeds.

In mid-1962 Ryan and BuShips began a test program of a preliminary engineering model of the height sensor aboard the hydrofoil "Sea Legs" in New York harbor. The tests were carried out in conjunction with Gibbs and Cox, a major ship designing firm.

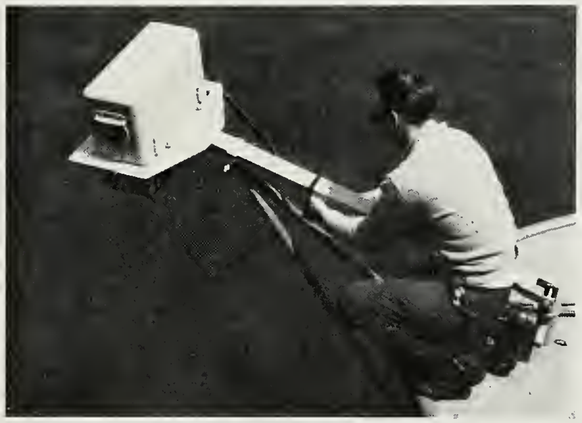
Ryan engineers worked directly with the hydrofoil engineers in achieving highly successful results in the tests. The scope of the current Ryan program calls for the development of advanced performance altimeters for ultimate evaluation aboard military hydrofoil craft.

In the high speed hydrofoil craft, the radar altimeter is probably one of the most critical instruments, as it must precisely measure the distance — in inches — of the craft's hull above the surface of the water, and immediately detect any change in the trim of the craft as it "flies" over the water.

Altimetry data is then furnished to the autopilot system which in turn makes the necessary adjustments in the underwater "wings" of the craft.

The Ryan hydrofoil altimeter program grew out of Ryan Electronics more than 15 years' experience in the design and production of highly accurate Doppler navigation systems for the Navy and Army. ■

Ryan Electronics hydrofoil height sensors will be evaluated on future Navy craft.



Ryan technicians, during dock tests, at left, checked the accuracy of the altimeter in "inches" with a steel tape. The altimeter measured precisely, 2 inch ripples on the water. Above, breadboard configuration was so successful it was housed in an available package and installed on the "Sea Legs." Operational models will be one-sixth this size.

Please send address changes to:

RYAN AERONAUTICAL COMPANY
P. O. BOX 311 ■ SAN DIEGO 12, CALIF.

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GENERAL ELECTRIC CO.
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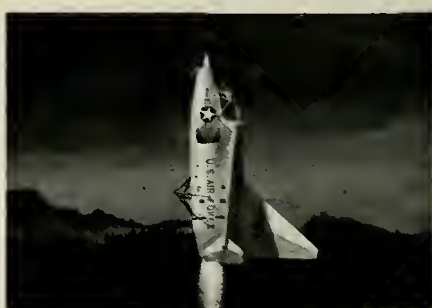
Out of Ryan's spectrum of capabilities: **FIRST IN V/STOL**

New V/STOL team-mates for battlefield mobility

The most experienced specialist in high speed V/STOL aircraft, Ryan is designing and building the Army XV-5A lift-fan aircraft under contract to General Electric. The lift-fan concept will provide greater payload/range than any other high speed vertical-take-off-and-landing configuration. Ryan is also working on the Vought-Hiller-Ryan XC-142A tri-service transport—the first U.S. V/STOL aircraft scheduled for operational evaluation. This tilt-wing aircraft is designed for a VTOL payload of 8,000 pounds or 32 troops. □ Since both V/STOL aircraft can be widely dispersed and concealed at advanced "soft bases," they add a new dimension in survivability. And teamed together, they step up battlefield mobility by giving the field commander quicker reaction, better target location, improved communication, and close-by tactical and logistic support. □ Ryan is also a leader in Doppler navigation systems, jet target drones, Flex Wing vehicles, lunar landing systems, space radar systems and space structures. □ Your inquiry is invited on how Ryan's spectrum of capabilities can help solve your Space Age problems.

RYAN AERONAUTICAL COMPANY, SAN DIEGO, CALIFORNIA



RYAN X-13 VERTIJET, world's first jet VTOL aircraft was developed under Air Force and Navy contracts dating back to 1946. This was the first aircraft to demonstrate feasibility of vertical jet take-off with transition to level flight.

RYAN REPORTER

NOV.-DEC., 1963

RYAN REPORTER

NOVEMBER-DECEMBER 1963/VOLUME 24 • NO. 4

About the Cover: Like exotic fingerprints, these patterns are left by the cutting tools which machine solid blocks of aluminum alloy into vital pivots which support the tilt-wings of the Vought-Hiller-Ryan XC-142A V/STOL transport. (Article, Page 7)

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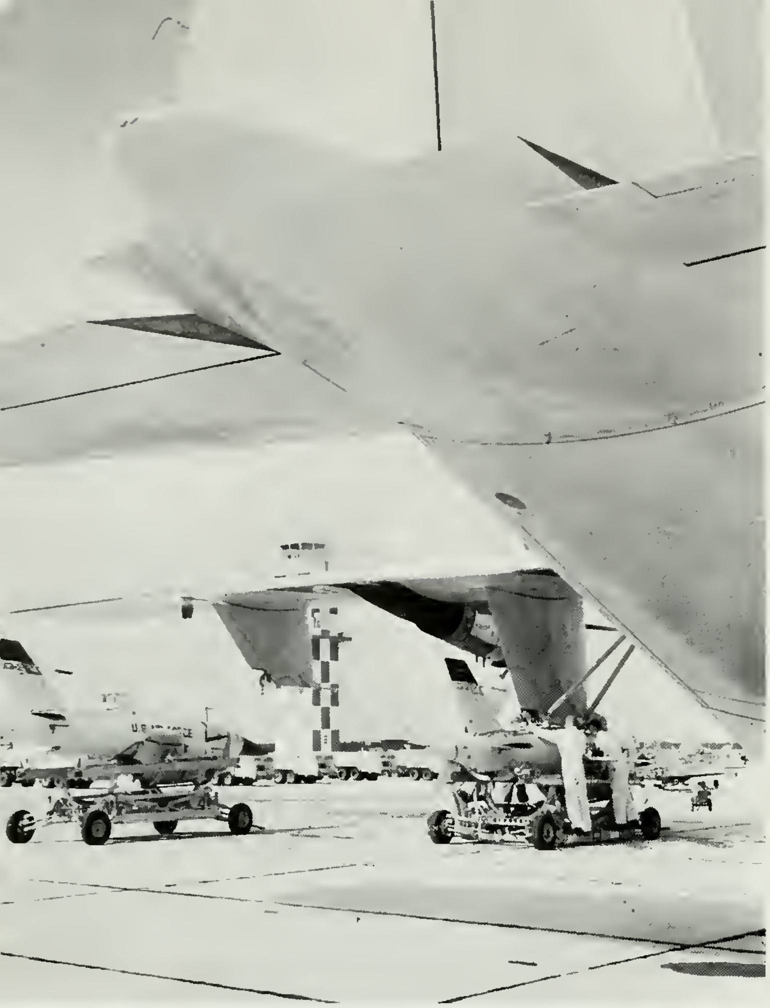
THE BIG APPLE



William Tell 1963 saw the Ryan Firebee "enemy" both air launched from GC-130s, shown being loaded at left, and ground launched, bottom, from beach front sites at Tyndall Air Force Base.

ONCE AGAIN the Ryan Q-2C Firebee has demonstrated its effectiveness as the sole target drone for the "World Series" of Air Force marksmanship.

Firebees challenged the skill of 14 sharpshooting supersonic fighter interceptor squadron teams assembled at Tyndall Air Force Base, Florida, October 7 through 13 from bases throughout the United States and overseas for the "William Tell 1963" competition. It was the fourth of the world-wide "William Tell" meets at which Ryan high-speed drones presented realistic targets in testing the accuracy of missile and rocket-firing Century series Air Force jets. Firebees also were exclusively used at the Tyndall AFB tournaments in 1958, 1959 and 1961.

The 1963 meet provided the largest usage of Firebees in the history of the competition, with 85 targets flown. The versatility of the Q-2C jet target was demonstrated by the nearly equal number of air and ground launches. Forty-four of the "birds" were launched from a Lockheed GC-130 transport, and 41 were catapulted from ground launchers. Parachute recoveries were made both on land and in the Gulf of Mexico.

Seventeen direct hits were scored by the eagle-eyed pilots, who were honored by presentation of traditional "kill" plaques awarded by Ryan to crews of aircraft capable of destroying the evasive subsonic targets.

One of the outstanding features of "William Tell 1963" was the quick re-use capability demonstrated by the Firebee. Within the few days' period of the meet, six Firebees which had been recovered on land undamaged were almost immediately "turned around" and launched on sec-

Air Defense Command F-102s and F-106s stand alert on the Tyndall flight line, ready to scramble.

ond flights. This dramatically showed how the remote-controlled Q-2Cs can be repeatedly used as an economical target system for both air-to-air and ground-to-air defense training.

The "William Tell 1963" competition was conducted in three categories, with F-101 Voodoos, F-102 Delta Daggers and F-106 Delta Darts as the "aggressor" aircraft. Winning teams were:

F-101B Voodoos—445th Fighter Interceptor Squadron, Wurtsmith AFB, Michigan;

F-102 Delta Daggers—146th Fighter Interceptor Squadron, Pennsylvania Air National Guard, Pittsburgh, Pennsylvania; and

F-106 Delta Darts—318th Fighter Interceptor Squadron, McChord AFB, Washington.

The 445th Fighter Interceptor Squadron was the first repeat winner of a "William Tell" meet, having also outscored its competition in the F-101 category in 1961.

In addition to winning top honors in the F-102 category, the Pittsburgh Air National Guard squadron outscored all other teams to take the over-all championship of the "William Tell" meet. In 1962 the squadron beat other Air National Guard units by retaining the Ricks Trophy, sponsored by the Air Force Association.

Points were tallied at "William Tell 1963" for skill in radar control, prescribed radio voice procedures, breakaway maneuvers after firing, and armaments loading, as well as for actual firing of the air-to-air missiles and rockets at the Firebees.

The realistic, 600-mile-an-hour targets were operated at Tyndall AFB by the 4756th Field Maintenance Squadron, and combat sorties controlled from sites at the base located on the Gulf of Mexico coast near Panama City, Fla. Missions closely simulated unknown aircraft attack conditions, with the Air Force teams firing Hughes Falcon air-to-air heat and radar homing missiles and Douglas Genie air-to-air rockets.

The crack air defense interceptor teams scrambled for their aircraft after their radar controllers detected the Firebees flying over the Gulf of Mexico firing range, and the teams were graded on their ability to shoot down the drone at altitudes above 50,000 feet, below 50,000 feet and on night missions.

This year's competition featured an intruder mission. The radar controller for each team was notified that somewhere over the Gulf a Firebee was approaching. He had to locate the target on his radar, scramble his team, and direct them for the "kill"—all within a few minutes after the chief judge informed him of the unknown intruder's existence.

In the F-101B and F-106 categories, both representing the Air Defense Command, the teams were controlled completely by the Semi-Automatic Ground Environment (SAGE) Center at Montgomery, Ala., 250 miles from Tyndall AFB. The weapons director there directed the interceptors electronically to the Firebees, but the pilots pushed the buttons to fire the missiles. Judges scored the competition with the Parsons Miss Indicators and the Multiple Airborne Transponder Tracking System (MATTS) built into the drone. Direct hits were not necessary since the scoring systems graded on how close the missiles came within the target area. With modern high explosive and nuclear warhead capability of the missiles, a detonation near the target could destroy a single plane or an entire squadron. ■

A V/STOL GIANT GROWS

DELIVERY OF GIANT COMPONENTS for the tri-service tilt-wing V/STOL (vertical take-off and landing) XC-142A transport has been started by Ryan Aeronautical Company to its "teammates" in the $70 million project.

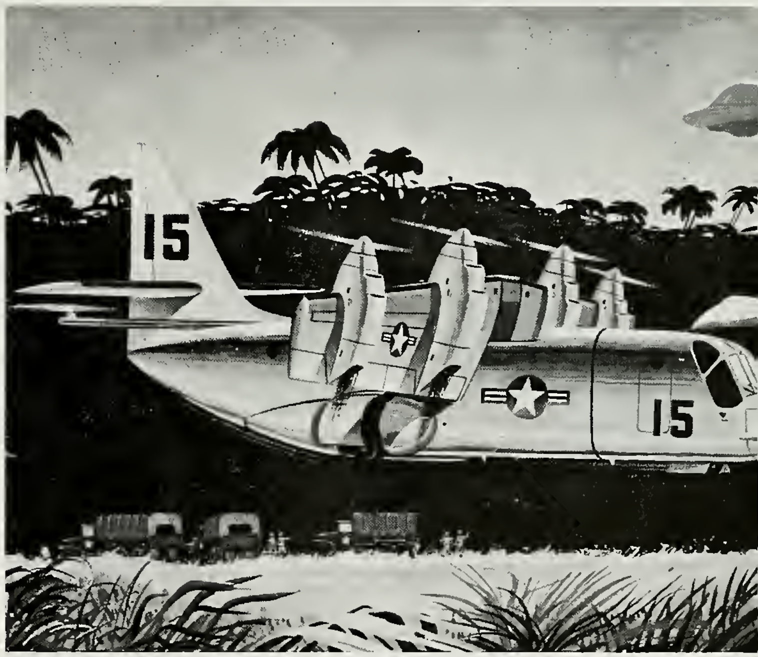
First large unit shipped from Ryan's San Diego plant was a giant wing torque box to the Hiller Aircraft Corp. in Palo Alto for testing with the Hiller cross-shafting transmission system which integrates the power of all four engines. This was followed soon afterward by the aft fuselage and empennage, sent to Ling-Temco-Vought of Dallas, Tex., prime contractor in the three-company team producing the XC-142A for all three military services.

Assembly of the first of five aircraft in the program is well along at the Ling-Temco-Vought plant, with target date for roll-out set for next March, and the first flight scheduled for next summer.

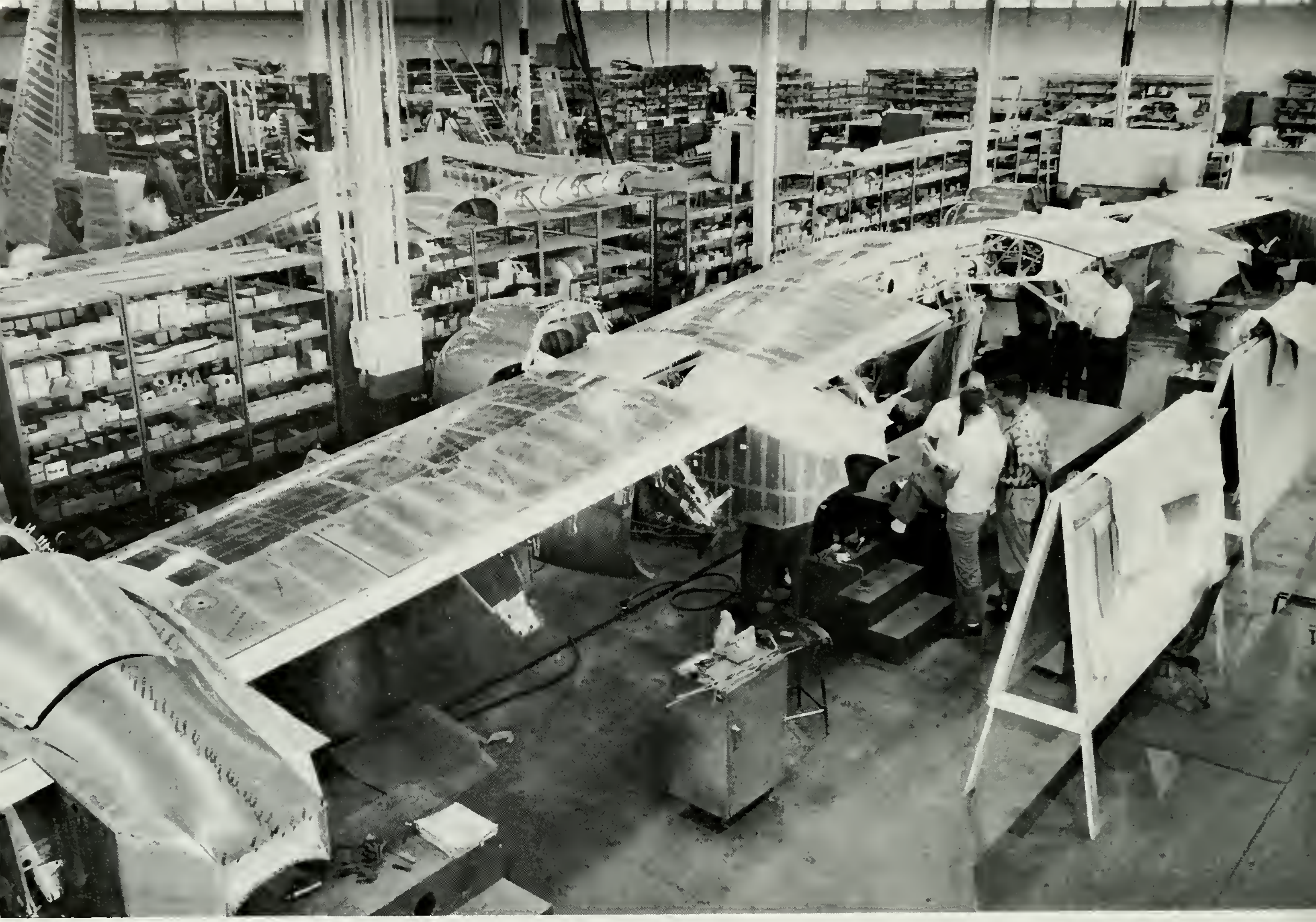
After an intensive design competition in 1961, Ling-Temco-Vought, Ryan and Hiller—three veteran firms in the aerospace industry—were awarded the contract in January, 1962, to develop and fabricate for the Department of Defense five experimental aircraft to investigate procedures and techniques associated with V/STOL operations in the 1965-70 time period. The Air Force was designated as developing agency for the Department of Defense.

Ryan is building seven wings—five for the prototype flying aircraft, one for static tests at Ling-Temco-Vought, and one for the Hiller transmission tests. In addition, Ryan is fabricating fuselage and empennage assemblies.

Current scheduling calls for completion of the fifth and final plane at Ling-Temco-Vought next September. Formal delivery of the first plane to the Air Force is due in December, 1964, and the fifth plane by September, 1965. The XC-142A will be distinguished by several "firsts"—first tri-



At Ryan's Lindbergh Field facility in San Diego, workmen put finishing touches on tail section for the XC-142A tri-service V/STOL transport (preceding page). Above: Artist's concept depicts role of tilt-wing aircraft, which will carry 32 combat ready troops.



Huge wing, taking shape at Ryan facility, when installed in the XC-142A will tilt through an angle of 100 degrees to give the aircraft a vertical take-off capability.

service aircraft, first V/STOL scheduled for operational use, and first to be designed and built by three associate contractors.

Designed to take off and land vertically in all types of terrain, yet achieve speeds of up to 350 miles an hour, the XC-142A employs a unique tilt-wing which enables it to perform like a helicopter, then transition to conventional horizontal flight. Its functions would include swift transport of troops, supplies and equipment from ships or airfields into unprepared areas under all weather conditions.

Carrying 32 combat-ready troops or 8,000 pounds of cargo, it will have an operational radius of 200 to 300 miles at speeds of from 50 to 350 miles an hour. With auxiliary fuel tanks it will have a ferry range of 2600 miles with a 4000 pound payload.

The plane's four General Electric T-64 engines drive four Hamilton Standard propellers and a tail rotor through an interconnecting shaft and gearing train.

The wing has an aspect ratio of 8.6 and can tilt through an angle of 100 degrees. It has full span, double-slotted slats; the aft outboard sections operate independently as ailerons. Leading edge slats for stall supression are incorporated on the outboard side of each engine nacelle to correct for the upflow of the propeller slipstream at these places during transition. The 100-degree angle of the wing gives the plane the ability to hover in a tail wind.

The vertical tail consists of a conventional fin and rudder arrangement centrally located on the fuselage and supporting the all-movable horizontal tail assembly. A horizontal eight-foot tail rotor with variable pitch blades gives the pilot longitudinal control during hover.

Since the aircraft normally cruises with two engines providing power to all four propellers, there is a wide margin of safety in the event of engine failure. This type of operation is made possible by a system of cross shafting connecting all four engines and the tail rotor. Lightweight gear boxes are provided integrally with the light weight fibreglas propellers. Over running clutches are installed between each engine and propellers to permit shutdown in flight.

Retractable, self-cleaning inlet screens protect the engines from foreign objects. A separate oil-fuel heater is provided to heat the fuel in extreme conditions and an ejector is included for oil cooling during low power ground operations.

The plane will have a wingspan of 67½ feet, an overall length of 58 feet and a height of 26 feet. The troop and cargo compartment is 30 feet long, 7½ feet wide and 7 feet high. The fuselage is a semi-monocoque structure with six longerons and stringers along the underside.

Engines will be mounted externally on the wing to eliminate wing structural discontinuity and major air ducts. The wing center section main structural box is continuous over the fuselage. Wing tilt is accomplished by dual synchronized wing-tilt actuators to provide "fail safe" reliability and adequate stiffness of wing support to accommodate wing elasticity.

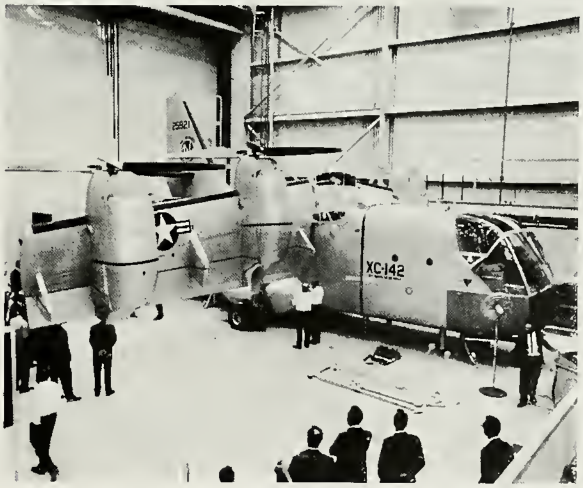
All primary flight controls are powered by dual hydraulic systems. The unique feature of the control system is a mechanical integrator linkage that transmits cockpit control motions to the proper control surface as a function of wing incidence. A dual four-function stabilization system controls roll, yaw, pitch and altitude during IFR flight. In hovering and transition the stabilization system provides pitch attitude and rate stabilization, roll attitude and rate stabilization, yaw damping and altitude damping.

To facilitate cargo loading, a clamshell door lowers to form a ramp. Troops and plane crew can be loaded by this ramp or through a side access door.

The three veteran aerospace industry firms developing the XC-142A have a wide range of experience in the V/STOL field. Ryan developed the world's first pure jet VTOL, the X-13 Vertijet, the deflected slipstream VZ-3RY Vertiplane, and is currently designing and constructing the experimental XV-5A lift-fan V/STOL aircraft for the Army under contract to General Electric, developers of the lift-fan propulsion system.

Ling-Temco-Vought's interest in V/STOL aircraft dates back to the design and flight testing of the V-173 "Flying Pancake" prototype and construction of the XF5U-1. Hiller developed the X-18 tilt-wing aircraft, and has produced lightweight helicopters for many years. ■

Aft fuselage, containing rear loading ramp, is mated to vertical tail assembly. The XC-142A will carry 8000 pounds of cargo.



The tri-service, tilt-wing transport will have a combat radius of 100-300 miles, and a hover time of 10 minutes.

Revolutionary Ryan tape processing console will duplicate tapes for ASW training.

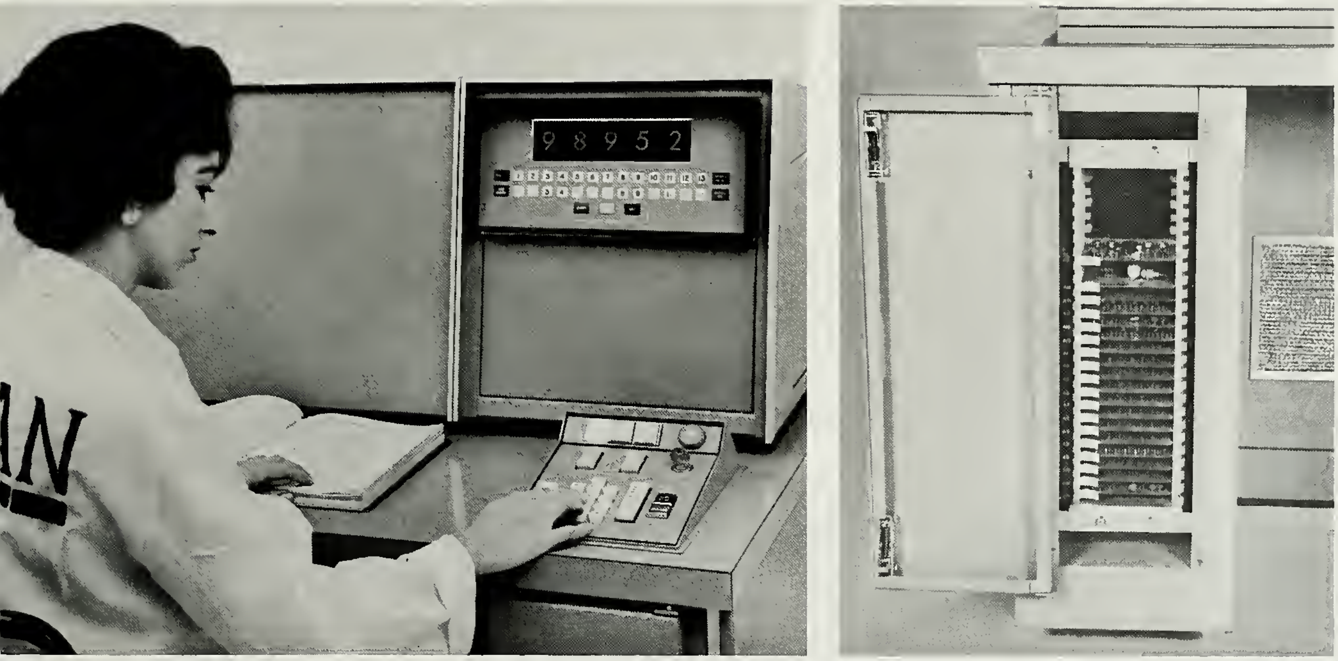
13 IS NOW A LUCKY

RYAN ELECTRONICS' newly developed data punching console, only one of its kind in the country, will play an important role in an anti-submarine warfare training program.

Program tapes processed on the console are being supplied the Huyck Systems Company, Long Island, New York, to program tests for an ASW automated checkout console.

Drastically reducing time required by former conventional manual methods of tape preparation, the Ryan Electronics tape processing console was originally developed to prepare program tapes for the Ryan Q-2C Firebee jet target basic systems checkout console. Interest was manifested by concerns throughout the country in application of the tape processing console to their requirements.

Major components of the console are a tape punch, a tape reader, and two associated, motor-



Major components of the console are a tape punch, a tape reader, and two associated motor driven, synchronized tape transports. Numerical lampbanks display keyboard entry.

NUMBER

driven, synchronized tape transports. The console features a 13-keyboard input for punching and verification. Numerical lampbanks display the keyboard entry, enabling the operator to double check entries before the tape is actually cut. Original tapes can be cut by selective keying from a time-code chart.

Verification is automatic as logic circuitry in the unit compares the punched holes to re-entered "master" data. The tape automatically advances unless an error occurs between the re-entered data and the tape being verified.

Duplicate tapes are made by positioning the master tape in the "read" station and the blank tape in the "punch" station. The two tapes are then automatically stepped in unison. Code signals from master tape initiate the punching of corresponding holes in the blank tape. ■


MARINES

FLEX BEE AT QUANTICO

RYAN'S UNIQUE "FLEX BEE" experimental reconnaissance drones were tested recently at Quantico, Virginia, as the final phase of exploratory development of these unique Flexible Wing vehicles. Testing was performed for the U. S. Marine Corps at their Landing Force Development Center, and reports from the Ryan crew at Quantico indicated a high degree of success was achieved.

The Marines at Quantico looked at Ryan's Flex Bee recently and the Flex Bee, designed to take high resolution photographs for reconnaissance purposes, looked back.

In aerial photograph, typical of those capable of being taken by Ryan Flex Bee, troops moving along roadway together with a jeep, a tank and a truck, are clearly visible.

. . . Flex Bee proves picture worth 1,000 word theory

Purpose of the flights was to test the ability of the "Flex Bee" to rapidly obtain for field commanders information on enemy dispositions under battle conditions a few miles beyond their front lines. An evaluation by Marine Corps Officers is now under way to determine whether the concept will be developed for operational use. A Ryan field crew headed by Harry Rollins, project engineer, launched the "Flex Bees" and remotely controlled the drones' flights and cameras.

Capable of being launched from forward areas, the "Flex Bee" drones are designed to bring back intelligence photographs of such targets as tanks, motor vehicles, gun carriers, troops, etc., that cannot be seen from the launching site.

The Ryanites at Quantico included, besides Harry Rollins, Art Akers, project coordinator; Herbert D. Krediet, flight test engineer; Oliver C.

Marine officials hear briefing on unique Flex Bee and portable field launcher during Ryan demonstrations at Quantico.

Peterson, Marvin Shook, Vernon Paderewski and Ray Palmer, all mechanics; and Gordon Siegel, marketing representative. The group was joined for varying periods by M. M. McDaniel, senior project engineer, Flex Wing programs.

Robert C. Jackson, Ryan President, observed reconnaissance flights performed for high-ranking Marine Corps Officers and representatives of the U. S. Army and Navy, the Royal Canadian Army, and civilian Signal Corps officials from Ft. Monmouth, New Jersey, and from Washington, D.C.

Among Marine Corps flag officers at the demonstrations were Major General Bruno Hochmuth, Deputy Chief of Staff for Research and Development, Marine Corps Headquarters, Washington, D.C., and Brigadier General Lewis W. Walt, Commandant of the Combat Development Center, Quantico. Project Officer for the Marine Corps is Major P. X. Kelley.

The evaluation flights at Quantico followed an intensive testing program at the Army-operated Yuma, Arizona, Test Station. The lightweight, highly mobile "Flex Bees" can be operated and maintained by only two men in the field. They are designed for ground launchings from a portable rail launcher using a cartridge type propellant, actuated by a string lanyard.

The "Flex Bee" can fly up to several thousand feet altitude at speeds of up to 75 miles an hour. Its small size and extremely low altitude capability would present difficulties to the enemy in identification. Ryan has been working on the "Flex Bee" concept since 1961, when the tests on the earliest such vehicles were conducted at the Marine Corps' Twentynine Palms, California, facility.

Cricket in a Cocoon

Versatile helicopter stirs military imaginations . . .

A ONE-MAN jet turbine driven helicopter, without a tail rotor, that tucks its rotors and tiny fuselage into a cocoon-like box 12 feet long, 2 feet wide and 3 feet high, recently completed a demanding nationwide demonstration tour, where its versatility stirred the interest and imagination of the country's military officials.

The helicopter, the Do 32, was designed and built by Dornier-Werke of Friedrichshafen, West Germany, and was demonstrated in the United States by Ryan Aeronautical Company under an exclusive agreement with Dornier. The tour began with dramatic performances on the lawn at the Pentagon. Ryan has nicknamed the helicopter "Cricket".

Department of Defense, Army, Navy and Air Force officials watched as Dornier pilot Fred Wissel danced the Do 32 through a high performance demonstration, after two crewmen took a quick four-and-one-half minutes to convert the box-like trailer to a helipad, and the folded helicopter to a flying machine.

Observers gazed open-mouthed as the helicopter leaped off the trailer heliport in a "2½ G jump take-off" then darted about in low altitude maneuvers.

Admirals and generals abandoned formality after Wissel climbed the Do 32 to 1500 feet, then shut down the jet turbine to make a perfect autorotation approach and landing immediately in front of the Pentagon crowd. The gathering of more than 500 burst into spontaneous applause in tribute to the performance.

In attendance at this first demonstration were Congressman Bob Wilson of San Diego and members of the House Armed Services Committee. "It's fantastic", said Wilson. "It's easy to visualize this helicopter being used by the Army for artillery spotting."

Equally impressed with the vehicle was Major General George Power, Deputy Chief of the Army's Research and Development Laboratory, who was quoted in a Copley News Service dispatch as remarking, "Very Impressive!"

In succeeding District of Columbia area flights, both at the Pentagon and at the Washington-Virginia airport, a short distance from the hub of the nation's capital, the Do 32 flight demonstrations were greeted with equal enthusiasm. Each flight was followed by an audience inspection of the "Cricket" on its trailer-helipad.

Besides military officials, Department of Interior, Department of Commerce, U. S. Forestry Service, Civil Defense Agency and foreign embassy personnel observed flights of the Do 32.

Included in the demonstration schedule, as the team toured the eastern and southern states, were Aberdeen and Quantico; Ft. Belvoir, Virginia; Ft. Bragg, North Carolina; Ft. Eustis, Virginia; Pensacola Naval Air Station, MacDill Air Force Base and Eglin Air Force Base in Florida; and Ft. Benning, Georgia.

Among those commands and officials viewing the demonstrations were the Advanced Research Projects Agency of the Department of Defense, the Army's Test and Evaluation Command, the Transportation Research Command, the Combat Developments Command, the Special Warfare Forces, the Air Force and Army combined Strike Command, the Air Force's Tactical Air Command, and the Navy's Air Training Command.

Army Aviation Board representatives and the 11th Air Assault Division viewed the Do 32 both

The Do 32 dances for crowds over the lawn of the Pentagon.

Pentagon crowds move in for a closer look at Do 32. Demonstrations were followed by lengthy question and answer periods.

Demonstrating the simple handling characteristics of the "Cricket," Pilot Fred Wissel brings Do 32 to hover. Note lack of vibration in hand controls.

on static display and in flight demonstration during its visit to Ft. Benning, Georgia.

On the West Coast leg of the tour the Do 32 was seen by Admiral U. S. Grant Sharpe, Commander in Chief, Pacific Fleet, and Vice Admiral Paul D. Stroop, Commander Naval Air Forces, Pacific Fleet. Demonstrations were conducted at the North Island Naval Air Station in San Diego, the Marine Corps' Camp Pendleton, and El Toro Marine Corps Air Station, the Lemoore Naval Air Station, the Army's Ft. Ord, and the Naval Missile Center at Pt. Mugu, California.

A Simple Design

The Do 32 is a simple design, and its simplicity and ease of flight incorporate many safety features revolutionary in helicopter operation. The "Cricket" is powered by a jet turbine that drives an air compressor. The compressor supplies air through hollow rotor blades to reaction jets on the rotor tips, and the efficient transmission of power to rotor tips, rather than rotor hub eliminates the need for a tail rotor on the Do 32.

The rotor system is a completely "free-wheeling" unit with no clutches, gears or shafts, and gives the Do 32 ideal autorotation capabilities. Pilot Wissel emphasizes the craft has no "deadman's" curve, familiar to helicopter pilots as the time required to de-clutch and otherwise make adjustments to normal helicopter rotor systems to achieve autorotation characteristics in case of propulsion system malfunction. "At any loss of power," Wissel stressed, "the Do 32 is automatically in autorotation."

The "Cricket" empty weighs 325 pounds, and can perform a maximum performance jump take-off with slightly more than 700 pounds. Its fuselage is 11 feet long and Do 32 height is six feet. Its maximum speed is 65 knots and it will cruise about 54 knots in normal atmosphere.

The Do 32 has a maximum climbing speed—with a jump take-off to 80 feet—of 1570 feet per minute. Range is 56 miles and endurance without auxiliary tanks is 50 minutes.

The jet turbine power plant on the Do 32 is a BMW 6012L turbo compressor with a multi-fuel

Dornier crewmen remove the top from box trailer to begin demonstration. Trailer becomes helipad, and in 4½ minutes the Do 32 is airborne.

capability. During the demonstration tour the Do 32 burned kerosene.

Ryan and Dornier officials envision wide applications for the Do 32, considered a helicopter that will live in the austere environment of front line military operations. The low maintenance aspects of the helicopter are seen as a major advantage over existing helicopters and is second only to the extreme mobility of the Do 32. Its capability to be stored and transported in its own box-like trailer — which in operation becomes a helipad—is a major breakthrough in mobility of front line air units.

This same storage and quick reaction capability Ryan sees as an immediate advantage for shipboard operation, where weather and salt water corrosion create major maintenance problems on exposed aircraft and equipment.

The imaginative response of both military and civilian officials to the recent demonstrations of the "Cricket in a Cocoon" indicate the future of the Do 32—when exposed to the light of critical military strategists—may be promising. ■

The Do 32, circled, is difficult to spot when approaching at tree-top level. Observers were impressed with its quiet and fast reaction movements in confined areas.

General Kennard, Commanding General of the 11th Air Assault Division, seated in cockpit, discusses Do 32 characteristics and performance following Ft. Benning demonstration.

The high performance Ryan/Army 124-E Firebee streaks from desert ground launch site at White Sands.

OF ARMY MISSILES AND TARGET MISSILES

THE U. S. ARMY has Air Defense and Land Combat missiles and it has Target Guided Missiles—and the Army Missile Command, headquartered at Redstone Arsenal, Alabama—has the responsibility of providing the best of both to Army troops in the field.

One function of the Directorate of Research and Development, Army Missile Command at Redstone, is to provide the best targets for the Army's rapidly expanding arsenal of Air Defense weapons. Besides developing the targets, the Target Guided Missile Branch of the Directorate is charged with placing the targets on the test range at White Sands, New Mexico, in the same time frame as new air defense weapons arrive. Colonel Daniel F. Shepherd is Director, Directorate of Research and Development, reporting in line to Major General Francis J. McMorrow, Commanding General, of the U. S. Army Missile Command at Redstone.

The task is an all-encompassing one—and is the responsibility of Jere D. Ducote, Chief of the Target Guided Missile Branch, a determined French-Irishman, with a flair for getting the job done. His bosses are Col. John O'Keefe, Chief of the Directorate's Development Division, and Gregory S. Moshkoff, Col. O'Keefe's Deputy.

The task of providing targets for Army missiles divides into two categories—targets to train field troops in the use of operational missiles, and targets to evaluate new air defense weapons systems fresh off the drawing boards. A target capable of doing both is the ideal.

Ducote operates on the general philosophy that "anything that flies is a potential target." He logs Army target requirements into a speed envelope that extends from low-slow (200 knots) to high-altitude, hypersonic-velocity ballistic trajectory vehicles. In this range Army Target Guided Missiles fall into six Army types.

Somewhere between low-slow and hypersonic high altitude, Ducote and his engineering staff have sandwiched the Ryan 124-E firebee a remote controlled, high performance jet target capable of speeds up to Mach .97 and altitudes up to 60,000 feet. Recoverable by parachute following completion of its mission it was recently type-classified as the Army's Standard "A" Type II Target.

In developing the 124-E, Ducote worked with Ryan engineers to modify the Ryan Q-2C Firebee —used by the Navy and Air Force—to meet Army requirements. He foresaw the Army need for and directed development of a ground launch capability for the Firebee target—which had formerly been air launched only from Air Force and Navy "mother" aircraft. In striving for an economical Army target program he envisioned the use of inexpensive tow targets—pulled behind the 124-E. Both the Navy and Air Force have now adopted both the ground launch and are interested in the tow target capabilities developed by the U. S. Army.

The Army's extensive use of remote controlled Firebees dates back to 1959 when the first Army Firebees were ground launched from a set of 80-foot-long rails at the White Sands Missile Range.

In successive developments, the Army worked closely with the Ryan Contractor Services team at White Sands to fly three different models of Firebees—ultimately achieving Army objectives with the 124-E.

During flights of prototype 124-E's at White Sands, one flight shattered all previous records to establish what stands as an all-time endurance record for Firebees.

Jere Ducote and Colonel John O'Keefe discuss missile test schedules.

The 124-E flew 1 hour 52 minutes, of which 1 hour 47 minutes was powered flight and 5 minutes was glide prior to parachute recovery. A new altitude record in excess of 61,000 feet was achieved, and a new record of endurance at high altitude was set when the Firebee flew 84 minutes at 55,000 feet or above.

The spectacular feat demonstrated the capability of the Firebee to remain on range for extended periods to provide for repeated target firings by Army air defense missiles.

At the same time a parallel perfecting of ground launch techniques was achieved at White Sands as Firebees graduated from the rail launcher to a zero length launcher. The launch system, now used by all three services, Army, Navy and Air Force, employs an 11,000 pound thrust JATO (jet assisted take-off) engine to boost the Firebee off the launch pad, after which the Firebee's J-69-T29 turbo-jet engine powers the aircraft through its mission profile.

Recently, at the request of the Department of the Army, under Ducote's direction the Ryan team at White Sands developed the Firebee-Towbee concept, in which a relatively inexpensive tow target is reeled out from the Firebee wingtip. The capability will save money for the Army and adds utility to the already versatile Firebee.

To maintain constant contact with the rapidly developing target guided missile field, Ducote and his engineering staff continually monitor Air Force and Navy target programs.

Among other targets in the Army inventory available are the OQ-19, the Beech 1025 and 1025(TJ), the RP-76, and the Lockheed Q-5 Kingfisher. Redhead-Roadrunner is under active

On recently completed, ultra-modern assembly line, Ryan technicians continue volume Firebee production.

Jere D. Ducote, surrounded by Army Missiles and Target Missiles is Chief of the Target Guided Missile Branch at Redstone.

development. To keep abreast of target developments, Ducote is also watching the Australian Jindivik and French CT-41 targets during their development programs.

A graduate Mechanical Engineer from Auburn and AF veteran of both World War II and Korea, Ducote has directed the efforts of the Target Missile Branch at the Army Missile Command—and its predecessor—since April, 1956. His staff numbers five missile development control engineers, each with broad background and experience in target guided missiles, and two secretaries. Under

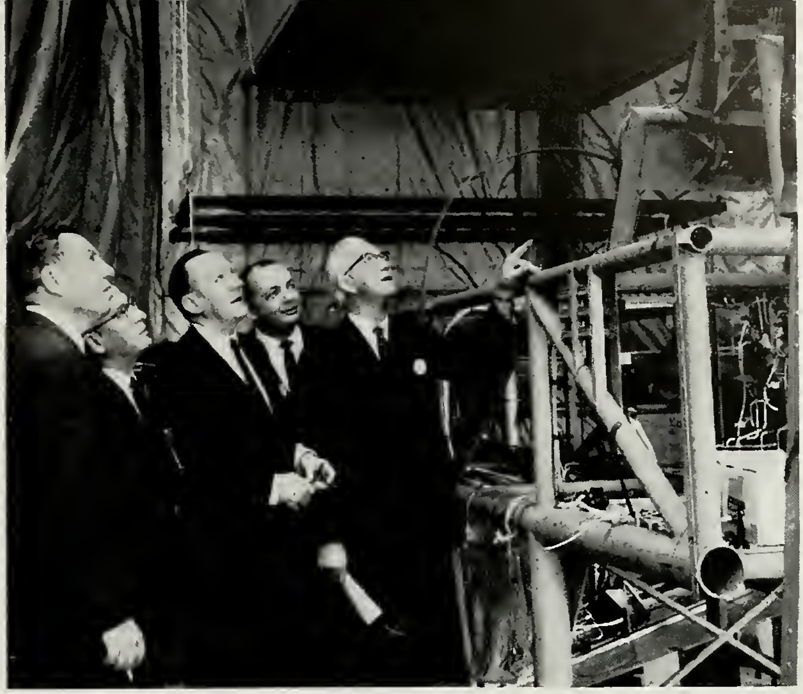
37 96

Ducote's direction Warren Sockwell manages the various programs of the Target Missile Branch. He is responsible primarily for the Firebee system. He is a graduate of Auburn, a Chemical Engineer and an Army veteran. Marshall Cherry, who holds a masters degree in Chemical Engineering from Vanderbilt manages the Redhead-Roadrunner program. Serge Tonetti, a retired Army Lt. Colonel and graduate Chemical Engineer, guides programs to apply target systems for multi-purpose uses. Carl Webster, with a masters degree in Chemical Engineering from Worcester Polytechnic Institute, is the staff electronics expert, and Raye Stanley, also a Chemical Engineer from the University of Tennessee, monitors all type classification details and handles all range activities on the family of Army target guided missiles.

Although the Target Missile Branch is a function of the Directorate of Research and Development at the Missile Command, another member of the target team at Redstone is the Target Missile/MTE (Multi-system Test Equipment) Commodity Office under the Deputy Commanding General, Air Defense Systems. Headed by Lt. Colonel Willis H. Clark, it is the managing agency for all Army Target Missiles and for the development and fielding of Multisystem Test Equipment, a complete field maintenance testing facility in support of Army missile systems.

Redstone Arsenal

The U. S. Army Missile Command is a major commodity command of the U. S. Army arsenals established in 1941 for the production of chemical shells. Today it is the home of the U. S. Army Missile Command, Nike Zeus Project Office, Army Missile Support Command, Ordnance Guided Missile School, Marshall Space Flight Center, and several private contractor firms conducting rocket and missile research. ■



Congressional Delegation recently toured Ryan San Diego plant and viewed such advanced facilities as Flight Simulator, containing most realistic simulation equipment of its kind in country. Escorted by Robert C. Jackson, Ryan President, at left, the visitors are shown the $500,000 Ryan Flight Simulation Laboratory. Visitors, left to right, are Con. James B. Utt (Rep.) of Santa Ana; Philip Kelleher, counsel to the House Armed Services Committee; Con. Bob Wilson (Rep.) of San Diego; and Con. L. Mendel Rivers (Dem.) of Charleston, S. C., a ranking member of the House Armed Services Committee who was honored in San Diego by the Navy League. 87 96

Under a $6 million contract, Ryan Aeronautical Company will build more than 175 Firebee jet targets for the U. S. Navy and Air Force, R. C. Jackson, Ryan president announced recently. The Navy will purchase about 80 percent of the order, with the remaining targets going to the Air Force. The contract will extend production of the high performance Firebee target into late 1965 at Ryan, and pushes the total number of Q-2C Firebee targets ordered from Ryan to over 1000. The $6 million pact is the sixth in a series dating back more than three years for the Q-2C, the latest member of Ryan's family of Firebee targets. Q-2C production was preceded by four years production of over 1100 Q-2A and KDA series Firebees.

Ryan Aeronautical Company, with its unique explosive forming process will continue production research on fuel compartment bulkhead segments for the Saturn V booster in the manned lunar landing program. The work is authorized under an amendment to an initial contract awarded Ryan last year by NASA's Marshall Space Flight Center. The aluminum apex and base units for the Saturn fuel compartment bulkheads will be explosively formed at Ryan's high energy forming facility, which has been producing numerous similar gore sections for more than a year. The Ryan-fabricated segments will be assembled at Huntsville into domed bulkheads 33 feet in diameter.

Out of Ryan's spectrum of capabilities: **FIRST IN V/STOL**

New V/STOL team-mates for battlefield mobility

The most experienced specialist in high speed V/STOL aircraft, Ryan is designing and building the Army XV-5A lift-fan aircraft under contract to General Electric. The lift-fan concept will provide greater payload/range than any other high speed vertical-take-off-and-landing configuration. Ryan is also working on the Vought-Hiller-Ryan XC-142A tri-service transport—the first U.S. V/STOL aircraft scheduled for operational evaluation. This tilt-wing aircraft is designed for a VTOL payload of 8,000 pounds or 32 troops. ☐ Since both V/STOL aircraft can be widely dispersed and concealed at advanced "soft bases," they add a new dimension in survivability. And teamed together, they step up battlefield mobility by giving the field commander quicker reaction, better target location, improved communication, and close-by tactical and logistic support. ☐ Ryan is also a leader in Doppler navigation systems, jet target drones, Flex Wing vehicles, lunar landing systems, space radar systems and space structures. ☐ Your inquiry is invited on how Ryan's spectrum of capabilities can help solve your Space Age problems.

RYAN AERONAUTICAL COMPANY, SAN DIEGO, CALIFORNIA

RYAN X-13 VERTIJET, world's first jet VTOL aircraft was developed under Air Force and Navy contracts dating back to 1946. This was the first aircraft to demonstrate feasibility of vertical jet take-off with transition to level flight.

RYAN
AERONAUTICAL COMPANY

RYAN REPORTER

SPRING / 1964

About the Cover: At first glance the U. S. Army XV-5A looks like an ordinary jet aircraft, but the distinctive features that allow it to take-off and hover like a helicopter are evident in Reporter's cover photo. Note wing fan "butterfly" doors and nose fan inlet louvers.

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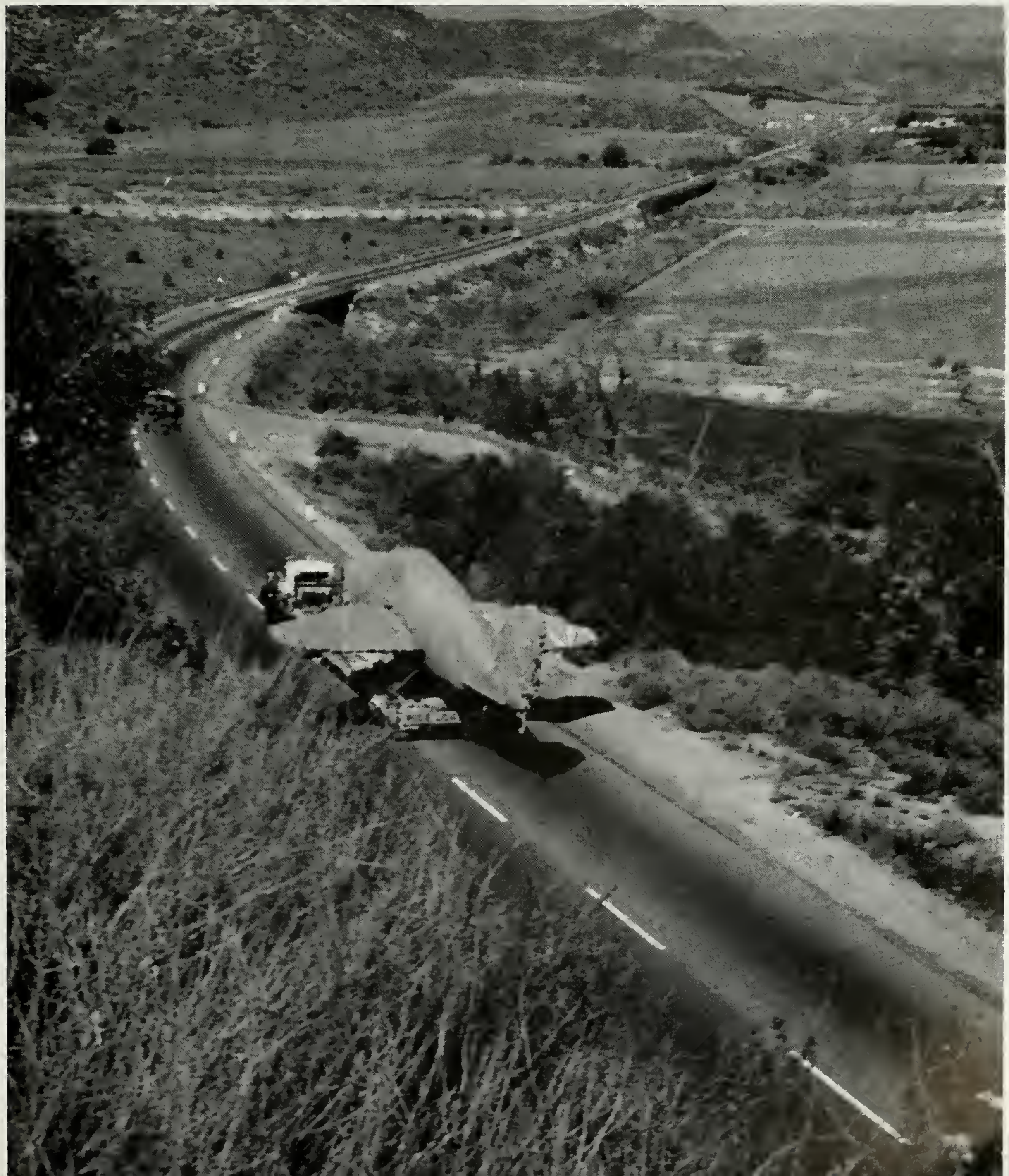
XV-5A TO FLIGHT TEST

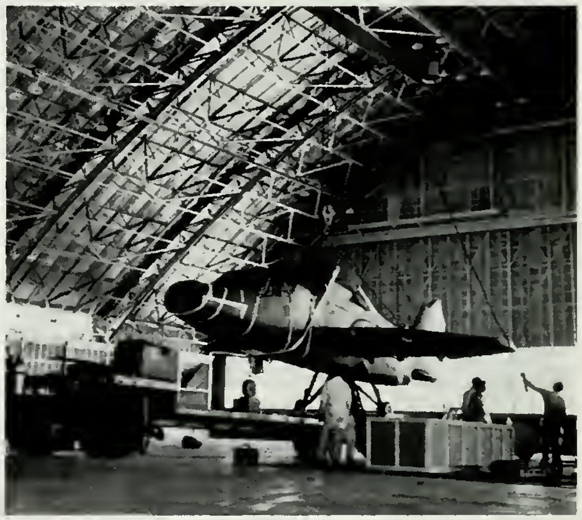
Delivery of the two U.S. Army XV-5A lift-fan jet V/STOL research aircraft by Ryan has triggered the start of flight test operations at Edwards Air Force Base, California, and set the stage for the final phase in more than a year-long wind tunnel test program.

The two aircraft, delivered recently to Edwards AFB and the Ames Research Center, Moffett Field, California, were designed and built by Ryan under contract to General Electric, developers of the lift fan propulsion system, for the U. S. Army Transportation Research Command, Ft. Eustis, Virginia.



One U.S. Army XV-5A leaves Ryan for shipboard ride to NASA Ames at Moffett Field, California.

The other was loaded on a flat bed truck for overland delivery to Edwards Air Force Base.



At Edwards, the aircraft is now undergoing flight test program to demonstrate lift-fan concept.

At Edwards, the first aircraft has begun ground tests before proceeding to initial hovering and conventional flight evaluation, in an Army program to demonstrate the flight characteristics of the unique lift-fan concept. The aircraft was transported by truck to the test site in the Mojave Desert.

The second aircraft was loaded aboard the aircraft carrier USS Ranger for shipment from Ryan's Lindbergh Field facility in San Diego, to the National Aeronautics and Space Administration's wind tunnel at the Ames Research Center, Moffett Field, California. It will undergo a series of aerodynamic tests in NASA's 40-by-80 foot wind tunnel before joining the actual flight test program at Edwards.

Both XV-5A aircraft had previously completed structural, ground resonance, systems functional and engine tests at Ryan's San Diego facilities.

The XV-5A, powered by General Electric's propulsion system, is an extension of work pioneered nearly 10 years ago by Ryan and General Electric on the principle of using fans submerged in aircraft wings for vertical lift. The significant feature of the propulsion system is a set of five-foot diameter lift-fans mounted horizontally within the wings, powered by the exhaust of the two G.E. J-85 jet engines to provide the lift for vertical take-off and hovering.

Capable of taking off vertically from an area no larger than a tennis court, aircraft based on the XV-5A concept can transition to a conventional flight pattern and accomplish military missions at high subsonic speeds, then return, hover, and land vertically in remote, rugged areas, such as small jungle clearings.

Designed to "live with the troops" in forward areas devoid of prepared landing strips, this type aircraft will combine relatively high speed with the versatility of a helicopter. It will demonstrate the essential elements of a high speed V/STOL aircraft.

The NASA-Ames wind tunnel tests with the completed aircraft will follow a year-long wind tunnel testing program in which a wealth of data was obtained in more than 640 hours of wind tunnel tests with scale models.

As part of the earlier program, NASA technicians at Ames carried out an independent study of the XV-5A design with a full scale model in the 40-by-80 foot wind tunnel at the Moffett Field facility.

Tests in the XV-5A wind tunnel program have been with both free flight and captive models, to acquire information that has resulted in optimizing the lift-fan aircraft design.

A one-fifth scale engine inlet model was tested in both low and high speed wind tunnels at the David Taylor Model Basin, Maryland.

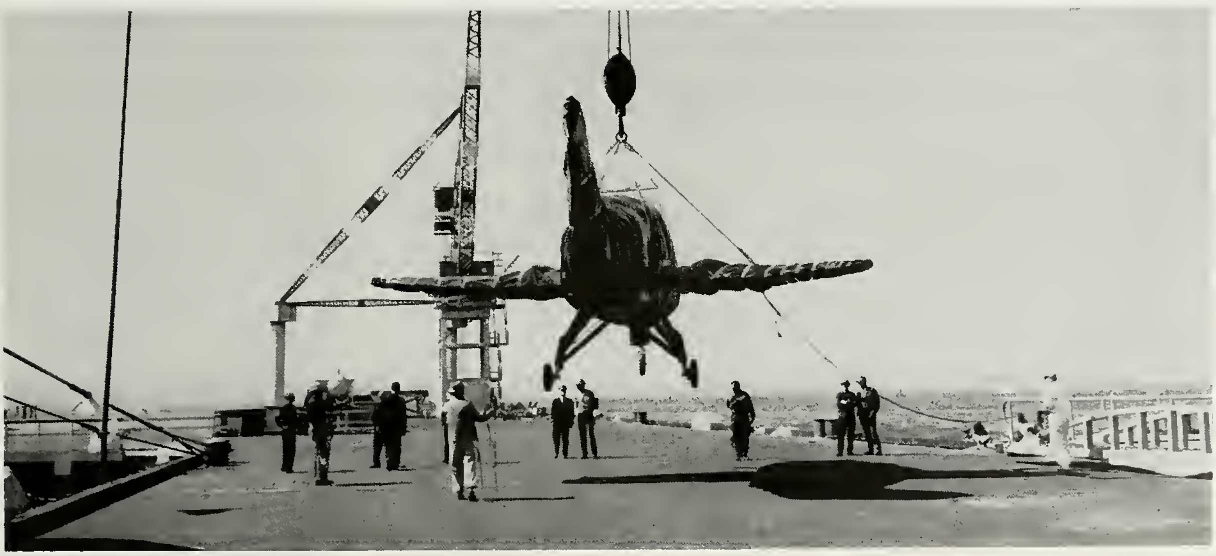
A one-eighth scale conventional horizontal

The future is assured for V/STOL aircraft, T. Claude Ryan (above) company Board Chairman and Chief Executive Officer, said at the recent roll-out of the first U. S. Army XV-5A.

"Only a few years ago the question was whether or not there would be a future for V/STOL aircraft," he told newsmen in attendance. "With ever-increasing world-wide interest, now that question has been answered in the affirmative. Today's question is which V/STOL system will prove to be the most efficient and the most practical."

"We believe the answer will be found in the lift-fan concept represented by this XV-5A aircraft.

The distinctive T-tail was removed from the Army XV-5A during shipment to distant test sites.



model was used for low speed tests at the Convair wind tunnel in San Diego, California and performed in high speed tests at the David Taylor Model Basin.

A one-sixth scale model with operable lift-fans was tested for low speed hovering and transition characteristics at the Convair wind tunnel in San Diego, and a one-twentieth scale flutter model, comprising the wing and simulated fuselage, was tested in the Ling-Temco-Vought wind tunnel in Dallas, Texas.

In the NASA tests with the completed aircraft, simulated step-by-step flight operations will be completed from take-off through transition at speeds from zero to 100 knots.

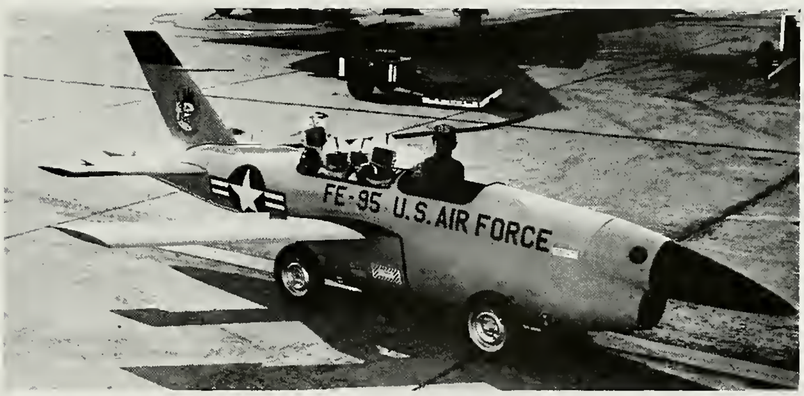
First tests of the lift-fan propulsion concept began in 1959 in G.E.'s outdoor testing facility, Evendale, Ohio. Tests have confirmed the propulsion system's efficiency and mechanical integrity in nearly 400 hours of fan running time at both G.E. and NASA facilities.

Although no date has been set for conclusion of the current series of wind tunnel tests at the Ames Research Center, the aircraft used in the tests is expected to be integrated into the flight test program at Edwards as soon as possible.

Among potential future applications of an aircraft based on the XV-5A concept is its use for observation, target acquisition and combat surveillance. The aircraft will "move-up" with the ground forces as they progress from one objective to the next, and in this environment will eliminate the need for construction and support of expensive, hard-to-maintain and protect runways and airfields.

The aircraft will respond fast. Flying at high speed and tree-top level it will present a hard-to-hit target. ■

Grand Champion Firebee . . . A Navy/Ryan Firebee operating on the Pacific Missile Range from the Naval Missile Center, Pt. Mugu may never rival Methuselah for longevity, but it has smashed all existing records for number of flights by one Firebee. The BQM-34A (formerly designated Q-2C) has just chalked up its 34th flight, has been tuned by Navy technicians at the Pt. Mugu Target Department, and is ready for its 35th flight. The Firebee's tour of duty with the Navy hasn't been a soft touch, for on numerous flights, angry missiles from ships and aircraft have chased it across the off-shore range. The flight record dramatically illustrates the recovery and re-use capability of the Firebee target system.



Once Around The Flight Line, Captain . . . This passenger carrying missile, bears a strange resemblance to the Ryan Firebee, but is called by Air Force observers at Dover Air Force Base, Delaware—the Dover Demon. According to Air Force news sources the craft is designed specifically to transport children, is earth-bound and has a 13-foot wing span and 26-foot fuselage. Built by technicians of the 95th Fighter Interceptor Squadron, the 26 horsepower aircraft is the first of its kind in the study of a kiddie airline. Scheduled for public unveiling on Armed Forces day, the aircraft was assembled primarily from a salvaged Ryan Firebee and a Crosley automobile during off-duty hours by the men of the 95th Fighter Interceptor Squadron. It can carry three to four children and will putt-putt at speeds nearing five miles per hour.

A LUNAR ODYSSEY

BEFORE the end of the decade, if National Aeronautics and Space Administration plans develop as expected, the United States will land two astronauts on the moon. The journey will span 239,000 miles and take about 70 hours. The astronauts will stay about 24 hours, exploring the lunar surface, collecting samples and scientific information, and placing instruments to record and transmit data long after they depart.

To realize this manned space Odyssey, called Apollo, the nation must pass technological thresholds barely envisioned six years ago when Congress passed the National Space Act and created the National Aeronautics and Space Administration.

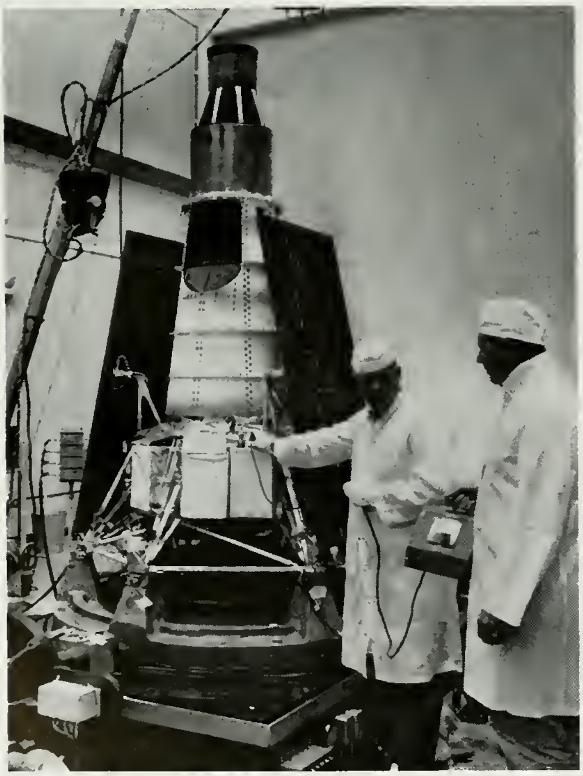
Dr. Robert Gilruth, Director of the NASA Manned Spacecraft Center in Houston, in a recent speech, called the Apollo effort, "the most ambitious and challenging effort in human history."

The Apollo path from earth to moon is virtually an unchartered one although scientists, assisted by batteries of computers and miles of space data gathered from prelude flights, will be

In support of the Saturn-Apollo effort, a Ryan Electronics developed altimeter has been flight tested on recent Saturn flights.

Ryan Electronics' landing radar and velocity sensing system has been selected for LEM

Ryan explosively formed and chem milled huge aluminum sections, which welded together formed 33-foot diameter fuel tank domes for the Saturn booster.



JPL technicians perform pre-flight tests on Ranger Reconnaissance Vehicle, carrying Ryan solar panel structures.

able to predict accurately the necessary requirements of the mission. Man's ability to survive in space and on the moon is just one aspect of the flight receiving extensive study, but an equally challenging and demanding problem surrounds the selection and physical characteristics of the astronauts lunar landing site.

Less than six years remain in which to achieve this prestige national objective, and to see Apollo successfully completed NASA has gathered an elite industry team numbering more than 5,000 firms.

Ryan Aeronautical Company has been asked to apply its advanced electronics capability and broad space structures experience to the Apollo mission and to prelude unmanned spacecraft flights to the moon.

Recently the Radio Corporation of America announced it had selected Ryan Electronics' design for the landing radar and velocity sensing system that will aid the astronaut-carrying Lunar Excursion Module in its approach and touchdown on the lunar surface.

Ryan's selection to design and fabricate the LEM landing radar package followed development contracts for a similar Doppler radar landing and velocity sensing system for the unmanned Surveyor soft lunar landing vehicle. Ryan Electronics has also developed a unique altimeter for the Saturn launch vehicle. The system will provide precise altitude information from 30 to 250 miles above the earth's surface, and has been flight tested on recent Saturn SA-4 and SA-5 evaluation flights.

Ryan has applied its space structures experience to the design and fabrication of solar panel structures for the Ranger Reconnaissance Vehicle, to the explosive forming of 33-foot diameter fuel tank domes for the Saturn launch vehicle, and to the welding and machining of titanium components for one of the two descent engine designs under study for the Lunar Excursion Module.

STEPPING STONES

Ranger "hard landing" and Surveyor "soft landing" spacecraft will precede the Apollo mission, Ranger to provide via television cameras a closer look at the lunar surface, and Surveyor to actually soft land on the moon to remotely conduct some experiments on the lunar surface. Plans are for Surveyor to check out some of the landing procedures that will be used with the LEM vehicle, hence the similarity in the landing radar and velocity sensing systems supplied by Ryan Electronics.

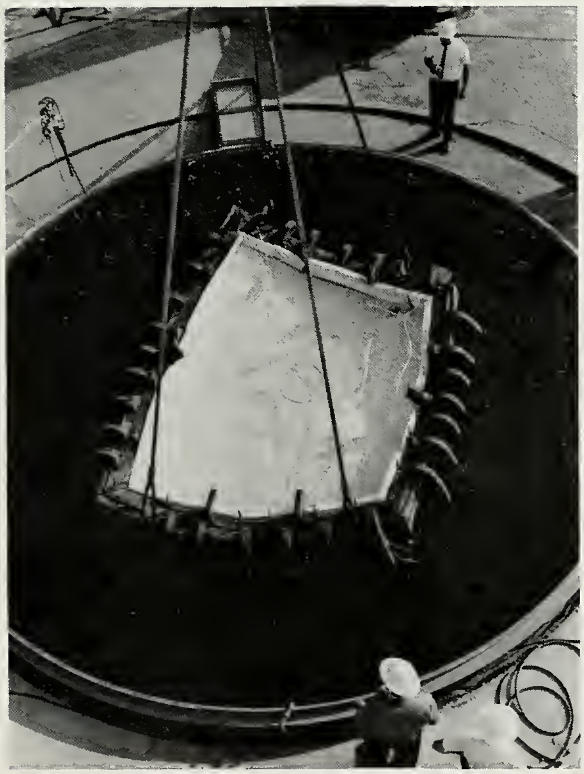
Ryan solar panel structures were aboard the recent Ranger lunar flight and are scheduled for the remaining spacecraft in the Ranger series. The rectangular structures, 30 inches wide and 60 inches long were built under a NASA contract for the California Institute of Technology's Jet Propulsion Laboratory. The Surveyor landing radar system was designed and built under a contract with Hughes Aircraft Company, and the Saturn altimeter was developed for the NASA Marshall Space Flight Center at Huntsville, Alabama.

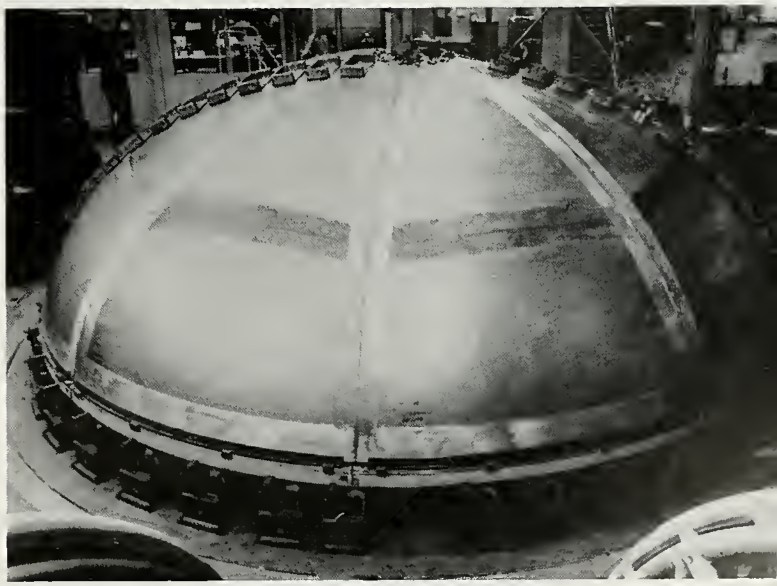
Ryan's fabrication work on the Lunar Excursion Module descent engine is being performed for TRW/Space Technology Laboratories. STL is one of two companies conducting parallel studies of the engine that will take the LEM capsule out of its lunar orbit and brake its descent to the surface of the moon.

LEM

In November 1962, NASA selected Grumman Aircraft Engineering Corporation of Bethpage, New York to build Project Apollo's Lunar Excursion Module (LEM). LEM is the vehicle

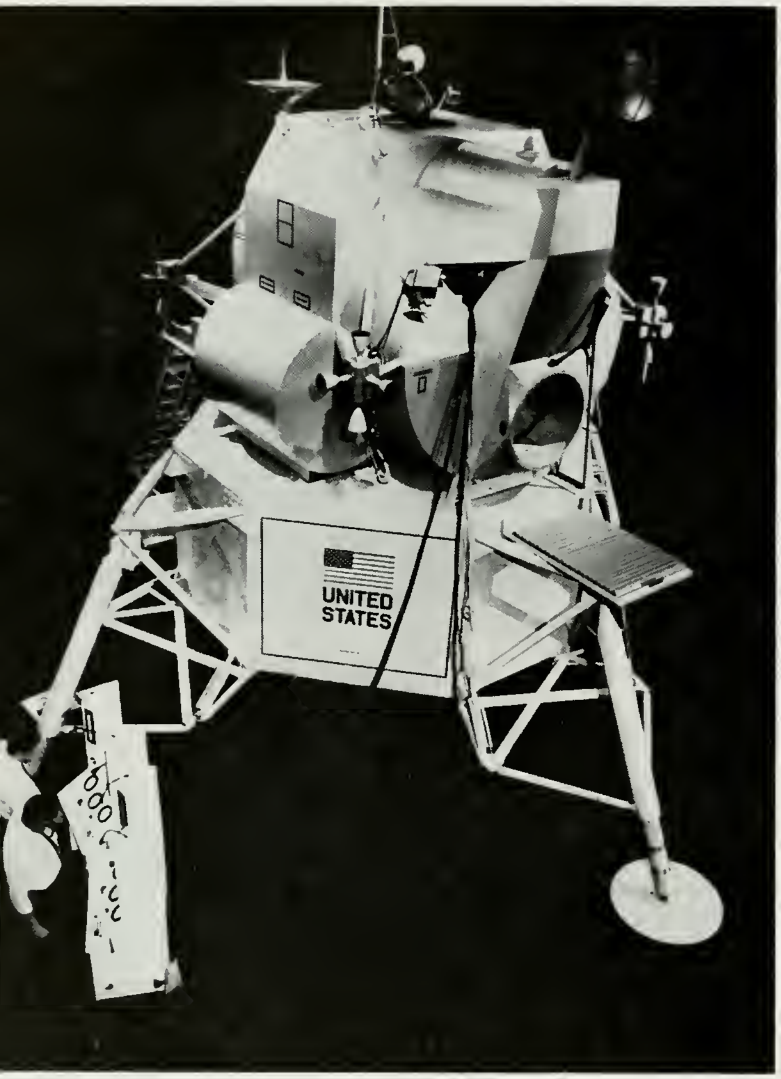
Astronauts standing in LEM capsule will manually land vehicle on the moon. Ryan designed and fabricated landing radar system will aid in descent from lunar orbit.





(Left.) Explosive forming die is lowered into massive water pit during Ryan program to explosively form sections for Saturn fuel cell domes. (Above) The sections are welded together in NASA rig to form 33-foot diameter dome. Chem milling was performed by Ryan to lighten structure.

LEM mission demands all systems be "man-rated". . .



The Lunar Excursion Module mock-up was recently unveiled at Grumman, prime contractor to NASA on the astronaut-carrying vehicle.

in which U.S. astronauts will land on the moon and return to a moon-orbiting mother craft for the return journey to earth.

The "Lunar Odyssey" will begin when a Saturn V booster lifts the multiple staged Apollo craft from the Atlantic Missile Range into earth orbit. LEM will be attached beneath the Apollo command service module. A three-man crew will ride in the command module at launch, the LEM cabin not being "man-rated" for earth launch operations.

Following in-flight and ground-directed checks in earth orbit, the Saturn's third stage engines will inject Apollo into lunar trajectory. During early stages of the translunar flight, and after passage through the Van Allen radiation belt, a transpositional docking maneuver will take place. Pyrotechnic devices will separate the command and service module from the LEM. Using a reaction control system, the command-service module portion of Apollo will rotate 180 degrees in a free-fly maneuver approaching the LEM docking interface to dock "nose first" to the top docking hatch of LEM. During the translunar flight, the service module engine will be used for mid-course corrections.

Apollo will then follow what is described as a "free-return" trajectory. With this maneuver, if the spacecraft approaches the retrofire point to enter lunar orbit but does not fire the service module engine, it can continue around the moon, and with the aid of the reaction control system, get back safely to a predetermined earth recovery area.

As the craft approaches the moon, the service module engine will be used to slow the spacecraft and place it in a circular orbit about 80 miles above the lunar surface. While in this lunar orbit, two astronauts will enter LEM and perform in-flight checks. LEM will then be separated from the command module and the descent engine will inject the LEM into an elliptical orbit with a perilune of 50,000 feet and an orbital period of 2 hours which is equal to that of the command-service module. These two orbits will intersect twice during every revolution about the moon. This orbit gives LEM an automatic abort ability. If the astronauts experience difficulties at the 50,000 feet point, they can rejoin the command module by letting LEM coast through to the intersection point.

If the landing attempt is continued, the astronauts at 50,000 feet will use the descent engine and with aid from the Ryan developed landing radar and velocity sensing system, descend to a hover condition at about 1,000 feet. From this point, the astronauts will be able to fly LEM laterally 1,000 feet in selecting the best landing spot.

The descent from 1,000 feet will be controlled manually with one astronaut "flying" the vehicle and the other acting as observer.

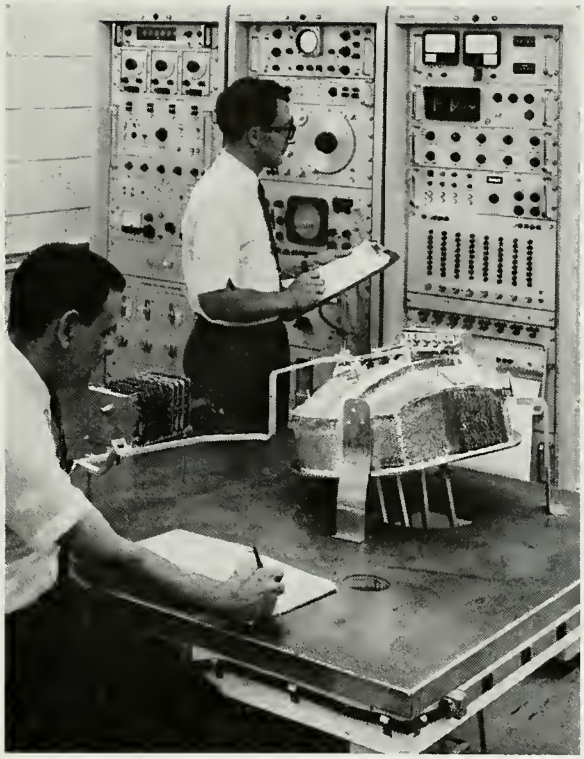
Immediately after landing, the astronauts will run a pre-launch checkout on all systems. After the checkout, they will then perform a variety of scientific and exploratory tasks. While exploring the lunar surface, the men will be able to communicate with the command module and earth stations using their backpack radios and a relay in LEM.

After spending 24 to 25 hours on the moon, the astronauts will prepare to launch the ascent stage and rendezvous with the command module. The launch profile calls for lift-off just as the command module appears over the horizon with it passing overhead as the ascent stage approaches its altitude.

LEM will be flown into line behind and below the command module and the distance and speed differential between the vehicles being reduced until LEM is about 200 feet from the command module and closing at about 10 feet per second. The remainder of the docking maneuver will be manually controlled by the LEM crew who will connect the LEM hatch to the command module hatch.

When the proper earth re-entry trajectory has been achieved, the service module will be jettisoned and the command module will be oriented for atmospheric re-entry. A triple parachute system will be used to lower the command module to an earth landing.

The Apollo Lunar Odyssey will demand technical excellence from the NASA/Industry team. Ryan has pledged itself to this challenging "man-rated" task. ■



Ryan Electronics' engineers complete extensive bench tests of Surveyor unmanned spacecraft landing radar and velocity sensing system. The Surveyor system was designed and built under contract to Hughes Aircraft Company. Cal Tech's Jet Propulsion Laboratory is developing the Surveyor system for NASA.

Ryan's extensive background in welding and machining titanium structures is being applied to similar work on the LEM descent engine for TRW/Space Technology Laboratories.

IN ARMY XV-5A

CRUISE POWER FOR

THE U.S. ARMY's investigation of jet V/STOL (vertical and short take-off and landing) aircraft with the versatility of a helicopter took major strides recently when two XV-5A aircraft began flight tests at Edwards Air Force Base, and final wind tunnel trials at NASA's Ames Research Center, Moffett Field.

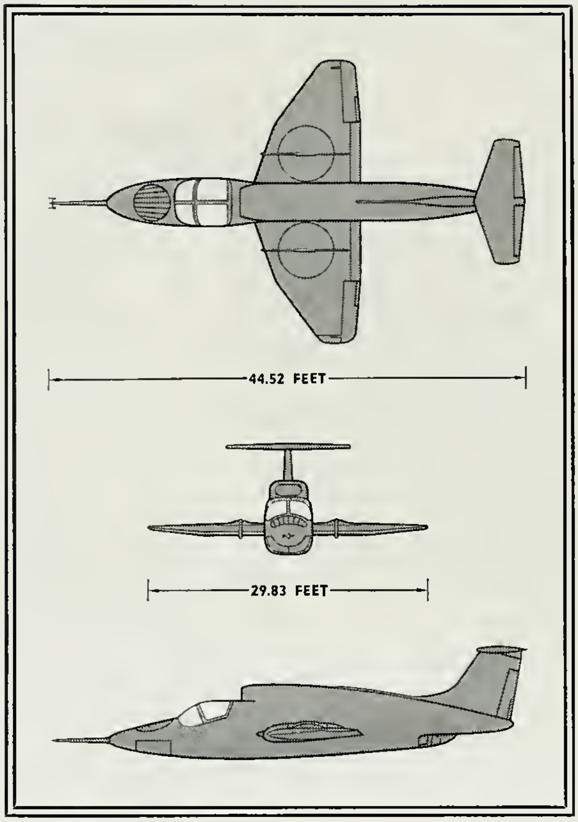
The unique aircraft will evaluate the fan-in-wing method of jet vertical take-off. They were designed and are being produced by Ryan under

JET VERTICAL LIFT

a contract to General Electric, developers of the lift-fan propulsion system, for the Army's Transportation Research Command, Ft. Eustis, Va.

The XV-5A is designed to take off straight up, dart away at high subsonic speeds, and return to land in an area no bigger than a tennis court. The aircraft's distinctive feature is a set of counter-rotating fans "submerged" in the wings which are driven by jet exhaust to provide lift for vertical take-off, helicopter-like hovering and vertical landings. For vertical flight, the rotating fans provide columns of relatively cool, low speed air for lift. A smaller fan in the nose of the airplane provides trim and pitch control.

The XV-5A incorporates rare operational advantages. In the aircraft, the total basic thrust of two General Electric J85 jet engines, 5316 pounds, is augmented nearly three hundred per cent by the fans for vertical take-off and landing. This major advantage makes possible important



savings in fuel consumption and logistics support, and provides greater range and payload capabilities.

Basic components of the XV-5A's propulsion system are the jet engines, mounted high on the fuselage, two five-foot diameter fans submerged in the wings, a smaller fan in the nose of the fuselage, diverter valves, tail-pipes, scrolls, fan inlet doors and fan exit louvers.

Technically, the lift-fan concept, as demonstrated in the XV-5A is unique in that it effectively blends the advantages of both the helicopter (the most efficient lifting system) and the conventional jet aircraft (the highest performance system).

A spectrum of aircraft lifting systems can be drawn which shows relative rotor diameters, efficiency in terms of lift per horsepower and disc loading. At one end of this spectrum curve, rotor craft are shown as the most efficient hovering vehicles but are limited in their forward speed.

At the other end of the spectrum, pure jet VTOL aircraft are shown to be the least efficient hovering vehicles but, conversely, are not limited in forward flight speed.

The lift-fan concept is situated on a break in this curve where its hovering efficiency is closely related to other mechanical rotor-type vehicles, yet it maintains the high forward velocity performance associated with conventional jet aircraft.

In all systems, lift is provided in excess of the gross weight of the vehicle to obtain VTOL. In the unloaded rotor and helicopter, the total installed power for vertical flight is utilized for cruise also. In all other cases, except the lift-fan, more power (or thrust) is installed in the aircraft for VTOL than can be efficiently utilized during cruise. Only the lift-fan system utilizing the normal power installed for cruise provides the additional hovering power by multiplying jet engine thrust with lift-fans.

The salient advantage of the lift-fan concept is that it permits the installation, in a V/STOL aircraft, of only that amount of jet engine thrust which is normally required for conventional flight. For vertical flight, the jet engine simply becomes a power producer which is pneumatically connected to a fan, which is sized to produce sufficient lift for vertical take-off and hovering.

Contrary to the belief that V/STOL capability automatically means high fuel consumption, the fuel required for take-off of a lift-fan aircraft such as the XV-5A, is in essence the same for vertical, short field or conventional take-off as well as any other equal size and performance jet aircraft.

A further advantage in having a jet engine sized for normal flight is that there is a completely normal engine/airframe match which relieves the aircraft designer of the problem of operating in normal flight with off-design power settings of the jet engine.

Major features of the XV-5A concept are the flexibility of the system and the long history of development and testing of its components. Both factors increase the reliability of the aircraft.

For example, power transmission is accomplished by pneumatic coupling. All gear boxes and shafting are eliminated, which reduces maintenance and parts problems. The entire control for hovering and transitional flight is obtained from the primary propulsion system, which eliminates the need for auxiliary ducting and variable nozzles.

Another reliability advantage is the low speed of the main fans which are simply multi-bladed propellers. These fans operate at only 2640 rpm maximum (2250 rpm normal), or about the same rpm as a light plane propeller. The low velocity and low temperature of the fans' efflux give the XV-5A good facility for flying from almost any small unprepared area.

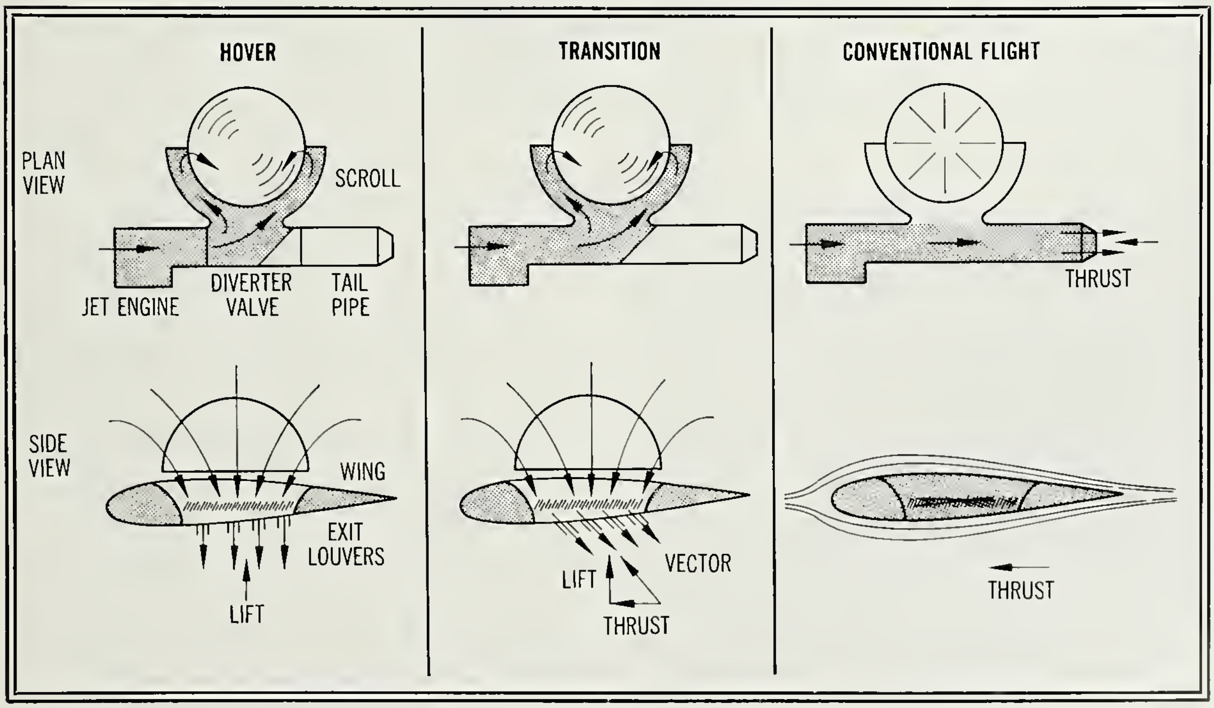
Performance of the XV-5A research aircraft is expected to exceed many of the Army's original program requirements. Under standard conditions at sea level, the VTOL take-off gross weight of 12,326 pounds includes 4,370 pounds of useful load.

The XV-5A is also designed for excellent STOL performance, using vectored thrust from the lift fans for take-off acceleration and landing deceleration. With fan exit louvers vectored aft, the fan system delivers 8,400 pounds of static thrust, compared with 5,316 pounds for the two J85 engines in the conventional turbojet mode. At the same time, 7,200 pounds of lift is produced, enabling the airplane to break ground very quickly.

The XV-5A will operate over a wide speed range, combining helicopter low speed capability with high speed at sea level. At landing weights (below 8,000 pounds) the XV-5A can land vertically at sea level on a single engine. In the conventional flight mode, the aircraft can take off and fly on a single engine at all gross weights up to the maximum of 12,326 pounds.

Cockpit controls and instruments will be familiar to both fixed wing and helicopter pilots. Attitude controls are mechanically connected through a mechanical mixer to the fans and to conventional control surfaces. Conventional stick

The nearly conventional Army XV-5A cockpit includes the normal control stick and rudder pedal arrangement together with a helicopter-type collective stick to the left side of the pilot's seat. The control stick and rudder pedals are used to regulate the aircraft's position in both the vertical and conventional modes of aircraft operation. The collective stick and twist-grip throttle are used only for vertical take-off and landing.



Power transmission from engines to wing and nose fans is accomplished by pneumatic coupling using a diverter valve-ducting arrangement. XV-5A is shown in vertical take-off mode with wing fan and nose fan doors open.

The nose fan (above) provides the XV-5A pitch and yaw control during hover. (Below) The high horizontal stabilizer can be programmed to adjust pitch trim during transition from fan-supported to wing-supported flight.

and rudder pedals control the airplane attitude in both vertical and conventional flight modes. All control forces are provided by the fans during hover, with the aerodynamic surfaces becoming effective at about 40 knots. Precise vertical control is provided by a lift stick at the pilot's left (similar to a helicopter collective stick). This provides vernier control of lift. This stick also incorporates a twist grip throttle. The pilot is not required to shift hand or foot positions during transition to or from V/STOL and conventional flight.

As V/STOL research aircraft, the XV-5A aircraft are designed to carry flight test instrumentation as their primary load.

GE-Ryan studies have predicted that, using the increased performance possible from a production version of the lift-fan propulsion system, an operational evaluation prototype of greatly increased capability can be quickly developed from the present XV-5A research aircraft.

This operational evaluation version can have provisions for a full range of surveillance avionics equipment, carried internally or externally.

Such operational evaluation aircraft can also incorporate provisions for all-weather close support missions. Armament provisions would provide flexibility under all flight regimes VTOL, STOL, or conventional take-off and landings.

Since 1955, both Ryan and General Electric have been continuously engaged in studies of V/STOL aircraft utilizing the Vertifan and fan-in-wing concept. The lift-fan was designed and developed by General Electric under contract to the Army's Transportation Research Command. Major contributions to the development of the complete lift-fan system have been made by the U. S. Air Force and NASA through their support of basic fan technology and testing.

Ryan is a leading designer and producer of high speed V/STOL aircraft with over three-and-one-half million man hours of engineering experience in this field. Ryan's Vertifan work began in 1955, culminating in the proposal which won the Army competition for a V/STOL research aircraft design in 1961.

Among early Ryan investigations, the company completed a U. S. Air Force contract to develop the parameters for well matched fan propulsion system and airframe configurations.

In addition to the XV-5A, significant Ryan V/STOL aircraft were the X-13 Vertijet (world's first jet VTOL aircraft), VZ-3RY Vertiplane (Deflected Slipstream STOL aircraft), and the YO-51 Dragonfly (Pioneer STOL aircraft). ■

"FLEEP" LIKE MAGIC CARPET

An easy-to-fly aircraft with a Flexible Wing is contributing to the advancement of STOL (short take-off and landing) vehicles in a significant flight research test program currently under way at the U.S. Army's Yuma, Arizona Test Facility.

This is the Ryan Flex Wing "Fleep," a Flexible Wing Aerial Utility Vehicle which has made a considerable number of flights over the desert area, and will make additional flights at various altitudes and speeds to investigate its operational handling qualities.

Described as a "workhorse" vehicle, the Ryan-designed U. S. Army XV-8A "Fleep" is completing flight testing at Army Yuma test facility.

Ryan pilot "Rick" Cotton in "Fleep" open cockpit discusses flight test details with Ryan ground crew.

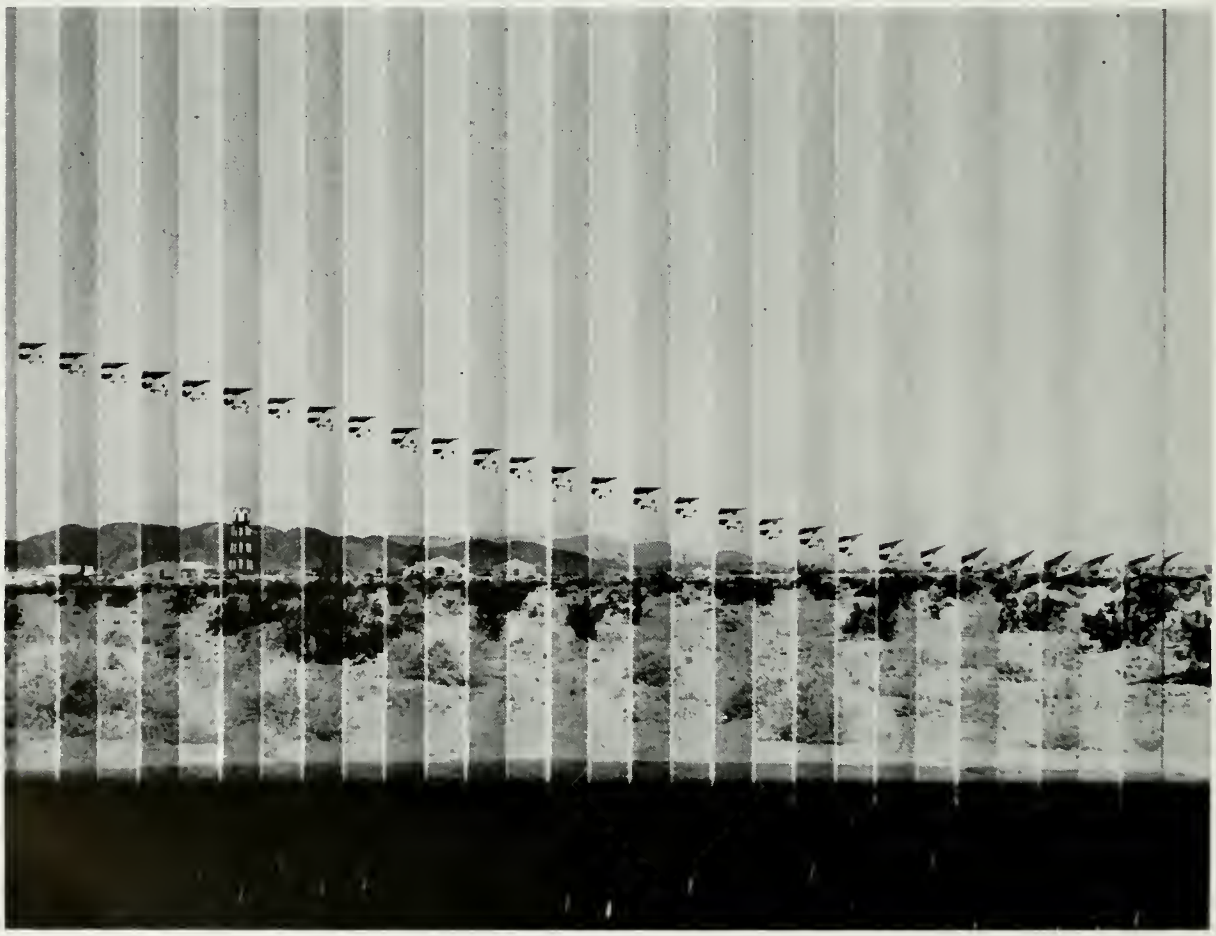
"All flight checks have proved satisfactory and have shown conclusively that the basic design of the original Ryan Flex Wing manned test bed in 1961 (the world's first aircraft of its kind) is still valid," H. C. "Rick" Cotton, Engineering Test Pilot in the "Fleep" program, said.

"Many design innovations resulted from tests with the initial vehicle, and today the control forces on the "Fleep" are so nominal that it is extremely easy to handle.

"The short take off and landing distances required indicate the "Fleep's" ideal characteristics for operations with military units in remote areas where limited airstrip facilities are available," Cotton said. "It is a workhorse vehicle with a good load carrying capability and the speed to accomplish logistic missions of this type.

"We need less than 500 feet for take off, and not more than 100 feet for the ground roll on landing into 6 to 8 knots of wind," Cotton

Army sequence cameras catch load-carrying "Fleep" in approach and short landing roll.



explained. "Sometimes on landings, I have the feeling I could practically step out the instant the wheels touch ground."

An experienced military pilot who has flown a variety of aircraft, Cotton said that the sensation of flying at high altitudes in the "Fleep" is unique.

"Sitting out in the open, in front of the 200 h.p. Continental pusher engine, and nothing in front of you but a motorcycle type plastic windshield mounted on the bullet-shaped nose, you get a totally detached feeling," he said. "You have the comforting illusion of floating, with no wind turbulence whatsoever in the cockpit."

Simplicity is the keynote of the "Fleep," whose flexible wing is made of a plastic-coated material attached to a keel and leading edge members to form an arrow- or V-shaped delta wing surface, offering an extremely lightweight, large aerodynamic lift surface.

The vehicle has no hydraulic or electrical system, and has a fixed pitch propeller, which is simpler and less costly than a controllable pitch propeller. Cotton pointed out that it is a two-control aircraft, in contrast with the conventional three controls, and that persons with limited flight experience should be able to learn to fly the "Fleep" readily.

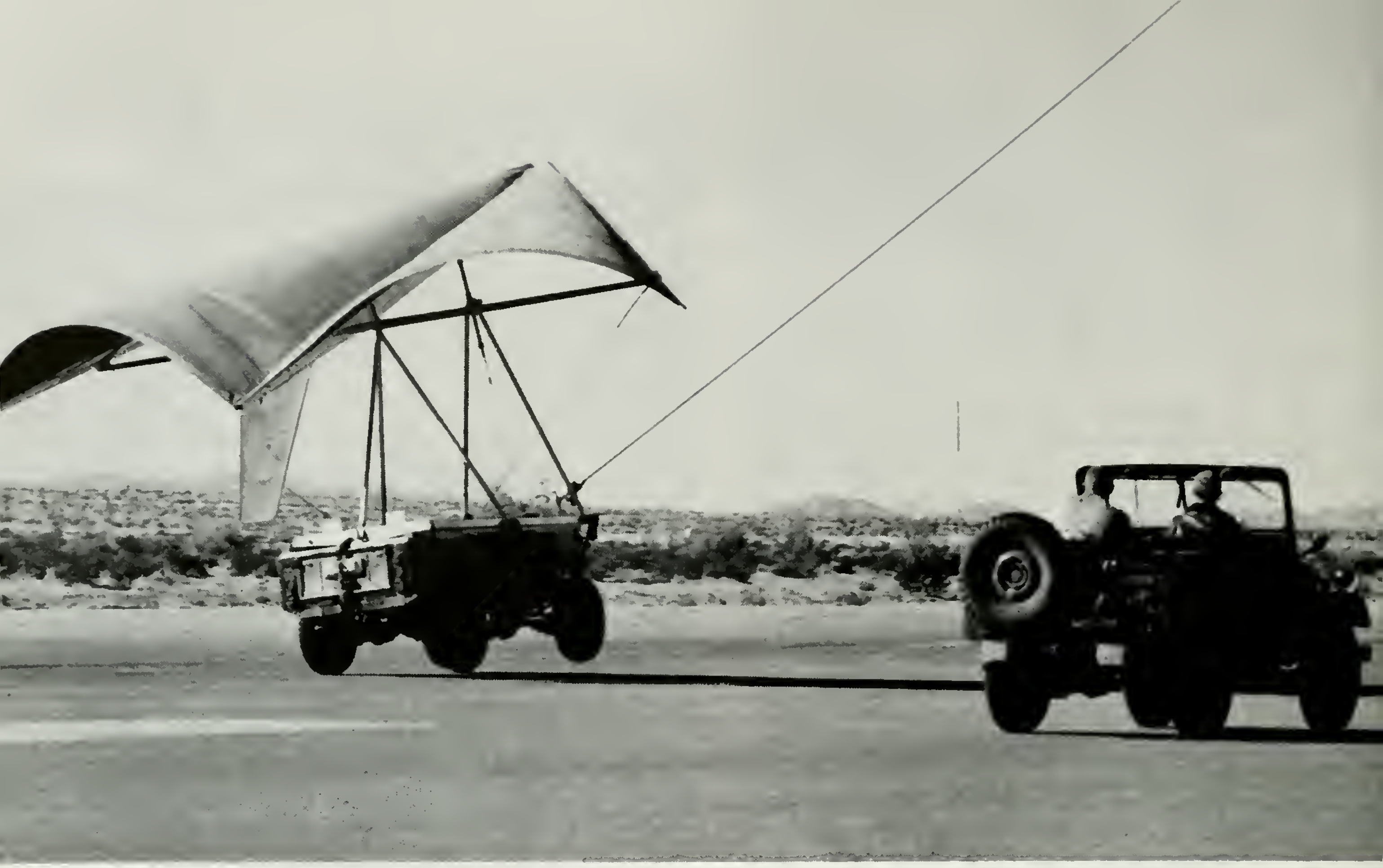
The "Fleep" has lateral and longitudinal controls, but does not need any rudder for directional stability, which is inherent in the flexible wing. A conventional control wheel is used for left or right turns, and the column on which the wheel is located is manipulated for climb and descent.

"It is virtually error-proof," Cotton remarked. "When approaching minimum speed, the pilot is warned by the high forces required on the column to hold it in proper attitude. As it nears maximum speed, the pilot recognizes oscillation as traveling waves, starting in the fabric midwing, move back rapidly and leave the wing."

On completion of the current flight test program, military pilots will be trained by Cotton to qualify for flying the "Fleep."

The Ryan ground support crew at the Yuma base consists of A. E. Hunt, Test Director; Rex Howard, Supervisor; and Joe Kendrick and Gary Stevenson, mechanics. ■

"You have the comfortable illusion of floating . . ."



An Army Jeep, towed under a Flex Wing by CH-34 helicopter, leaves runway during Army-Ryan tests.

"MULES" CAN FLY

Towed by helicopters, Army wheeled vehicles sprout Ryan Flex Wings.

A NEW CONCEPT in air mobility, whereby Jeeps and other small wheeled carriers can be carried aloft by a Ryan research Flexible Wing Air Cargo Delivery system and towed behind helicopters, has been dramatically demonstrated in tests successfully completed at the Army's Yuma, Arizona, Proving Ground.

Small vehicles, which have previously been airlifted in transport planes and helicopters, can be driven to a clearing, secured to a Flexible Wing system attached by cable to the helicopter, and towed a short distance until the Flexible Wing provides sufficient aerodynamic lift to tow the vehicle off the ground. The vehicle is then flown to its destination and delivered, either under tow or in radio-controlled free flight, to the desired landing area after release from the helicopter cable.

The Flexible Wing concept, being studied by the Army for a variety of mobility applications, can be utilized to increase several times the normal internal cargo capacity of helicopters.

In a particularly graphic demonstration of the Flexible Wing's conversion of an observation helicopter into an aerial "tow truck," a three-place Hiller OH-23G Raven multiplied its normal lifting capacity several times by towing a "Mule" Army utility vehicle.

Comprising a total weight of more than 1,300 pounds, the payload was airborne with no difficulty, and the "Mule," suspended beneath the Flexible Wing, was towed for approximately 20 minutes, then landed on tow in rough terrain. The "Mule" remained upright and undamaged as it rolled to a stop on its own wheels in less than 100 feet.

On landings after free flight, the roll has been as short as 20 feet. An automatic flare maneuver has been built into the Flexible Wing which causes an upward rotation just prior to landing, serving as a brake and producing a gentle touchdown. A pendant which swings about 30 feet below the glider is equipped with a small electrical switch at its end. When this touches the ground, it actuates a mechanism which triggers the flare maneuver.

In tests with a larger helicopter, the Sikorsky CH-34 Choctaw, flights were made at Yuma with a Flexible Wing glider carrying a stripped-down Army Jeep. With a slightly larger wing, a fully loaded Jeep could be towed easily.

The tests were performed under a contract with the Army Transportation Research Command to demonstrate that the Air Cargo Delivery System can carry odd-shaped cargoes, in addition to supplies stacked in rectangular containers, previously demonstrated at Yuma.

In those earlier tests, skid-equipped cardboard boxes as well as wheel-equipped aluminum containers, both loaded with ballast, were towed by helicopters. The skid-equipped, or STRACPAC (Strategic Army Command Package) containers were attached to wooden pallets and placed on 4-wheel dollies for take off. The dollies then rolled clear as the cargo became airborne. STRACPACs have also been towed during take off without the use of the dolly.

The tests with STRACPACs, Jeep and "Mule" showed that helicopters in the military service inventory have the capability of towing a payload several times the normal internal payload capacity of the vehicle.

"The helicopter can now be considered, in

Ryan conducted tests for Army Transportation Research Command to demonstrate Air Cargo Delivery System capability to carry variable loads and odd-shaped cargoes.

addition to a man-carrying aircraft, a logistics vehicle that can deliver, at normal cruise speeds, critically needed supplies, weapons and equipment into forward areas," Robert C. Jackson, Ryan President, explains.

The Flexible Wing, in contrast with conventional rigid, metal-covered surfaces, is of flexible, plastic-coated material attached to a keel and leading edge members to form an arrow- or V-shaped, kite-like surface.

With its remarkable lifting capability, it is being studied by the Army Transportation Research Command, Advanced Research Projects Agency, and others as an inexpensive, highly mobile, easy-to-maintain system that can perform missions which under more conventional means would be impractical or too costly.

In the Yuma tests, a steel tow cable was attached to the wheeled vehicle and a control saddle connected with the Flexible Wing. As the rising helicopter gained speed and forward direction, the "Mule" or Jeep became airborne, suspended directly beneath the Flexible Wing.

Testing was performed in gusty winds with velocity ranging as high as 40 miles per hour, and the Flexible Wing Air Cargo Glider demonstrated remarkable stability, both during flight and in the landing maneuver.

The "Mule" and the Jeep have been landed on tow—with the tow cable disengaged just off the ground, permitting the vehicle to roll to a stop—and have also been delivered by radio-controlled free flight after release from the helicopter in flight at altitudes of 4,000 feet.

The impressive performance of the Flexible Wing carrying a "Mule" in tow of a light helicopter was observed by representatives from the Army Transportation Research Command, National Aeronautics and Space Administration, and the French Army.

Ryan has been pioneering the concept of the Flexible Wing Air Cargo Delivery system for more than two years, and expects to broaden the applications further in the future.

Ryan built the world's first Flexible Wing manned, powered flying test bed, which was flown in 1961 to demonstrate functional and aerodynamic characteristics. This has been followed by engineering studies, fabrication and testing of a variety of Flexible Wing vehicles for several government agencies. ■

Skid-equipped STRACPACs were towed during the program both with and without wheeled dollies for ground roll.

Cargo-delivering Army Flex Wing is nearly obscured against Thailand rice paddy background.

Ryan Flex Wing

JUNGLE TACTICS IN THAILAND

DEMONSTRATIONS of Ryan Aeronautical Company's unique Flexible Wing Inflatable Precision Drop Glider (PDG) system to deliver high priority cargoes during tactical re-supply operations have been successfully concluded in Thailand.

The test program, conducted by crews of U.S. personnel and Thai trainees, was performed under contract to the U.S. Army Transportation Research Command, with headquarters at Ft. Eustis, Va., for the Defense Department's Advanced Research Projects Agency (ARPA).

Tactical re-supply problems which would be operationally encountered by the PDG were duplicated in the hot, humid, semi-jungle environment along the west coast of the Gulf of Siam. Base facilities were provided by the International Civil Aviation Organization, and support functions by the Police Aerial Reinforcement Unit, a branch of the Thai Border Patrol Police. The base of operations was located at Hua Hin, the site of the Thai Royal family's summer palace, about 95 miles southwest of Bangkok.

Ryan-designed Flex Wing Precision Drop Gliders were delivered from fixed wing aircraft and helicopters during the Army-Defense Department tests in Thailand jungle.

Royal Thai troops observe Flex Wing drop as soldier in foreground remotely controls the Precision Drop Glider to landing site.

The unique Ryan PDG Flex Wing system consists of a delta wing shape fabricated from lightweight flexible material which provides a large aerodynamic lifting surface, and a control platform housing the required electronic and control equipment to accomplish maneuvers required for precise cargo delivery under either manual or automatic homing modes of operation. Various types of high priority cargo including ammunition, fuel, medicine, electronic equipment, food, clothing, etc., can be attached to the control platform.

The Flex Wing PDG is capable of being air-launched from either fixed or rotary wing aircraft at altitudes up to 9,000 ft., with the system's 3-to-1 glide ratio offering launch points in excess of five miles from a predetermined landing point. Deployment of the wing system, which is initially stowed in the control platform, is accomplished by a static line/sleeve arrangement. After glider deployment, the PDG is capable of being automatically guided through all weather conditions to the desired landing site.

The Ryan PDG system has numerous immediate applications in the operational environment of Southeast Asia. Using this technique, cargo resupply may be provided to remote outposts in rugged terrain without subjecting launch aircraft to low altitude flight and ground fire previously experienced with parachute delivery.

In the Thailand tests, not only was feasibility of the Flex Wing PDG demonstrated, but crews of the Royal Thai Air Force, the Royal Thai

100 kilo bags of rice were delivered to jungle outposts by Flex Wing glider shown landing in clearing.

Navy and the Police Aerial Reinforcement Unit were trained in maintenance and control of the PDG system. Representatives of the SEATO nations as well as U.S. military groups participated in the program. Support aircraft were supplied by the Royal Thai Air Force as well as U.S. agencies.

Headed by Bob Gibson, Ryan Senior Field Representative, the Ryan crew in the 5-month Thai operations included Jerry Burkhead, Electronics Engineer; Vernon Paderewski, Experimental mechanic; Donald Cook, Electronics Technician; and Burt Kurz, Project Engineer.

On conclusion of the successful tests, Gibson remarked that, "It was felt by all concerned that if the system worked in that environment, it could work anywhere."

Lt. John E. Hempstead, U.S. Army TRECOM Engineer who accompanied the team to Thailand, remarked: "the Precision Drop Glider makes possible aerial delivery of cargo into areas and under conditions which until now were considered impossible."

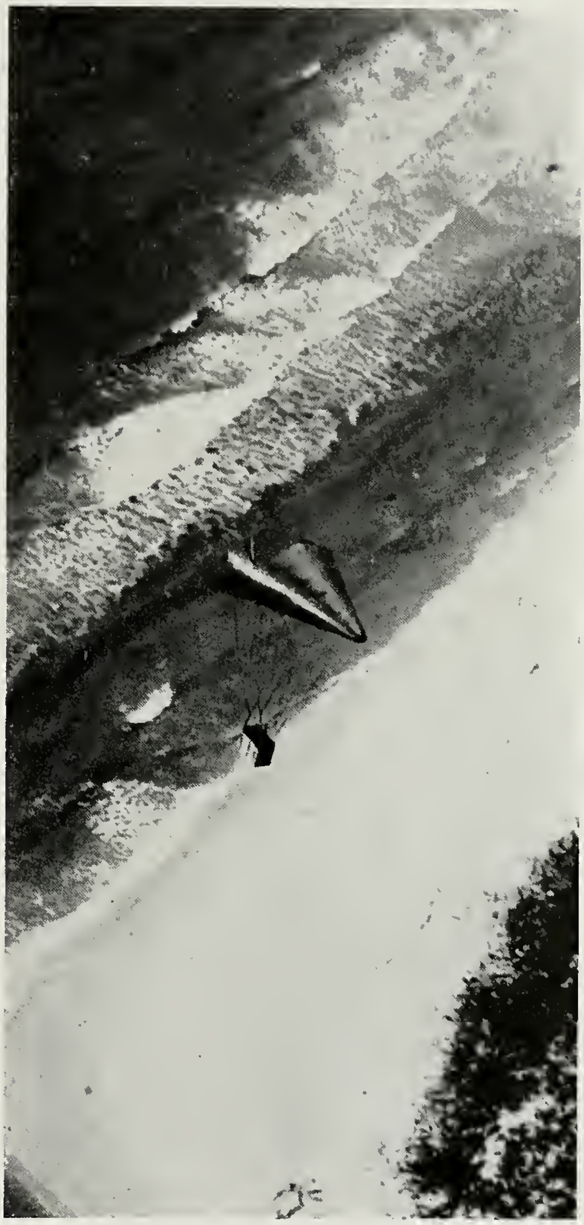
Lt. Hempstead reported that 100 kilo (220 pounds) bags of rice were delivered into the jungle to Thai personnel on two occasions. The usual "payload" during the Thailand tests consisted of bags of sand.

Ryan designed and fabricated the Flex Wing PDG system, including radio guidance and portable beacons, from commercial grade, off-the-shelf components, making it both economical and serviceable for operations in any part of the world.

The Thailand tests concluded the first research stage of the Precision Drop Glider test program. Information gained from these tests and also from more than 150 test drops at Yuma, Arizona, is expected to lead to the design and development of a prototype 500 pound payload wing. Actual use of the Precision Drop Glider system for resupplying troops in a tactical situation is still some time away.

The Flexible Wing concept offers a stable lightweight lifting surface which couples the maneuverability of an aircraft with the weight and cost advantages of a parachute system.

In addition to the PDG, Ryan's Flex Wing is being applied to numerous other concepts. For the U.S. Army Transportation Research Command and ARPA, Ryan has developed the XV-8A "Fleep," a manned aerial utility vehicle (a "flying truck"); and for the Army an Air Cargo Delivery System utilizing helicopter-towed gliders; and a Flexible Wing Individual Drop Glider system which would enable airborne troops to control their flight path after dropping from aircraft long distances from their target. For the U.S. Marine Corps, Ryan is applying the Flex Wing to development of the "Flex Bee" reconnaissance drone. The Flex Wing is also being applied as an atmosphere re-entry wing for the recovery of huge space vehicle boosters. ■



Flex Wing delivery system has 3-to-1 glide ratio providing launch capability in excess of five miles from landing point. Gliders can be launched over water bound for landing sites deep in the jungle.

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RYAN REPORTER

SUMMER / 1964

About the Cover: Motionless above runway at Edwards Air Force Base, Ryan-built XV-5A V/STOL recently demonstrated fan-in-wing vertical lift capability in its first hovering flights of Army test program.

At controls of the XV-5A during historic initial hover was L. W. "Lou" Everett, Ryan engineering test pilot. "We were pleasantly surprised at the ease of control during the first moments immediately after liftoff," remarked Everett.

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HOVER

On July 16, 1964, and on succeeding days at Edwards Air Force Base, the U.S. Army XV-5A completed its first hovering flights with Ryan test pilot Lou Everett and Republic test pilot Val Schaeffer at the controls.

Their unrestrained praise for the capability of the aircraft to take off vertically and hover, dramatized the ease with which the XV-5A completed these first crucial hovering flights.

Everett piloted the unique lift-fan V/STOL aircraft in the first three hovering flights, then Schaeffer took the controls for his initial vertical take off — the fourth for the XV-5A.

The XV-5A, based on Ryan's Vertifan concept, was designed and built by Ryan for the U.S. Army Transportation Research Command, under contract to General Electric, developers of the aircraft's propulsion system. Republic Aviation Corporation is assisting Ryan in the flight test program at Edwards Air Force Base.

Both Everett and Schaeffer had high praise for the handling characteristics of the XV-5A in hovering. Among other things, the dramatic first hover flights proved the capability of the automatic stabilization system. After the first flight Everett said he thought it would be a "hands-off" aircraft while in hover.

Schaeffer, in discussing his first hover flight , said "the stick harmony is beautiful. This is one of those airplanes where you just have to think what to do and its done. Some airplanes you have to drive, but in the XV-5A you feel like you're part of the airplane. It's like driving a sports car."

On the first vertcial take off and hovering flight, Everett gently coaxed the controls, holding the aircraft very near the ground until he was satisfied with its response. Later in the first flight and on subsequent flights he took the aircraft higher, and by the third flight was hovering and completing maneuvers at 30 and 40 feet above the ground.

In the following article, Everett discusses the handling characteristics of the XV-5A in more detail.

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by W. L. EVERETT *Engineering Test Pilot, Ryan Aeronautical Company*

The greatest initial unknown in the flight testing of any V/STOL aircraft is the effect of self-induced ground disturbances as the plane rises on its "elevator" of hot jet gases.

In the first hovering flights of the Ryan XV-5A lift-fan research Army plane, we immediately discovered the surprising ease with which we were able to control the aircraft during the first moments after liftoff.

Hundreds of hours in the Ryan flight simulator and in the NASA-Ames wind tunnel at Moffett Field, Calif., provided a wealth of pre-flight performance data, but by the very nature of the phenomenon, ground effects and their influence over V/STOL performance, cannot be truly simulated. Hence this was one of our major concerns, and the results of our first four low altitude hovering flights have greatly increased our confidence level.

In the first hover flight on July 16, at Edwards AFB, we became aware of random, inconsistent disturbances, most prominent about the roll axis. There was, however, a marked absence of any requirement on my part to correct any pitching or yawing oscillation. Based on our present knowledge, we can attribute this to an optimization of gains of the stability augmentation system in the pitch channel.

Ground effects tended to reduce considerably at about six feet of wheel height off the ground, and the XV-5A settled down considerably. It was obvious that the aircraft was responding to all control inputs. On such a flight, with no backup experience in the plane responses, we are simply trying to learn how to fly the vehicle. Becoming familiar with its behavior and its response to control inputs is a large part of the knowledge gained on the first hover.

I was elated that our roll control power is considerably greater than I had anticipated, thus eliminating any probable lack of control subsequent to heavy disturbances about the roll axis, the most critical of the three axes.

In our stability augmentation system, rate damping is effected about the pitch, roll and yaw axes, and we have the ability to change the gains of these functions in the cockpit, providing a flexibility that enables us to optimize stability for hovering while in flight.

After approximately one minute of hovering, I accomplished a relatively smooth low velocity descent to touchdown, requiring no extraordinary control input to accomplish.

In our second hover July 17, we confirmed that ground effects appear predominantly in the area up to 4 or 5 feet of wheel clearance, and that above this altitude, the random disturbances almost completely disappear.

I learned quickly that the XV-5A has adequate vertical control, with use of the lift stick, to arrest the descent rate even when operating at such extremely low altitudes.

During the second hover, I did a slight amount of maneuvering, yawing about 180 degrees and also executing low speed lateral translations by small lateral displacements of the stick. The XV-5A responded nicely to control inputs in these maneuvers—the lift stick demonstrating sufficient authority to give adequate altitude control. This was evidenced when I made a conscious effort to maintain constant engine rpm while hovering and using only the lift stick for altitude control. Sensitivity and effectiveness of the lift stick were excellent.

We can now, with full confidence, delve deeper into hover investigations to explore the aircraft response to higher maneuvering velocities in all directions. We will go higher in altitude to obtain a better evaluation of lift stick authority and sensitivity, and to ascertain whether there are any higher layers of ground effects. Several more low altitude hovering flights — below 20 feet — are scheduled as we expand our maneuvering capability, and optimize the gains of our stability augmentation system.

We will then be able to initiate a transition buildup to forward flight from hover, then back to hover and descent followed by a complete transitional cycle — the major objective of the flight test program.

To date, everything has functioned as planned and expected, or better than anticipated.

The thrill I experienced when I made my first conventional flight in the XV-5A in May, a 23-minute hop, is compounded with every hover flight as we investigate the capability of one of the world's most unusual V/STOL aircraft. ■

XC-142A V/STOL ROLLOUT

The world's largest V/STOL (vertical and short take-off and landing) airplane — a product of the three-company aerospace industry team of Vought, Hiller and Ryan—made its official debut June 17 in a roll-out ceremony at the Ling-Temco-Vought plant at Dallas, Texas.

The tilt-winged giant—the first of five such aircraft to be completed by the Vought-Hiller-Ryan team—was rolled out of its hangar as more than 400 industry dignitaries, military and government officials, and press representatives looked on. As the gleaming craft was unveiled, the large, clam-like door in the rear opened and 32 Marines, bayoneted rifles in hand, scrambled out, deploying about the area in a demonstration.

The XC-142A tilt-wing tri-service transport, which can take off and land vertically like a helicopter, yet fly at higher speeds than World War II fighters, may herald an entirely new era in aerial transportation.

Not only is it capable of carrying 8,000 pounds of equipment or supplies, or 32 combat-ready troops on military missions of 230 to 470 miles, but it has a wide variety of potential uses in commercial transportation. These would include flights from one city center to another, roof-top-to-rooftop transportation, delivery of supplies to inaccessible disaster areas, rescue operations, and recreation and exploration in remote regions.

The XC-142A is a tilt-wing plane that also utilizes the deflected slipstream principle for lift. It is powered by four General Electric T-64 turbo-prop engines linked together so that even a single engine can turn all four propellers and the tail

Vought-Hiller-Ryan tilt-wing V/STOL transport, world's largest of its kind, was unveiled recently in Dallas. Below, wing in position for vertical take-off. Ryan built fuselage, tail surfaces, wing and other components.

Ready for combat, troops can be landed by XC-142A in forward areas with no prepared airstrips. Unique transport is capable of carrying 8,000 pounds of cargo or 32 fully equipped men 230 to 470 miles.

rotor—a capability which was dramatically demonstrated to those attending the recent roll-out ceremonies.

Vertical flight is achieved by tilting the XC-142A wing and engines skyward while the fuselage remains in a horizontal position. The airstream also is deflected by flaps during transition from hover to forward flight to prevent separation of the airstream and provide excellent wing stall characteristics.

When the XC-142A reaches the desired altitude, the wing and engines are tilted forward and the aircraft gains forward speed to operate like a conventional plane.

The wing can tilt through an angle of 100 degrees to maintain a level fuselage when hovering with a tail wind. It can be placed in a number of different tilt positions for short take-offs and landings at overload gross weights.

All of the G.E. engines, each with take-off rating of 2,850 shaft h.p., are connected to the propellers by a system of cross-shafting and gearing to permit any desired number of engines to turn all four propellers and the tail rotor. A system of overrunning clutches permits the pilot to shut down any engines he wishes during flight. Thus, the XC-142A can cruise on two engines for fuel economy and, under emergency situations, land vertically even with one engine out.

Ryan designed and built the aft fuselage, tail surfaces and engine nacelles for each of the five XC-142A aircraft and static test article in a contract awarded by the Department of Defense and monitored by the Air Force for all three services. In addition, Ryan tooled and built the huge 67-foot wing for each plane and constructed two additional wing torque boxes for static test and testing of transmission systems.

Ling-Temco-Vought is the lead contractor. Hiller Aircraft Corp., of Palo Alto, Calif., designed and built the aircraft's unique cross-shafting and transmission system which connects all powerplants and the tail rotor.

Work has been under way on the project since January, 1962. After test flights by LTV pilots, scheduled to begin late this summer, the planes will be delivered to the military services for extensive evaluation of this new V/STOL concept in meeting tactical military situations.

Using special fuel tanks inside the cargo space, the XC-142A would have a ferry range of nearly 3,800 miles, using a short take-off of 680 feet and a vertical landing at destination. For shorter operational distances, the plane can carry up to 8,000 pounds of cargo.

Span of the Ryan-built wing is 67½ feet. The aircraft is 58 feet long and 26 feet high, with troop and cargo compartment 30 feet long, 7½ feet wide and 7 feet high.

These dimensions permit the plane to carry a wide variety of payloads—including a 106 mm rifle, components of the Pershing missile system, an 1¼-ton truck, 32 troops, 24 litter patients, a 2½-ton trailer, a 105 mm howitzer and ¾-ton truck, or many other weapons and combinations. ■

Ryan officials T. H. Beck, left, and F. G. Jameson view XC-142A rollout with Lt. Col. G. T. Singley.

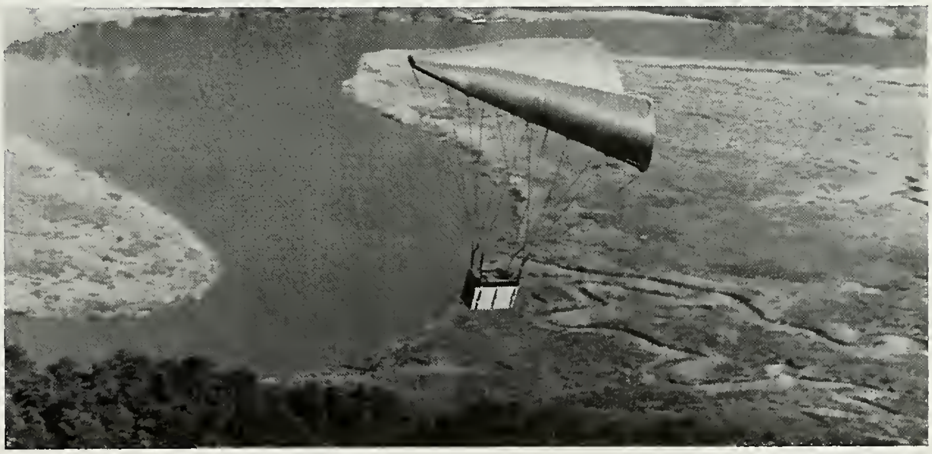
GLOSSARY OF FLEX WING VEHICLES .... by Ryan

ACG
Air Cargo Glider

The ACG system, which increases several times the normal internal cargo capacity of helicopters, is being studied by the Army for a variety of mobility applications. Jeeps and other small wheeled carriers have been carried aloft by ACG systems and towed behind helicopters. Skid- and wheel-equipped containers, both loaded with simulated cargo, have also been successfully towed by helicopters during flight test of this unique ACG system.

PDG
Precision Drop Glider

The PDG, designed to carry large quantities of priority cargo into areas of limited landing space, has been tested in the United States and abroad. Dropped from fixed wing aircraft or helicopters, the PDG can "home" on a portable ground beacon, or be remotely controlled to a pinpoint landing by the launch aircraft or an operator on the ground. This Army system has successfully demonstrated its ability to land payloads of up to 300 pounds in prescribed areas.



XV-8A FLEEP
Utility Cargo Vehicle

Successful flight testing of the Army XV-8A "Fleep", a Flex Wing Aerial Utility Vehicle, was just recently completed. The test program included operations from rough, unprepared desert surfaces, and lifting close to 1000 pound payloads. Short take off and landing characteristics make this "flying jeep" ideal as a possible utility vehicle for military units operating in remote areas where limited airstrip facilities are available.

Ryan's family of Flex Wing aerial vehicles comprise an entirely new category of aircraft based on the use of wing surfaces of cloth or other flexible material attached to a keel and leading edge members to form an arrow-shaped, kite-like structure which supports the payload suspended beneath the wing. Here are nine members of this new Ryan family.

PDGS

Precision Delivery Glider System

New, high performance PDGS vehicles for the USAF are designed, after launch from aircraft, to deliver payloads of 2000 pounds, utilizing packaging and deployment concepts of Ryan-built inflatable, Flex Wing gliders already demonstrated under controlled flight conditions for wings sized from 10 to 38 feet in length. Unique PDGS advantages include automatic homing or remote guidance, all-weather capability, and ease of maintenance.

FLEX BEE

Surveillance Drone

Ryan's lightweight, highly mobile "Flex Bee" experimental reconnaissance drones for the USMC, are designed for launching from forward areas to bring back intelligence photographs of enemy targets that cannot be seen from the launch site. "Flex Bees" are ground launched from a Ryan-designed portable rail launcher using a cartridge type propellant actuated by a lanyard, and can be operated and maintained by only two men in the field.

TUG

Towed Universal Glider

The Ryan TUG system for the Army is designed to deliver 4000 pound payloads, the largest payloads ever carried in a Flex Wing vehicle. Cargo body suspended beneath the Flex Wing will be able to carry liquid petroleum or high priority dry cargo, including ammunition, food, machinery and other essential items. TUGs would enable helicopter squadrons to move into forward bases of operation and establish supply dumps, thus helping solve logistic problems complicated by terrain.

LUG

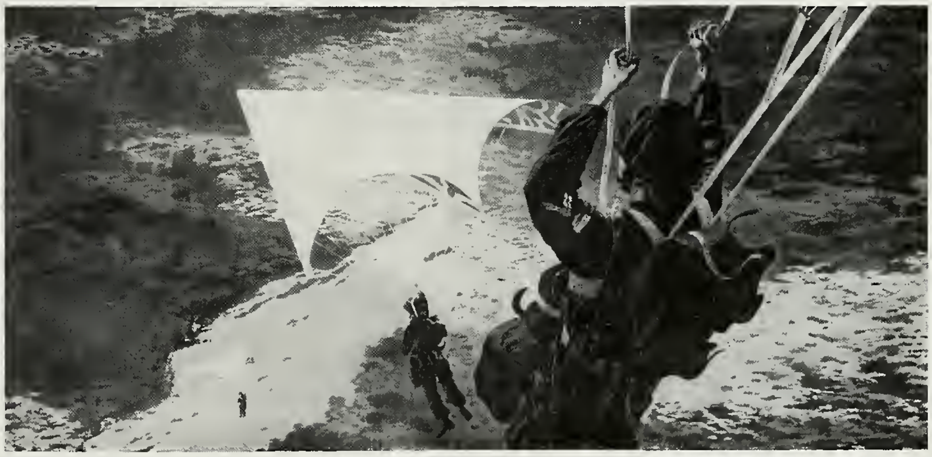
Light Utility Glider

The Ryan LUG system concept for the Army is aimed toward providing an extremely versatile cargo delivery vehicle of simple design and low cost for use in a highly mobile and dispersed combat environment. Utilizing this LUG system, pre-packaged or odd-shaped payloads ranging from 1000 to 1500 pounds can be suspended beneath the Ryan Flex Wing and towed by rotary wing military aircraft.

IDG

Individual Drop Glider

Using the inflatable Flex Wing IDG system, designed and tested for the Army, airborne troops can control their direction and rate of descent after jumping from an aircraft. When the system is fully developed, airborne personnel using the IDG system could, for example, be released at 10,000 feet altitude approximately seven miles horizontal distance from the target, and guide themselves to a pre-determined objective in controlled descent.



FLEX WING

Manned Test Bed

Through the cooperation of the National Aeronautics and Space Administration and the U. S. Army, the world's first manned, powered flying Flex Wing test bed — predecessor to the XV-8A "Fleep" — successfully completed extensive wind tunnel testing in 1961, demonstrating functional and aerodynamic characteristics.

CINERAMA FLIGHT SIMULATOR

Long before the Ryan-designed Army XV-5A lift-fan jet V/STOL lifted off the desert lakebed for the first time at Edwards Air Force Base, Test Pilots Lou Everett and Val Schaeffer had a good idea what to expect.

They had been "flying" the XV-5A for some 18 months—rising vertically, hovering, transitioning to forward flight, and landing—under circumstances so realistic that Everett says, "I could almost feel acceleration."

"Flights" of the world's first lift fan vertical and short take-off and landing aircraft were made in a unique facility at Ryan—the Flight Simulator—in a 6,000 square foot, $500,000 laboratory completed in mid-1962, which enables engineers to optimize system performance at minimum cost while the vehicle is under construction and design changes can be effected.

While Everett "flew" the XV-5A in a cockpit fully equipped with controls and instruments, he faced a "wrap-around" cinerama-like screen depicting terrain and sky in color, and providing a sensation of motion although the cockpit remained stationary in the darkened room. The instrumentation accurately reflected flight maneuvers, with the pilot's responses as natural as if he were actually in the air instead of reacting in the environment of a moving projected image of landscape.

Connected to the control hardware in the cockpit, an analog computer completely simulated characteristics of the aircraft, generating from equations of motion its position and attitude under varying conditions. In this closed-loop system, such motions were realistically projected on the giant screen, and as Everett observed these motions, he responded to them with typical flight control reactions.

Even winds or gusts, and emergency conditions were introduced during the "test flights" to simulate unfavorable conditions and to determine their effect on the pilot's movements and the dynamic response of the XV-5A components.

In the closed-loop system, Everett's response as he observed the position and motion of the projected visual display duplicating normal six-degree-of-freedom contact flight, resulted in input motions to the cockpit controls. These motions were then introduced into the simulator's hardware and analog computer sections, set up to simulate the characteristics of the XV-5A.

The computer integrated and produced outputs representing the resultant motion of the vehicle; such outputs were then fed into the servo drives of the projector, which presented to Everett in proper scale the visual display on the screen.

"As a result of these simulated flights, we were able to make quite a few changes to the various systems to improve the plane's characteristics," Everett observed.

It was learned, for instance, that control stick forces were too high and control displacements too large. Control stick sensitivity and forces were changed to optimize the kinesthetics and mechanical behavior of the system.

In simulating possible system failures, procedures were developed for correcting the deficiency, or determining whether the aircraft could be saved subsequent to failure. The result was establishment of corrective procedures in flight.

Everett cited as an example the possibility of a "runaway" horizontal stabilizer from an electrical short or other electrical system failure. If such an eventuality occurred, it was determined the aircraft could be saved if the failure were noticed *in time.* As a result of the simulated horizontal stabilizer failure, a change was recommended to provide a visual and an oral signal to the pilot to indicate any inadvertent, uncommanded movement of that portion of the tail which would upset a balanced flight condition. Rapid detection by signal—a beeping sound and a large light prominent in the cockpit—will warn the pilot soon enough to lead to swift correction.

"As we progressed in our simulator studies, we made design changes to improve the plane's handling qualities, and we anticipate excellent results," Everett said.

"The Ryan Flight Simulator let us know what to expect long before the first XV-5A take-offs," observed Lou Everett, Ryan engineering test pilot.

He is excited about the potential of the XV-5A. "The lift fan principle shows the greatest promise of any existing V/STOL concepts," Everett declared. "We were certain of this before we took the XV-5A to Edwards. The Flight Simulator helped tell us that prior to the first flights. ■

Simulator wrap-around screen realistically "tests" experimental aircraft before it leaves the ground.

DOPPLER NAVIGATION AT "DESERT STRIKE"

Army aircraft, such as Mohawk equipped with Ryan navigation system, and tanks participated in "Desert Strike." Pilot, below, prepares for mission.

Ryan automatic navigation equipment was an essential element in the effective Army air surveillance that provided information on the "enemy" to ground troops in "Operation Desert Strike," the second largest military exercise in the nation's history.

The U.S. Strike Command conducted the giant mock war in May in a 22,500 square mile area of the desert country in California, Arizona and Nevada, involving more than 100,000 Army and Air Force personnel.

Ryan Doppler AN/APN-129 continuous wave all-weather navigation systems were installed in Grumman OV-1 Mohawk reconnaissance aircraft that flew missions around the clock, averaging as many as nine sorties in a 24-hour period.

The twin-turboprop STOL type Army aircraft, equipped with SLAR (side looking aerial radar), were guided on their target runs by the AN/APN-129 readout systems, which give the pilot exact relative ground speed and aircraft drift angle. The Ryan systems stabilize SLAR to assure against map distortion in conveying data on deployment of opposing forces.

High tribute was paid the AN/APN-129 by commanders of the hard-working Air Surveillance and Target Acquisition platoons (ASTA), which conducted low-level aerial infrared and radar surveillance missions operating from desert air strips near Kingman, Arizona and Needles, California.

Capt. Lanny Standridge, who headed the newly activated ASTA of the 5th Aviation Battalion, 5th Mechanized Division, Ft. Carson, Colorado, declared at the conclusion of "Operation Desert Strike":

"The AN/APN-129 system is a vital piece of equipment necessary to obtain the best results with our SLAR gear. And the dependability of the AN/APN-129, combined with Ryan's technical assistance, gave us the capability to furnish the division what it needed."

Ryan support of the Mohawk missions was doubly appreciated by Standridge, whose group received their aircraft only a week prior to the launching of the desert maneuvers, which actually constituted the platoon's field debut.

Standridge's Mohawks operated from a site west of Kingman, where Robert Avery, Ryan Field Engineer, was stationed with the Phoenix Joint Task Force in the mythical nation of "Nezona." On the western side of the Colorado River, where the Mojave Joint Task Force was arrayed in opposition to defend "Calonia," another Ryan Field Engineer, Aage Andersen, provided technical support of the ASTA Platoon of B Company, 501st Aviation Battalion, headed by Capt. D. McMillon.

"We were glad to have the AN/APN-129 equipment," McMillon said. "It was new to us, but with this outstanding example of Army-industry coordination, we completely utilized our unit's capabilities and serviced division requests and related areas of interest."

Avery and Andersen reported that the Ryan Doppler navigation equipment performed excellently under the most severe field conditions, and helped in the discovery of buildup of armor and mechanized units that led to prompt counteraction. The Mohawks flew just above the horizon to monitor movements on both sides, thereby minimizing surprise tactics.

Unfavorable sand and wind conditions were constantly encountered, with dust clouds blowing across runways on take off. Rough take offs were the rule as the Mohawks operated from strips that had been cleared of desert brush only a short time before.

A Mohawk was credited with one of the outstanding reconnaissance finds of the entire exercise—a pontoon bridge being secretly built across the Colorado River. It was spotted by the aircraft's infrared detector, and an air strike was launched to destroy the bridge early the same morning.

"Operation Desert Strike" demonstrated dramatically the need for swift transmission of information on the fast-moving, wide-ranging type of mechanized warfare simulated in the exercise, and reports indicated that a strengthening of air reconnaissance capability may be proposed as a result.

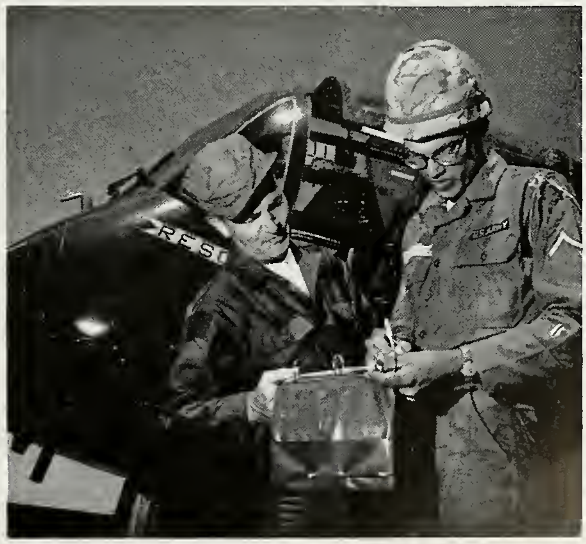
The maneuvers also showed, according to the aviation trade press, that U.S. Strike Command officers were gratified by an increasing integration of Army and Air Force units.

Further improvement in control and coordination of both Air Force and Army aircraft in the air space above the battlefield was envisioned by Gen. Paul D. Adams, STRICOM commander.

He listed as among the major achievements of the exercise the collection of data on intelligence and reconnaissance methods, and the command and control of highly mobile, widely deployed combat units. ■

Aerial Surveillance Platoon leader, Capt. D. McMillon, left, lauded Ryan navigation equipment.

Ryan field engineers Aage Andersen, above, and Robert Avery, left below, watched gear closely.



First flight tests of the revolutionary new Ryan-designed Army XV-5A lift-fan jet demonstrated that the V/STOL research aircraft responds "classically" to control inputs, W. L. "Lou" Everett, Ryan chief engineering test pilot, reported from Edwards Air Force Base.

"It's an honest airplane and handles beautifully," Everett said. "In some of the flight configurations, it actually performed better than we might have had reason to expect.

"For example, there was some concern over elevator effectiveness, but the nose wheel lift-off speeds during conventional take-off were by no means as high as we anticipated they might have been."

As preliminary to full cycle vertical take-off, hovering and transitional flights, Everett and Val H. Schaeffer, Jr., Republic Aviation Corp. test pilot, have made conventional flights in the inauguration of the testing programs at Edwards. Altitudes to 15,000 feet and speeds to 160 knots were flown in the initial tests in the CTOL mode — conventional take-off and landing.

Support of the flight test program is being provided by Republic, of Farmingdale, N. Y., under an agreement with Ryan.

"It was a thrill," said Schaeffer, who made the historic first flight May 25—a 19-minute hop in which he found the XV-5A "extremely easy to handle, taking off and landing easily, with no problems in maneuvering."

XV-5A FIRST FLIGHT

Subsequent flights have demonstrated "no unusual aircraft behaviors that might tend to surprise, as is ordinarily to be expected in an aircraft based on a completely new concept," Everett declared.

Ryan has designed and built two XV-5As under contract to General Electric Co., which developed the aircraft's distinctive lift-fan propulsion system, for the Army Transportation Research Command.

The principle of using fans submerged in aircraft wings for vertical lift was pioneered a decade ago by Ryan and General Electric. In the XV-5A, a set of five-foot diameter lift fans is mounted horizontally within the wings, powered by the exhaust of two G.E. J85 jet engines to provide lift for vertical take-off and landing. Thus, using a power plant conveniently sized for cruise in the conventional flight mode, the thrust is multiplied three-fold with no increase in fuel consumption.

Among other "surprises" provided by the XV-5A in its initial test flights was lower-than-expected stall speeds in some configurations, Everett disclosed.

"Stall approaches, up to and including the stall break itself, have been very moderate, with no tendencies toward violent wing drop or heavy buffet," he said. "As the XV-5A goes through the stall break, it experiences a classical nose drop straight ahead."

Also pleasing to the test pilots was behavior of the aircraft in the "pre-conversion" configuration, between conventional flight and fan supported flight.

"During our test flights, we have made configuration changes from flaps-down condition into the pre-conversion configuration," Everett explained. "Prior to converting to fan flight, the nose pitch fan inlet louvers and pitch fan exit doors are opened, and the wing fan exit louvers are positioned down to a 45-degree vector angle.

"The next step would be to switch over to fan flight, accelerating the fans to produce vertical lift.

"The act of converting the plane to pre-conversion configuration occurs with no associated aircraft disturbances. Opening the wing louvers into the airstream does not affect the XV-5A—there is no turbulence or adverse motion resulting from making this change. As a matter of fact, the plane trims itself out during the change into the pre-conversion configuration."

He pointed out that in conventional forward flight, the XV-5A's behavior is that of a conventional aircraft. In hovering flight, it performs similarly to a helicopter. But in transition, it is like no other plane.

Transition, the most difficult sequence in V/STOL flight is accomplished when wing supported flight is achieved following vertical take-off through fan-produced lift.

For forward flight, the diverter valves close off exhaust gases to the fans and allow operation as a conventional jet aircraft. The nose fan is used to provide lift, pitch trim and control.

When the louvers, or deflectors, immediately beneath the fans are moved as far aft as they can be driven, the XV-5A will have reached a speed of 90 to 100 knots, at which velocity the plane can fly on wing lift. Conversion is completed, the fans are stopped, and the aircraft picks up speed—to more than 500 miles an hour—on wing lift alone.

Everett describes the vertical takeoff as a relatively simple operation. "The requirements on the pilot are identical to those in a helicopter, with the XV-5A controls exactly the same as a helicopters' in vertical take-off," he explained. "There are the conventional stick and the rudder pedals and a collective stick with a throttle twist grip as in helicopters."

A stabilization augmentation system, in operation during all fan-supported flight (including hovering and transition), overcomes the tendency of disturbed air to upset a plane in vertical takeoff. This system senses angular rates, and prevents or heavily damps these rates automatically.

"We have two such systems, but we can still fly the XV-5A even if both systems failed," Everett pointed out.

The dual stabilization augmentation system is only one example of redundancy built into the XV-5A to maximize safety characteristics. Other dual systems appear in all primary controls up to the point of the actual control surfaces. Two hydraulic systems have authority over the actuators which control the wing fan exit louvers, wing fan inlet doors, nose fan inlet louvers, nose fan exit doors and horizontal stabilizer trim.

What is the sequence of pilot functions during transition, in which the XV-5A is "like no other airplane?"

From the hover mode, by means of a switch on the helicopter-type stick grip, the pilot vectors the wing fans' exit louvers aft. This can be performed continuously or intermittently. As the louvers move aft, forward propulsion is realized and the aircraft accelerates forward.

When the louvers are moved to their maximum aft position, and flight speed of 90 to 100 knots is attained, a mode selector switch is actuated. This is on the collective lift stick, which is similar to that used in a helicopter for vertical rise. The switch actuates a diverter valve in the engine exhaust system that directs the jet exhaust through the tailpipe as in normal jet operations, and puts the XV-5A in the conventional turbo jet mode. The exhaust which in vertical fan-supported flight drives the wing fans, now is diverted to provide conventional turbojet thrust.

At the same time the diverter valve is actuated, the wing fan inlet doors are closed and the XV-5A is flying conventionally. The flaps are still down, but when they are raised, complete closure of the wing fan exit louvers and the nose fan inlet louvers and exit doors is effected.

During conventional flight, control of the flaps is separated from control of the louvers by placing the louver switch in the "conventional" position, instead of in the "fan" position which enables simultaneous control of louvers and flaps.

During the flight test program at Edwards AFB now under way, procedures of approaching the new problems presented by V/STOL techniques will be formulated.

After initial conventional flights at moderate and low speeds, Everett and Schaeffer began investigating the fan flight regime, detailed hovering maneuvers, and eventually will build-up to transition at maximum fan-supported flight speeds.

"The relationship of all these phases of testing," Everett says, "is to approach the actual conversion from fan to conventional flight, or vice versa, from both ends of the flight regime."

Transition and conversion from hover to conventional flight could be the next step, with subsequent conversion investigations, from fan flight to conventional flight and vice versa. The ultimate will be a complete demonstration of lift off, hovering, transition, conversion to conventional flight, conversion to fan flight, transition, hover, and land.

Enthusiasm over XV-5A performance was expressed by Val M. Schaeffer, Jr., Republic test pilot, in debriefing after XV-5A's first conventional flight. Standing, left, Lou Everett, Ryan test pilot. Others, officials of Ryan, of Republic, which is supporting the test program, and General Electric, developer of propulsion system are (standing left to right) John Mansfield and John Melrose, (seated left to right) Hank Russell, Robert Clark, and Jack Widland.

During the flight tests, data has been obtained from full scale wind tunnel tests at the National Aeronautics and Space Administration's Ames Research Center, Moffett Field, Calif. The second of two XV-5A's built by Ryan was shipped to Ames soon after delivery of the first to Edwards AFB. In Ames' 40-by-80 foot wind tunnel, aerodynamic tests provided a stream of data fed to Ryan engineers and the flight test crew.

A Ryan test pilot for nine years, Everett has been privileged to fly every drastically new type aircraft developed by Ryan in that period. These include the X-13 Vertijet, world's first pure jet VTOL, which hung from its nose on a ground service trailer for takeoff; the conventionally configured VZ-3RY Vertiplane, which depended on propeller slipstream deflected against huge flaps for its vertical lift; the world's first manned Flexible Wing vehicle, which demonstrated feasibility of using flexible, plastic-coated wings instead of rigid, metal-covered surfaces for certain flight functions; and the XV-8A "Fleep," a Flex Wing Army "flying truck."

He's excited about the potential of the XV-5A. "The lift fan principle shows the greatest promise of any VTOL concept," Everett declared. ■








BEHIND THE SCENES

Test pilot Schaeffer climbs out of XV-5A after successful first conventional flight at Edwards Air Force Base. In debriefing attended by flight test director, program manager, crew chief, shop superintendent, test engineers and other technical personnel from Ryan, General Electric and Republic, Schaeffer remarked. "The plane was extremely easy to handle. It takes off and lands easily, and there were no problems in maneuvering."

"FLEEP" FLIGHT TESTS COMPLETE

Flight testing of the Army XV-8A "Fleep," a unique Flex Wing aerial utility STOL vehicle, has been completed three weeks ahead of schedule by the Ryan Aeronautical Company. The "Fleep" was piloted during these tests by H. C. Cotton, Ryan Engineering Test Pilot.

"Ability of the 'Fleep' to land power-off, simulating emergency conditions, and its take off, landing and taxi performance under operational conditions brought especially favorable reaction," Cotton said.

Flights in the research test program for the U. S. Army Transportation Research Command and Department of Defense's Advanced Research Projects Agency (ARPA) at the Army's Proving Ground, Yuma, Ariz., covered a two-month period, and were followed by an evaluation of the aircraft by Duane R. Simon, Army research test pilot.

Simon, a former Captain and Army aviator with experience in helicopters and fixed wing planes, was enthusiastic over the short field landing performance of the "Fleep." The aircraft is simple to operate and inexperienced pilots should learn to fly it readily.

"I felt comfortable and 'at home' soon after starting to fly this completely different type of aircraft," Simon said. "I was impressed with its simplicity and stability."

Nearly 50 flights were made during the testing program conducted by Cotton, and numerous operations were made from rough, unprepared desert surfaces away from the conventional landing strip of the test facility.

"We took off and landed from cleared areas of hardpacked sand and rocks, dirt roads, and across Jeep ruts and tank tracks," Cotton said.

"The aircraft did better than original expectations, exceeding design specifications in nearly all performance categories."

The test flights included lifting large cargo boxes lashed to the platform between the pilot and the 210 h.p. Continental pusher engine. Flights were made to altitudes of 9,500 feet and at maximum gross weights of up to 2,300 pounds, including 1,000 pounds payload.

"The tests proved that the 'Fleep' can operate from almost any unimproved site that can accommodate normal helicopter operations," Cotton explained. "We demonstrated that the plane can stop under ideal conditions with a minimum of landing roll."

The "Fleep's" flexible wing is made of plastic-coated material attached to a keel and leading edge members to form a V-shaped delta wing surface, offering an extremely lightweight, large aerodynamic lift surface. There is no hydraulic or electrical system, and the aircraft has a fixed pitch propeller, simpler and less costly than a controllable pitch propeller. In contrast with the conventional three controls of most fixed wing aircraft, the "Fleep" is operated with only lateral and longitudinal controls, and does not need a rudder for directional control.

Its short take off and landing characteristics make the "Fleep" ideal as a possible utility vehicle for military units operating in remote areas where limited airstrip facilities are available.

Engineering studies, fabrication and testing of the "Fleep" and a variety of other Flex Wing vehicles have been performed for several government agencies.

These include studies for the National Aeronautics and Space Administration on adaptability of the Flex Wing for recovery of the first stage booster of the Saturn space vehicle,and construction and demonstration of a surveillance drone, the "Flex Bee," for the U. S. Marine Corps. For the U. S. Army and ARPA, Ryan has tested an Individual Drop Glider system to enable airborne troops to control their directional descent to a target area; has evaluated in southeast Asia the Precision Drop Glider system; and built and tested the Air Cargo Glider deliver system which increases several times the normal internal capacity of helicopters. ■

Army research test pilot Duane R. Simon checks Ryan "Fleep" during successful testing program at Yuma Proving Ground.

General von Kann is Commanding General, United States Army Aviation Center, and Commandant, United States Army Aviation School, Fort Rucker, Alabama.

A veteran of the 82nd Airborne Division at Fort Bragg, N.C., General von Kann made 46 parachute jumps during his two-year assignment and left the Division as a senior parachutist. He obtained his rotary wing aviator rating in 1958 and assumed duties as Director of Army Aviation the following year. In addition to his helicopter rating, General von Kann is qualified in fixed-wing and twin-engine aircraft and is instrument rated.

General von Kann served overseas in World War II in North Africa, Sicily and Italy. He was awarded the Silver Star for gallantry in action and holds the Legion of Merit.

"We have not had a national R&D effort in any way comparable to that which has marked our movement into outer space."

THE NATIONAL

*by Maj. Gen. Clifton von Kann**

When I left the paratroopers at Fort Bragg in 1959 and journeyed to Washington to become Director of Army Aviation, I soon became aware of what was then a brand-new term for me. As you have probably guessed already, the term was V/STOL — Vertical and Short Takeoff and Landing.

The more I found this term in the papers that I read, the more conflicting definitions I found. I simply couldn't pin it down. On the other hand, I did not feel too badly about this because I seemed to be in the same boat as 99% of the other people dealing with the term.

Seriously, the point is that there is a great deal of misunderstanding about terms when we get into this area of aeronautics.

As a matter of fact, we don't have to look too far to find that there is not only V/STOL and VTOL, but there are such exotic things as ESTOL, which I am told means Extra short takeoff and landing (or is it Extremely short takeoff and landing?), and GETOL, which has to do with ground effects takeoff and landing.

Now, confusion in terminology is not new, especially in the realm of acronyms; however, in this case I feel there has been a serious adverse effect on V/STOL development because of the tendency to equate current test beds with the entire V/STOL spectrum. For example, in the Army there are many officers who think that V/STOL refers to nothing but some of our more exotic test beds — the tilt wing, the tilt rotor, the fan-in-wing, the augmented jet.

Those whose tastes do not run in this direction therefore conclude that the Army has no real reason to be very interested in V/STOL, when in truth V/STOL may well be vital to the future mobility of the Army and quite possibly, its entire tactical effectiveness. Witness the helicopter! Think where the Army would be if its planners had ignored it 15 years ago.

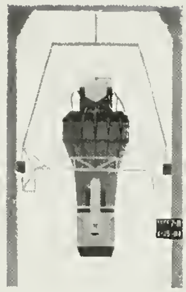
Let me try to pin down what *I* mean by V/-STOL. For purposes of this discussion V/STOL is:

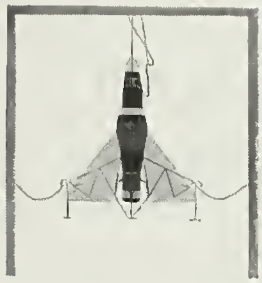
(1) A capability to lift off the surface vertically at normal gross weight and to climb out at a very steep gradient; and

(2) A capability to hover out of ground effect with full control to move in any direction; and

**Speech delivered by the Army Chief of Aviation before the National Security Industrial Association.*

STAKE IN V/STOL





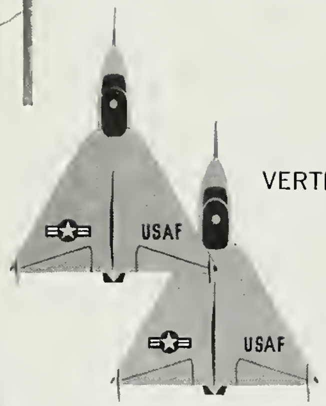
(3) A capability to take-off with a short ground roll at more than normal gross weight.

Now when we look at it this way we recognize V/STOL as covering a broad spectrum of aerial vehicles, going all the way from those with low disc-loading like the helicopter, on up through compounds, tilting rotors, ducted fans, lift fans, ejector jet, and pure jets which, of course, involve extremely high thrust to weight ratios. Again, I make the point that whereas an individual or a military organization may be more interested in one end of the spectrum than the other, he is still interested in V/STOL and probably needs V/STOL quite badly.

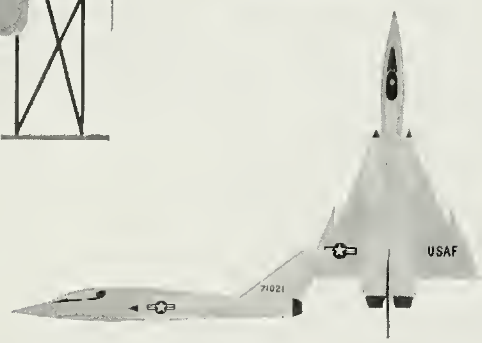
I think it can be said, as a generalization, that V/STOL offers something to everybody just as surely as the reciprocating engine has innumerable applications. To put it another way, *anyone who can usefully employ a vehicle which can rise from one point vertically and land at another is interested in V/STOL,* be he military or civilian. However, let me pause to point out that recognition of universal need is only part of the story with V/STOL. Less expensive items, like razor blades or shoes or even cars will appear in profusion once universal need is recognized. Since V/STOL requires much technical research, much expensive testing, and fairly large risks, it will not necessarily "come true" just because everyone needs it.

In any event America has a large stake in V/STOL in that much of our future movement, whether individual, mass transportation, or military, in my opinion will involve the use of V/STOL. Up to now this country has been among the world's leaders in the application of technology for purposes of V/STOL. For many reasons, including our balance of payments problem, the maintenance of this leadership is important to our country.

In this connection, it is both challenging and encouraging to note that our allies in Europe are moving fast and with great boldness. Regardless of its ultimate application, the fact is that in the P-1127 the United Kingdom moved ahead of us in one important application which has done a great deal to advance the state of the art (a project, by the way, that the Army supports with 50% of the U.S. funds). Nor is the effort limited



VERTIJET



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to Government-sponsored projects.

In Europe, private enterprise is often willing to take risks and to engage in V/STOL test-bed research to the extent that its pocketbook will allow. The Agusta organization in Milan (which I had the pleasure of visiting two months ago) has shown great willingness to engage in this type of research and development, and has actually produced some very interesting prototypes—again without Government funding. There are many other examples. So we must keep in mind that Europe is moving, and doing so with courage and conviction.

"Without the best possible National V/STOL Program we face the possibility of forfeiting one aspect of leadership."

As an individual who has been concerned primarily with low altitudes—very low altitudes, in fact—and relatively low airspeeds, I cannot help but look wistfully at what seems to me to be an imbalance between our efforts in "outer space" and those in "inner space." (I am not using the term "inner space" in the Navy sense, but rather as an easily understandable term to indicate the lower reaches of the troposphere.)

We do have a national program in outer space. Notwithstanding the tremendous challenge and equally tremendous expense, it appears to be making solid progress. I, for one, am very thankful for this.

On the other hand, within the lifetime of those here in the room, and certainly for the basic elements for our military establishment, the problems of movement in the regime I have chosen to call "inner space" should be of equal concern and should also receive a concerted effort.

In the past, many interesting and potentially important V/STOL projects have been dropped at midstream, usually dying of that disease which I call "budgetary starvation." At Fort Rucker we have in our Museum the first convertiplane ever flown. This aircraft, the XV-1, was built by McDonnell over 10 years ago. It is rather symbolic that after a successful test program the XV-1 sat in a junk yard for 5 years.

During the 1950s many research and development projects to develop a flying crane were initiated. All of them were under-funded; and the flying crane finally had to be developed by industry, although it took much longer this way. Today in South Vietnam flying cranes to evacuate downed aircraft would be almost worth their weight in gold. I could cite hundreds of other examples.

On the other hand, industry may also have been at fault. Many complain about American industry lacking confidence in the future of the V/STOL market (which is rather difficult to believe) and not showing comparable aggressiveness to that of its European counterpart. And it is true that many companies feel that they've gone as far as they can without more Government support. So here we have a "chicken or egg" question; but whatever the answer, the fact is that progress has been very slow.

Certainly *we have not had a national R&D effort in any way comparable to that which has marked our movement into outer space,* and I expect that NASA's interest in V/STOL is unclear or unknown to many people, especially in view of its small aeronautics budget as compared to its space budget.

Of course, all is not negative. For example, the Army is rather proud of the VTOL program it has sponsored. This includes the first compound, the first successful tilt-wing, tilt rotor and ducted fan. Our current programs include an augmented jet and a fan-in-wing as well as participation in the tri-service programs.

However, these current programs are geared primarily to research and the development of experimental prototypes, and they do not cover all the bets.

"It is on the wings or rotors of operational hardware that the state of the art really advances."

Military and congressional leaders discussed the progress of the U. S. Army XV-5A flight test program during meetings held recently at Edwards Air Force Base. The aircraft, based on Ryan's Vertifan system, has completed its first dramatic hover tests at the Mojave Desert site in California.

I have now painted myself into the same corner as the fellow who didn't like the food at the Officers' Mess, and I must now expect to be asked what we should do about all this. I think the answer must be that we need a National V/STOL Program. In my opinion, such a program should include the following features:

1. The military must initially take the lead.

2. Industry must be willing to believe in the market potential.

3. NASA and FAA must carry their share of the load. (I might say in this respect that I am certain that Administrator Halaby would be more than willing to do so, just as he has shown a willingness to support many other worthwhile and important aeronautical developments).

4. A program for operational prototypes should be pushed. *It is on the wings or rotors of opera-*

tional hardware that the state of the art really advances. For this purpose it is not important whether or not the prototype has an operational or commercial payoff. The goal is to learn our technological lessons as rapidly as possible.

5. We must not let the current programs channelize our thinking about future possibilities. There is a tendency to let these current programs give us a "tunnel vision" into the future, and this tends to block out many promising applications of great potential value.

6. We must support a stepped-up compound program to preserve the option of a sound, single step forward in the event that the broad jump to more sophisticated types falls short.

7. We should support a new engine program. There is so much to be gained by improving our thrust-to-weight ratios. As a matter of fact, I think it can be said that unless there is a very considerable improvement here our national V/STOL effort will be badly delayed.

8. Finally, we must block out the timing and relationship of critical decision points in the game; because here as in all things a time comes when we must define the eventual military and civilian requirements and develop firm programs for their fulfillment. Up to this point, however, we should be as open-minded as possible concerning V/STOL applications.

I hope my enthusiasm for V/STOL has not given you the impression that I believe it to be a complete panacea for all transportation problems or that there are not many technical difficulties and economic roadblocks to conquer. However, as a former division commander, I am morally certain that V/STOL offers the first army to have such vehicles in number a great advantage over an enemy not so equipped. I can't speak for the other Services or for the commercial operator, but am sure that there, too, the applications are innumerable.

This, of course, is merely the outline of a program. I know that many of you could add important elements. The real point is that *without the best possible National V/STOL Program we face the possibility of forfeiting one aspect of leadership* which, twenty years from now, must be recognized as vitally important to our nation. ■

Data obtained on thrust stand at Edwards Air Force Base is correlated with wind tunnel tests at Ames Research Center, prior to start of extensive vertical flight test program.

XV-5A WIND TUNNEL TESTS

The U. S. Army XV-5A jet V/STOL (vertical and short take-off and landing) research aircraft has completed tests in the world's largest wind tunnel. Basic aerodynamics of the XV-5A underwent an "across the board" checkout in the 40-by-80 foot wind tunnel of the National Aeronautics and Space Administration at their Ames Research Center, Moffett Field, California.

Expectations of the original design criteria were met, and results of the wind tunnel tests have been correlated with the actual flight tests being performed with another XV-5A at Edwards Air Force Base, Calif. Ryan Aeronautical Company, San Diego, has designed and built two XV-5A aircraft under contract to General Electric, developers of the aircraft's distinctive lift-fan propulsion system.

Completion of the NASA/Ames wind tunnel studies will result in increased test activity when the XV-5A which was at Ames goes on flight status to join the other aircraft for actual flight testing at the Edwards Air Force Base site in the Mojave Desert.

The wind tunnel program demonstrated what the XV-5A will do and how it will react in all fan and conventional low speed flight modes. Information was obtained on stall characteristics, control at various forward speeds and angles of attack, lift and drag. Fan control effectiveness was determined on the NASA/Ames vertical thrust stand before the airplane entered the wind tunnel.

Experimental data obtained earlier from more than 640 hours of wind tunnel testing of full scale and smaller scale models of the XV-5A configuration at several military and civilian establishments while the two XV-5A aircraft were under construction, was validated at NASA/Ames.

Before the first conventional flight of the XV-5A at Edwards Air Force Base on May 25, its sister airplane "flew" in the NASA/Ames wind tunnel. The important data obtained from the first conventional flight in the wind tunnel was immediately tied in with the flight test operations at Edwards AFB — emphasizing the importance of the concurrent programs. Simulated, step-by-step flight operations, from vertical take-off through transition to horizontal flight at speeds from zero to 100 knots, have since been accomplished at NASA/Ames.

Basic and applied research in support of the nation's space and aeronautical programs is performed at this NASA facility, located just 35 miles south of San Francisco. Studies at the Ames Research Center are currently being conducted in support of the national effort to develop a supersonic transport, as well as advanced research on vertical and short take-off aircraft, and on air-breathing hypersonic aircraft.

In the V/STOL program, another Ryan airplane, the VZ-3RY Vertiplane, which utilizes large wing flaps to deflect propeller slipstream for vertical lift, has been undergoing extensive tests at NASA/Ames.

One of nine major NASA centers in the United States, the Ames Research Center is staffed by 2200 civil service employees, of whom more than one-third are scientists and engineers. The center is named for Dr. Joseph S. Ames, chairman of the predecessor National Advisory Committee for Aeronautics (NACA) from 1927 to 1939.

Besides conventional wind tunnels, Ames' specialized facilities for aerospace research include entry-heating simulators, free-flight ballistic test equipment capable of conducting tests at speeds through and above earth escape velocity, and laboratories to study solar and geophysical phenomena, life synthesis, life detection, and life environment factors. ■

RYAN'S NEWEST FLEX WING ... LIGHT UTILITY GLIDER

Webster tells us that to lug is " to pull with force; to haul." And that, as far as it goes, pretty well describes the logistics role to be filled by Ryan's newest Flex Wing vehicle, the Light Utility Glider (LUG).

LUG is a cargo-carrying flatbed suspended beneath a flexible wing and towed behind a helicopter or other airborne tug.

Evaluation of LUG will be conducted as part of a recently announced contract awarded by the Army on behalf of the Department of Defense's Advanced Research Project Agency (ARPA).

The evaluation is designed as a further step in development of this unique method of unmanned delivery of high priority cargoes into combat areas. The Army's 11th Air Assault Division, Ft. Benning, Georgia, will conduct tests to determine the feasibility of the LUG concept under an air assault type operation.

The tow glider concept system multiplies several times the carrying capacity of Army helicopters, as successfully demonstrated in previous tests for the Army and ARPA in which heavy loads were towed by such aircraft.

The Ryan Flex Wing is made of flexible, plastic-coated material attached to an aluminum alloy tubular keel and leading edge members to form an arrow- or V-shaped, kite-like surface.

Suspended beneath the Flex Wing as it is towed is the cargo, which can comprise all types of supplies, weapons and fuel — and even vehicles such as Jeeps and other small wheeled carriers. Payloads of several thousand pounds can be delivered by the Flex Wing, following release, in a glide to a prescribed area under radio control from the aircraft or the ground.

With the LUG system, the evaluation would be applied to payloads ranging from 1,000 to 1,500 pounds, using either pre-packaged or random, odd-shaped cargoes.

The Light Utility Glider system is an extremely versatile cargo delivery vehicle of simple design and low cost, urgently needed for use in a highly mobile and dispersed combat environment.

In previous testing programs for the Army, Ryan Flex Wing ACG (Air Cargo Glider) systems operated from rough terrain for both towed take off and landing, and with both wheel and skid-supported vehicles. Included in these testing programs was successful demonstration of an automatic flare system to reduce landing velocity to preserve cargo, and to minimize landing roll-out. Numerous missions were flown with the same glider, with a minimum turn-around time.

Outstanding features of the ACG system included simplicity of construction, ease of maintenance, interchangeability of components, and extensive use of off-the-shelf items. The operational Light Utility Glider, or LUG, will be even more simple structurally than its predecessors.

The LUG control platform is a rectangular structure built of aluminum alloy extrusions cut to length and bolted at the corner joints to form the main box assembly. Damaged sections can be repaired quickly by unbolting these portions and inserting and refastening new sections. Attached to the cargo tie-down fittings are standard off-the-shelf Nylon webbing belts with quick release couplings, and hook-ends to support various shaped cargoes.

The tow bridle consists of four lengths of standard aircraft 3/16ths inch diameter steel cable. The tow bridle system generates corrective moments around the aircraft yaw and pitch axes to dampen out tow cable oscillations, and to reduce differential altitude changes between the towed and towing vehicles. Tow cable length is approximately 400 feet.

The roll control rotary actuator, relay control assembly, interconnecting lines and harnesses are contained within the forward platform structure and are reached by removing a section of the floor planking.

The battery box is attached to the platform by four standard quick-disconnect pins. The control actuating devices receive their operating power from two 12-volt lead-acid type storage batteries.

An automatic flare switch hangs suspended under the glider by a 30-foot lanyard assembly. When the switch contacts the ground, the automatic flare circuit is actuated, permitting the wing to rotate in the pitch plane to the flare position.

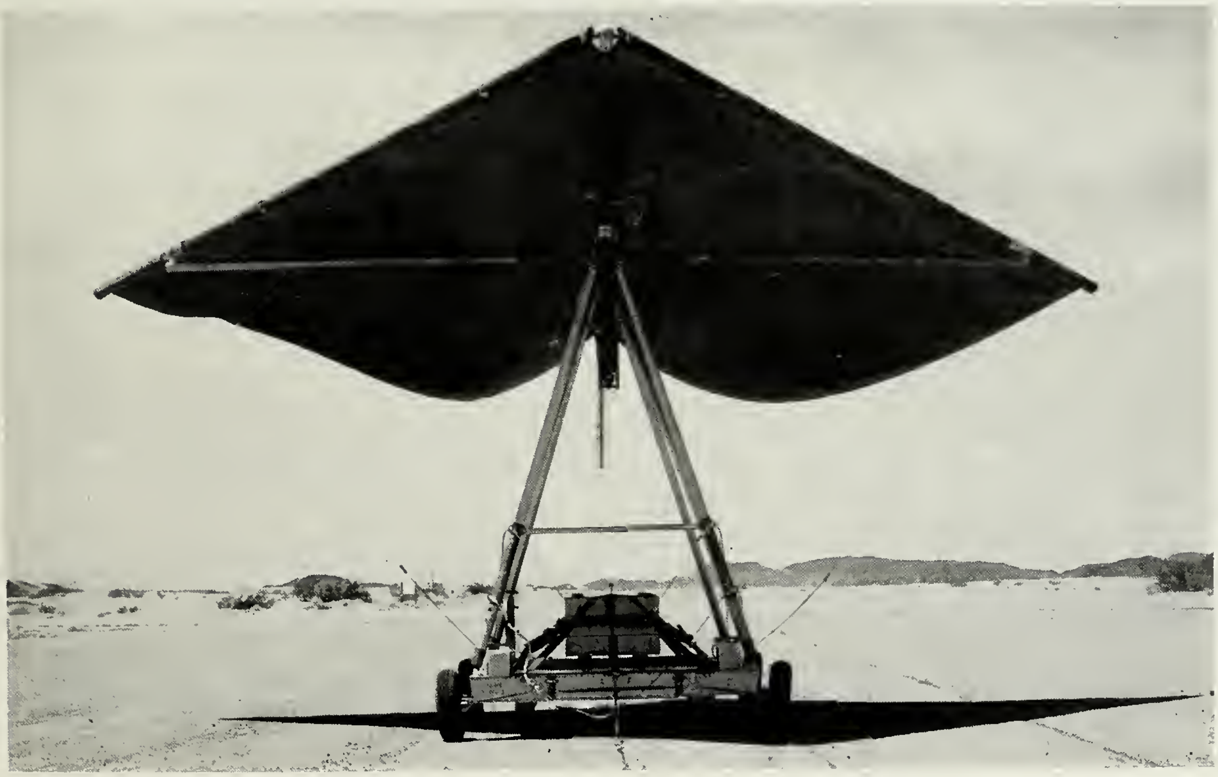
In tests of earlier Air Cargo Glider systems, satisfactory take off and landing performances were demonstrated at gross weights up to 1,800 pounds, with take off runs of approximately 700 feet.

The Flex Wing LUG systems now being tested by Ryan are capable of being towed without control inputs, other than wing trim and the vectored forces induced by the tow cable from take off through landings by the UH-1 helicopter.

The LUG gliders will also be capable of remote control during towed and free flight, and will have the automatic programmed flare maneuver for free flight landings.

The LUG contract is being monitored by the U.S. Army Transportation Research Command, Ft. Eustis, Virginia, an element of the U.S. Army Air Materiel Command, St. Louis, Missouri. ■

LUG system is designed as a cargo-carrying flatbed—capable of handling payloads ranging from 1,000 to 1,500 pounds—suspended beneath flexible wing and towed behind a helicopter or other airborne tug.



FROM RYAN'S SPECTRUM OF CAPABILITIES:

V/STOL AIRCRAFT

Which V/STOL concept is best? That depends upon the mission to be flown.

Whatever the mission requirement, Ryan will continue to make significant contributions to successful V/STOL technology.

Three current Ryan V/STOL projects, each of a different technical approach, are illustrated here.

On these, and on such pioneering projects as the X-13 Vertijet, the VZ-3RY Vertiplane and the YO-51 Dragonfly, Ryan has expended nearly four million engineering/developmental manhours. Notable gains in V/STOL technology have resulted from Ryan's original work on direct thrust systems, variable nozzles, jet reaction controls, unique V/STOL simulation, auto-stabilization and deflected slipstream aerodynamics.

But V/STOL is only a single band in Ryan's broad spectrum of capabilities.

Ryan Firebees have tested more U.S. surface-to-air and air-to-air weaponry than any other jet target missile. Ryan Doppler equipment contributes to the navigation of fixed-wing aircraft, helicopters and space vehicles.

Lightweight Ryan structures support the solar cell panels on Mariner, Ranger and Transit V spacecraft.

In many fields of aeronautics, electronics and astronautics, strength for tomorrow is being forged today — at Ryan!

RYAN AERONAUTICAL COMPANY • SAN DIEGO • CALIF.

NEWEST RYAN V/STOL is Army XV-5A, lift-fan research aircraft built under contract to General Electric. Designed to take off vertically on no more power or fuel than is needed for high speed cruise, the XV-5A is now in flight test.

FLEX WING STOL "FLEEP," popular name of the easy-to-fly XV-8A, is under study by Army's Transportation Research Command as an aerial "truck," capable of operating out of rugged areas.

TILT-WING V/STOL TRANSPORT XC-142A is being built by Ryan (jointly with Vought and Hiller) for Army, Navy and Air Force. It will be capable of transporting troops and equipment into unprepared areas under all weather conditions.

RYAN

RYAN REPORTER

WINTER/1964-65

About the Cover: A Ryan XV-5A flight test crew member at Edwards Air Force Base spots hovering U.S. Army XV-5A for vertical landing. (See articles Pages 10, 22 and 31.)

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Taking the moon in stride...

LEM'S ELECTRONIC

PROJECT APOLLO will reach its major objective with the landing of two American astronauts on the moon and their safe return. The historic landing will be made in a vehicle called the Lunar Excursion Module (LEM), for which Grumman Aircraft Engineering Corp. is prime contractor to the National Aeronautics and Space Administration.

LEM is a two-stage vehicle that will function as a space ferry—a ferry to carry two astronauts from a lunar-orbiting mother ship to the moon's surface and back.

Designed for complete self-sufficiency, LEM is equipped with the subsystems necessary for life support, navigation and guidance, attitude control, communications and instrumentation.

The landing radar which will provide data on altitude and velocity in relation to the moon's surface, and act as electronic cushions, is being designed and built by Ryan under contract to Radio Corporation of America, which is responsible for several major electronic subsystems. After evaluation of all landing radar proposals, RCA's Aerospace Systems Division decided the Ryan Electronics design, as a result of Ryan's previous experience in a comparable project, would meet the LEM requirements with minimum technical, schedule and cost risks.

The LEM landing radar design is similar in principle to that designed and built by Ryan for Surveyor and numerous Ryan fixed wing and helicopter navigational systems. Specifically, three narrow beams of continuous-wave RF energy are used for measuring the spacecraft velocity and one narrow, frequency modulated, continuous-wave beam is used to measure altitude or range along the beam to the lunar surface.

A three-stage Saturn V rocket will be used to first put the Apollo spacecraft into an earth orbit and then into a translunar trajectory. Upon arrival in the vicinity of the moon the Apollo spacecraft composed of the Lunar Excursion Module, Service Module and Command Module will be placed in a near circular lunar orbit.

LEM will be coupled to the Apollo Command Module (CM) and Service Module (SM) during the earth-to-moon passage. Shortly after the combined CSM-LEM arrives in the vicinity of the moon and achieves a lunar orbit, two of the three astronauts riding in the CM will enter LEM through a connecting tunnel. LEM will then be separated from the CSM and, under the control of its crew, will descend and land on the moon at a preselected landing site.

During their planned stay on the moon, the astronauts will carry out scientific tasks such as gathering soil samples, measuring temperature, gravity and magnetic field strength, and conducting communications experiments. Local explorations are also planned.

The LEM itself is a two-stage vehicle. The lower stage contains the landing gear and a gimbaled throttleable descent rocket engine. The Ryan landing radar is affixed to the lower stage. The upper stage consists of a pressurized crew compartment, equipment areas and an ascent rocket engine. LEM is a completely self sufficient vehicle and is equipped with the subsystems necessary for life support, navigation and guidance, attitude control, communications and instrumentation.

Upon completion of their lunar exploration, the two astronauts will use the ascent stage to return to lunar orbit and rendezvous with the Command and Service Module. The descent or lower stage of the LEM will be used as a launch platform for the ascent or upper stage and will be left on the moon. After rendezvous and docking in lunar orbit, the two lunar explorers will rejoin the third astronaut in the Command Module. The Command and Service Module will then return to earth leaving the LEM in the lunar orbit.

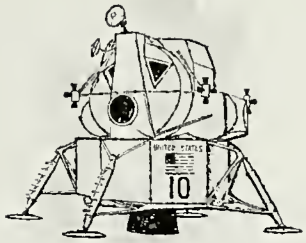
The landing radar system is composed of an antenna assembly with an integrated tilt mechanism plus an electronic assembly for signal processing. The tilt mechanism places the antenna in either of two positions which are programmed to occur at specific altitudes during the descent phase. This programming keeps the antenna beam pattern near vertical to the lunar surface although the LEM vehicle attitude varies during descent.

The LEM attitude changes from near horizontal at start of descent to a vertical or tail sitting position at the time of landing.

The operation of the radar is simple and straightforward. The antenna assembly is a planar array and transmits four very narrow beams of

By: C. J. Badewitz
Senior Project Engineer
Ryan Electronics

CUSHIONS

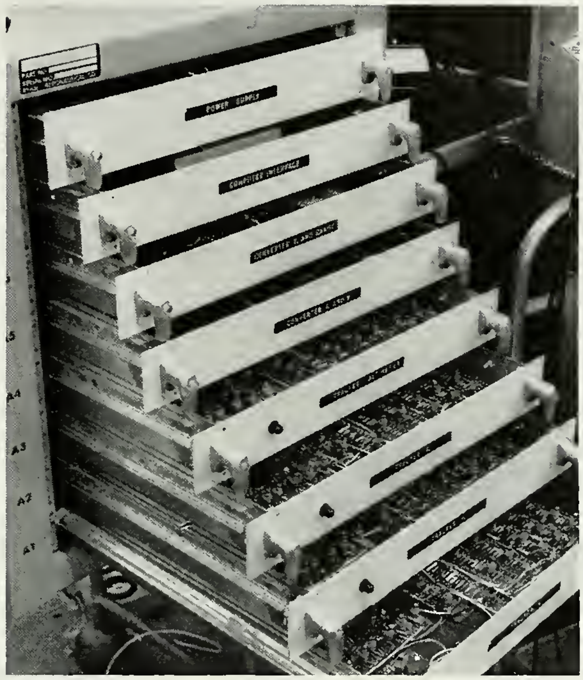


microwave energy in known angular relation with respect to the spacecraft coordinate system. Three continuous-wave beams are used for velocity sensing and one FM/CW for ranging. The return signals from the lunar surface are immediately mixed with a portion of the transmitted energy. As a result, frequencies proportional to the components of spacecraft total velocity sensing beams are obtained in a direct RF to audio conversion. A frequency proportional to range along the fourth beam is obtained in a similar manner. Solid state transmitters are used in lieu of conventional klystrons because of their higher reliability, lower power requirements and the ability to operate with very low supply voltages.

The direct RF to audio conversion produces a pair of quadrature signals for each beam. The quadrature pairs are used to determine if the velocities are positive or negative. The signals (Dopplers and range) are amplified and fed to the electronic assembly for processing.

The electronic assembly employs a frequency tracker for the outputs of each of the four beams. Each frequency tracker automatically searches a frequency range within which the return signal is expected to fall. Upon acquisition of the return signal and proof of its authenticity, the tracker produces a single output frequency corresponding to the frequency at the center of power of the received signal spectrum. An arithmetic section then performs essential combination of the tracker frequencies in order to produce range and orthogonal components of the total velocity vector in both the antenna coordinate system and space craft coordinate system. These outputs are then fed to the LEM guidance computer where they are further processed and used for updating the inertial guidance system. The range and velocities are also fed to a Control Assembly where they provide visual indication to the astronauts.

Ryan is designing and building special test equipment sets to support the landing radar. The basic requirement is to prove by test that the landing radar meets all of its performance requirements and to prove system compatibility by simulating all expected external loads. The test equipment simulates lunar return signals in the RF domain by capture and modulation of the transmitted RF energy providing variable attenua-



The LEM landing radar electronics breadboard is neatly packaged in drawers.

Ryan Electronics' engineer performs functional test on scale model of planar array antenna.

As the Lunar Excursion Module (LEM) approaches the moon, the Ryan designed and produced landing radar and Doppler velocity system begins operation. The two-position planar array antenna sends out four narrow beams of microwave energy to acquire the lunar surface. Later as the spacecraft programs over for vertical landing, the antenna tilts with it to maintain a constant fix on the lunar surface.

tion to signal level to simulate trajectory conditions, and then feeding the signal back into the microwave receiver. The capability to simulate the full range of expected trajectory conditions is a basic characteristic.

A very extensive test program is required to prove and insure extremely high reliability requirements for the landing radar. Critical environmental tests, reliability acceptance tests, and qualification tests must be successfully completed to insure the acceptability of the flight models. Something in excess of one year of continuous testing on eight systems is required. In addition, Ryan plans an early flight test in a helicopter using the breadboard radar presently in test. Subsequent flight tests are planned in both helicopter and fixed wing aircraft using one of the critical environmental test models. These tests will simulate portions of the descent trajectory and reveal any design difficulties early in the program.

As with all space projects, new design problems are continually being encountered. In the case of the landing radar, the unknowns relate to the lunar surface reflectivity characteristics, the effects of lunar dust stirred by the landing rocket engines, and the rocket plume effect upon the transmitted energy. Concurrent studies of these and other problems will lead to solution prior to a manned landing. Thermal control of the antenna assembly poses a challenging design problem. It may face either deep space or full solar radiation during the complete translunar phase and be exposed to intense radiation from the rocket skirt during the descent phase.

Since Grumman undertook the responsibility of creating the LEM vehicle, the time has been spent, primarily, in defining the vehicle's structural configuration and establishing detailed performance requirements of the subsystems.

Among the many program activities at Grumman during the past year was the construction of full-scale LEM mockups. These mockups were evaluated by a NASA technical team from many standpoints . . . the space and mobility afforded the occupants . . . the crew station arrangement . . . the convenience of operating controls . . . the accessibility of equipment packages . . . the arrangements for docking with the CM.

From these evaluations and subsequent design refinements has emerged the configuration illustrated. Although design improvements will continue, what is shown here will, by and large, be the ultimate hardware version.

Grumman is also exploring the needs for missions beyond the initial Apollo mission and has defined several LEM derivatives:

THE LEM TRUCK—*an unmanned logistics version that would stay time on the moon, provide vehicles for astronaut mobility, provide equipment and shelter, and provide landing-site surveying capabilities.*

RECON LEM—*a manned, lunar-orbiting, reconnaissance version equipped with photographic, scientific and surface-probing sensors to determine the most suitable landing sites for our lunar-landing capsules.*

STEM LEM—*a manned version to make use of possible increases in allowable LEM weight by incorporating a greater payload for extending surface exploration staying time and mobility.* ■


TUG

Towed behind helicopter Ryan TUG will carry 500 gallons of fuel or 4000 pounds of dry cargo.

AN AIRBORNE U-HAUL-IT

STRATEGIC AERIAL DELIVERY of fuel and high priority military cargo to remote areas will be further enhanced by means of Flexible Wing Towed Universal Glider ("TUG") systems currently being built by Ryan Aeronautical Company under a recently announced contract awarded the San Diego firm by the Army for the Department of Defense's Advanced Research Projects Agency (ARPA).

The "TUG" systems will be capable of carrying 500 gallons of fuel or 4,000 pounds of dry cargo, when towed by Army helicopters. Mixed loads of fuel and dry cargo would be transported by utilization of dividers within the cargo compartment.

After being towed to the predetermined site, the "TUG" body can be operated as a Jeep trailer by removing the flexible plastic-coated wing and strut assembly. The cargo can thus be hauled to the specific ground locations where it is immediately needed.

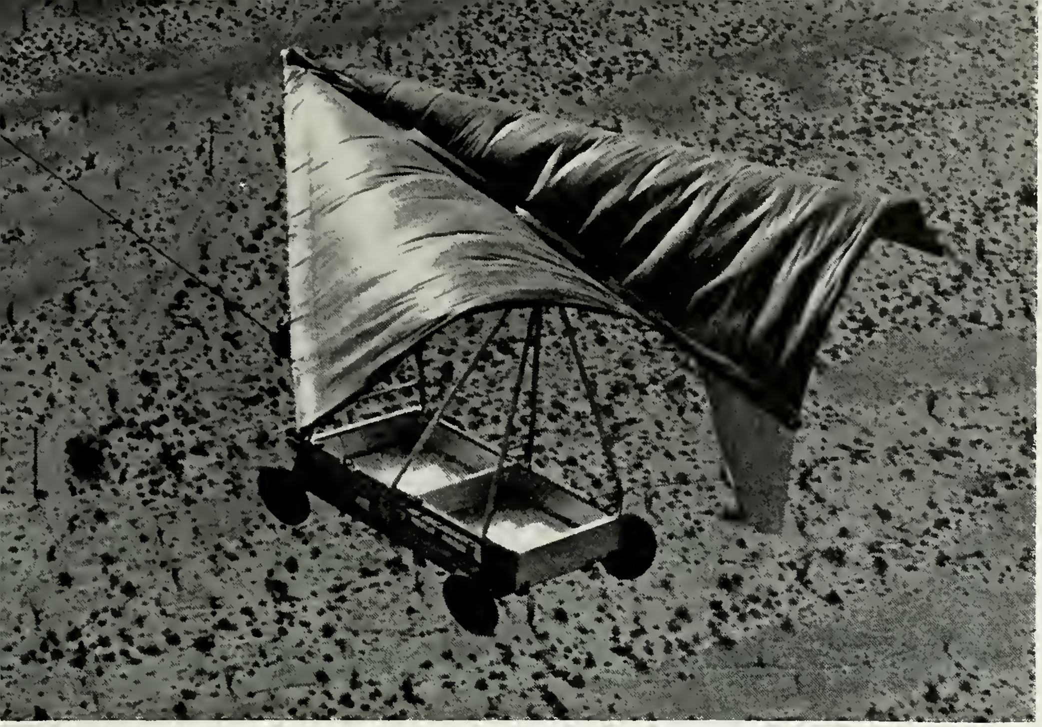
Ryan has been a pioneer in the development of various types of Flex Wing vehicles, including the "Fleep," a manned "flying truck"; a Precision Drop Glider; an Air Cargo Drop Glider; a "Flex Bee" reconnaissance powered drone; and an Individual Drop Glider for airborne troops.

A quantity of Air Cargo Gliders have been built for the Army and ARPA, and successful tests have been conducted with helicopter-towed cargoes of varying configurations, including Jeeps and other small wheeled carriers.

In such tests, the Flex Wing gliders made free flight landings and towed take-offs on rough terrain. The deliveries can be performed in radio-controlled free flight after release from the towing helicopter, or can be towed directly to the target.

The new "TUG" concept is applicable to local, limited "brush-fire" combat situations, in which mobility and instant reaction are essential. This system can multiply by several times the normal internal payload capacity of the towing aircraft, and reduce personnel hazard.

Army helicopters are called upon for short haul transport to expedite tactical operations and logistic support in forward areas, where fixed wing aircraft cannot operate, where surface transport is not practical, and where time is an important element. By nearly tripling helicopter payloads,



the "TUG" system would obviate the requirement for a greatly increased number of helicopters to meet logistical needs.

Another major factor is increased survivability. If the "TUG" is hit and fire breaks out, it can be jettisoned with no danger to the helicopter crew.

Ryan engineers contend that the most practical and economical method to satisfy the requirement for a simple airborne fuel supply system under limited warfare conditions is the Flex Wing approach.

The Ryan Flex Wing system consists of a polyester-coated Dacron base cloth membrane, a telescoped tubular aluminum alloy keel, leading edges, a jointed spreader bar and various fittings for wing attachment and adjustment. All connections and joints are of standard sheet metal construction, and are designed to allow ease of disassembly and replacement.

The glider body is shaped similar to that of a conventional pickup truck bed. It has a cargo deck with cargo tie-down fittings, a cargo divider with fixed sides and front, and a removable tail gate at the rear. Two dock boards are stowed on the sides of the body and are manually positioned on the aft end of the cargo deck for rolling wheeled cargo in and out of the body. A tow bar is attached to the front end of the body that mates with existing military tow hooks for ease in ground handling before and after flights.

The fuel cell is a flexible, collapsible container made of rubberized fabric in a convenient pillow design.

The body is supported by a rolling gear designed for ground handling and take-off runs. Two longitudinal wooden skids, attached to the underside, absorb the major landing loads, and reduce tendency of the glider to bounce. Rolling gear springs, made of Fiberglas in the form of conventional single flat leaf springs, are similar to those developed and tested for the "Fleep." Wheels and brakes are standard Jeep equipment.

The 400-foot tow cable is a standard woven wire strain cable wrapped with electrical wires and covered with a Neoprene jacket.

The "TUG" contract is being monitored by the U.S. Army Transportation Research Command, Ft. Eustis, Virginia, an element of the U.S. Army Aviation Materiel Command, St. Louis, Mo. ■

XV-5A TRANSITION

Extended hovers, high speed flight demonstrated

LAST FEBRUARY a new breed of airplane arrived at Edwards Air Force Base.

It was the U.S. Army XV-5A, the first of two such aircraft built by Ryan Aeronautical Company in San Diego, California.

For all practical purposes, it looked like and was to fly like a conventional jet aircraft. But unusual five-foot diameter fans tucked in each wing and a third but smaller fan in the nose, forward of the cockpit, betrayed this airplane's capability. Flight tests would prove the XV-5A could take off and land like an elevator—straight up and straight down—and in an area no larger than a tennis court.

A busy summer of extensive flight testing followed. Hover tests, conventional flight tests, conversions from wing-supported flight to fan-supported flight at altitude, and short take-off and landing tests on fans were completed.

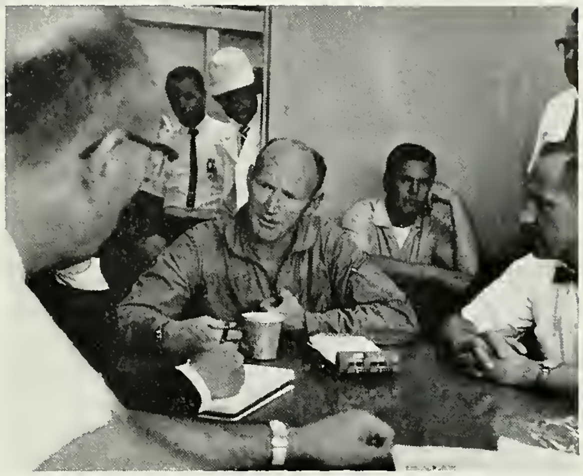
The XV-5A flew all over the Edwards sky completing maneuvers expected of any conventional jet aircraft. Then for good measure the Ryan-built XV-5A flew backwards, sideways and made 360 degree turns from its hovering position 30 feet above the Edwards runway. During such maneuvers, crack Air Force test pilots—impressed by very little in their high speed world—would gaze in disbelief at the strange XV-5A antics.

Then in November, combining all the elements of its impressive repertoire, the XV-5A took off vertically, hovered momentarily, then darted away in high speed flight. After a high speed, low-level pass at the Edwards runway, the XV-5A flew back over the runway, slowed gradually to a hover and landed—like an elevator—straight down.

The complete transition flight represented a major milestone in development of the aircraft by Ryan Aeronautical Company and General Electric for the U.S. Army Transportation Research Command at Ft. Eustis, Virginia.

The plane piloted by engineering test pilot Val Schaeffer climbed straight up on its triple column of jet thrust provided by two wing fans and a nose fan, hovered momentarily at an altitude of 30 feet, then moved forward and gathered speed as it demonstrated the complete cycle of vertical take-off, followed by forward flight.

The XV-5A, powered by General Electric's distinctive propulsion system, is an extension of work pioneered by Ryan and General Electric on the principle of using fans submerged in aircraft wings for vertical lift. Feature of the propulsion system is a set of five-foot diameter lift fans mounted horizontally within the wings, powered by the exhaust of two G.E. J85 jet engines to provide the lift for vertical take-off and hovering. The fans within the wings and nose accelerate the exhaust from the conventional jet engines, providing three times the lifting power of the jet thrust alone.



Test pilot Val Schaeffer debriefs after historic first transition flight.

Capable of taking off vertically from an area no larger than a tennis court, aircraft based on the XV-5A concept can transition to a conventional flight pattern and accomplish military missions at high subsonic speeds, then return, hover, and land vertically in remote, rugged areas, such as small jungle clearings.

U.S. Army officials took advantage of the annual gathering of the Association of U.S. Army in Washington to announce the successful transition of the XV-5A.

Acting as the Army's official spokesman Brigadier General William T. Ryder, Deputy Chief, International Programs in the Army office of the Chief of Research and Development said in part: "It is with considerable pride that the Army announces that on 5 November 1964 at Edwards Air Force Base, the XV-5A successfully demonstrated a vertical take-off and transition to conventional jet flight. The aircraft also performed a high speed fly-by and reconversion for a vertical landing supported by its lifting fans. The XV-5A can now be utilized as a valuable research tool in

The U.S. Army XV-5A takes-off on first transition flight at Edwards Air Force Base. The XV-5A took off vertically, hovered momentarily then darted away in high speed conventional flight.

the further investigation of the problems attendant to conversion from vertical lift and descent to horizontal flight."

Further he said, "In the last 15 years, the Army has conducted research in at least 14 different types of V/STOL aircraft. The XV-5A is one of three jet models under current study. The lift-fan XV-5A was built under Army contract by the General Electric Company and the Ryan Aeronautical Company. The aircraft in its present configuration was built specifically to test the fan-in-wing principle of vertical lift. A tactical version capable of performing battlefield tasks would require a different airframe."

In his briefing remarks to the assembled newsmen, Major Paul Curry of the Army's Transportation Research Command said in part, "The recent complete transition of the XV-5A from hovering flight to conventional flight and back to a vertical landing is a significant event in this program and has provided the contractor and the Army with a valuable flight research tool with which we can continue to gather data for both the lift-fan concept and to provide improvements in future V/STOL aircraft design."

Ryan chief engineering test pilot Lou Everett straps in for XV-5A test flight.

In a discussion of the merits of the XV-5A Major Curry said further, "The lift-fan concept offers several important advantages. These are: large augmentation of basic engine thrust giving a good match between power required to hover and power required for cruise speed; a slow, cool downwash; two engine reliability for cruise, and the assurance of level flight even if one engine fails. Roll and yaw control are obtained from the lift system without the need for auxiliary reaction controls such as trim tabs or nozzles." ■

T. Claude Ryan, Chairman of the Board, Ryan Aeronautical Company (white cap), congratulates W. T. Immenschuh, Chief Engineer, after first transition flights of the XV-5A.

T. Claude Ryan comments:

It was a tremendous sight—the first full-cycle transition flight by a vertical take-off and landing plane using the lift-fan principle.

When Test Pilot Val Schaeffer brought the XV-5A back to earth at Edwards Air Force Base after rising vertically, transitioning to conventional forward flight, then converting back to fan-supported flight, and finally settling gently to a vertical landing, the reaction of everyone who witnessed this feat was:

"We really have something!"

After many years of study and experimentation with a variety of concepts—including direct thrust and deflected slipstream—we are convinced that the XV-5A is a major breakthrough in V/STOL technology.

For this plane does what no V/STOL before it could. It can take off straight up, hover, and convert to horizontal flight using no more power or fuel than is required for conventional flight.

This is the key to the success of V/STOL. It means greater payload, longer range, less logistic support and lower fuel requirements. This is now possible, as the XV-5A is demonstrating, because the same basic power output can be used for all flight modes.

The XV-5A has without doubt established itself as the most logical and advanced V/STOL concept. It is the first plane that doesn't need three times the power used for normal cruise in order to achieve vertical take-off. Thus, future VTO planes built on this concept will perform useful functions, not just make stunt demonstrations. It pays no penalty for its unusual capability.

"It's so easy to fly you won't believe it," Schaeffer told us as he climbed out of the XV-5A. "Easier than a helicopter and way ahead of any other fixed wing V/STOL."

In more than 40 years of aviation experience, I can't recall any greater satisfaction than observing this first complete transition flight. The thrill had a twofold origin—the efficiency of the operation, and perhaps even more important, the significance of this flight.

I don't think any of us can yet grasp the full potential of what we have now proven. Here is a plane that has the vertical and hovering ability of a helicopter, combined with the high performance of a forward-flight fixed wing aircraft—doing both jobs well without compromise or penalty. The XV-5A doesn't make a lot of sacrifices to perform efficiently, either as a conventional plane or as a vertically rising vehicle.

The imaginary technical problems that might be expected to develop—all those which we were on guard against in certain areas—have shown themselves capable of solution. In vertical lift-off, in hovering flight, in forward translation, the XV-5A is steady as can be. I was amazed to see how solid it is under all conditions.

This first full-cycle transition flight was a beauty. The plane took off gently and steady as a rock. It lifted effortlessly with no forward speed and can fly straight up as high as necessary to clear any surrounding obstacles. When Schaeffer attained 30 feet altitude, he flew forward on the fans until reaching the speed needed for wing-supported flight. Then, merely by flicking a switch, he converted the XV-5A to conventional wing-supported flight on tailpipe thrust.

Aside from forward speed, the major improvement in the basic conventional plane in the future must involve its take-off and landing characteristics. Today's aircraft, after 50 years of refinement, are still restricted by operating requirements at point of departure and point of arrival. They must have runways. Major improvements must involve take-off and landing characteristics. This is what we have accomplished in the XV-5A—a good conventional plane; a good VTO. ■

MUSCULAR FIREBEE

A "BEEFED-UP" TARGET ground launch system developed under an Army Missile Command contract by Ryan Aeronautical Company promises to increase the payload capability of the Ryan-built Army MQM-34D Firebee target guided missile by 300 per cent, R. C. Jackson, Ryan president disclosed recently.

The system is being flight tested by Ryan's contractor team at the Army's White Sands Missile Range, New Mexico, under the direction of Army Missile Command, Redstone Arsenal, Huntsville, Alabama. Mr. Jere Ducote is responsible for the execution of this program as well as all other Army research and development efforts in the field of target guided missiles.

The Army originally sponsored development of the ground launch system for the Firebee in 1959, a concept that has since been adopted by both

U. S. ARMY PHOTOS

Its more powerful rocket booster spurting flame, the Ryan-built U.S. Army MQM-34D Firebee leaves the launching pad at the White Sands Missile range, New Mexico. The bigger booster combine with extended wingtips to lift an additional 1000 pounds.

the Air Force and Navy. Used operationally by all three services, Firebees are either blasted from ground launchers by JATO (Jet Assisted Take-Off) bottles, or air launched from "mother" aircraft.

To increase the Firebee's load carrying capacity, a JATO bottle with twice the burning duration has been adapted for the remote controlled target. The 11,000 pound thrust JATO will burn for approximately 4 seconds or about twice as long as JATO units currently in operational use with the Firebee.

Additionally the target's wing tips have been extended to provide greater lift, as a match for the increased payload.

"The additional boost at launch and the greater wing area," Jackson said, "could allow the Firebee to carry upward of 1,000 additional pounds." An announced Army objective of the development program is the addition of wing pylon mounted fuel tanks to extend the jet target's endurance.

Additional planning flights are expected to fully develop the concept.

The high performance MQM-34D Firebee jet target guided missile was recently adopted by the Army as the Standard Type II target, and is the counterpart of the Navy and Air Force BQM-34A (formerly Q-2C).

Ryan Firebees have flown more than 6,000 missions from bases throughout the world in support of Armed Forces training programs and missile evaluation exercises. ■


SOLAR
ARRAYS

Space erectable structures could open like rose buds

SOLAR ARRAYS that can capture the sun's energy to furnish power for space vehicles while providing improved flexibility of packaging and efficient deployment, are under study by Ryan Aeronautical Company. Preliminary phases of development are being done under a contract just awarded the San Diego aerospace firm by the National Aeronautics and Space Adminstration's Goddard Space Flight Center.

Foldable, roll-out, pleated and other array concepts are being studied by the company, which draws on its experiences in successful construction of solar panels for several space vehicles.

The semi-rigid or flexible solar arrays would provide rigidization in space after deployment, compatible with solar cell mounting techniques, would be light weight and would provide large areas. They would maintain dimensional integrity while spinning on spacecraft bodies, would be capable of reliable operation in the hard vacuum of space, and could withstand shock, vibration and accelerations as might be experienced during launch.

The basic substrate material for the solar cells would be a sheet of coated glass laminated fabric, approximately 13 inches wide by 8 feet long.

In the foldable, or segmented beam concept, small, bulbed, T-shaped ribs are cut at four locations along the longitudinal axis, into approximately one centimeter lengths, so that a lateral increment of the substrate acts as a hinge in these locations.

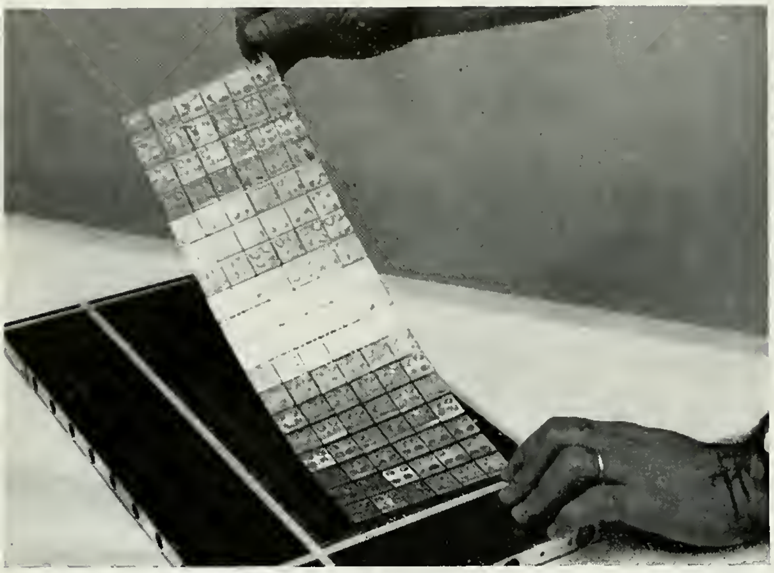
The bulb portion of the ribs is pierced and threaded with a continuous steel wire for the 8-foot length. One end of the wire is stopped at the outermost tip of the segmented beams. The inboard ends are secured to motor-driven spools which are part of the interface structure. When the wires are slack, the substrate will lie in small chords around the 90 degree and 180 degree bends. To deploy the array, the two wires are reeled onto their respective spools. Tension is then applied, and the cut edges of the rib segments come together and butt, thus straightening out the substrate to a flat plane. An appropriate layout of solar cells would be mounted on both surfaces of the substrate.

In the roll-out concept, the flexible material substrate is wrapped, as in a rectangle with semi-circular ends, around two parallel rollers. Solar cells would be mounted in lateral rows to both sides of the fabric substrate. The end of the substrate which is to be deployed away from the vehicle is secured to a tie-bar attached to the extendable ends of parallel, telescoped arms. These arms hinge outward 90 degrees from their stowed position, and are then actuated to their maximum extended length. In doing so, the flexible substrate follows, unwinding from the rollers to expose the array of solar cells. Deployment would be motivated by a stored energy system, either pneumatic, chemical or mechanical.

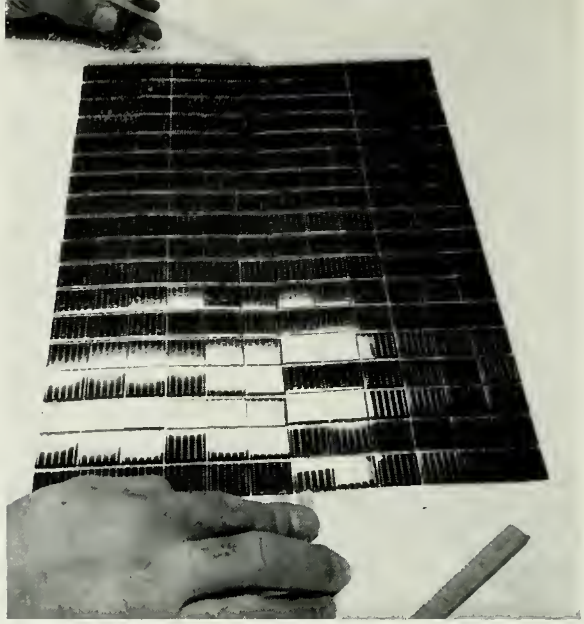
It is anticipated that development of this design concept would advance several principles applicable to future designs for other space components, such as corner reflectors, space antennas, erectable structures and light-sensing devices needed on future spacecraft.

Another concept advanced by Ryan is a pleated solar array, which would consist of a continuous lightweight fabric sheet, with solar cells applied to both sides of the fabric in rectangular modules, and parallel lazy tongs along the edges to extend the array. Each rectangular group would be separated from the next by a narrow band of the base fabric to pre-determine the fold. In the nested or packaged position, the rectangles pleat in accordion fashion, following the zig-zag arrangement of the collapsed lazy tongs.

One end of the pair of tongs is hinged to a base structure. To deploy the array, it is mechanically



Pacing the industry with solar array development, Ryan has combined solar cells in blanket form.



Ryan-developed techniques for laying solar cells promise to speed production of solar panels.

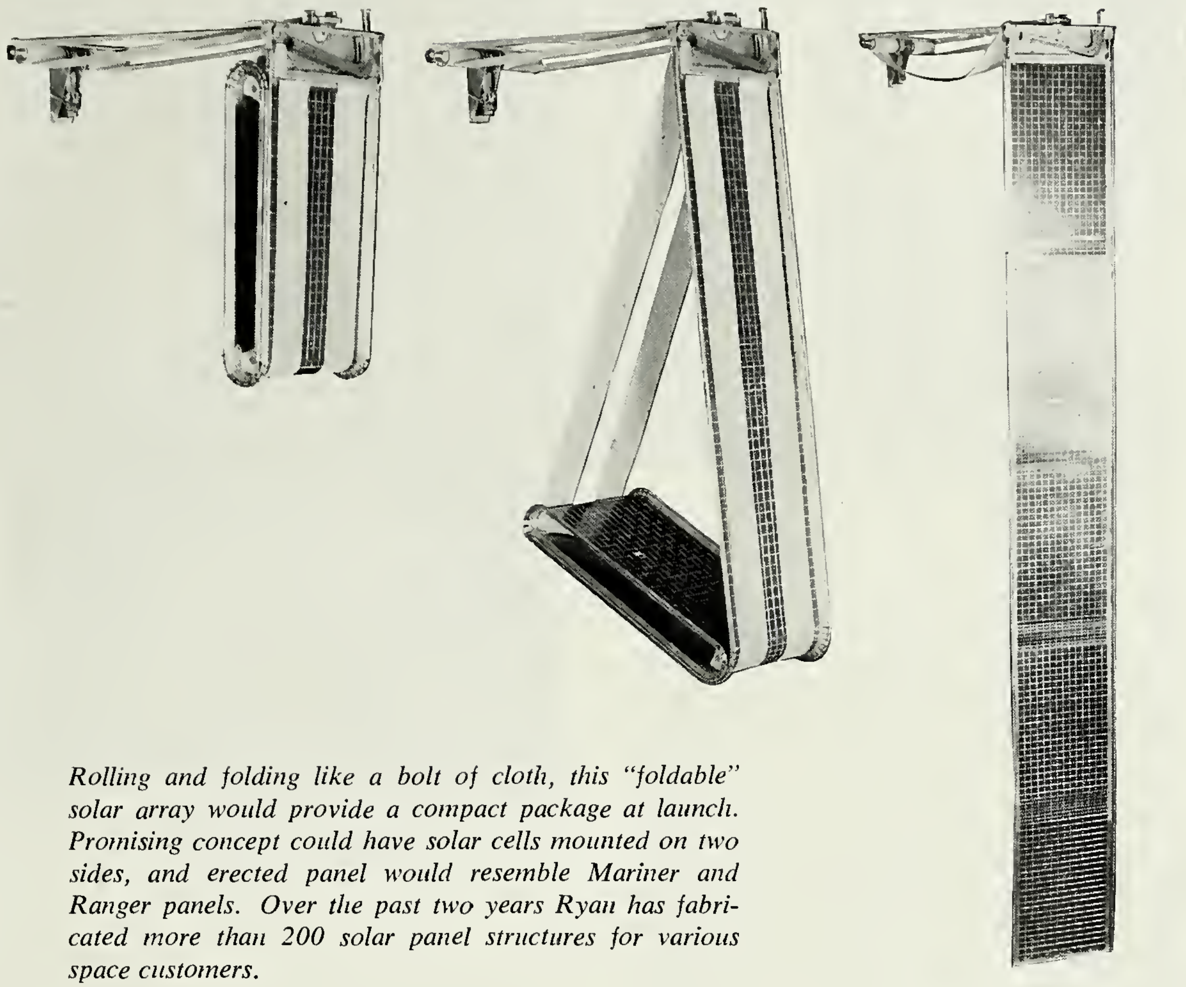
Resembling a rose bud (above) in its collapsed form this unique structure would open (below) in space to provide energy conversion device.

erected outward through a 20 degree arc and locked. At the same time, small wires reeved through guides at the tip of each pair of scissoring arms are reeled onto a motor-driven pair of spools. This reduces the angles of all the scissored arms, extending the array to fully deployed position.

Ryan has already successfully applied this principle in deployment of a 10-foot diameter, parabolic-shaped, all metal solar concentrator for a space power system. This consisted of 36 petals which folded up into a 28½ inch diameter about the centerline. In deploying, the petals pivoted about an axis at their root, twisting and lowering to form the paraboloid. Lazy tongs were used at the rim to synchronize and lock the petals in the proper location, thereby completing the deployment cycle.

Still another design studied by Ryan is a roll-and-fold array, which is similar to the unrolling of a bolt of cloth. The array can either be semi-rigid type which folds up about a base segment, or if made as a flexible fabric substrate, it can be wrapped around a simple oval-shaped frame.

Telescoping arms or an equivalent extendable structure are used for deployment. The root sections of the arms include opposing pivot pins which serve as the rotating axis of the frame or base segment. When packaged, the substrate is wrapped around the frame, or folded around the base segment, and stowed in a mounting structure.



Rolling and folding like a bolt of cloth, this "foldable" solar array would provide a compact package at launch. Promising concept could have solar cells mounted on two sides, and erected panel would resemble Mariner and Ranger panels. Over the past two years Ryan has fabricated more than 200 solar panel structures for various space customers.

The deployment arms are telescoped with the pivot pins fitted into slots inside members of the mounting structure. The outer end of the substrate is pinned to a tie-bar that is secured to the tips of the telescoped arms.

To deploy the array, the telescoped arms are mechanically erected to a position normal to the mounting structure. When the arms extend, the substrate is unfolded in a rolling motion.

The roll-and-fold array appears the simplest solution to supporting the package during the launch phase.

A modular fold-out panel array would consist of four modules made as honeycomb sandwiches or with a corrugated core and two face skins. Ryan has had considerable experience with this type of panel, in the Mariner, Ranger, and S-66 space vehicle programs.

Deployment would be accomplished with torsional springs at the hinges, or by telescoping arms at the two longitudinal edges. A lightweight, unreeling cable arrangement at these same edges would control rate and mode of deployment for a spring-loaded hinge system.

Supporting these advanced concepts is Ryan experience in fabricating solar arrays which meet environmental requirements and exhibit high solar energy conversion efficiency. During the past two years, more than 200 such assemblies have been supplied to various customers, with panel structures ranging in size from 4 to 23 square feet. Among Ryan customers in this field have been the Jet Propulsion Laboratory of California Institute of Technology; Johns Hopkins University's Applied Physics Laboratory; Hoffman Electronics Corporation, and the U. S. Naval Avionics Facility. ■

WINDMILLS IN SPACE

THE MARINER IV SPACECRAFT speeding toward Mars on the deepest, most complex space probe ever attempted by the United States, is equipped with Ryan solar panel structures. It looks like a space-age windmill.

The solar panel structures, four of more than 200 designed and built by Ryan for premiere spacecraft and satellites, represent the ever broadening application of Ryan capabilities to the nation's space exploration efforts.

When deployed in space the solar panel structures extend outward from Mariner's octagonal base, resembling giant rectangular propellers. Ryan-devised fabrication techniques assure the survival of the structures during the extreme vibrations experienced during launch, and give the necessary strength to withstand the multiple stresses encountered in orbital flight, midcourse maneuvers and deep space flight.

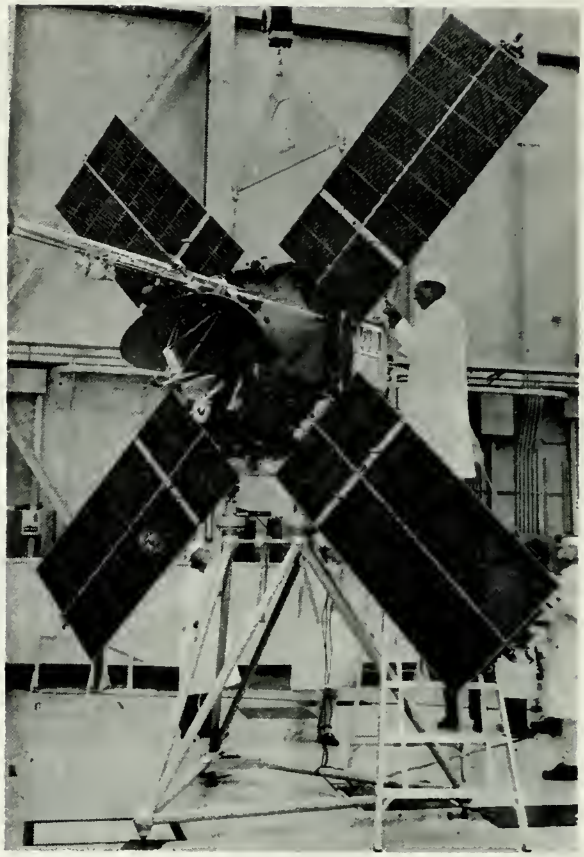
The aluminum skins of the panels are fortified by continuous aluminum corrugations attached by resin bonding, providing excellent resistance to fatigue at launch and in the hard vacuum of space.

The panel's contain thousands of solar cells which convert the sun's energy for the vehicle's power requirements as it transmits to earth scientific information obtained during its unprecedented fly-by of the red planet.

Ryan solar panel structures have been a distinctive physical and functional feature of other premiere spacecraft such as the Mariner II that traveled to the vicinity of Venus in 1962, and Ranger VII that just made space history by taking more than 4000 close-up photographs of the lunar surface in 1964. The Explorer B satellite now orbiting the earth, conducting ionosphere and laser experiments, is equipped with Ryan solar panel structures with cells mounted on both sides.

Mariner IV

Initial U.S. planetary exploration is being carried out by the Mariner program. Frontrunner in the Mariner series was the Venus probe launched in 1962. Although the Soviets have attempted more than a dozen planetary probes, the Mariner II remains as the only successful planetary spacecraft to date. It transmitted data about 54 million miles in 1962 before its signal disappeared.



Ryan solar panel structures give Mars-bound Mariner that windmill appearance.

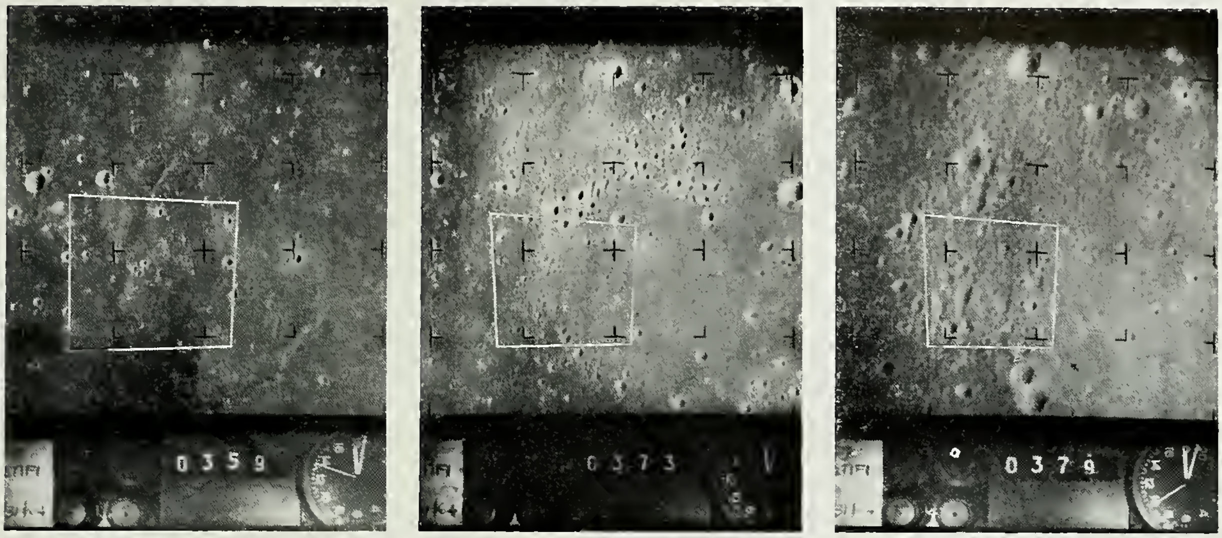
Magnitudes larger in scope and objectives, the Mariner Mars spacecraft will spend 8½ months in flight from earth to Mars. It will be required to communicate over 150 million miles.

Two Mars experiments are planned. A television camera will take up to 22 photographs of the Martian surface, and occulation studies of Martian atmospheric pressure will be based on the spacecraft's radio signals as it passes behind the planet. Additionally, six interplanetary experiments will measure radiation, magnetic fields and micrometeorites in space and near Mars.

Ryan fabricated Mariner II and Mariner IV solar panel structures for Cal Tech's Jet Propulsion Laboratory.

Explorer B

Explorer B has four, two-sided, aluminum Ryan solar panel structures, 10 inches wide and 66 inches long, covered with solar cells on both sides to convert the sun's energy into electricity to recharge nickel cadmium batteries. The power system is adequate to operate the satellite components for about three years. Built by Ryan for

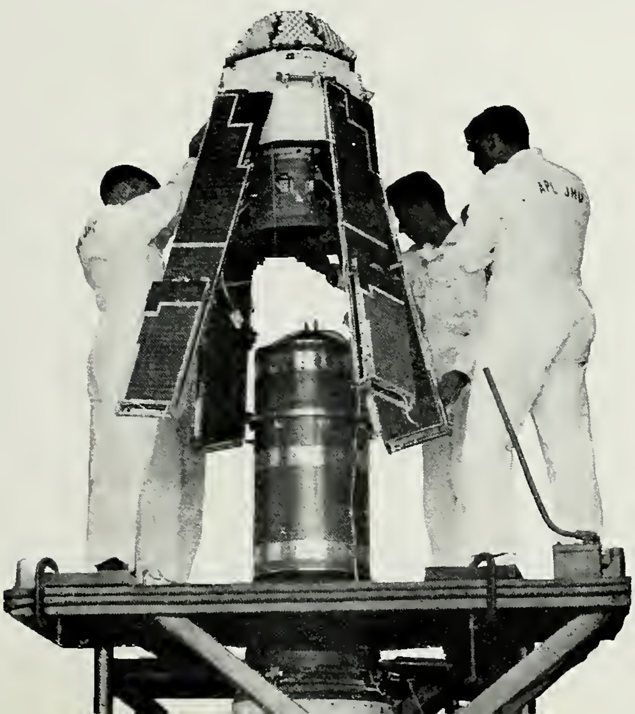


These detailed photographs of the lunar surface were taken by Ranger VII equipped with Ryan solar panel structures.

the Applied Physics Laboratory at Johns Hopkins University, the structures extend from the sides of the satellite.

Launched in October 1964 from Pt. Arguello, Explorer B is known as the ionosphere beacon satellite. It is designed to make global measurements of the ionosphere to make possible plotting of the form and structure of the ionosphere, enabling scientists to describe its behavior under varying conditions of solar activity, season and time of day.

On Explorer B, four two-sided aluminum solar panel structures are folded for launch, extended in space.



In the Explorer B launch phase, the Ryan-built solar panels were folded down over the fourth stage of the launch vehicle and were held in place by the cables of the despin weight assembly.

Ranger VII

After a series of early program disappointments, NASA and Jet Propulsion Laboratory scientists were rewarded with the seemingly flawless performance of Ranger VII in 1964. The Ranger spacecraft impacted on the moon almost in the exact location predicted for its "hard" landing, but not before it took and transmitted 4316 high quality photographs of the lunar surface. Two more Ranger spacecraft will be sent on similar missions, with their targets (possible LEM landing sites) selected prior to the midcourse maneuver.

The Ranger spacecraft is a conical shaped, polished aluminum structure, mounted on a hexagonal bus, with two solar panels and high gain antenna extending from the base of the bus. Fully extended the solar panel span measures 15 feet and the spacecraft is approximately 10½ feet high.

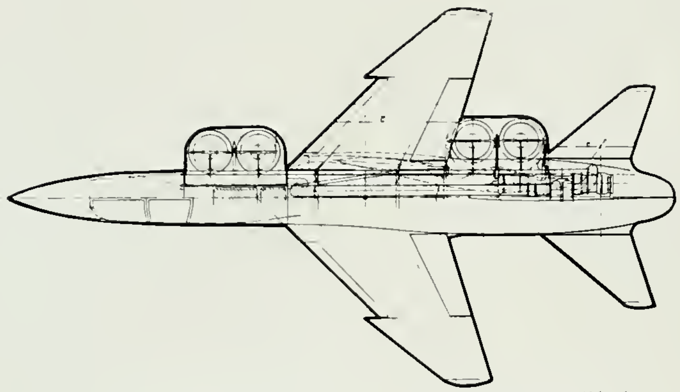
The last two Rangers, for which Ryan has already completed the solar panel structures will be launched by Atlas-Agenas from Cape Kennedy in 1965. ■

COMING VERT

FAN ATTRACTIONS

IN LATE DECEMBER, the Research and Development Subcommittee of the House Armed Services Committee concluded a series of hearings that began on May 13, 1964, with a report and recommendations on vertical and short take-off and landing V/STOL aircraft. The report stated:

(1) "Our primary recommendation is for the Department of Defense to proceed with the implementation of a program to develop and acquire sufficient quantities of V/STOL tactical fighter aircraft to determine the operational suitability of this type of aircraft for application to the tactical air missions of the military services."



This advanced Vertifan concept features lift-fans that tuck in fuselage like landing gear during conventional high speed flight.

According to the report, the series of hearings was prompted during the committee's consideration of legislation to authorize appropriations for fiscal 1965 procurement of aircraft, missiles and naval vessels, and research, development, test and evaluation, for the Armed Forces. Several members questioned the adequacy of effort being expended on the development of aircraft capable of vertical and short take-off and landing. Questions were raised also on the development efforts for engines to propel such aircraft and the United States contribution and support of V/STOL developments by our NATO allies.

Industry, military and Department of Defense officials appeared before the committee during the extended hearings.

Throughout the report, the committee's interest in development of an operational evaluation V/STOL program was apparent. At one point the report said, "Currently, a truly operational V/STOL aircraft is nonexistent in the free world today. The ways in which V/STOL aircraft can be effectively utilized in warfare as well as their possible inherent advantageous characteristics as related to mobility and flexibility of operation have been broadly theorized over the years, but have never been put to the test. Probably the most significant factor in the lack of V/STOL development in the United States is that the time, money and effort required to build and test operational aircraft have never been expended. This means that any attributes of V/STOL aircraft, from an operational standpoint, remain in the area of conjecture."

The report summarized the findings of the committee hearings and outlined the progress being made with several United States V/STOL programs, including the XC-142A, X-19, X-22, XV4-A, and the XV-5A. Foreign programs reviewed included the British P-1127, and 1154, the French Balzac and Mirage III-V, the German VJ-101C and D, VAK-191B and the Dornier DO-31. Propulsion systems were reviewed.

In reporting their findings, the committee report continued "approximately $50 million of U.S. funds have been invested in support of the British P-1127 aircraft and its related engine, the BS-53. Undoubtedly this contribution has been of great assistance to the British in gaining leadership in V/STOL aircraft and engines. It has been said that the British are two years ahead of the rest of the free world in the development and production of lift and lift/cruise engines."

"Over the past 14 years the Department of Defense has expended over $300 million on V/STOL aircraft programs and has yet to obtain any prototype in sufficient quantities to conduct an operational suitability evaluation."

Citing earlier studies of V/STOL aircraft the committee said, "Two Department of Defense ad hoc groups in the last eight years have recommended that aggressive action be taken in the overall field of V/STOL technology."

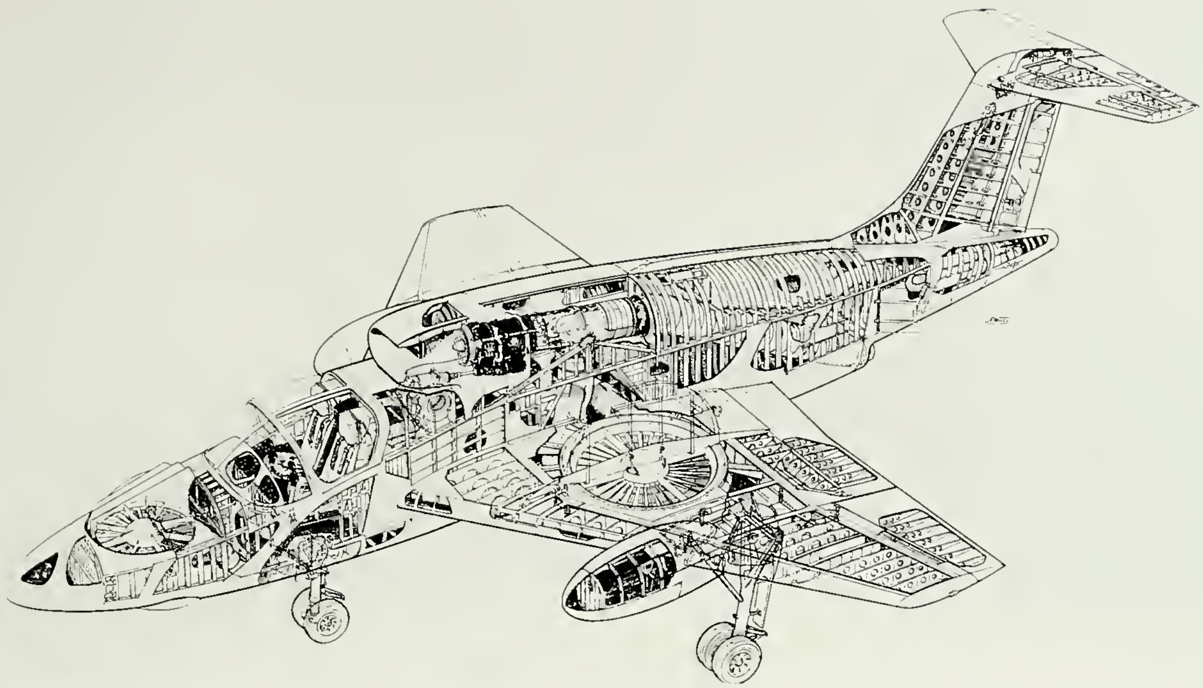
Concluding, the committee report said, "The technical feasibility of V/STOL fighter and transport type aircraft has been clearly demonstrated. A technological breakthrough in propulsion or aerodynamics is not required for the development of V/STOL aircraft with useful payload and range capabilities. An analysis of the data presented indicates that there are valid military requirements for V/STOL transport and tactical fighter aircraft."

XV-5A Completes Phase One

Shortly after the committee released its report, the U.S. Army XV-5A significantly completed Phase I flight tests at Edwards Air Force Base. Recording 14 flights in an impressive three day finale the two XV-5A research aircraft, designed and built by Ryan Aeronautical Company, completed Phase I flights on December 31. The last 50 flights were flown in less than 30 working days.

Ryan designed, built and flight tested the aircraft for the Army Transportation Research Command under contract to General Electric, developers of the XV-5A's lift-fan propulsion system.

Recalling the impressive performance of the XV-5A during this first series of flight tests, T. Claude Ryan, Chairman of the Board and Chief Executive Officer of Ryan Aeronautical Company said, "the U.S. Army XV-5A, embodying the Ryan Vertifan concept, has set the pace for world V/STOL aircraft development with the completion of Phase I flight tests. We are convinced that the XV-5A is a major breakthrough in V/STOL technology."



Detailed cutaway drawing shows XV-5A modification proposed for Operational Evaluation testing. Note outboard double landing gear for soft site operation and larger wing area for increased gross weight.

Evaluating the accomplishments of the initial flight tests, William T. Immenschuh, Ryan Chief Engineer, V/STOL Aircraft, said the XV-5A performed to expectations. "The aircraft proved the capability of the lift-fan propulsion system in vertical take-off, hovering, and transition to conventional flight. We completed detailed investigations of aircraft performance from zero speed at hover to more than 500 mile per hour."

"As a result of the multiple accomplishment of Phase I testing," Immenschuh said, "we have tremendous confidence in the capability of the aircraft, and look for it to contribute valuable V/STOL flight and engineering data as more advanced flight tests get underway in Phase II of the program."

Immenschuh said that the Vertifan concept is equally adaptable to supersonic tactical aircraft and to high speed transports, all with excellent V/STOL capabilities.

Vertifan Born

During the 1950's under government study contracts, Ryan engineers were developing an entirely new VTOL concept, which became known as Vertifan, featuring rotor-like fans submerged within the wing and powered by tip turbines, driven by jet exhaust to provide the lift for vertical take-off and hovering. In normal horizontal cruise, the power of the jet engine is diverted from the fans to straight thrust. This Vertifan concept, as embodied in the current U.S. Army XV-5A, is applicable to a wide range of conventional jet subsonic and supersonic aircraft.

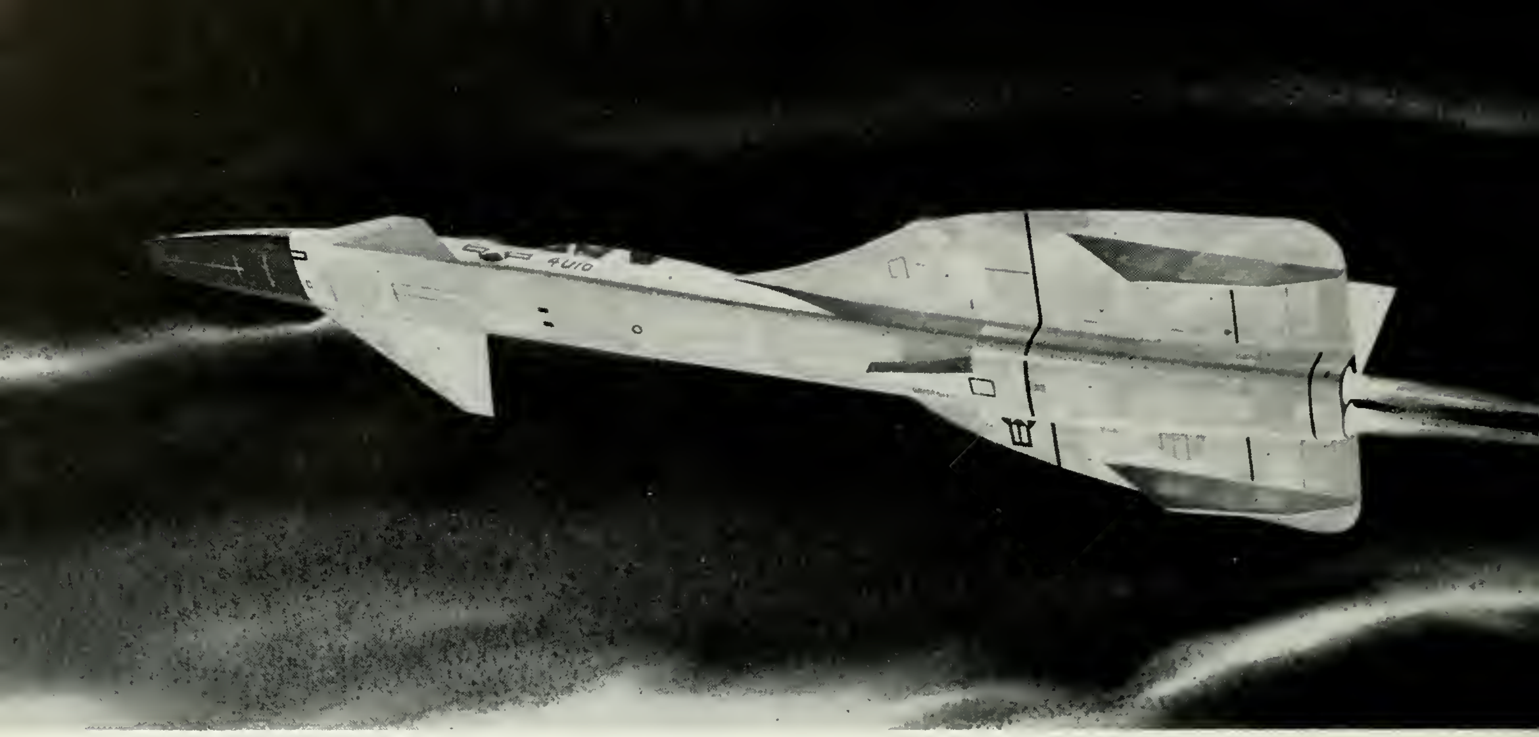
Ryan's work in this field was recognized by the Air Force with award of a preliminary design study contract, followed by a design competition, sponsored by the Army Transportation Research Command, which was won by Ryan. The result was an order to build two XV-5A aircraft, under contract with General Electric, developers of the lift-fan propulsion system.

"The obvious advantage of the Vertifan concept," Immenschuh said, "is that it permits the installation, in a V/STOL aircraft, of only that amount of jet engine thrust which is normally required for conventional flight."

"Vertifan advantages over the direct lift jet technique are believed considerable," he continued. "By fan augmentation, high vertical lifting thrust can be achieved with low installed basic propulsion thrust. Thus, the required thrust yield can be obtained from smaller engines, with lower fuel consumption."

Immenschuh further discussed the advantages of the Vertifan aircraft.

"The required jet engine size and, therefore, cost and fuel consumption, are identical to any other conventional jet aircraft of equal size and



In artist's illustration of Mach 3 Vertifan, note the fans submerged in the high aspect ratio wing, and in the fuselage forward of the cockpit.

performance. Furthermore, a broad selection of proven jet engines are available "off-the-shelf" for lift-fan aircraft designs. Another advantage in having a jet engine sized for normal flight is that there is a completely normal engine-airframe match which relieves the aircraft designer of the problem of operating the aircraft in normal flight with off-design power settings of the jet engines.

"The entire control for hovering and transitional flight is obtained from the primary propulsion system, which eliminates the need for auxiliary ducting and variable nozzles. Another reliability advantage is the low speed of the main fans, which are simply multi-bladed propellers. Thus, lower downwash velocities and impingement temperatures on the take-off and landing surface are achieved.

"The Ryan Vertifan is the only V/STOL concept, which is associated with the high speeds of conventional jet aircraft in forward flight while maintaining a hovering efficiency nearly equal to other large rotor craft, such as propeller V/STOLs.

"In the Vertifan concept, only that amount of jet engine thrust required for conventional flight is installed, and the fans, using this installed jet engine thrust as a basic power source, are sized to produce lift in excess of the aircraft's gross weight. The result is considerable savings in terms of engine size, cost, fuel consumption, and associated logistics."

Operational Evaluation Envisioned

Immenschuh judged that the Vertifan concept will be ideal for operational evaluation on V/STOL aircraft. He said, "with the increased performance possible from a production version of the Vertifan propulsion system, an operational evaluation prototype of considerably greater capability can be quickly developed from the present XV-5A research aircraft.

Immenschuh continued, "The basic advantages of the lift-fan concept in the subsonic regime are also directly transferrable to supersonic applications of the future. The current status of the Vertifan concept is merely on the threshold of development. It can be compared to jet engines of the 1945-47 time period. The XV-5A represents culmination of a considerable amount of data accumulation in recent years, but Ryan engineers' believe that orders-of-magnitude increases within the Vertifan state-of-the-art can be expected with continued development."

"At Ryan," Immenschuh concluded, "officials are enthusiastic about the long-range production potential of vertical and short take-off and landing aircraft. For the Air Force and the Army, such planes will be able to operate from small, unimproved landing areas and maneuver in any direction over all types of terrain. The Navy need for ASW aircraft falls within VTOL capabilities." ■

SURVEYOR SELENOGRAPHY

Ryan Electronics' landing radar and Doppler velocity sensor system that will assist the Surveyor unmanned lunar exploration spacecraft in landing gently on the surface of the moon, has entered an advanced phase of testing after successful completion of first flight tests.

The system was activated in a series of helicopter flights at Holloman Air Force Base, New Mexico, and the Hughes Aircraft Company airport at Culver City, California, at altitudes ranging from 6,000 to less than 20 feet. On Surveyor the landing radar and Doppler velocity sensor will be required to operate from 50,000 feet to the moon's surface.

In functional test, Ryan designed and built Surveyor antenna radiates into free space.

Hughes, under contract from the California Institute of Technology's Jet Propulsion Laboratory, is responsible for the basic spacecraft system of Surveyor, which is to be launched in 1965 to obtain information on the moon's surface and on micrometeorite showers prior to the actual manned landing with Apollo.

Following the tests aboard helicopters, controlled drops of spacecraft from balloons have been started to simulate the final descent to the lunar surface. Rocket engines are fired to slow descent as information is obtained from the Ryan landing radar and velocity sensor to control landings.

Meanwhile, Ryan has begun production of the actual flight hardware that will be installed on the Surveyor unmanned mission to the moon, and deliveries of these operational systems to Hughes have started. Ryan Electronics designed and built the radar and velocity sensor system under contract to Hughes.

The Surveyor spacecraft, measuring about 10 feet tall and about 14 feet across at its landing pads, is scheduled to be launched some time this year from the Eastern Test Range at Cape Kennedy. It will settle on the moon after a 66-hour flight—touching down more gently than a manned parachute landing on earth. Seven Surveyors are scheduled to be launched by Atlas-Centaur boosters during the current phase of this program.

After separation from the Centaur, the Surveyor will maneuver to align itself with the sun and the star Canopus. After about 20 hours of its 66-hour flight to the moon, engineers of JPL/NASA's Deep Space Instrumentation Facility will radio instructions to the spacecraft to adjust its flight path by thrust of its vernier engines so that it will intercept the moon.

As Surveyor approaches the moon, a television camera will be turned on and pictures of the lunar surface will be transmitted back to earth. A large retrorocket and three vernier rockets will also fire to slow the descent of the space vehicle.

After the retrorocket burns out, it will separate from the spacecraft. With the vernier rockets still burning, the Ryan Electronics Doppler radar and velocity sensing system will sense the spacecraft's velocity and adjust the vernier engine thrust to slow Surveyor to a gentle moon landing.

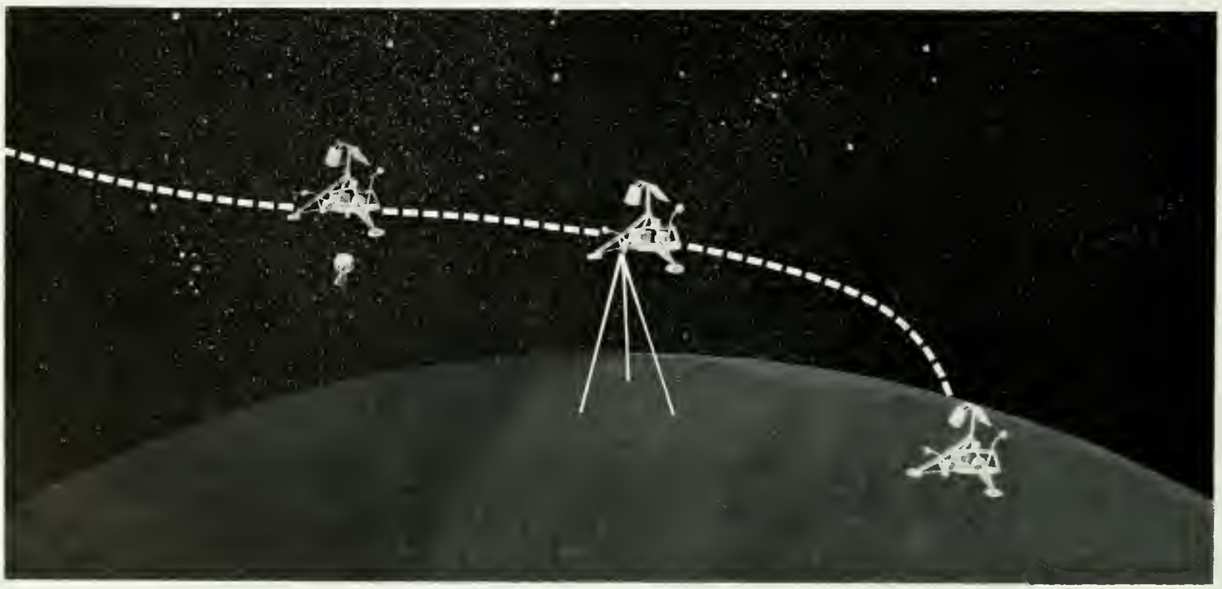
Carrying a scientific payload that will include three high quality television cameras, the ultimate purpose of future Surveyor missions will be to transmit data back to earth about the lunar environment and surface. With its various instruments Surveyor, a Space Age Selenographer, will view, feel, and chew the moon's surface to unlock the secrets of the moon that have challenged the imagination of man since time began.

Mission Explained

In May, 1964, Milton Beilock, Assistant Surveyor Project Manager explained the Surveyor's mission.

"Surveyor missions will originate from Cape Kennedy, Florida. Upon being boosted to an alti-

Approaching the lunar surface at about 50,000 feet, the Surveyor discards its retro-rocket. With vernier rockets still burning the Ryan Electronics' Doppler radar and velocity sensing system will sense the spacecraft's velocity and adjust the vernier engine thrust to slow Surveyor to a gentle moon landing.



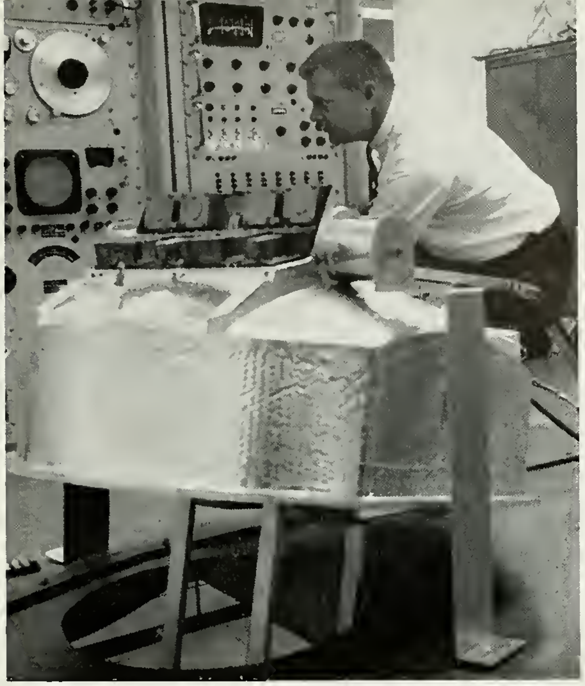
tude of approximately 60 miles by an Atlas/Centaur booster, the spacecraft shroud will be jettisoned. The spacecraft will then extend its three landing legs and two omnidirectional antenna booms and transmit a radio signal to permit tracking.

"After separation, tracking acquisition will occur at Johannesburg, South Africa with later tracking by stations at Canberra, Australia and Goldstone, California. Three cold gas reaction jets located on the landing gear legs will control the spacecraft through an angular search to acquire and track both the sun and the star Canopus. When the appropriate sensors lock on to these celestial points, an inertial reference system will be established in space to be maintained automatically during transit.

"Tracking data received in sequence from the three stations will be processed and used to compute the required midcourse correction approximately 20 hours after launch. The magnitude and direction of the midcourse correction will be sent from the Goldstone tracking station to the spacecraft where it will be stored. Upon radio command, the spacecraft will then orient itself along the specified thrust vector, and at the appropriate time, three storable liquid-fueled vernier rocket engines will provide a midcourse alteration of the trajectory which will ultimately bring the spacecraft to the chosen lunar landing area. After the midcourse correction is completed, the spacecraft will reacquire the sun and Canopus to maintain its previous attitude.

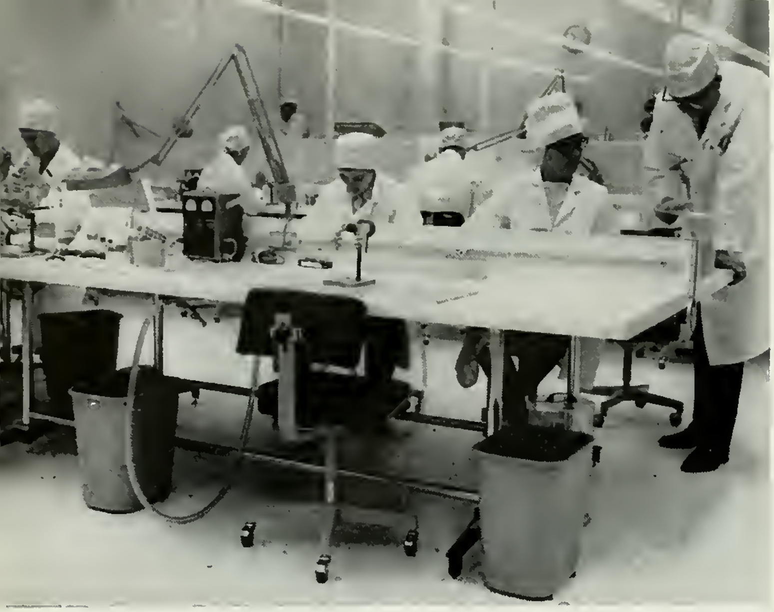
"Approximately 66 hours after launch, Surveyor will be within 1000 miles of the lunar surface. Upon command from the Goldstone tracking station, the spacecraft changes attitude to align the thrust of its retro-rocket with the computed spacecraft velocity vector. As the spacecraft approaches the moon, at a relative speed of about 9000 feet per second, the altitude marking radar generates a signal at the 60 mile point causing the first vernier engines and then the solid propellent main retro-rocket motor to ignite. Main retro-ignition will expel the radar from the retro-rocket nozzle and decelerate the spacecraft. At an altitude of approximately 40,000 feet, the main retro-rocket burns out and its empty case is dropped from the spacecraft.

"At this point the spacecraft will be close enough to the lunar surface to receive a good signal from the Ryan designed and developed radar altimeter and Doppler velocity sensor system. Signals from this system will be processed by the flight control electronics and used to control the three vernier rocket engines. Thus, the spacecraft will continue



Antenna components for the Surveyor moon landing radar system are given a final check-out.

As Ryan began production of actual Surveyor flight hardware, prime contractor Hughes confirmed all details of functional design in test with full scale spacecraft.



Production components for Surveyor landing radar system are being fabricated in Ryan Electronics' clean room.

to decelerate along a preprogrammed range-velocity curve until an altitude of 13 feet is reached. At this time the horizontal and vertical components of velocity are less than 5 and 15 feet per second, respectively, and the vernier engines are turned off. The spacecraft will fall the remaining short distance to the surface of the moon with the touchdown cushioned by the landing legs and crushable energy absorbers located under the spaceframe.

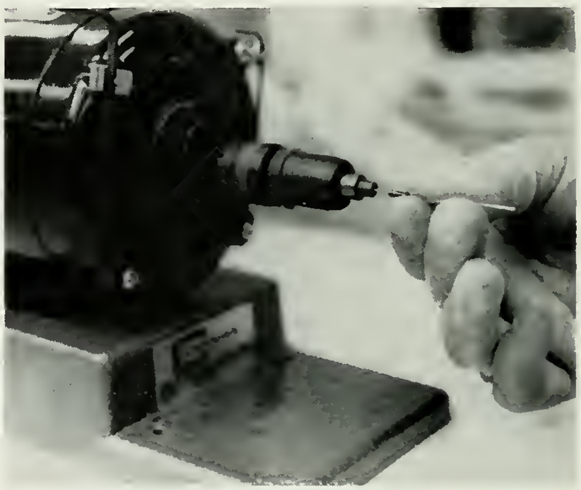
"Once safely landed on the lunar surface, the spacecraft will be commanded via its omnidirectional antennas to search an angle to acquire the sun and earth with the solar panel and high gain antenna. With communications thus established, exploration of the lunar surface will begin."

Mr. Beilock reported that initial Surveyor landings are planned to occur near the lunar equator where the spacecraft descent trajectory is nearly vertical. Although Surveyor is designed to be capable of landing at unbraked impact angles as high as 45 degrees, near vertical approaches (20 deg. or less) have been chosen to maximize the probability of a successful landing. Initial Surveyor landings will be made in the area of interest for the Apollo landings.

Ryan Electronics began its work on the Surveyor project in July, 1961. Assembly of the production components of the lunar landing radar system is being performed under near sterile conditions, to meet rigid NASA quality standards, in a "clean room" facility at Ryan Electronics.

In a closely related program, Ryan Electronics engineers have begun design and development work on a similar landing radar system for the astronaut-carrying Lunar Excursion Module (LEM). Ryan Electronics was selected to design and build the LEM system by the Radio Corporation of America. ■

Ryan skill in advanced electronics packaging techniques has been applied to the Surveyor system.



Ryan technicians exercise extreme care in fabricating the landing system.

With gear up and wing fan doors closing, the U.S. Army XV-5A demonstrates conversion from vertical lift to conventional flight during acceptance tests at Edwards Air Force Base.

ARMY ACCEPTS XV-5A

THE U. S. Army formally accepted two XV-5A V/STOL lift-fan aircraft January 28 at Edwards Air Force Base, California.

Official receipt of the aircraft by the Army followed several days of technical demonstration flights in which both XV-5A aircraft performed identical vertical takeoff and landings, hovering maneuvers, and transitions from vertical flight to conventional jet flight, exceeding 500 mph, followed by vertical landings.

The aircraft were designed and built by Ryan Aeronautical Company, under contract to General Electric, developers of the lift-fan propulsion system, and the prime contractor to the U. S. Army Transportation Research Command.

T. Claude Ryan, Chairman of the Board and Chief Executive Officer of Ryan Aeronautical Company, said Army Transportation Research Command dignitaries represented the Army in the official acceptance of the aircraft.

Ryan said the procedure was an interim step between completion of the contractor directed Phase I flight tests and more extensive Phase II tests now in progress.

"100 flights in a highly successful first flight test program, during which the aircraft met or exceeded all of the design requirements, dramatically demonstrated the capability of Ryan's Vertifan concept embodied in the XV-5A," Ryan said.

Army officials said the purpose of the Army flight program is evaluation of the lift-fan propulsion concept. The flight research program is expected to yield valuable data and design criteria for application to future V/STOL development programs.

Ryan said the Ryan and General Electric companies will team with the Army Transportation Research Command in the Phase II program expected to last about six months. A test director, additional test pilots and flight test engineers will join the test team from the U.S. Army Aviation Test Activity at Edwards.

Army officials disclosed that Air Force, Navy, Federal Aviation Agency, and National Aeronautics and Space Administration pilots will take part in the flight tests as the flight evaluation progresses. ■

SKEET FOR THE FLEET

Jet-fast Firebees challenge modern Navy trapshooters

By: Kyle McGonigle
Journalist First Class
U. S. Navy

LESS THAN 200 YEARS ago, fire control was largely a matter of skillful seamanship and naval guns were fired at point blank range. Today, naval weaponry can bring power to bear over distances measured in hundreds and even thousands of miles through electronic control.

Accuracy over extended range didn't appear until 1898. These were the days of "one over, one under, and one on" as cannoneers trained their weapons on floating barrels to gain marksmanship.

In this era of highly sophisticated weaponry, 200-year-old maxims don't suffice. Insurance of complex weapon accuracy has grown into an endeavor involving hundreds of thousands of dollars. In the Pacific alone, four entire air squadrons exist with the express purpose of providing target services.

Antiaircraft practice (a skeet shoot) for a First Fleet aircraft carrier begins simply with a request to Commander Training Group, U.S. Pacific Fleet. This scheduling agency in turn sends a message to one of the utility squadrons. If the message is directed to Utility Squadron Three (VU-3), the squadron's Planning Office coordinates squadron operations to meet the requirements set for the "shoot."

The Planning Office selects the type of drone to be used and work requests are issued to three shops, Avionics, Airframes, and Power Plants. For a missile shoot, the clay pigeon used will be a 500 mile per hour Q-2C Firebee drone (BQM-34A) built by Ryan Aeronautical Company.

With the work requests out and the type of drone chosen, the three shops go to work. Avionics maintains the flight control systems. These include telemetering devices (airspeed, altitude and RPM), radio control equipment, the recovery system, and special radar equipment. Airframes works on the structural part of the drone. They provide the basic target aircraft and add all modifications required. Power Plants shop is responsible for the operation and maintenance of Firebee's Continental J69T29 turbojet engine.

Utility Squadron Three can provision a drone to fit any special need. For example, if air-to-air Sidewinder missiles are to be fired, the basic Q-2C is modified to prevent the heat-seeking Sidewinder from going up the drone's tail pipe and exploding. This is done by mounting four flares on the outboard trailing edges of both wings. The flares burn with more intensity than the engine fuel and

Launched by a Navy mother plane, the jet powered Firebee target missile will rendezvous for an enemy mission.

serve as heat guides for the missiles. These flares can be keyed by remote control in any desired sequence giving a potential of four separate target runs.

Avionics can install special electronic equipment to give any selected presentation on the radar receivers of the shooting unit. This presentation can be manipulated to appear as a fighter or bomber of any type. By using this radar presentation changing ability, a higher degree of realism is established during an exercise.

After the required apparatus is incorporated into the built-up drone, work orders are checked and the quality control team takes over. In VU-3, quality control is the responsibility of three highly trained and experienced inspectors. An inspector representing each shop checks all work accomplished by that shop. Electronic equipment is checked and compared to readings received from the basic systems console.

Quality control checks are completed and two drones are mounted on a P2V Neptune mother plane. Although most target runs require only one drone, two are mounted giving VU-3 potential backup ability. Preflight checks are performed using equipment in the drones and mother aircraft, and by visual methods.

The crew is briefed and the P2V Neptune leaves North Island Naval Air Station for the target area. Immediately before reaching the drop area, a Direct Control Operator (DCO) in the

The Firebee acts as enemy "stand-in" as Navy surface vessels and aircraft fire angry missiles in defense. Firebee is equipped with scoring devices to eliminate the need for direct hit each time missile is fired.

Its mission completed, the Firebee is retrieved by helicopter after landing by parachute.

mother plane radios his counterpart on the ground. This counterpart, the RCO or Remote Control Operator, relays what drone control signals are being electronically given and the DCO visually checks the drone to make sure the signals are being properly answered. When all control signals are checked the engine is started and the drone falls away from the mother aircraft's wing. The RCO starts to fly the drone on a predetermined shooting course, following the flight of his clay pigeon by radar and by airspeed, engine RPM, and altitude instruments.

As the drone is vectored toward the ship it is picked up on Combat Information Center (CIC) long range search radar. The target is identified and its position and course entered on the vertical plot board. A Weapons Liaison Officer finds the incoming target on his weapons system radar and locks on. As he tracks the target, he assigns it to a specific missile battery. Battery radar then acquires the target and the missile coordinator selects the kind of missile to be used. From CIC comes the word to fire and the missile leaves the launching rail toward the incoming drone.

As the missile streaks toward its target, it sends out radar waves. These cut through similar waves being transmitted by the drone. The time the

Proud of their role, VU-3 men have posted a mission objective large enough for the world to read.

Navy technicians repack the parachute that will save Firebee from a watery grave.

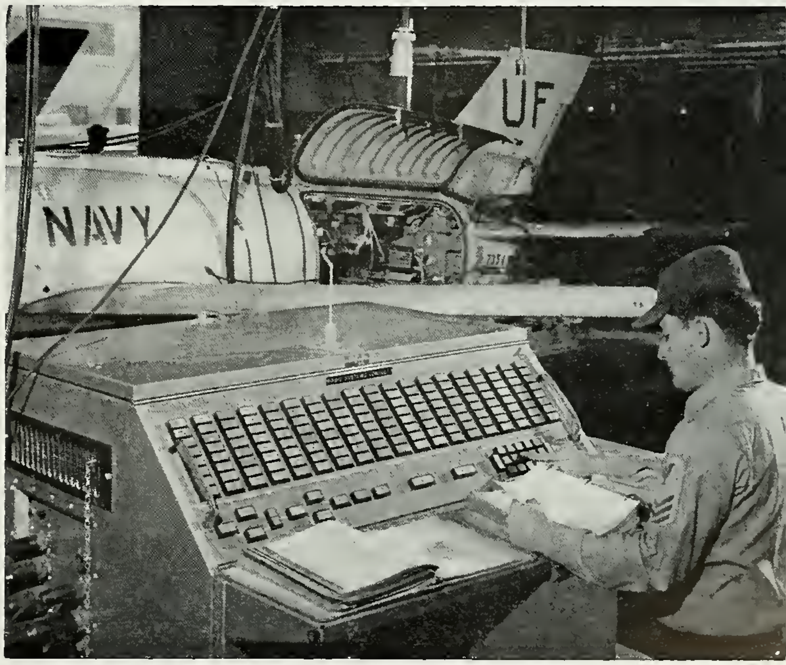
missile sends its signal and the time the drone receives it is recorded. It is possible to calculate the "miss distance" or how close the missile comes to the drone by measuring the difference.

After the ship fires its missiles, the drone continues through its pattern to give the ship's aircraft a chance to test their accuracy. Pilots flying Combat Air Patrol missions each make a firing run. After locking on the drone by radar, the pilot radios the word "hotshot" to the Remote Control Operator on the ground. The RCO keys a flare and the pilot fires his missile.

With the skeet shoot over, the drone parachutes into the ocean. Helicopters from Helicopter Utility Squadron One (HU-1) pick up the drone and fly it back to the ground control station. The mother lands at the master control station to pick up VU-3 personnel and the spent drone is loaded to be taken back to North Island.

The drone is completely disassembled and all parts are washed down and flushed out. Parts are rejuvenated or replaced and the components join those ready to be assembled.

Aboard the carrier, results of the skeet shoot are critiqued. A message comes from the scheduling agency and once again VU-3 starts the cycle that provides Skeet for the Fleet. ■



As Firebees are readied for continuing assignments, Ryan-designed ground test equipment insures the birds' readiness for action.

XC-142A AIRBORNE

First flights of the Vought-Hiller-Ryan XC-142A Tri-Service V/STOL transport have been called "excellent" by LTV pilot John Konrad. The XC-142A, the largest vertical and short take-off and landing airplane ever developed, made its first flight at the Ling-Temco-Vought plant in Dallas, Texas on September 29.

The flight marked a major milestone in the United States' V/STOL program—the first time this nation has flown a V/STOL airplane built for operational evaluation.

Then on December 29, the XC-142A passed one of its most important milestones when it made its first vertical take-off and hover flights at Dallas. Both industry and Air Force officials described the flights as highly successful. The initial hover flights were intentionally held to five feet or less.

Its tilt-wing, engines and propellers pointed skyward, the V/STOL lifted into the air vertically and hovered for several minutes on each flight with chief test pilot John Konrad, and project test pilot Stuart Madison at the controls.

A few short days later, on January 11, the XC-142A made what the pilots called a "flawless" first transition flight, taking off vertically like a helicopter, then lowering its tiltable wing to speed forward like a conventional airplane and then easing down to a vertical landing.

The big transport rose vertically, about 15 feet off the runway, with its tilt-wing and engines pointed skyward. It then eased its wing forward, picked up momentum rapidly and was speeding along in conventional flight before it had flown over 2,500 feet of runway. After circling the field, it reversed the procedure, halting in the air about 15 feet above the runway and easing down vertically to a very soft landing.

Contributing its vast background and experience in V/STOL aircraft, Ryan Aeronautical Company designed and fabricated the aft fuselage section, tail surfaces, and engine nacelles and built the 67 foot wing for the large transport.

Konrad, Chief Test Pilot and Manager of the Engineering Test Department of LTV's Vought Aeronautics Division, said the airplane has responded to the controls smoothly and demonstrated excellent flight characteristics. The airplane aerodynamically was extremely solid and the systems were excellent, he said.

Konrad was particularly impressed by the XC-142A's acceleration. "With all its surplus power, this airplane goes like a scared jack rabbit. It feels like it wants to run right out from under you."

In the initial flight, the airplane was operated much as a conventional airplane. Its wing was elevated 10 degrees for take off and landing but lowered to horizontal for most of the flight.

Konrad took the airplane to 10,000 feet on the first flight which lasted 38 minutes. He flew the XC-142A up to a speed of approximately 175 miles per hour, leaving the gear down throughout the entire flight.

"The airplane used considerably less than its maximum power during the initial hover flights," Konrad said. Gross weight of the airplane, normally 37,500 pounds for vertical operations, was kept to 36,500 pounds in the flights as an additional safety factor.

The XC-142A's first transition flight came only six flights after it had accomplished its initial hover flight on December 29.

With its vertical take-off and landing capability, the XC-142A can rush to a remote area, use small clearings for landing and take-off operations, and deliver troops and supplies where they are needed rather than where airport facilities dictate. Its speed, range and vertical operation features make it particularly well suited to rescue and mercy missions.

Commercially, it holds promise of direct city-center transportation, avoiding long drives from an airport and opening up aerial service to smaller cities which can't afford costly airport installations.

The XC-142A is the largest vertical and short take-off and landing airplane in existence and the first V/STOL developed by the United States for

Ryan built wing is 67 feet long. Nacelles house powerful GE T-64 turbo-prop engines.

The tri-service XC-142A made its first transition flight following vertical take-off on January 11.

evaluation as an operational airplane as opposed to experimentation as a flight research vehicle.

As such, it will be used by the military to evaluate V/STOL operations for the future and will help determine the course the nation's V/STOL program takes.

The XC-142A is a tilt-wing, deflected slipstream airplane which can take off and land vertically and yet achieve speeds of more than 430 miles an hour in level flight. It is powered by four turboprop engines linked together so that even a single engine can turn all four propellers plus a tail rotor used for hover.

The airplane performs vertical flight by tilting its wing and engines skyward while the fuselage remains in a horizontal position. When it reaches the desired altitude the wing and engines are tilted forward and the airplane gains forward speed to operate like a conventional airplane.

A combined program of the Army, the Navy and the Air Force, the XC-142A was developed by three veteran firms in the aircraft industry. Ling-Temco-Vought is the prime con-

Vought Chief Test Pilot John Konrad leading group away from aircraft called first flights of the aircraft "excellent."

The XC-142A made its maiden hover flights on December 29, 1964.

tractor. Ryan Aeronautical Company and Hiller Aircraft Corporation are principal subcontractors.

The Air Force is XC-142A developing agency for the Department of Defense, and the program is managed by the Tri-Service V/STOL Project Office of the Support Programs Project Directorate at the Aeronautical Systems Division, Wright-Patterson Air Force Base, Ohio.

Designed for swift transport of combat troops, equipment and supplies from assault ships or airfields into unprepared areas under all weather conditions, the XC-142A will carry 32 fully-equipped combat troops or 8,000 pounds of cargo in an operational radius of 230 to approximately 470 statute miles. It has an ocean-spanning ferry range of nearly 3,800 miles when equipped with special internal fuel tanks. Providing the XC-142A's tremendous power are four General Electric T-64 turbo-prop engines with take off rating of 2,850 shaft horsepower each. These drive four Hamilton Standard lightweight Fiberglas propellers 15.6 feet in diameter, plus the eight-foot tail rotor.

All of the engines are connected to the propellers by a system of cross-shafting and gearing to permit any desired number of engines to turn all four propellers and the tail rotor. Overrunning clutches permit the pilot to shut down the engines he wishes during flight.

This system permits the XC-142A to cruise on two engines for fuel economy and to hover and land vertically even with one engine out.

LTV, Hiller and Ryan were awarded the contract in January 1962, to develop and fabricate five of the experimental transports to investigate the future of V/STOL operations. After the flight test program, the aircraft will be delivered to the military services for extensive evaluation of the V/STOL's contributions to military missions in simulated tactical situations.

With its ability to operate vertically from a very small area, the V/STOL airplane also is expected to have valuable commercial applications.

The XC-142A is scheduled to complete contractor test and demonstrations in the summer of 1965. ■

THE ULTIMATE in tape-controlled machine tools—a $500,000 Giddings & Lewis 5 axes Variax profiler—has gone into service at Ryan Aeronautical Company, where its first assignment was the machining of complex three- and four-dimensional parts for the wing, fuselage and empennage of the XC-142A tilt-wing tri-service military transport.

Ryan is the first plant in San Diego and one of the few in the country equipped with this mechanical marvel. Less than a dozen of the Giddings & Lewis 5 axes profilers are in operation.

In addition to the vertical, lateral and longitudinal movements of conventional profilers, the Giddings & Lewis has a column swivel and head tilt, thus making possible the operation of five motions simultaneously and the complete machining of many parts in one setup. It can machine to tolerances of plus or minus 0.0005 inch.

Although the machine operates automatically after the operator pushes a button to start the tape-controlled sequence, human brains actually command every movement through careful tape preparation which hinges on ability to write a mathematical expression to describe a surface. ■

Dwarfed by its size, Ryan flight test crewmen inspect Air Force Precision Delivery Glider System after flight.

HEAVYWEIGHT FLEX WING

In another of Ryan Aeronautical Company's growing list of Flex Wing programs, the U.S. Air Force has received a quantity of Ryan Precision Delivery Glider Systems. This new USAF program is a follow-on to successful testing and field use of this technique in the United States and Southeast Asia, where simulated operational missions were performed.

The new, higher performance Precision Delivery Glider System has been designed to deliver payloads of 2,000 pounds, utilizing the packaging and deployment concepts of Ryan-built, inflatable, Flex Wing glider systems which have been demonstrated under controlled flight conditions for wings sized from 10 feet to 30 feet in length.

In recent years, Ryan has demonstrated aerodynamic advantages of the flexible wing in providing an extremely lightweight, foldable lifting surface with inherent stability characteristics.

Ryan has built and tested 300-pound payload inflatable precision drop gliders, manned utility test vehicles, powered surveillance drones, cargo gliders towed by helicopter, and inflatable individual personnel gliders.

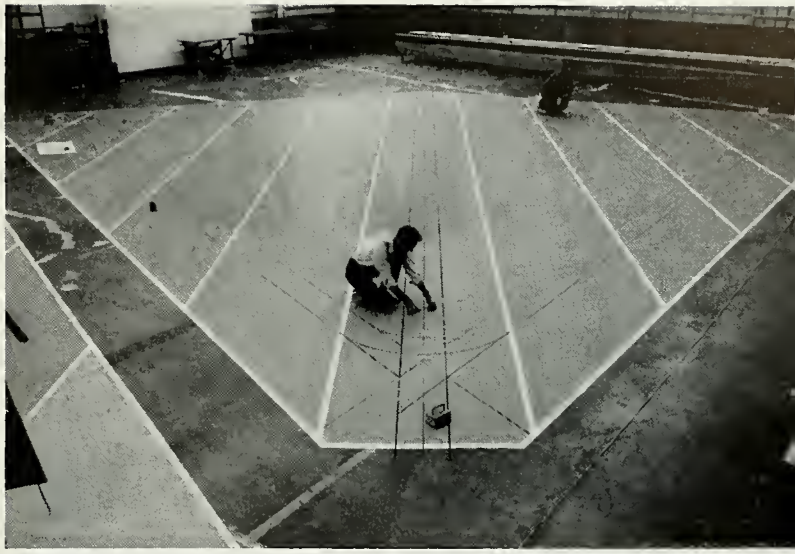
The Precision Delivery Glider System for the Air Force has the unique capability of multiple delivery of high priority cargoes from aircraft standing off a considerable distance from the target delivery area. Other unique advantages include all-weather capability, automatic homing or remote guidance, and ease of maintenance.

Under the USAF contract to Ryan, the system is designed for cargo launch from a C-130 or C-123 type aircraft, and will operate with existing military cargo extraction systems.

The Flexible Wing consists of three inflatable structural members, and a flexible membrane. The structural members consist of two leading edges and a keel. The two leading edges join at the apex to form a near triangular wing platform. The keel runs longitudinally aft from the apex along the centerline of the wing. Three structural members, each 38 feet long, are bonded together at the apex and form a single inflatable chamber.

The flexible membrane, continuously attached to the leading edges and the keel, is made of 3.8-ounce Dacron base fabric coated on two sides with polyester film. The inflatable tubes are made

The remote controlled, inflatable wing system will deliver 2000 pounds of cargo.



On hands and knees, Ryan technicians lay out the initial pattern for giant wing.

of 5.8-ounce Dacron coated base fabric.

The control platform and payload are suspended beneath the wing with lengths of 2,000-pound rated nylon parachute shroud line. Contained within the control platform is the deployment sequencer which consists of a lanyard-operated power switch, and a series of electric time delay relays and power control relays. The sequencer programs the time of drogue chute release, tube inflation, parachute mode release, guidance system turn-on, flare pendant release, and system turn-off after landing. All functions are automatic.

The air inflation system consists of two steel 3,000 p.s.i. pressure vessels located in the control platform, a control valve, two flexible hose assemblies, and two automatic shut-off quick-disconnect couplings.

The wing inflation process is conducted during the parachute stage of the operation. When the Flex Wing is released for transition into the wing configuration, a lanyard operates the inflation quick-disconnects and releases the two leading edges from the inflation system.

The flight control system consists of the servo control actuator, mechanical flare and power control. The servo actuator is a reversible motor with a reel type drum on its output shaft. As power is received at the servo control, the drum is caused to rotate, reeling in a control line connected to the spoiler flaps. Simultaneously, it reels out a control line attached to the opposite spoiler flap, causing a drag which turns the glider.

Speed of the glider just prior to touchdown is reduced by a mechanical flare maneuver triggered by a flare pendant, or weighted line, lowered a predetermined distance below the payload while it is gliding. Prior to touchdown, the flare pendant touches the ground with sufficient force to activate a g-sensitive switch, which completes an electrical circuit releasing the front risers of the glider to an extended position, and sharply increasing the wing's angle of attack to produce an immediate "stall" condition thereby decreasing both horizontal and vertical velocity.

The platform is an aluminum rectangular box, 60 inches long, 45 inches wide and 10 inches deep, and is divided into three compartments.

The Flex Wing delivery gliders, shown here in fabrication at Ryan's San Diego facility, can be launched from C-130 cargo aircraft.

The forward compartment contains the radio control receiver and its associated battery, a mechanical latch assembly, antenna network and fittings, a battery charging connection, and associated wiring and cable assemblies.

The center compartment contains the folded flexible wing, and the aft compartment holds a rotary actuator reel assembly, the sequencer box, a mechcanical latch assembly, the inflation system, and associated wiring and hardware.

One mode of operation is completely automatic, all-weather and night operational, and is similar to a beam rider technique. The other mode is a command link that can control the flight from the ground, or from the launch aircraft.

The Ryan Precision Delivery Glider System is compatible with standard U.S. Air Force aircraft cargo handling and aerial delivery systems.

The gravity extraction system is utilized, with

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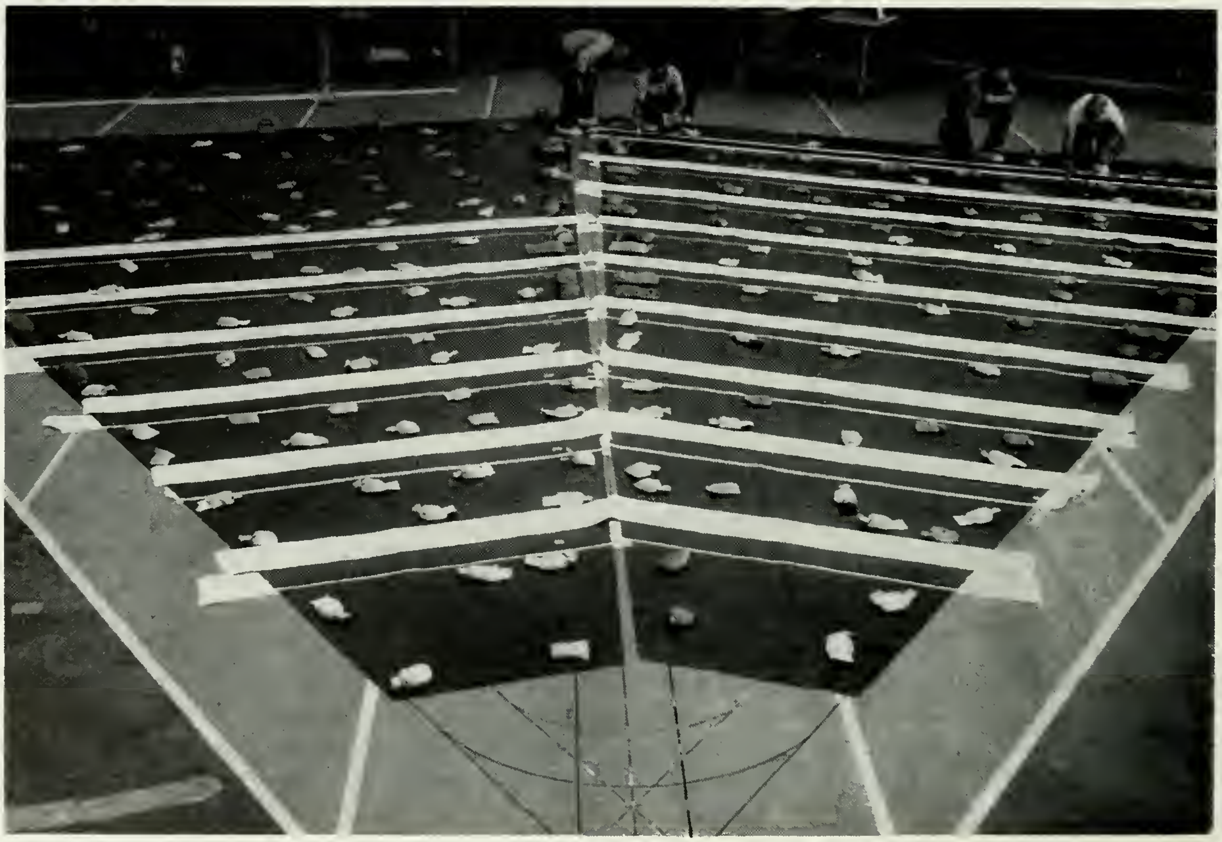
Flex Wing form is evident, as Ryan technicians begin shaping wing of 3.8 ounce Dacron base fabric coated with polyester film. Inflatable members are 38 feet long bonded together at the apex.



the cargo or cargo container secured to a conveyor roller system by a tie-down restraint bridle. The roller conveyor is inclined by a change in the aircraft attitude, permitting the cargo to move from the aircraft by gravity once the restraint is removed, either by manual release or by drogue chute automatic release, the latter being used when a series of such gliders would be dropped consecutively.

Excessive tumbling of the system immediately after exit is prevented by exerting a break load on the system by the drogue chute static line as the bag is pulled from the control platform. The drogue chute suspension lines are deployed from the bag to full length prior to parachute canopy inflation. The deployment bag and static line remain with the aircraft.

A static line, connected between the drogue chute suspension system and the PDGS wing sleeve, extracts the PDGS wing after drogue chute riser release. The wing deploys into a modified parachute shape retained for six seconds to provide load deceleration and stabilization prior to glider line release and to allow structural members to inflate with air in order to provide rigid members required for glider flight.

After stabilization is accomplished, the automatic homing system is actuated, and the glider begins to track automatically toward the transmitter location. The PDGS normally glides at 40 knots with an approximate 3-to-1 glide ratio, and the flare maneuver provides a sink rate of 12 feet per second at touchdown.

Such gliders will be capable of delivering a cargo of 2,000 pounds payload on release from a cargo aircraft traveling at 150 miles per hour and at altitudes of up to 30,000 feet under adverse weather conditions, and in night operations. ■

To study shroud line lengths, connectors and center of gravity elements, Ryan built scaffolding and a tubular metal Flex Wing replica.

Please send address changes to:
RYAN AERONAUTICAL COMPANY
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ARMY XV-5A
AMERICA'S NEW JET V/STOL

The XV-5A does what no V/STOL before it could. It takes off vertically, hovers, and transitions into horizontal flight using no more power or fuel than is required for conventional flight. This unique capability is derived from its lift-fan propulsion system, which triples the force of normal jet thrust when it is diverted to spin rotor-like fans for vertical flight.

Flight tests at Edwards AFB for Army's Transportation Research Command are now demonstrating the advantage of this high-performance V/STOL, designed and built by Ryan Aeronautical Company under contract to General Electric, developer of the lift-fan system.

This new concept, with the same basic power output serving the entire range of flight modes, avoids the usual penalty for vertical and short take-off and landing capability. And a pneumatic, exhaust gas coupling between horizontal-flight jet engines and vertical-flight wing fans eliminates complex mechanical power transmission systems, thereby assuring high operational reliability.

The lift-fan holds promise for greater V/STOL payloads and longer ranges with reduced logistic support and lower fuel requirements; and practical operation from undeveloped airstrips.

But Ryan's spectrum of capabilities goes far beyond leadership in V/STOL technology.

Ryan is contributing importantly to the nation's space effort in navigation aids and space components. Ryan is pioneering new type Flex Wing aerial vehicles. Ryan's Firebee is the most widely used jet target missile in the world.

In broad fields of aeronautics, electronics and astronautics, strength for tomorrow is being forged today — at Ryan!

RYAN AERONAUTICAL COMPANY • SAN DIEGO • CALIFORNIA


RYAN
REPORTER
JUNE-JULY / 1965

About the Cover: Except for its presentation by radar, the cover picture is what a Navy gunner's mate might see as he draws a bead on the newest target in existence . . . "Firefish."

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READY, AIM FIREFISH!

Surface defense tactics against enemy PT boats—a conventional battle concept reminiscent of World War II—is being revived at flank speed today by the U.S. Navy ☐ One of its partners in this effort is Ryan Aeronautical Company, builder of the world-famous "Firebee" target drone. ☐ Applying "Firebee" principles to tactical surface situations, Ryan has developed, built and is supplying the Navy with a quantity of radio-controlled surface craft called the "FIREFISH"

Navy's search for fast, high-performance target boat in late 1964 led to development by Ryan of Firefish system. Development phases and demonstrations were closely watched by ranking Navy officials.

Heretofore, Navy gunners used target sleds, towed at a fixed speed and course, as a means of sharpening their accuracy. The only variations in target speed or course were those introduced through either simulated means or changing speed and course of the ships firing on the tow targets.

The Gulf of Tonkin incident in August 1964—the real starting point of escalated combat efforts in Viet Nam by U.S. Forces—placed an urgent demand on the Navy for revised training concepts.

North Viet Nam torpedo boats penetrated radar defense perimeters of the destroyers USS C. Turner Joy and USS Maddox, proving the feasibility of PT-boat potentials. In this case, the boats were sunk or driven off.

In its current program of refining anti-PT boat training, Navy officials considered slow, non-maneuvering towed targets unsatisfactory. Next, a widespread search was launched for a suitable target that would combine speed ranges, maneuverability and physical characteristics of North Viet Namese torpedo boats.

Responding to this need, Ryan engineers applied Firebee ingenuity to water-borne elements, producing a 17-foot, reinforced Fiberglas-hull Firefish as a prototype production model.

Production units went into service with the Pacific fleet last October and a quantity of production models are currently being delivered to both Atlantic and Pacific fleet units.

Boasting speed capabilities of 30 knots, the Firefish is commanded by radio control to turn, increase or decrease speed and complete a wide spectrum of evasive maneuvers in much the same fashion as its airborne counterpart, the Firebee.

The remote control range of the Firefish and acquisition limit is six miles, according to Robert C. Jackson, Ryan President.

The biggest task of all—developing tactical training exercise concepts in the fleet—is now underway with Firefish serving as its prime vehicle on which training can be based.

At the San Diego headquarters of Rear Admiral William H. Baumberger, Commander, Cruiser-Destroyer Force, U.S. Pacific Fleet, a fleet operational investigation, in connection with countering

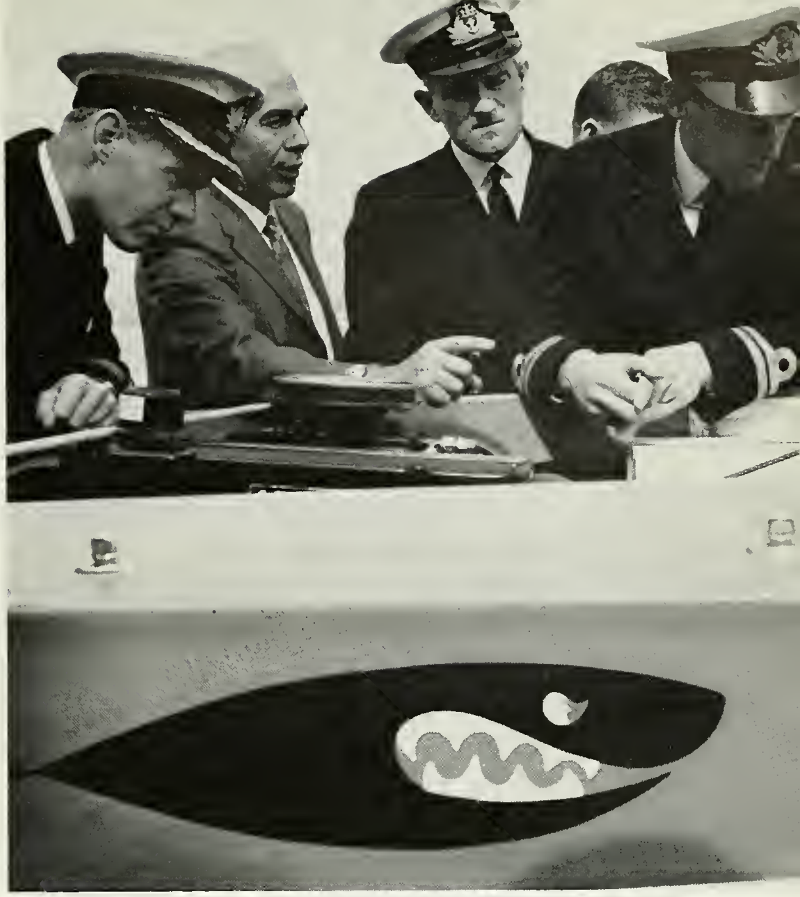
FIREFISH SPECIFICATIONS

Performance

Speed	*30 knots in light chop, long swells — 20 knots in approx. 2 to 3 sea state*
Endurance	*4 hours at maximum speed, 6 hours at 10 knots*
Control Range	*6 miles approx., depending on transmitter power and height of control antenna*

Description

Length	*17 feet*
Beam	*80 inches*
Gross Weight	*1650 pounds*
Propulsion	*120 H.P. MerCruiser engine coupled to a MerCruiser One Stern Drive Unit*



HMS Kent officers were briefed on Firefish system during ship's visit to San Diego in early 1965.

small, high-speed surface craft with conventional armament, was conducted in late 1964.

Acting as coordinator to the project, Commander I. W. Bonnett, Staff Assistant Training and Readiness Officer, collected data and compiled a report which contained recommendations that a "lightweight, high-speed drone target be procured for Navy use."

Since enemy PT-boat attacks during World War II were of a limited nature, few training procedures had been previously explored.

The Pacific Fleet effort underway today involves primarily the resources of three commands, each working in close harmony on evolutionary phases of developing new, anti-high speed surface craft training exercises.

Admiral Baumberger's force is engaged in the development of elements within the overall concept; Utility Squadron Three, a San Diego based command under Utility Wing, Pacific, is the unit responsible for eventual maintenance and operational usage of the Firefish; and Training Command, Pacific, is in the process of producing the

Firefish system operational-maintenance course was conducted for Navy personnel at Ryan plant.

Firefish underwent close scrutiny of key Navy officers at San Diego as target boat production began.

long range exercise procedure.

Utility Squadrons One, at Hawaii; Three, at San Diego; and Five, Detachment "A," at Cubi Point, Philippine Islands, maintain operational control of Firefish in the Pacific; in the Atlantic Fleet, Cruiser-Destroyer Flotilla Four and Destroyer Development Group Two, both based at Newport, R.I., are assigned operational control of Firefish programs.

Thus does the role of the amazing Firefish assume significant proportions as hub of this world-wide activity.

Working with the Navy in this effort in areas well beyond manufacturing stages, Ryan is also engaged in training Navy personnel from both Atlantic and Pacific units in operational and maintenance procedures.

Ray S. Hatherill, Ryan's Training Director, points out that Navy men assigned to the classes were given a week of in-plant instruction at San Diego plus an additional week of operational exercises in waters nearby.

Within the foreseeable future, Firefish applications will be phased into air-to-surface tactics for training exercises involving Navy aviation units, according to Navy program officials.

As the world's leader in the design and production of the remote-controlled flying Firebee—the most widely used target drone in existence today, Ryan has added a new dimension to its capabilities with the introduction of Firefish.

"We feel justifiably proud of this new product, and the values it is serving the Navy. An even more significant contribution is represented by this program, however," points out one official.

"The U.S. Navy's strongest favorable characteristic has been and is today its diverse flexibilities, the talent for responding to challenge.

"Through its Firefish program, Ryan has become an active partner in helping the Navy maintain this personality." ■

FIREFISH BULLETIN

As the Reporter went to press, word was flashed from Long Beach Navy headquarters that the USS Brinkley Bass had scored the first "Kill" of a Firefish target boat on Tuesday, June 22.

It was the Bass' first Firefish operation and the "Kill" was achieved as the target was running at thirty knots, some 7600 yards from the Bass.

The USS Hubbard, serving as control ship during the operation, reported that the Bass fired approximately 56 rounds at the target, set it aflame with hits and the boat sank before salvage operations could be conducted.

Ryan officials, praising the accuracy of the Bass gunners, said a Firefish "Kill" plaque would be presented in formal ceremonies to the ship.

A member of Destroyer Division 132, the Bass is commanded by Commander W. E. Lassiter.

Fortunate for the Navy today, is the presence of onetime enlisted Fire Controlman I. W. Bonnett, serving now as Gunnery training officer on the staff of Commander, Training Command, U. S. Pacific Fleet.

One of those credited for the spadework on the Navy's development of an anti-PT boat doctrine, Bonnett served in the cruiser, USS Nashville during WW II actions, an experience that gives present day planners a foundation for surface defense tactics.

His contributions to today's concepts are acknowledged by those charged with its implementation at fleet unit levels as, "a truly pioneering effort, one that put us on the right road."

The maverick cinderella of modern metals

RYAN TAMED TITANIUM

by L. M. Limbach
Vice President-Plant Operations
Ryan Aeronautical Company

Ryan technician makes in-process inspection of titanium LEM rocket engine chambers and shells.

IN THE EARLY 1950's, when Ryan Aeronautical Company began some of the pioneering studies in the forming of intricate structures from titanium, this new industrial metal presented such paradoxical characteristics that it became known as the "Dr. Jekyll and Mr. Hyde" of our Development Laboratories.

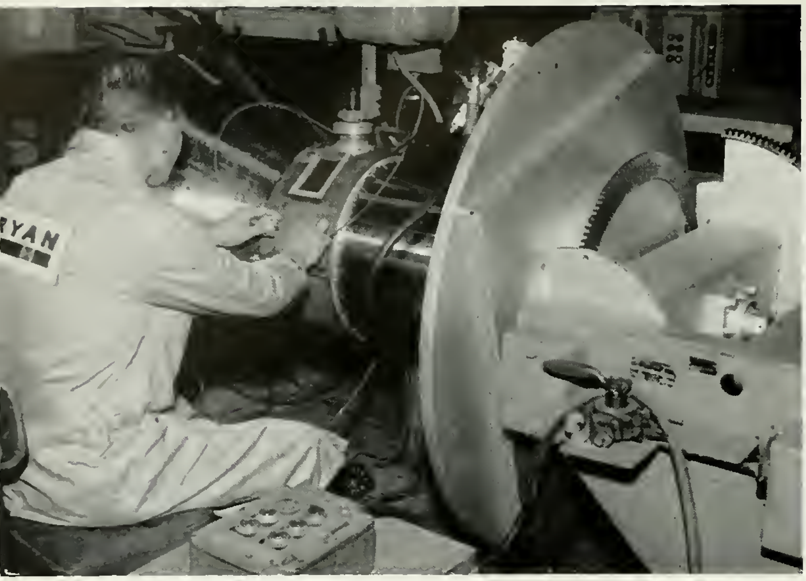
Endowed with ideal qualities applicable to aircraft, titanium nevertheless behaved in such an exasperatingly contradictory manner as to offer perplexing problems to the metallurgist.

Although it possessed an extremely high melting point for its weight — higher than steel — it still could not withstand continued use at temperatures above 1000 degrees. It was so "affectionate" for other elements that it instantly combined with other substances when molten, and would not weld with any other metals by known processes.

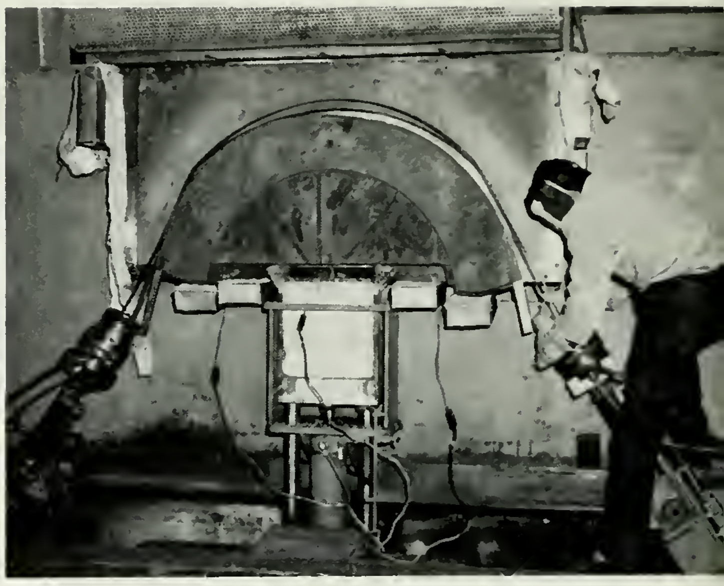
Despite these maverick characteristics, Ryan engineers 13 years ago anticipated the use of titanium and its alloys in the formation of surfaces for supersonic planes. Today their judgment is borne out by the employment of this problem child of metallurgy in such high speed aircraft as the recently announced Lockheed A-11 — and titanium has emerged, as it has repeatedly in more than a decade of development, as the Cinderella of modern metals.

As long ago as 1951, when Ryan started its experiments with titanium, this bright newcomer to the metals field exhibited an attractive potential to aircraft manufacturers because of its light weight with relation to strength and resistance to temperature. Engineers had relied on heavier steel alloys in the design of structures which required more strength than aluminum alloys could provide at elevated temperatures. Because aluminum alloys lose strength rapidly at temperatures above 300 degrees F., this meant that a wide variety of components, such as fire walls, ducts and shrouds, had to be built of stainless steel.

Titanium retains its exceptional strength up to temperatures of approximately 1000 deg. F., weighs only 56 percent as much as steel, and approaches the best steels in strength. It has been known to metallurgists since 1791, when it was discovered in England, but it was not produced commercially until 1946, when William Kroll, U. S. Bureau of Mines engineer, evolved a process for separating it from its ore. By 1950, it was still a "rare" metal commercially. In that year, only 120,000 pounds were refined (compared with 12.2 million pounds in 1963), and although the ore could be purchased in the market at only two cents a pound, cost of the refined metal ranged from \$10 to \$20 a pound (about twice today's price) — reflecting the tremendous affin-



Titanium welding at Ryan is achieved through use of argon purged environment inside of stainless steel shield. Operator controls process by peering through plate glass port hole in shield.



Titanium "Z" section structural frame for DC-8 jet engine was formed on specially designed Hufford hot stretch press at Ryan which became nation's largest producer of titanium DC-8 parts.

ity which titanium has for other substances and the difficulty of extracting it from the ore.

Ryan began research on titanium in August, 1951, and was one of the first companies in America to form this metal successfully by the drop-hammer process. Sections of complex shape were fabricated for exhaust system shrouds for Piasecki HUP-1 helicopters. Subsequently Ryan was awarded research and development contracts from the Air Force and the Navy Bureau of Aeronautics aimed at taming the temperamental metal, and became the nation's largest producer of finished titanium parts in the DC-8 program.

Nine tons of commercially pure titanium were used monthly at peak production of Ryan jet engine pods and pylons for the DC-8. Each set of pods and pylons contained 1,667 titanium parts, totaling almost 7,000 components of this metal for each four-engined DC-8 at a time when its cost of approximately $30,000 a ton was greater than silver.

The world's first lift-fan jet V/STOL (vertical and short take-off and landing) aircraft — the XV-5A, built by Ryan for the U.S. Army and now being flight tested at Edwards Air Force Base — contains over 600 parts made of titanium "6-4" alloy (6 percent aluminum, 4 percent vanadium).

Today, Ryan is fabricating titanium plenum chambers for the Sikorsky H-37 helicopter in a production program that has been under way for several years, and has launched its newest titanium project — the welding and machining of rocket engine chambers and chamber shells for the descent rocket engine of the National Aeronautics and Space Administration's Lunar Excursion Module (LEM) in a contract with TRW/Space Technology Laboratories.

The Air Force research and development contract with Ryan in the early 1950's resulted in one of the most extensive reports ever made on fabricating airframe and engine components from commercially pure titanium. Every process involved in sheet metal manufacturing techniques with commercially pure titanium was analyzed — including forming, welding, riveting, grinding, sawing, drilling, cleaning, annealing and dimpling.

Experiments were conducted in both hot and cold forming. Drop hammers, punch presses, brake presses and power rolls were among forming tools used, and titanium sheets and dies were heated by both mechanical and electrical means.

Experience showed that parts, other than those embodying shallow draws, could not be cold-formed in the drop hammer because the impact caused the parts to fracture in the stage dies after relatively small amounts of deformation. Hot forming was successful under proper procedures. As stamping experiments progressed, it became apparent that heated dies were not accomplishing the purpose of keeping the blank hot for forming. It was decided to try the standard technique used to form stainless steel, involving use of Kirksite dies and lead punches.

To avoid the possibility of lead contamination and to prevent the heat from melting the lead, the punches were jacketed with mild steel on their contact faces. A generous coating of heavy weight commercial oil was applied to the die to serve as a lubricant and heat insulator.

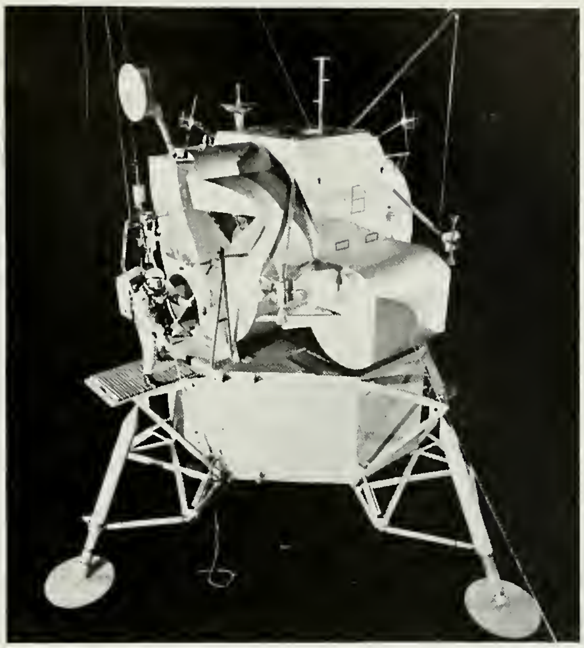
With the blanks furnace heated to 1,000 deg. F., the parts were repeatedly formed with satisfactory results. The Ryan experiments showed conclusively that commercially pure titanium could be formed as satisfactorily as stainless steel counterparts without basic engineering design changes other than judicious selection of edge and corner radii at abrupt contour changes and liberal use of stage dies. It was found necessary to maintain blank temperatures about 700 deg. F. for optimum forming characteristics.

The study showed that inert gas shielded welding was the only type of fusion welding that could be made on titanium to maintain adequate physical properties. Molten titanium will react with, and be embrittled by, all known welding fluxes as well as air.

Several new presses used in hot-forming titanium were acquired, ranging from a Dake arbor press with a platen area 24 inches square, to two giant Dake presses capable of forming a titanium sheet 3 feet wide and 12 feet long. Built to Ryan design was a Hufford stretch press, used specifically to form ribs made of titanium, and exerting a tremendous pressure over a platen area of 36 inches by 72 inches.

Titanium has a "plastic memory" — hence the emphasis on hot forming. If cold formed, the metal has a tendency to return to the original position. But the plastic memory is removed if a titanium part is formed under pressure at elevated temperatures (1,000 deg. F.), and the part remains as formed. In the DC-8 program, this was extremely important. Douglas required that pod and pylon components be interchangeable between its jetliners, meaning that parts had to be held to extremely close tolerances.

Ryan's extensive background in forming, machining and welding titanium is being applied today in the LEM project. TRW/Space Technology Laboratories was one of two companies conducting parallel studies of the rocket engine that will take the LEM capsule out of its lunar orbit and brake its descent to the moon's surface. TRW/STL was a NASA contract to design the rocket engine that would be widely throttleable over a thrust range from 1,000 to 10,000 pounds. The descent engine will be required to burn continuously from about 50,000 feet to within a few



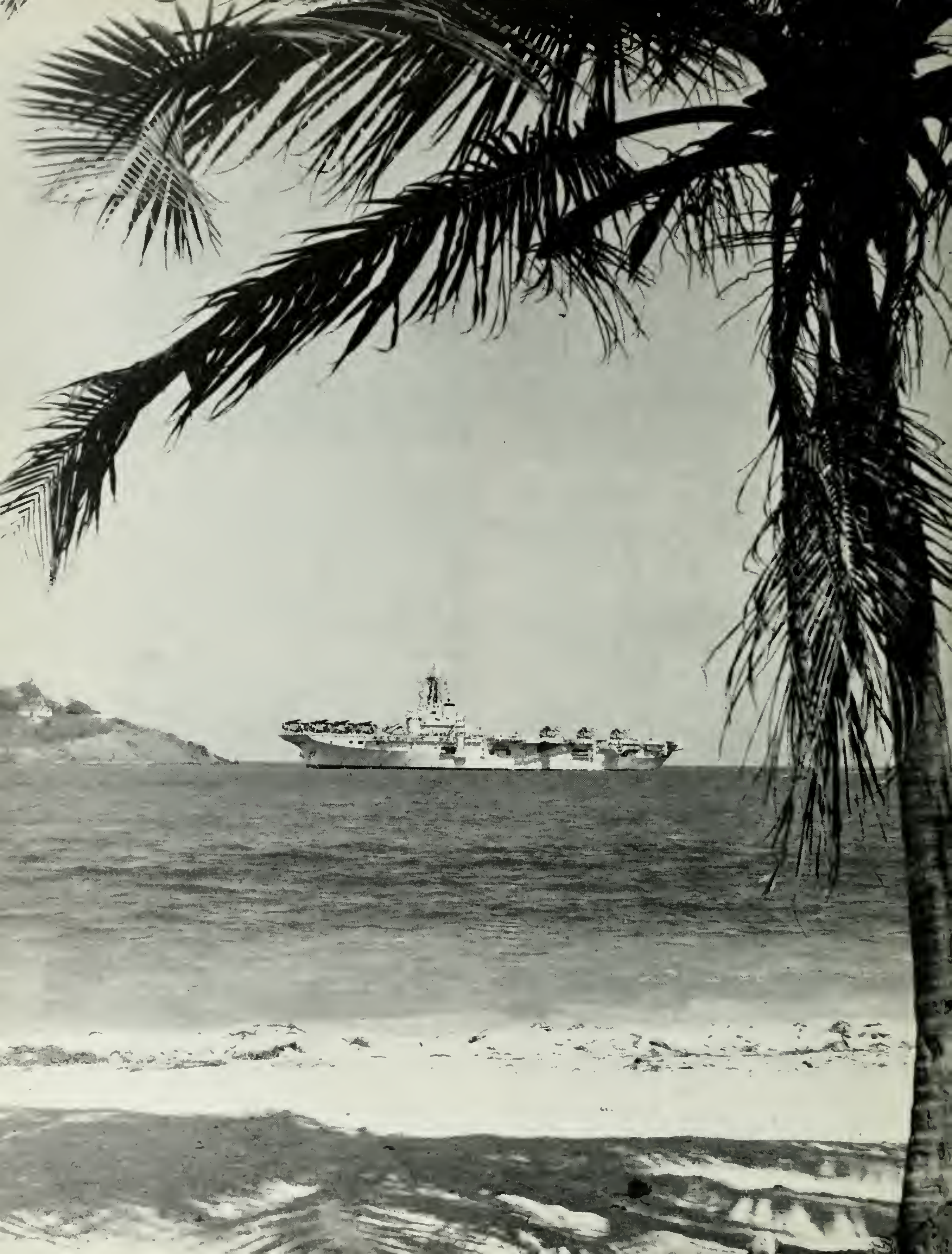
Man's moon landing will be achieved through use of LEM vehicle such as this mock-up. Ryan is welding and machining titanium components for TRW/STL and NASA of the desecent rocket engine for the LEM vehicle.

feet of the lunar surface. Under the contract with TRW/Space Technology Laboratories, Ryan technicians will complete machining and welding work on the titanium rocket engine chambers and chamber shells.

Ryan has devised a novel shielding in the automatic tungsten inert gas titanium welding process to prevent air contamination of the weld. A stainless steel shield was developed in Ryan's welding laboratory. The part rotates inside the shield, and the welding is performed in an environment purged with argon, the operator controls it by peering through a glass plate porthole in the shield. To further insure a perfect weld, water-cooled backup tooling is provided to keep the back side of the weld cool.

Susceptibility to embrittlement militates against conventional welding of titanium with other metals. However, progress has been made in joining titanium with other metals through brazing, ultrasonic welding, LASER welding and electron beam welding.

For more than 30 years, Ryan has been taming tough metals, and at one time handled more different alloys — 80 — in current production than any other aerospace company. Ryan research has helped prevent Cinderella titanium from reverting to a scullery maid role. Today, the future of this metal for specialized applications appears assured. ■



SPRINGBOARD '65

A pedestal to air-surface defense training

THAT TRADITIONAL "FIGHTING TRIM" of the U.S. Navy is gaining unparalled support today from Ryan Aeronautical Company through its world-wide complex of target drone facilities and men.

A testimonial to this was Operation Springboard-65, an Atlantic Fleet air defense exercise concluded in late March in waters off San Juan, Puerto Rico.

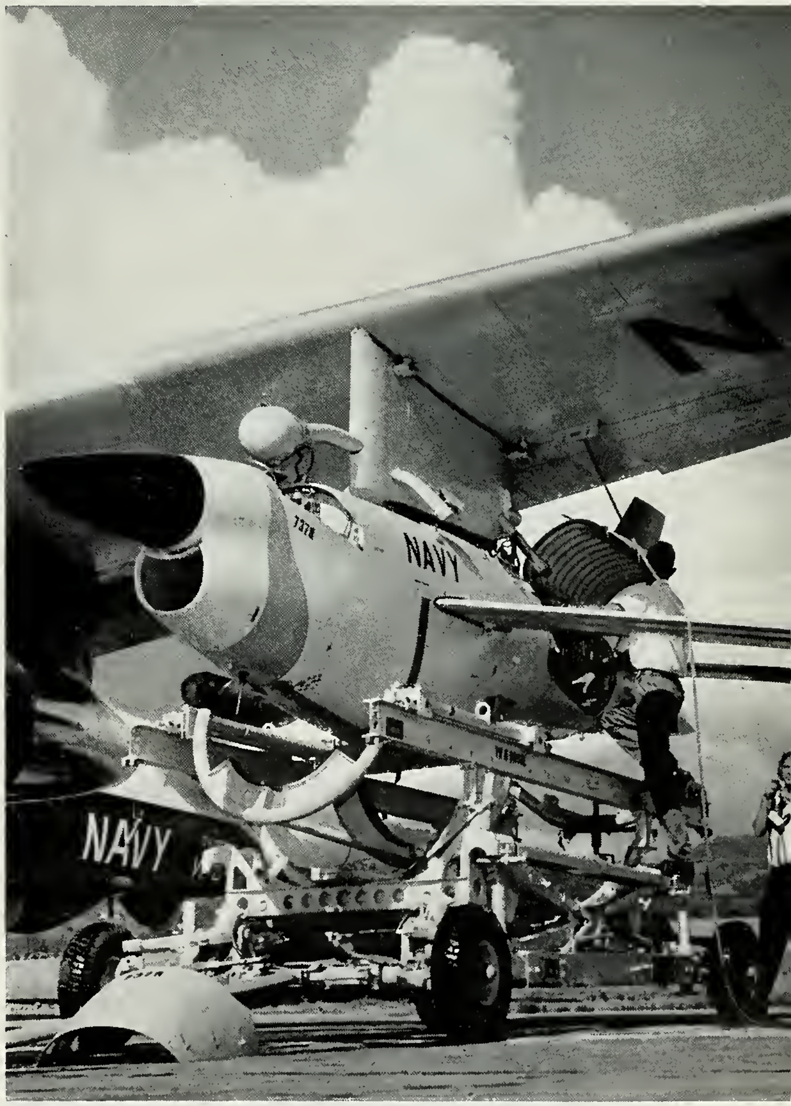
Nearly three months of activity in the air, at sea and on land — involving some 10,000 officers and men, 220 ships and countless numbers of aircraft — went into what is called the "most successful fleet training exercise to date."

Ryan's role throughout Springboard included services of a 28-man Firebee crew stationed at Roosevelt Roads Naval Station. Target presentations were made by the crew in unprecedented numbers, according to reports issued by Bob Lankard, Ryan base manager, who logged 70 Firebee drone flights during the 89-day exercise period.

Commencing in early January, Springboard participants began arriving in Caribbean waters ready to fire missiles, lay mine fields, conduct gunnery exercises, drop torpedoes, make amphibious assaults on off-shore islands, practice anti-submarine warfare and engage in almost every type of ship and aircraft weapons system training known to the Navy today.

Conducted under the overall command of Rear Admiral H. H. Caldwell, Commander, Caribbean Sea Frontier, this year's Springboard exercise represented a 52-percent increase in total surface operations over last year's. Added to this operational magnitude was the international flavor of British and Canadian forces which joined U.S. units in air-sea defense training.

As Springboard-65 unfolded—as a significant advance for the U.S. Navy—it also marked a



Ryan field engineers at Roosevelt Roads pre-flight Firebee for air-launch from Navy DP-2E Neptune. HMCS Bonaventure (photo at left) arrives off picturesque Puerto Rico to engage in Operation Spingboard-65, Navy's biggest exercise.

Nocturnal activity continued during Springboard-65 as minesweepers prepared for operations.

Fuel expended, Firebee gets a lift to home base.

Missile fired from cruiser seeks out target plane.

milestone for Lankard's Ryan unit: It was during the operation that the 500th Firebee mission was racked up.

The 600-mph drone made two target runs at altitudes of 7,000 and 14,000 feet over a 39-minute period as missiles were fired from Atlantic fleet warships.

On completion of its mission, the drone was recovered virtually undamaged and returned to base for future flights, according to Lankard. The precedent-setting flight was made from a Navy Neptune DP-2E piloted by Lieutenant Commander R. Hanegan and co-pilot Ensign J. H. Stanley. Ryan direct control operators Jim Jernigan and Harry Penny were also aboard for the historic flight.

Ryan's team indicated an over-all target system presentation reliability of 94.29 percent through the period that ranged from Jan. 19 through Mar. 27.

Low, intermediate and high altitude missions by BMQ-34A Firebees, ranging from 5,000 to 50,000 feet, were flown during this period with Atlantic fleet ships scoring 12 "kills."

As indicated by Operation Springboard, this broad base of activity in the utilization of the Firebee target drone system is extended into a boundless area of application.

Though Springboard target presentations were made through the air launch system, Ryan Fire-

Helicopter picked up "Firebee" at sea, returning target plane for servicing in preparation for next flight.

bee operations also include ground launches from stationary or mobile ground platforms.

The basic mission of the drone is to provide missile crews with a realistic target for air defense training and weapon systems evaluation. Ideally equipped for this mission, the BMQ-34A is designed for sustained flight capability of one hour or longer at altitudes ranging from 300 feet to in excess of 50,000 feet at speeds of more than 500 knots.

During flight, the drone is remotely controlled by radio through all normal flight maneuvers. A radar beacon is employed for tracking and telemetry supplies in-flight data to aid the remote control operator.

As indicated in Springboard — and while this was a major sea exercise — Firebee systems are designed for over-land or sea operations. Styrofoam flotation blocks, compartment sealing and a fuel expulsion system to reduce weight insure flotation while the drone awaits retrieval from the water.

Bob Lankard's official report couldn't reflect his personal feelings. Completely objective, it presented the volume of flights, degree of success and reliability of the Firebee system.

Beyond this report, however, Lankard and his Roosevelt Roads crew can feel the quiet measure of pride that goes with job of keeping the U.S. Navy in "fighting trim." ■

Operation Springboard-65 — the Navy's "most successful" training exercise ever held, was under overall command of Rear Admiral H. H. Caldwell, Commander of the Caribbean Sea Frontier. His staff held responsibility for planning, scheduling, and conducting the exercise, which involved 220 ships and 10,000 officers and men.

Captain John Collingwood, Assistant Chief of Staff for Operations, headed up the team that ran the exercise. His principal assistant was Lieutenant Commander Carlos F. Font.

RYAN VERTI

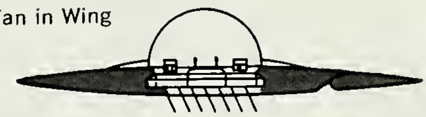
By John Peterson
Chief, Advanced Design
Ryan Aeronautical Company

The V/STOL aircraft designer must combine conventional aerodynamics with a V/STOL concept in such a manner as to not jeopardize the capability of the ultimate aircraft to perform so-called conventional mission requirements.

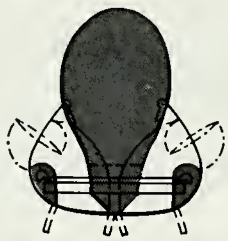
Artist's concept

. . . not just a fan in wing

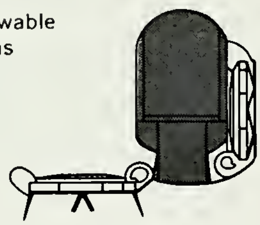
Fan in Wing



Fan in Fuselage



Stowable Fans



Inherent flexibility of fan installations allows wide latitude in matching operational configurations in terms of aerodynamic considerations, CG travel, control power requirements and allocation of internal volume, as illustrations indicate.

THE U.S. ARMY XV-5A, designed and built by Ryan Aeronautical Company, under contract to General Electric, developers of the lift-fan propulsion system, has demonstrated remarkable performance during flight tests at Edwards Air Force Base, California.

In more than 170 flights the vertical and short take-off and landing (V/STOL) aircraft has performed vertical take-off, landing and hovering maneuvers using "cruise power" only. Transition maneuvers and conversions from vertical take-off to conventional flight, then back to vertical landing have become routine. The XV-5A has demonstrated low fuel consumption in all flight regimes, high subsonic speeds and vertical take-off and hovering operations with only minor ground erosion.

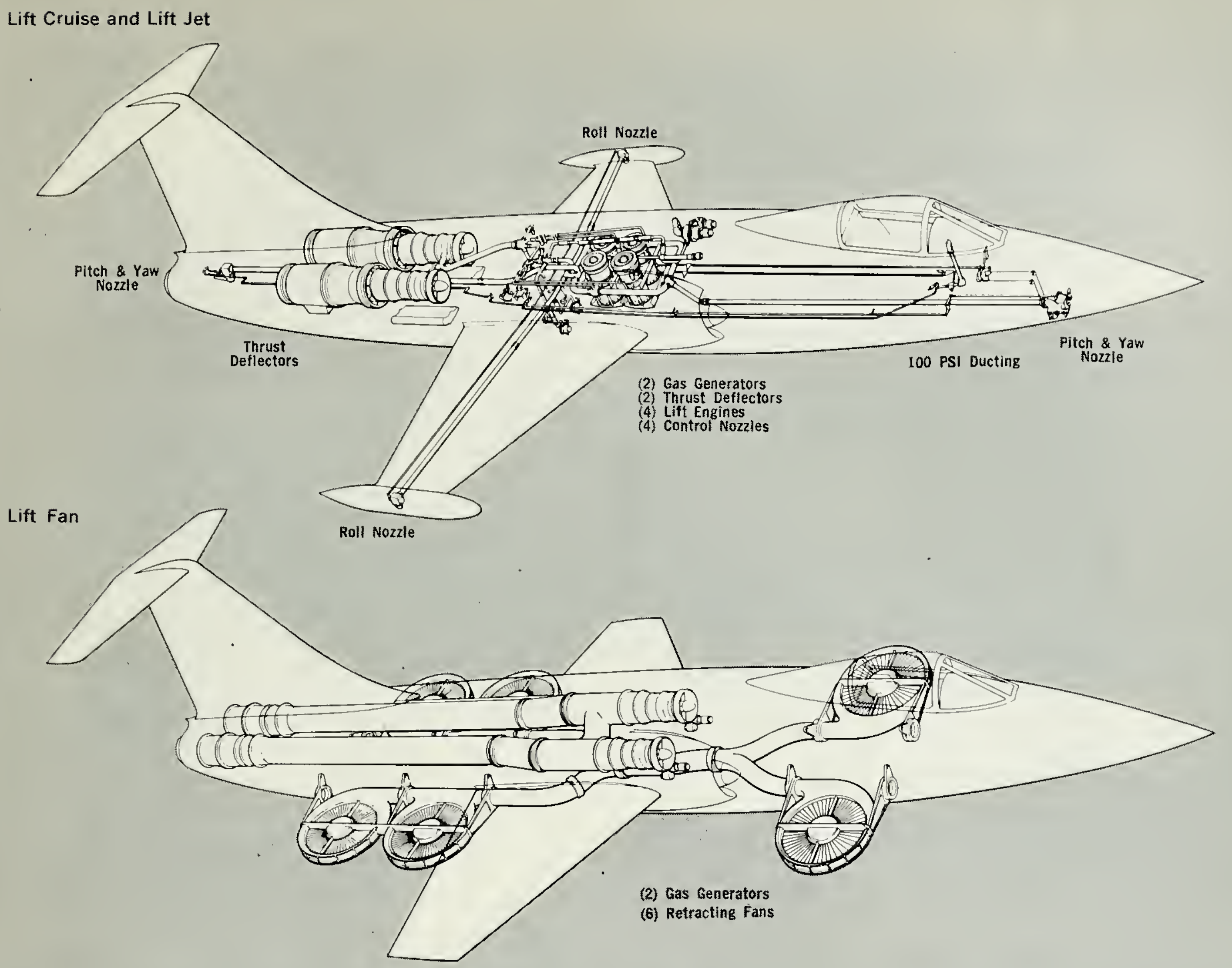
As the XV-5A continues to expand its flight capabilities in the Phase II flight test program, Ryan engineers envision new applications for the remarkable capability of the Vertifan concept to augment basic engine thrust from 200 to 400% for vertical take-off and landing.

By adapting the Vertifan concept, in conjunction with the latest jet engines, to specific mission requirements, high performance fighters and transport aircraft can afford a V/STOL capability without detracting from mission or payload as compared to conventional aircraft flying today.

Vertifan installations can be fan-in-wing, fan-in-fuselage, retractable fans or various combinations of these. Comparison with other high subsonic and supersonic V/STOL concepts indicate that the lift-fan is competitive on a weight and volume basis and exceeds them with respect to low fuel consumption, minimum development, production time and costs.

Vertifan System Explained

Vertifan system components include the engine (or engines), diverter valves, scroll and associated ducting, fans, and conventional jet tailpipes. In vertical take-off and hover operation, the jet engine exhaust is directed by a diverter valve through a scroll located at the periphery of the fan where the exhaust then impinges on small "tip" turbine blades to turn the fan — much as water turns a water wheel. Augmentation of the jet engine thrust is obtained by converting the high energy, high velocity, small mass flow of the jet engine to a relatively large mass flow, low velocity fan efflux, reducing the effective disc loading and multiplying the basic jet



Comparison illustration (bottom) depicts dramatic simplicity of retractable fan system as compared with direct lift jet-powered concept. Preponderance of component complexities are readily apparent in top drawing. Fans may be located in wings, fuselage or retractable, or any combination of these utilizing Vertifan concept. Lift fan require no compressors, burners, fuel or oil systems.

engine thrust. Atmospheric air drawn through the fan adds mass and lift to the augmentation.

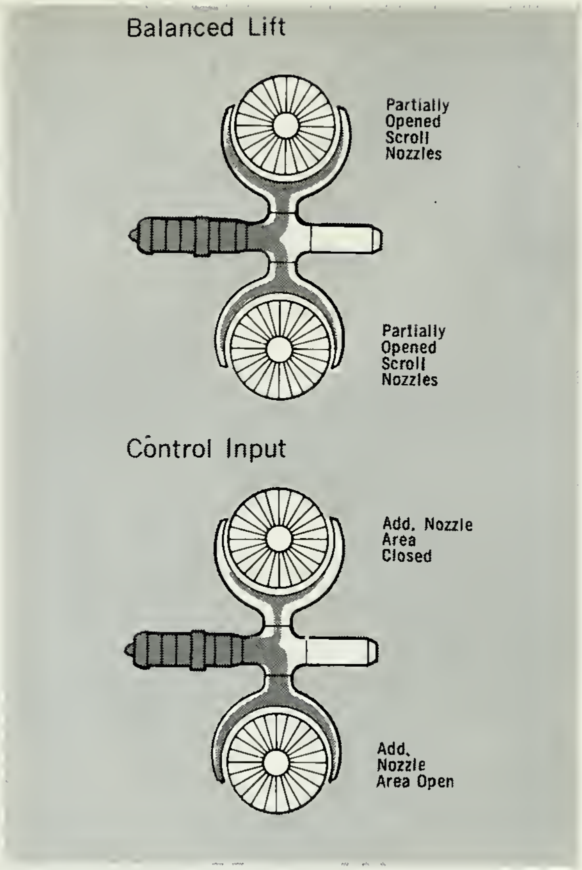
Whether the fans are installed in the wings, the fuselage or are retractable the various components operate on the same principle.

Unlike jet engines, lift fans are simple, multi-bladed, shrouded propellers that operate at low rpm. For example, 2,650 rpm is the maximum for the main fans on the XV-5A. The fans do not require compressors, burners, fuel systems, or oil systems. Current lift-fan research hardware has accumulated more than 1,000 hours of operating time without shutdown due to fan or ducting system malfunction.

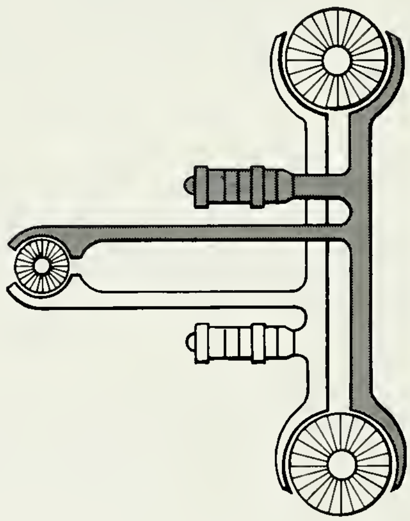
V/STOL With Little Penalty

Mission requirements in terms of Mach number, range-payload, structural criteria, equipment requirements, and other operational considerations must be met by the aircraft design regardless of the mode of take-off and landing.

The V/STOL aircraft designer must combine conventional aerodynamics with a V/STOL concept in such a manner as to not jeopardize the



In future designs power will be transferred from one fan to another in the series to provide hover control, as illustrated in the drawings above.



Jet engine exhaust is independently connected to each fan, allowing balanced flight with one engine out, as illustrated in this drawing above.

capability of the ultimate aircraft to perform so-called conventional mission requirements.

Further, he must provide the V/STOL flexibility and effectiveness at minimum cost to the total system. The application as well as the selection of the V/STOL concept is of paramount importance in achieving these goals.

The designer must determine first the jet engine thrust required for conventional flight. Working with this available thrust he then determines the number, size and location of lift fans to provide the necessary lift for vertical take-off and control.

Finally he combines jet engine and fans into a suitable aerodynamic configuration to accomplish the desired mission. This process assures perfectly matched lift and cruise propulsion systems, using only that power already installed for conventional flight.

The concept is applicable to subsonic and supersonic fighters, bombers, and transports.

The inherent flexibility of fan installations allows wide latitude in matching operational configurations in terms of aerodynamic considerations, center of gravity travel, control power requirements, and allocation of internal volume.

A plus factor in the application of the Vertifan concept to such aircraft is that no additional fuel is required for V/STOL because the aircraft's jet engines are matched for conventional flight and are used as a power source for the lift fans.

Safety and Control

Considering safety requirements and control systems in the Vertifan concept, jet engine exhaust is independently connected to each fan, allowing balanced flight in an engine out condition.

A significant departure from the concept as applied to the XV-5A, future Vertifan aircraft will use power transfer techniques for control during vertical take-offs, landings and hover. Louvers on the XV-5A lift-fans spoil thrust to achieve control. In future designs power will be transferred from one fan to another in the series to provide hover control. This results in no lift loss, giving the Vertifan aircraft a significant edge over other high performance V/STOL concepts.

Ground erosion and site preparation are equally important factors to be considered in designing operational V/STOL aircraft. Vertifan propulsion is the only high performance V/STOL concept that does not require extensive site preparation. Thus a lift-fan aircraft should be capable of rapid dispersion to a remote site for mobility and

Propulsion system of retractable fan concept, as illustrated above, has been tailor-made to mission requirement of aircraft. Wide latitude in configuration in sub and supersonic design includes V/STOL capability bonus. U.S.-Federal Republic of Germany have agreed on joint studies of such an aircraft.

survivability. Noise levels are also a consideration in any design. The noise level for a lift-fan system is similar to a piston engine. By comparison, at the Port of New York level, Vertifan aircraft would require a separation distance of 500 feet as opposed to 5,000 feet for a turbojet, base on a 60,000 pound aircraft.

Development Cost & Time Comparison

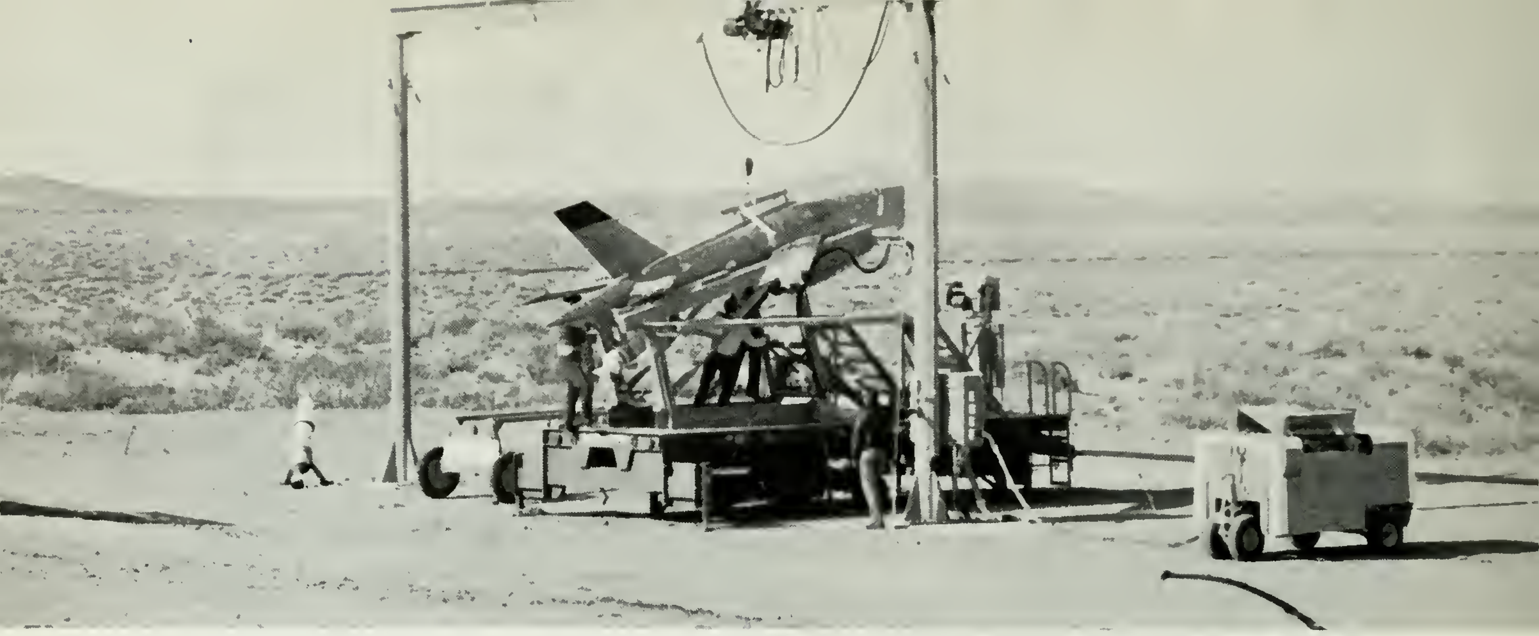
Any jet engine can be a power source for lift fans. Because the lift fan is simple, its development time and costs and production and spares costs are but a fraction of cruise or lift jet engines. As aircraft requirements and gross weights change, the lift-fan can be exactly optimized in dimensions and lift for any application without being restricted to multiples of standard hardware.

In essence the Vertifan concept is more than just another V/STOL method. It is a technological breakthrough. Lift-fan propulsion systems are competitive with other high subsonic and supersonic V/STOL propulsion systems in weight and volume. They are superior in terms of — minimum lift loss for hover control; minimum ground erosion; minimum production cost; minimum logistic support requirements and early availability. Additional lift-fan characteristics include:

- *excellent single engine out capability*
- *non-critcal transition*
- *rapid start-up and shut down of lift system*
- *high reliability and maintainability*

Vertifan aircraft also offer extended hover and slow flight in the fan mode, where extended operating times are required for such missions as finding landing sites in zero-zero weather, evasive nap-of-the-earth approaches to a V/STOL landing sites, and detailed post-strike area damage assessment.

Highly reliable and easy to maintain, Vertifan is not just a fan-in-wing concept. It is the most effective and versatile V/STOL system in operation today. ■



Mobile launch capability at McGregor Range adds new dimension to Firebee operations in New Mexico.

METAMORPHOSIS

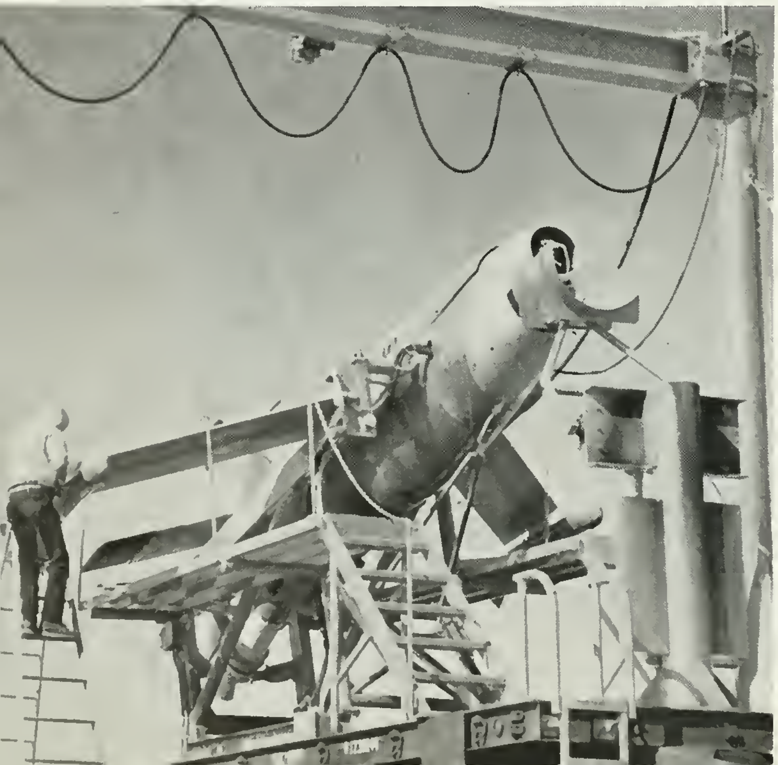
FIREBEE OPERATIONS ARE IN "GO!" condition at the sprawling McGregor Range a facility of the U.S. Army Air Defense Center, following a seven-month "make-ready" period completed recently by a Ryan Aeronautical Company field service crew.

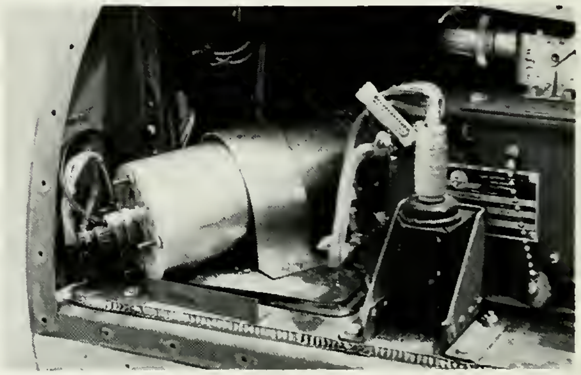
This marks the first time that the Firebee target drone are engaged in operational training programs conducted at McGregor.

The Ryan field service crew, led by C. D. "Bud" Miller, fabricated ground support equipment, installed temporary ground launch facilities and established a complete operational-maintenance base.

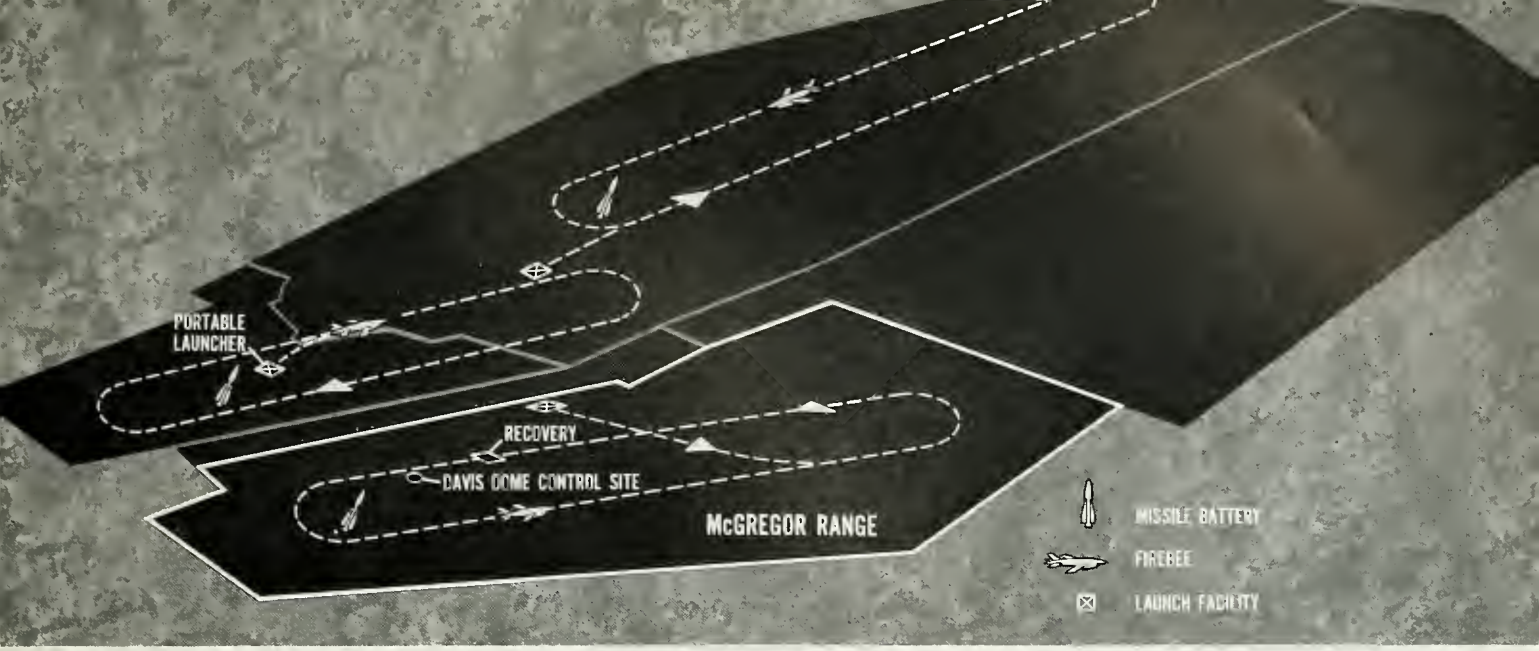
Firebee operations have been contracted by the U.S. Army Air Defense Center that will carry through the end of fiscal year 1966 (June 30).

The introduction of Firebee operations at McGregor adds a significant advance to the Army's complex in New Mexico, extending its capabilities at White Sands — where weapons research, development and testing is conducted — well into the area of air defense training.





Firebee scoring system is compactly packaged, as illustrated in photo above. Ryan technician (at left) prepares Firebee-Towbee system for launch on McGregor's mobile facility.



White border sets boundaries for Firebee Operations now conducted at McGregor Range complex.

N NEW MEXICO

McGregor Range will continue to be used for annual service practice by Army "Hawk" air defense missile batteries stationed throughout the world.

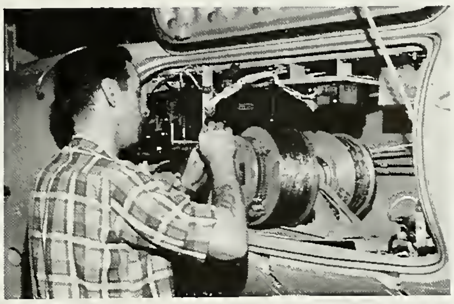
Firebee and its recently-developed companion device, Towbee, will be utilized in continuing operations there as target vehicles.

The Towbee system employs small, expendable targets which are towed at a distance behind the radio-controlled Firebee.

Ryan field service crews have operated and maintained Firebee jet target drones at nearby White Sands for the past five years, during which a variety of ground-to-air Army missiles were tested and evaluated and a series of improvements were made in target performance.

In addition to the Firebee-Towbee combination, Ryan developed a "beefed up" target ground launch system that extends payload capability of the target by 300 percent.

White Sands and McGregor Ranges, two of the world's largest installations for free-flight test work, are located in isolated country about 45 miles north of El Paso, Texas. ■



Technician installs Towbee cables in Firebee (above). Firebee target poised for launch (left). Hawk missile batteries (at right) undergo intensive use at McGregor Range where Firebee-Towbee operations are in "Go" condition today.

U.S. Army Test Pilot William Anderson performs cockpit check in XV-5A at Edwards AF base.

THE UP-DOWN CORPS

XV-5A PILOT TRAINING PROGRAM

Army test pilots at Edwards Air Force Base are learning to fly in a new environment — one created by the unusual performance of the U. S. Army XV-5A, a jet aircraft that can take-off, land, hover and maneuver like a helicopter, yet can fly at speeds of up to 500 miles per hour.

The XV-5A was designed and built for the Army Aviation Materiel Laboratories by Ryan Aeronautical Company, San Diego under contract to General Electric, developers of the aircraft's unique lift-fan propulsion system.

Now in Phase II flight tests at the sprawling desert Air Force test base, the XV-5A has demonstrated its unusual capability many times. The Army formally accepted the aircraft in January following successful completion on Phase I tests.

Val Schaeffer and Lou Everett had made the Phase I flight tests as the aircraft made significant contributions to the still young and growing V/STOL (vertical and short take-off and landing) aircraft field.

Because the aircraft is so unusual the pilot training program carries its own significance. Included in the group were three Army pilots, Major Paul Curry of the Aviation Materiel Labora-

Army Capt. William Welter, XV-5A test pilot, and Ryan engineer Jim Maroney, watch Phase II flight tests on XV-5A at Edwards AF Base.

XV-5A "student" pilots William Anderson (in cockpit), Maj. Paul Curry and Capt. William Welter, discuss cockpit functions with Ryan training supervisor Ray Hatherill during early phases.

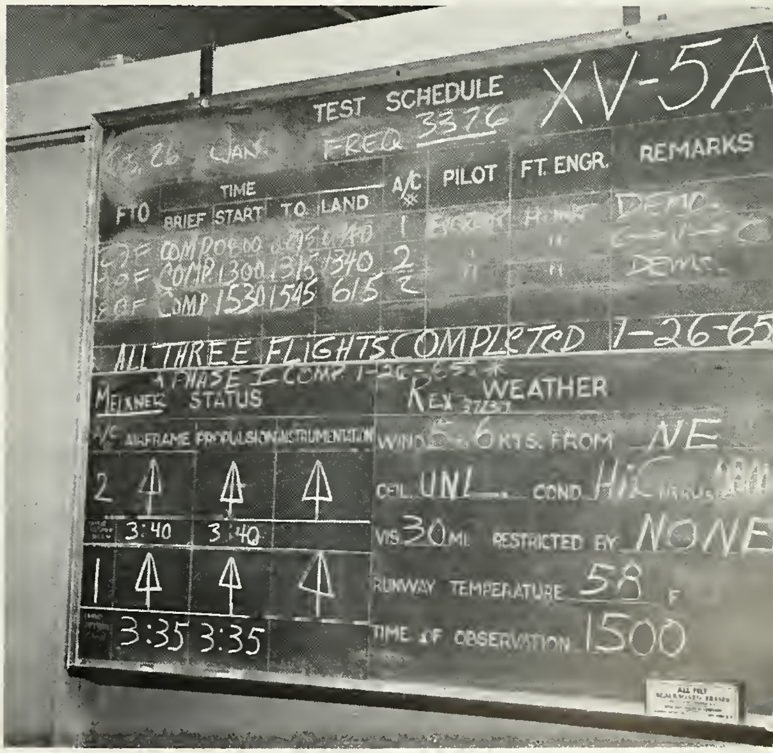
tories, Capt. Bill Welter and Bill Anderson, a civilian of the Army Test Activity at Edwards Air Force Base, and Richard Scoles a General Electric test pilot.

Additional military and civilian pilots from NASA the Air Force, Navy and Federal Aviation Agency are also slated to join the program.

Curry, Welter, Anderson and Scoles began their flight training program last January at Ryan's Lindbergh Field facilities in San Diego.

An intensive familiarization and indoctrination schedule, including "flights" in the XV-5A simulator at the Ryan plant was conducted as a

Training Flight status board reflects program's rapid pace achieved to close out Phase I testing of XV-5A. Notation-"All three flights completed"- was a major milestone in V/STOL history.



(Above) Ryan XV-5A "flights" were completed in simulator at Ryan's San Diego plant during familiarization and indoctrination program, preliminary to Phase II flight tests at Edwards AF Base. XV-5A "student" pilots were (from left) Maj. Vern Riesterer, Maj. Paul Curry, Capt. William Welter and civilian pilot William Anderson.

(Left) Certificates of completion of Ryan XV-5A flight simulator program were awarded by William T. Immenschuh, Director, Aircraft, to (from left) Capt. William Welter; Richard Scoles, GE test pilot; Maj. Paul Curry; William Anderson; and Maj. Vern Riesterer at San Diego.

prelude to Phase II flight hops at Edwards.

For this "ground school" segment of the program, Army engineers and technicians joined the detailed training curriculum. Included was Major Vern Riesterer, now the resident director of Army XV-5A flight operations at Edwards.

The program was divided into four parts. The first two weeks at Ryan included basic study of the aircraft and its various systems.

Following familiarization flights in the Ryan simulator, the team reported to Edwards to join the Phase II program.

Early flights were confined to aircraft operation in the conventional mode, then later flights included extensive hovering maneuvers and conversion from vertical take-off to configurations conventional level flight. The training program was completed with conversions from conventional flight to fan mode and back to conventional flight.

Now fully qualified in their new environment, the Army pilots are working with the contractor pilots in developing a dramatically new era in aviation. ■

Phase II flight tests of Army XV-5A are underway at Edwards Air Force Base.

Ryan-designed landing radar system for Lunar Excursion Module transmits three energy beams for spacecraft velocity and one for altitude from antenna array located on underneath side of helicopter now testing system at San Diego firm's Ryan Electronics facility for Radio Corporation of America.

LEM-Man's adventure to the moon

Calibration check is made by Norris on system that is designed to land manned spacecraft on lunar surface. Ryan is designing and building special test equipment sets to support the landing system.

A TWO MONTHS' FLIGHT test program to demonstrate design feasibility of the Ryan landing radar for use in the Lunar Excursion Module (LEM) is being conducted at Ryan Electronics.

The "breadboard" radar has been installed in a Sikorsky H-34G helicopter provided by the National Aeronautics and Space Administration, and borrowed from the Navy, for testing in a series of flights over the San Diego area.

Ryan is developing the radar system in a contract with Radio Corporation of America, which is responsible for several major electronic subsystems for LEM, the capsule which will land two men on the moon. The radar will provide data on altitude and velocity with relation to the moon's surface, to help effectuate a soft landing.

Grumman will integrate the landing radar with the overall sensor subsystem, which will include the rendezvous radar being designed and built by RCA to enable the astronauts to rejoin

Extensive tests to insure reliability of landing radar system designed by Ryan is paving way for man's eventual lunar landing. Helicopter, simulating LEM space vehicle, will be used in conducting tests over period of one year before moving on to next phase. NASA Pilot Roger Davidson conducts pre-flight check.

the parent Apollo spacecraft after takeoff from the moon.

The Ryan "breadboard" radar is mounted inside the helicopter, which is fully equipped with cameras that "look" at the ground and cameras which photograph the instrument panels that contain displays similar to those the astronauts will observe to determine the velocity and altitude of their spacecraft.

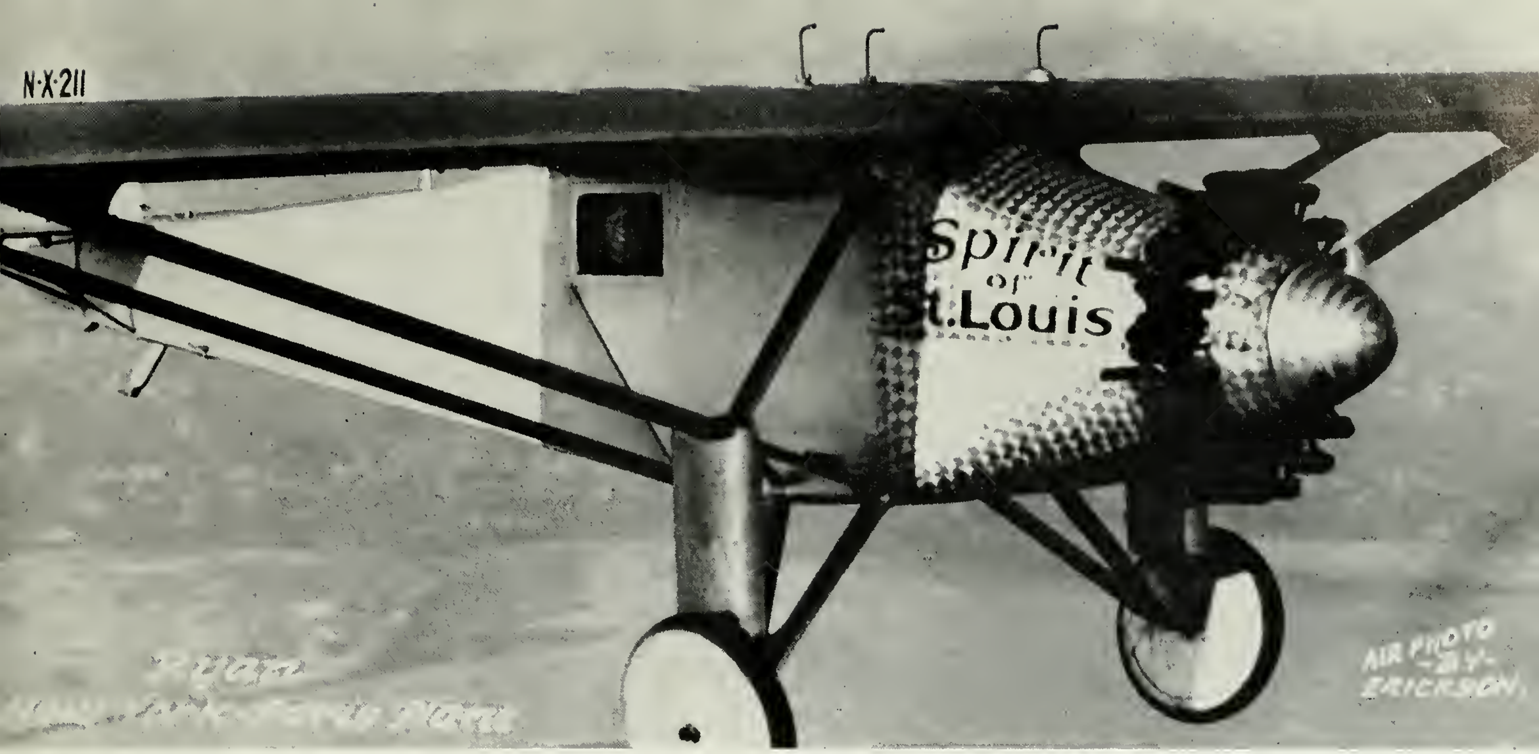
Warren Norris is Ryan test conductor in charge of the flight test phase of the program, and George Warr is senior group engineer responsible for overall testing of the landing radar.

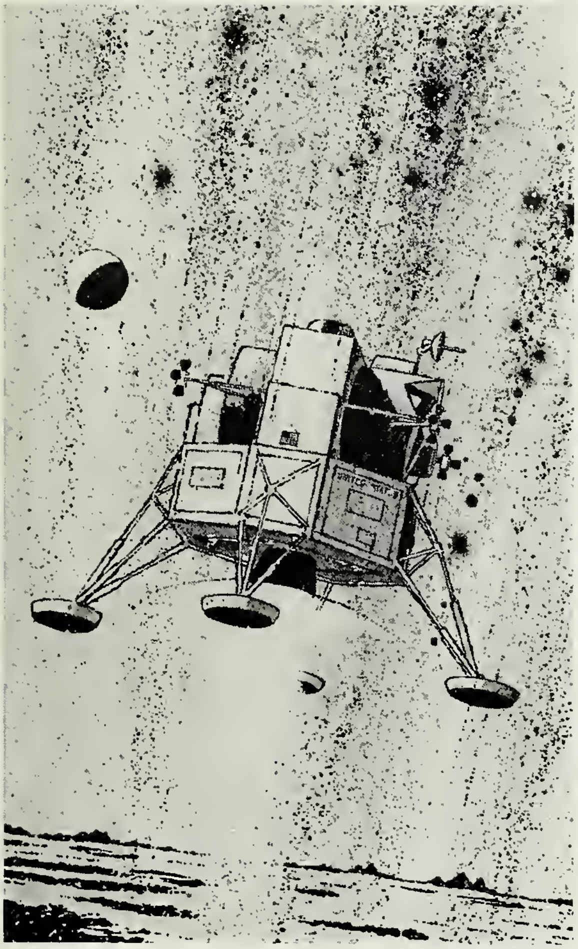
Expected to make flights during the testing program are observers from NASA, RCA, and Grumman Aircraft Engineering Corporation, prime contractor for the LEM vehicle.

A "heliport" has been cleared in the parking lot adjoining the Ryan Electronics plant on Kearny Mesa as one of its newest facilities. ■

Landing area at Ryan Space Electronics facility enables helicopter to become an actual component of test labs, making test data readily available.

58-10





From Lindbergh . . . To LEM

"RYAN-BUILDS-BETTER" . . . a historically documented fact established by Charles A. Lindbergh 38 years ago in his Ryan-Built "Spirit of St. Louis."

It's been going on ever since at Ryan Aeronautical Company.

Space-age specialists today call this quality "Zero-Defects." That's the end result of what Ryan's been doing all along.

Ryan Space Electronics Center is engaged today in programs which will help land men on the moon, riding in a Lunar Excursion Module (LEM). They're also creating a broad array of space electronics components and devices for use in America's space effort.

These new challenges are man's most formidable. But, they only strengthen the spirit at Ryan Aeronautical Company. There's seldom any doubt about it, either. All anybody has to do is look at the record. It spells out: "Ryan Builds Better."

S-Oct '65

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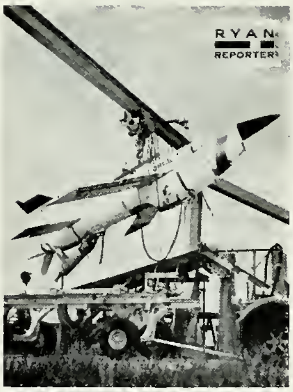


About the Cover: The Firebee being readied for launch at Tyndall AF Base serves as a symbolic prelude to the activity provided in support of William Tell '65, Oct. 1-9.

WILLIAM TELL '65

FIREBEE GETS TOP BILLING

One of the most demanding Firebee build-up programs since the inception of the speedy aerial target drone is under way at Tyndall Air Force Base today, in advance of the start of William Tell '65 weapons meet.

The Air Force's World-Wide Fighter-Interceptor Weapons competition, an event that is scheduled to draw a record number of competing teams of Air Defense Command's top squadrons, will run from October 1st through the 9th.

In preparation for what project officials call, "the most challenging of them all," a special Ryan crew of 34 men is engaged in final systems check-out of 67 jet-powered, BQM-34A Firebees.

William Tell authorities say 85 ground launches are estimated for the week-long period of competition. Unlike past William Tell events, this year's is expected to be a ground launch operation for Firebee targets.

Lt. Col. H. S. Anthony, Project Officer for the 73rd Air Division, one of the host commands for the meet, said the William Tell '65 competition would attract 16 fighter-interceptor teams, the largest number to ever participate in the biennial aerial shootout.

Included in this number is the 425th Fighter-Interceptor Squadron, a Royal Canadian Air

Pilots race for their planes during "scramble" at Tyndall AFB, Fla., site of William Tell '65 meet.

1

2

3

4

Photo sequence tells story of William Tell '65 build-up program's intensity. (1) Ryan Field Service crew conducts round-the-clock work schedule as pilots undergo briefing for "dry run" missions (2). Firebee unit is towed to test area (3) for final system check (4) and engine run-up by Ryan Field Service crew.

Force unit and the first non-U.S. team to ever compete in a William Tell event.

Four categories, each representing different aircraft and weapons, have been established. Category I will involve the F-101 Voodoo; Category II, the F-102 Delta Dagger; Category III, the F-106 Delta Dart; and Category IV, the F-104 Starfighter.

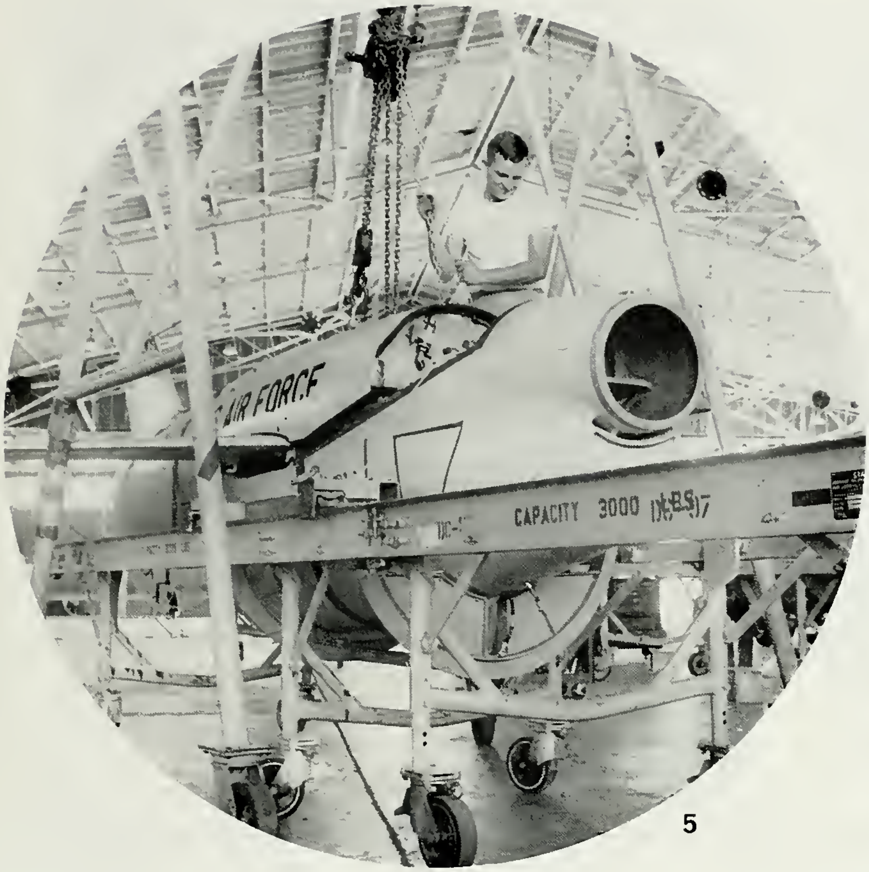
Aircraft will be firing the Falcon family of missiles, the Douglas "Genie," the "Sidewinder" heat-seeking missile and 20mm "Gatling" cannons.

The teams will include: 13th Fighter-Interceptor Squadron, Glasgow, Mont.; 425th RCAF Fighter-Interceptor Squadron, Bagotville, Quebec; 445th Fighter-Interceptor Squadron, Wurtsmith, Mich.; 62nd Fighter-Interceptor Squadron, Sawyer, Mich.; 84th Fighter-Interceptor Squadron, Hamilton, Calif.;

Also, the 64th Fighter-Interceptor Squadron, Paize Field, Wash.; 326th Fighter-Interceptor Squadron, Richards-Gebaur AFB, Mo.; 59th Fighter-Interceptor Squadron, Goose AFB, Canada; 32nd Fighter-Interceptor Squadron, Camp New Amsterdam, The Netherlands (USAFE);

In addition to the 157th Fighter-Interceptor Squadron, Air National Guard, McIntyre AFB, Eastover, S.C.; 5th Fighter-Interceptor Squadron, Minot, S.D.; 71st Fighter-Interceptor Squadron, Selfridge, Mich.; 456th Fighter-Interceptor Squadron, Castle AFB, Calif.; 318th Fighter-Interceptor Squadron, McChord AFB, Wash.; 331st Fighter-Interceptor Squadron, Webb AFB, Tex.; and the 319th Fighter-Interceptor Squadron, Homestead, Fla.

Directed by the Air Defense Command at Colorado Springs, Colo., the project is being conducted at Tyndall under the direction of Brig. Gen. Thomas A. Beeson, newly arrived Commander of the 73rd Air Division.



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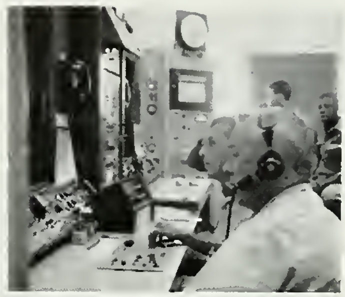

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Ryan Field Service technician lowers Firebee fuselage onto nacelle (5). Ryan crew of 34 men is based at Tyndall AFB. Airborne control and tracking is conducted by unit under Maj. R. S. Burnley (6). Under constant radar contact when airborne, the Firebee can be visually contacted (7) as the flight ends.

Ryan's Firebee crew was dispatched to Tyndall in early June. Bert Hale, Jr., one of Ryan's most seasoned engineers in the target drone programs, guides the buildup operation as Base Manager. His responsibilities include overseeing modification and checkout of units prior to the competition and decontamination and rehabilitation of Firebees used during the meet.

Like William Tell meets in the past, this year's event will have its new aspects, one of which is the addition of the BIDOPS scoring system. Manufactured by the Babcock Electronics Corp., the Dual Doppler Missile Radar Scoring System will be utilized together with a Multiple Airborne Target Trajectory Scoring System.

All of the Firebee targets are being equipped with the dual scoring systems prior to the closing days of September, according to Hale.

MATTS scoring is achieved through the installation of units in the target, missile and interceptor which provides continuous tracking signals to two ground stations.

Points to be earned by competing teams will be based over a spread of activities, including skill in radar control, prescribed voice radio procedures, breakaway maneuvers after firing, and armaments loading as well as actual firing of weapons at the Firebee targets.

"Kill" points are earned on the basis of intercept distances between the weapons fired and the targets through the use of the BIDOPS and MATTS scoring systems.

A three-fold objective has been assigned for this year's meet, according to William Tell officials: "To provide recognition for the Air Defense Command aircrew and controller teams; demonstration of capabilities of interceptor weapons systems; and to evaluate the ability of Air Force crews to maintain, handle and load de-

Preview of William Tell '65 activity catches pilots on the run from line trailer to planes. Timing is critically important in contest for points which, when compiled, will decide top team.

fensive weapons."

Lt. Col. Ed Hook, William Tell '65 Project Officer for the 4756th Air Defense Wing and a three-time veteran of William Tell meets, estimated that this year's event will be "the most challenging of any to date."

Recalling those since the Air Force held its first meet in 1958, Col. Hook termed the competition, "the most realistic proving ground short of actual combat conditions that exists."

One of the new events to which interceptor pilots will be exposed during the October meet will be employment of Electronic Counter Measure missions.

While the Ryan team is engaged in preparation of the 600-mile per hour Firebee targets, it is the 4756th Maintenance Squadron, a 72-man unit, and the 4756th Drone Squadron, in whose hands the successful outcome of William Tell '65 will be achieved.

These two Tyndall organizations share responsibilities for over-all operational maintenance, launch, control and recovery of Firebee targets. Reflecting Firebee's high degree of reliability and that of the men who operate it at Tyndall is the repeated rapid "turn-around" record the two units have established.

Numerous instances exist where Firebee targets have been flown, recovered, decontaminated, and flown again, all within the span of several days during previous William Tell events.

Teams will be alerted as to the approximate time their targets will be in the air, but the actual firing will be conducted under realistic "scramble" conditions, according to Colonel Hook. The alerts will send fighter-interceptor teams out over the Gulf of Mexico in an exercise area. Their mission will be to locate the target, select procedures for the intercept and attempt to score an electronic "kill."

Each of the winners in the four categories will receive Air Force-wide recognition through the award of the Richard I. Bong trophy, a perpetual recognition award that remains at Tyndall Air Force Base.

Of near equal significance is the Ryan Aeronautical Company "kill" plaque that will go to teams scoring "kills" against the Firebee target. After five William Tell events, interceptor teams have arrived at the start of each meet with a common objective:

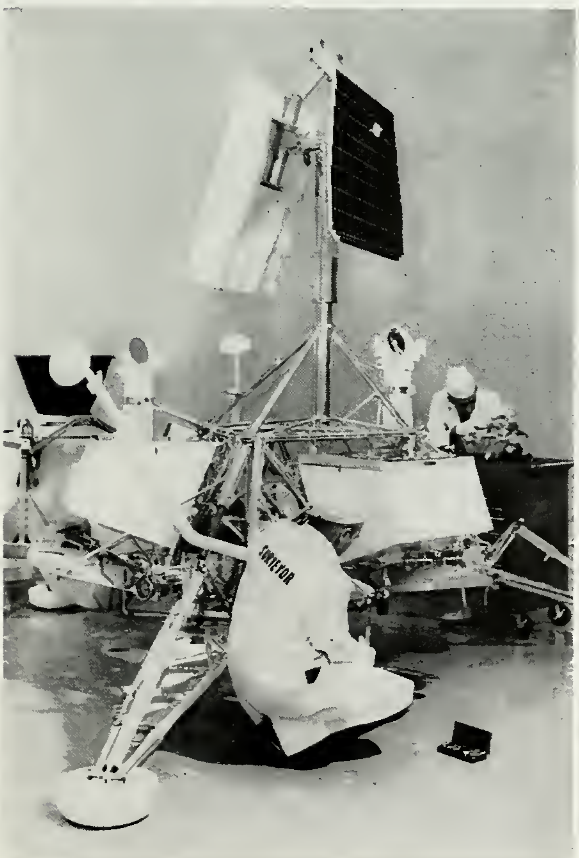
"Let's pluck the Big Apple!" ■

DESTINATION: SPACE

Space Electronics Center at San Diego covers 100,000 square feet and employs a work force of 500.

By Carl Plain, Assistant Financial Editor
The San Diego Union

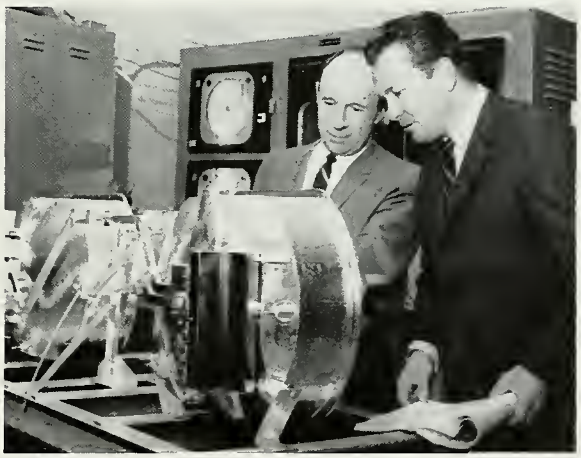
Editor's note: This is the first in a planned series of articles devoted to space electronics programs in which Ryan Aeronautical Company is engaged today.



RADAR DEVICES created in San Diego will guide U.S. space vehicles to their first unmanned and manned moon landings.

Work on this equipment is sparking explosive growth, both quantitative and qualitative, at the Ryan Aeronautical Company Space Electronics Center.

One of the most pressing problems at the 100,000-square-foot facility is space—the under-roof kind. This pinch resulted from an increase to 500 from 300 employees in the past 12 months. Most of the gain has come in engineering areas. Even now, many highly specialized engineering personnel are wanted.



Electronics Center Director Dick Iverson and Charles J. Badewitz, Chief Engineer, LEM Project, examine Surveyor guidance system. Assembled as in photo at left, system will control attitude and vertical velocity during lunar landings.

J. R. (Dick) Iverson, Ryan Director, Electronics, would be happy to see the over-all growth proceed at a rate of 10 to 20 per cent yearly.

"That is what we are gearing ourselves to do," he says.

At 36, Iverson heads a young, aggressive management that strives for more than excellence: it seeks perfection in every detail of its vital programs because lives of astronauts and national prestige are at stake. An error-free environment is the goal of a newly launched "Ryan Builds Better" program.

Beyond any doubt, Ryan is the Free World leader in space altimetry. Its programs include:

Landing radar for the Lunar Excursion Module (LEM) which will carry two U.S. astronauts to the moon, probably in 1969 or 1970.

Landing radar and a Doppler radar velocity sensor system for the Surveyor unmanned lunar landing, expected late this year. Two Russian tries at such a soft landing have failed.

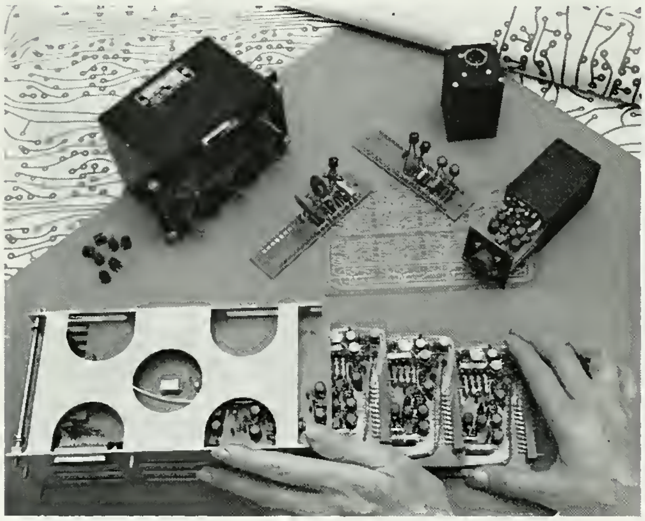
Radar space altimeters for tests of Saturn, the launch vehicle for the Apollo-LEM moon mission. Ryan's units have successfully operated in all six shots, the latest showing the altitude of 310 miles with an accuracy of 100 feet or 0.006%.

Ryan has won almost every space radar competition it has entered. Its unique capability grew from automative Doppler navigation systems which Ryan began producing 7½ years ago and still builds in small volume as it seeks contracts for "new generation" systems.

Yet Ryan is not confining its radar effort to air and space realms.

Under contract, it has developed a hydrofoil wave height sensor that measures to a 1-inch accuracy in 50 feet so the underwater wings on which the vessel rises can be adjusted for smooth sailing in rough seas.

"We project quite a future here," Iverson comments. He adds that a logical outgrowth of this small, accurate radar would be a hand-held ver-



Ryan's capabilities include development of electronic circuitry design, packaging and production (left) which incorporates soldered cordwood components or modules. Coupled to this capability is exacting test standards to which products are exposed, such as antenna array (right) being subjected to vibration test. Remote testing pad is located about 200 feet from environmental laboratory, permitting space radiation during test.

sion that could measure range to objects for the blind or for astronauts in extra vehicular activities.

Scientific studies for the National Aeronautics and Space Administration complement Ryan production and research efforts. Looming large in the company's future is an upcoming investigation of varied earth surfaces and their "Back scattering" characteristics at radar frequencies. This study may lead to Doppler systems that could operate over all surfaces, and systems that could orbit distant planets and report on their surface characteristics.

Another study for NASA shows it is feasible to put a long life transponder (transmitter-receiver) on the moon's surface to certify that a site is suitable for a spacecraft landing.

Ryan began flight testing on a developmental model of the LEM Landing Radar just a year after receiving the contract go-ahead from Radio Corporation of America, the firm responsible for

Sensor system that measures hydrofoil wave height was designed and built by Ryan Electronics, then tested (above) in actual operation. Photo at top right illustrates exacting standards exercised in space electronic component assembly. Technician at right conducts one of a series of exhaustive tests to which integrated circuitry design will be subjected during its development-packaging processes.

Ryan's IBM 704 computer facility (top) is nearing capacity workload in support of Space Electronics programs. Assembly work on electronic components is done in clean room where workers wear special clothing to prevent contamination.

Carl Plain, Assistant Financial Editor, San Diego Union and author of "Destination: Space," is uncommonly skilled at blending business-industry news into financial reporting. His 10½ years with Union and constant observations of Ryan give this article a voice of qualified authority.

the space vehicle's major electronic subsystems.

Development work on space projects moves from early "bread-boarding" through engineering model and production model stages with much testing at every step.

As the work moves along in space and avionic programs, Ryan is coming up with new capabilities. For example, it has become the U.S. leader in precision magnesium dip brazing. The method is used for LEM's light-weight, accurate landing radar antenna.

Ryan's IBM computer is being used around the clock, six days a week, and Iverson's group is responsible for about half of that utilization. For example. the LEM antenna and all new antennas are designed on the computer.

Production involves few units but quality standards are incredibly high. Each part has a pedigree. It can be traced from its arrival at Ryan back to exact details of manufacture and the raw material source, so any faults can be pinpointed.

Assemblers doing soldering or welding must go through a 40-hour NASA-certified training course, then take periodic. eight-hour refresher courses. Assembly is done in an atmosphere-controlled "clean room" where workers wear smocks, headgear and finger coverings.

Iverson, a San Diego State engineering graduate who has been with Ryan 13 years, says the company is studying sterile techniques that will be needed to avoid contaminating yet-to-be explored planets other than the moon.

"We are fairly deep into this because it will be the next extension of our space activity," he concludes. ■

Lunar Landing Research Vehicle

Simulated moon landing amid clouds of dust, LLRV settles gently through use of Ryan Doppler landing radar.

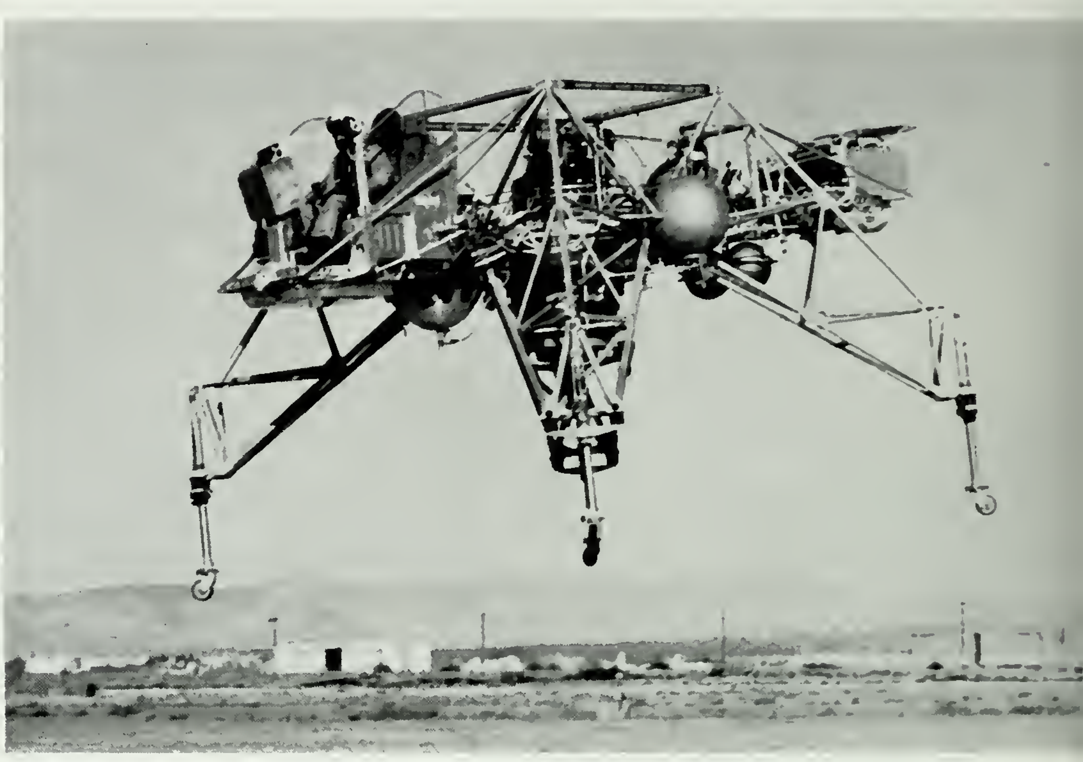
SIMULATED MOON OPERATIONS are being conducted regularly at Edwards Air Force Base today through the use of a spider-shaped Lunar Landing Research Vehicle equipped with a Ryan Aeronautical Company Doppler landing radar system and an array of "black boxes."

A forerunner to the Lunar Excursion Module in which Apollo astronauts will descend on the moon, the 3,600-pound vehicle has completed twenty successful simulated moon flight missions to date.

The test vehicle, operated by the National Aeronautics and Space Administration Flight Research Center at Edwards, is used to explore the flight envelope expected of the actual Lunar Excursion Module. Thrust measurements and linear accelerations expected to occur in the lunar gravity field are simulated through these operations.

Test pilots Joe Walker and Dave Mallick have

Twenty successful "moon missions" flown by LLRV...



Spider-shaped Lunar Landing Research Vehicle is piloted through simulated moon mission at NASA's Flight Research Center, exploring actual lunar landing flight envelope.

executed flight profile excursions exceeding project lunar flight expectations, according to Don Bellman, NASA, LLRV Project Manager.

To obtain and establish precise hovering and descent movement, Ryan and NASA Electronic Engineers have modified the Ryan APN-97A Doppler Navigation system for application to the LLRV. This continuous-wave system indicates the vehicle's precise drift and heading velocities to assist the pilot in landing at velocities of less than 6 feet-per-second.

Designed primarily for use as a hovering indicator in helicopter operations the Ryan APN-97A was modified by Ryan and NASA engineers for installation on the research vehicle at Edwards.

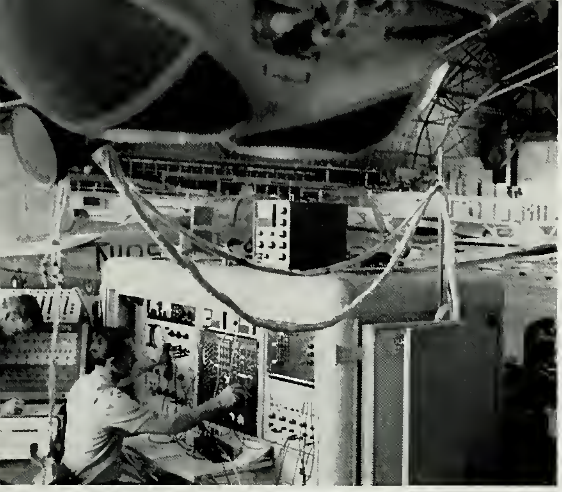
Significantly, Ryan is currently designing and has begun initial flight test of the actual landing radar system that will be installed in the Lunar Excursion Module. Its basic capability will be similar to that of the APN-97A.

The modified system indicates to the pilot his precise drift and heading velocities in increments of 2.5 feet-per-second and increased unit limitations to plus or minus 70 feet-per-second read-out.

Landing velocities during projected lunar missions are perhaps the most critical areas involved, according to program officials. They credit the ANP-97A for displaying this vital information to the pilot.

With the absence of an atmosphere on the moon, the Lunar Landing Research Vehicle was designed without usual aerodynamic inhibitions, thus the spider-like appearance that facilitates descent and take-off operations.

The LLRV is equipped with an automatically controlled jet engine, regulated to counterbalance



Globular "eyes" of LLRV are antennas of Ryan Doppler landing radar system, shown at left, undergoing maintenance checks by NASA technicians. Ryan built system originally as a hovering indicator for Navy SH-34J helicopters. Modifications of system extends application to LLRV program.

five-sixths of the vehicle's weight. This compensates for the one-sixth lunar gravity field.

NASA pilots have expanded the projected Lunar Excursion Module flight envelope to include maximum pitch and bank movements of 30-degrees with longitudinal excursions of 60 feet-per-second and descent velocities of 20 feet-per-second.

Essentially a VTOL (vertical takeoff and landing) vehicle, the LLRV is powered with a General Electric CF 700 turbofan jet engine. Pilot control is achieved by ignition of variable thrust rocket motor clusters.

Approaching the point of descent, the pilot controls the vehicle's lift by ignition of two variable thrust hydrogen-peroxide rocket motors. Six additional lift rockets have been provided for emergency use.

Vehicle attitude is controlled by two sets of eight reaction control rocket motors which are ignited in pairs.

Its fuel payload includes 400 lbs. of jet fuel and 600 lbs. of hydrogen-peroxide which is sufficient for the programmed four-minute flight duration.

This fuel is disbursed under pressure obtained from two helium tanks to maintain the vehicle's center of gravity. NASA engineers installed a special pressure-sensor metering valve to insure positive distribution of the fuel payload.

The current program is scheduled for completion in June, 1966, after which it is anticipated that the vehicle will then be transferred to the Apollo astronauts for use as a training device.

By then, project officials agree that simulated lunar missions will have provided invaluable data for actual application in man's first expedition to the moon. ■


RYAN
FIREFISH

FIREFISH IN FLEET

Navy gunners sharpen aim

RYAN AERONAUTICAL COMPANY'S perky Firefish target boat has earned her ratings as a permanent member of the U.S. Navy, gaining acceptance as "the most realistic training device for Navy gunners now in existence," according to reports issued by ship commanders in the Atlantic and Pacific Fleets.

Designed and built by Ryan since summer of 1964, following the Gulf of Tonkin incident, a quantity of the 17-foot, high-speed target boats is now in operational fleet use.

Firefish target systems are replacing

time-honored Navy tow-target sleds and are helping update surface defense exercise concepts.

Two of the craft have already been sunk during firing exercises by destroyers in the Atlantic and Pacific fleets.

The first "kill" was scored by the USS Brinkley Bass, a Long Beach-based ship attached to Destroyer Squadron 13. Operating with the USS Hubbard as control ship, the Bass achieved the Navy's first Firefish "kill" on June 22, off southern California.

Commander W. E. Lassiter, skipper of the Bass, praised the Firefish target system, noting that the "realistic qualities it provides in our exercises was unattainable until the development of this system."

Scheduled to deploy soon for the Western Pacific areas, the Bass' 270 men will be sporting the Navy's first Firefish "kill" plaque.

The plaque was presented to Commander Lassiter and his USS Bass crew during ceremonies held at Long Beach. William T. Immenschuh, Program Director for Ryan, termed the destruction of the Firefish target boat, "demonstrated effectiveness of your training programs and reflects the high standards of naval gunnery precision."

The Bass fired 56 rounds, setting her prey afire before it sunk. The target boat was running at 30 knots and 7600 yards from the Bass when hit.

Some three thousand miles away, the USS Purvis performed similar actions in sinking the first Firefish target in the Atlantic Fleet on July 28.

Sunk at 5600 yards from the Purvis, which was on a closing course of about 50 knots, the Firefish sustained a direct hit. The Purvis, commanded by Commander H. R. Moore, had fired 80 rounds.

For both ships, destruction of the target came during their first training exercise with the Firefish target system.

Currently, Firefish operational control is maintained in the Atlantic Fleet by Fleet Composite Squadron-Six at Norfolk, Va.; Commander Cruiser Destroyer Flotilla Four, also based at Norfolk; Commander Cruiser Destroyer Flotilla Six at Charlestown, S.C.; and Commander Destroyer Development Group Two at Newport.

Pacific Fleet units controlling Firefish systems include Commander Cruiser Destroyer Force, U.S. Pacific Fleet; Fleet Composite Squadron One, at NAS, Barber's Point, Hawaii; Fleet Composite Squadron Three, NAS, North Island,

Navy's first Firefish "kill" was scored by USS Bass, winning Ryan plaque for crew (below left). Atlantic Fleet's first Firefish boat was delivered by Ryan's H. E. Shapard to Capt. C. A. Sander at Newport, R.I.

Calif.; and Fleet Composite Squadron Five "A" at Cubi Point, Philippines.

Ships operating thus far with the Firefish target system include the target ships, USS Kalmia, Mohopac, and Targeteer, USS Bridget, Duncan, Edson, Parks, Bronson, Hull, Frank Evans, Turner Joy, Eversole, O'Brien, Henderson, Brinkley Bass, Purvis and cruisers, USS Canberra and Chicago.

Anti-Submarine Squadron 23, in addition to other units under Commander Naval Air Force, U.S. Atlantic Fleet, have conducted exercises in air-to-surface missile systems utilizing Firefish targets.

Ryan engineers developed the Firefish, a sophisticated, yet simple target boat system adaptable to standardized applications at fleet levels.

Compatible with shipboard electronics, the Firefish control system consists of a receiver-decoder unit, completely transistorized and possessing twenty channels. Ten of these channels are utilized for speed changes, turn commands and engine start-stop functions.

A corner radar reflector is rigged atop Firefish's aluminum mast as a device supplementing conventional shipboard search and radar tracking devices.

Its control system embodies a rudder servo, throttle actuator, auto-pilot assemblies, power junction box and command receiver with interconnecting wire harness and cabling used in remote control functions. Solid state circuitry in the auto-pilot develops a direction of rotation signals corresponding to the difference between the actual Firefish heading and the commanded heading.

Firefish has a gross weight of 1650 pounds. Her Fiberglas reinforced hull design follows a deep-V configuration for open sea stability.

Design engineers at Ryan provided Firefish with a minimum six mile radar acquisition range; however, it has been successfully tracked and fired upon at distances up to twelve miles.

Twin 18-gallon fuel tanks give Firefish six hours of cruising time at alternating speeds and four hours at its 30-knot top speed. Operational exercises have demonstrated 20-knot speed capabilities in sea states two and three.

The development of the Firefish target boat system by Ryan extends its capabilities well into a new element. Noted world-wide for the famous Firebee aerial target, Ryan is the free world leader today in remote controlled target presentation systems, both in the air and on the sea. ■

Surface gunnery exercises are being advanced in the Navy today using Ryan Firefish Target Systems as primary vehicle in exercise concept. Remote-controlled, 30-knot target boat fills role of hostile PT-boat.

BIGGEST V/STOL IN OPERATIONAL TESTING AT EDWARDS

A NEW AGE IN AVIATION is being forged today at Edwards Air Force Base by the veteran aerospace team of Vought-Hiller-Ryan, builders of the V/STOL transport plane, XC-142A.

Now undergoing initial phases of an intense, 18-month operational evaluation test are two tilt-wing, four-engine aircraft of five being built for tri-service use.

The first was delivered to the Air Force Flight

V/STOL twins—world's largest of their kind—will be joined by three more under XC-142A contract.

XC-142A could shuttle men-supplies to forward areas during combat

Test Center in early July from the LTV plant in Dallas, Texas, a distance of some 1200 miles. The cross-country flight marked the first extensive cruise range test faced by the XC-142A and was completed without incident.

Demonstrated for a throng of press, military and industrial dignitaries on its arrival at Edwards, the vertical and short takeoff and landing craft dazzled its audience with flight characteristics of a helicopter, yet performing at high speeds in conventional modes.

Already acclaimed as the world's biggest, newest and most advanced concept in the V/STOL transport field, the XC-142A is designed for rapid movement of troops and supplies into unprepared areas under all-weather conditions.

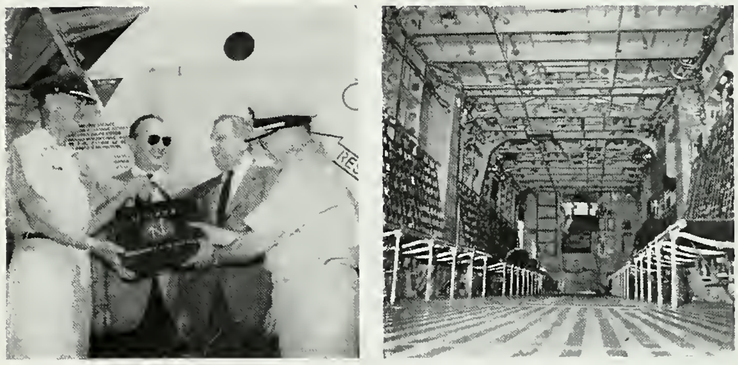
It can take off from an area no larger than a tennis court, cruise at speeds topping 430 miles per hour, and span a distance of 3800 miles with special fuel tanks.

In its Edwards demonstration, the unique, propeller-driven craft rose straight up from a standstill, hovered, circled and sped by the crowd below in level flight, alternately tilting and straightening its wing.

Ryan Aeronautical Company's participation in the XC-142A program involves design and fabrication of the aft fuselage section, tail surfaces, engine nacelles and the 67-foot wing.

Like most important advances in aviation, the huge V/STOL transport is to serve primarily in areas of military application. Its potential uses, however, could extend well beyond its combat mission.

City-center-to-city-center or rooftop-to-rooftop transportation, delivery of vital supplies to a virtually inaccessible disaster area, rescue operations, recreation and exploration in remote areas are but a few of the aerial activities which can be advanced by the V/STOL craft.



Flight log of first XC-142A accepted by military were turned over to Maj. Gen. Irving L. Branch and Vice Adm. Paul D. Stroop by LTV's President Paul Thayer and Ryan President Robert C. Jackson. The plane can carry 32 combat troops.

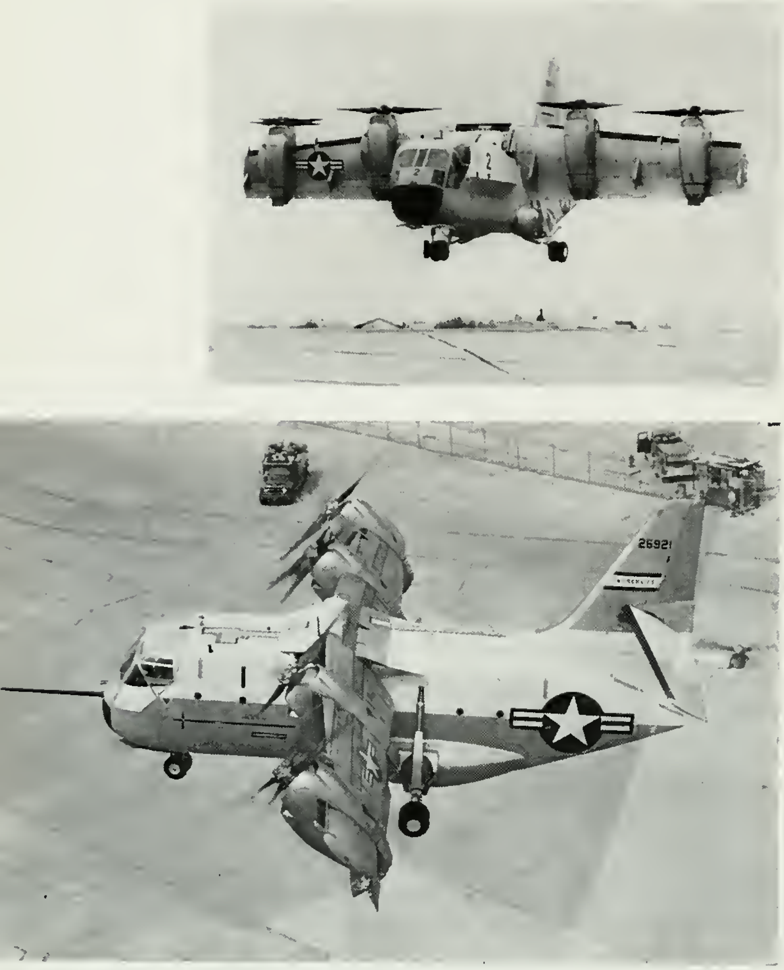
Paul Thayer, president of LTV Aerospace Corporation, predicts the XC-142A concept will make contributions to "virtually every facet of civil aviation" in addition to fulfilling its military objectives.

The tilt-wing, deflected slipstream transport is powered by four turboprop engines linked together so that even a single engine can turn all four propellers and its tail propeller.

Capable of speeds seemingly inconsistent with its squared-off appearance, the airplane is designed to take off and land vertically in all types of terrain.

The LTV-Hiller-Ryan aircraft achieves vertical flight by tilting its wing and engines skyward while the fuselage remains in a horizontal position. Increasing the effectiveness of this system, the airstream also is deflected by flaps during transition from hover to forward flight to prevent separation of the airstream and provide excellent wing stall characteristics.

When the XC-142A reaches desired altitude,



World's largest V/STOL aircraft demonstrates hover capabilities (top photo) with its Ryan-built wing tilted skyward, then assumes a conventional flight mode as wing rotates to near horizontal.

the wing and engines are tilted forward. As it gains forward speed, it transforms into conventional flight modes.

Its Ryan-built wing can tilt through an angle of 100 degrees to maintain a level fuselage when hovering even in a tail wind. For overload gross weight, it can be placed in a number of different tilt positions to achieve short takeoffs and landings.

A system of cross-shafting and gearing connects its engines to the propellers, enabling any desired number of engines to turn all four props and the tail propeller.

A system of overriding clutches permits the pilot to shut down the engines he wishes in flight.

These systems, combined with the airplane's surplus of cruise power, permit it to cruise on two engines for fuel economy and to hover and land vertically even with one engine out.

Designed to carry 32 fully-equipped combat troops, or 8,000 pounds of cargo in an operational radius of from 230 to approximately 470 statute miles, the XC-142A has a ferry range of nearly 3,800 miles.

Its blunt design was dictated by operating efficiency and payload carrying potential. The short nose and large windscreen area offers helicopter-like visibility. The squared fuselage area and large unrestricted tail-loading ramp make possible transportation of large pieces of equipment and offer a large exit for airdrop of weapons and supplies.

Its troop and cargo compartment is 30 feet long, seven-and-one-half feet wide and seven feet high.

All five of the XC-142A models built for Army-Navy-Air Force use will undergo operational evaluation at Edwards. The 18-month program will pit the new concept against the stiffest possible tests, creating realistic combat situations and operational environment for which it was designed.

Already a winner of accolades from those who have flown it, the XC-142A performed flawlessly on its maiden cross-country flight from Dallas.

LTV's Chief Test Pilot John Konrad reported that the V/STOL transport's surplus power "makes it go like a scared jackrabbit. It feels like it wants to run away from you."

Piloted from Dallas to Edwards by Air Force Major Gay E. Jones, the first delivery model was praised as "a pleasure to fly." It has no conceptual problems.

"In fact, the easiest part of flying the XC-142A is in the transition," noted Jones.

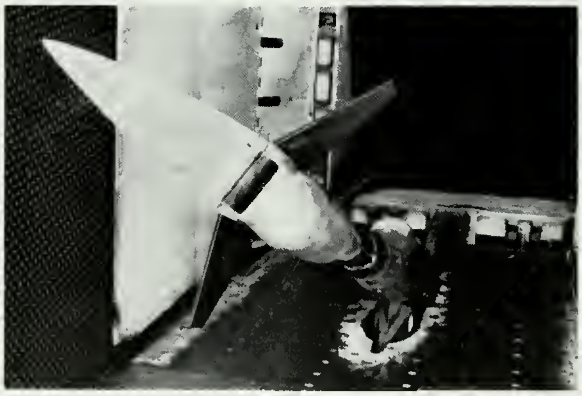
Viewed at the Edwards arrival demonstration by Vice Admiral Paul D. Stroop, Commander of the Navy's Pacific Fleet Air Force, the XC-142A was termed, "useful as an anti-submarine warfare weapon." Stroop said he foresees the possibility of the V/STOL transport being used to set down on open sea through modification of the fuselage to attain watertight integrity. A sonar device could be lowered and search launched for undersea activity, he noted.

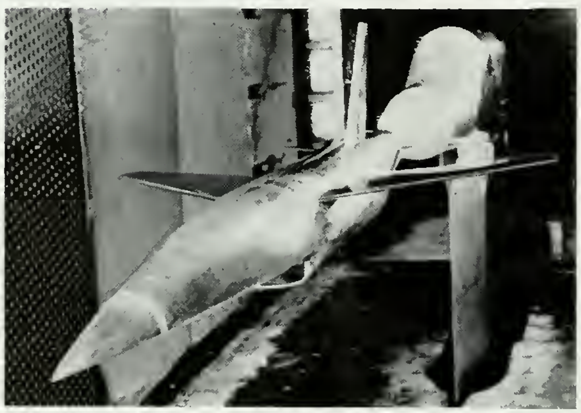
Its testing at Edwards marks the first U.S. V/STOL to move into operational evaluation without first undergoing conceptual feasibility trials.

The XC-142A program development is under management of the Air Force's Aeronautical Systems Division, Wright-Patterson AFB, Dayton, Ohio. ■

NAVY
FIREBEE II
A NEW DIMENSION IN RYAN
TARGET PRESENTATION

Growth version Firebee II carries Ryan tradition into supersonic regimes . . .





Wind tunnel tests of XBQM-34E in 1964 led to award of recent Navy contract directing fabrication of growth-version Firebee units at San Diego.

A SUPERSONIC, GROWTH-VERSION Firebee target missile that will fly faster, higher and for longer periods than any Firebee over the past 17 years is in the design-fabrication stages at Ryan Aeronautical Company.

Under contract to the Navy Bureau of Weapons, Ryan will build the new-breed Firebee for scheduled static and flight testing at the Pt. Mugu Pacific Missile Range, California in early 1967.

Designated the XBQM-34E, the new, higher performance Firebee will fly at speeds of Mach 1.5 (approximately 1,000 miles per hour) and at altitudes in excess of 60,000 feet.

Its evolution as the latest in a family of Firebee remote-controlled target missiles adds a totally new dimension to the target presentation capabilities offered by Ryan.

Designed primarily for supersonic flight, the XBQM-34E can also perform subsonic missions. A fuel pod carried under the fuselage is jettisoned after completion of subsonic missions, permitting the jet-powered target to then assume supersonic characteristics.

This extension of cruising time provides ground defense crews a longer duration of tracking time than has ever been possible.

Many present-day Firebee components will be utilized in the new growth version target missile. It will be powered by the same basic Con-

Sleek mockup of supersonic Firebee forms backdrop to discussion of its capabilities by Ryan engineers (from left) Ron Reasoner, Sam Sevelson and Carroll Berner. XBQM-34E will fly nearly 1,000 mph.

tinental J69 engine used in the BQM-34A except for a 140-pound boost in engine thrust which has been added.

Slightly longer than the subsonic Firebee, its new look includes shorter wings and a slimmer fuselage. Flush antennas have also been designed to maintain harmony with its supersonic aerodynamics.

Laboratory and ground testing of its structural design and engine tests will begin in late 1966.

The Navy awarded Ryan a $265,000 contract in mid-1964 for wind tunnel testing of the XBQM-34E, its preliminary design studies and fabrication of a mockup.

A world leader over the past 17 years in the aerial target presentation field, Ryan has manufactured and delivered more than 2500 subsonic Firebee target missiles to the Army, Navy and Air Force.

The remote-controlled, high-performance Firebee is used as a primary vehicle in ground-to-air and air-to-air missile training exercises and weapons systems test and evaluation programs. ■

Post-contract award conference on Ryan's new supersonic Firebee target missile was held at company's San Diego plant for discussion of program with Navy, Air Force and civilian representatives.

XV-5A FLIGHT TESTS AT EDWARDS

27 01

Ryan's V/STOL design world's most advanced; Phase II of program drawing to a close.

Ryan's Base Manager at Edwards Flight Test Center, J. W. Mansfield, gets first-hand report from pilot who has just returned from area flight.

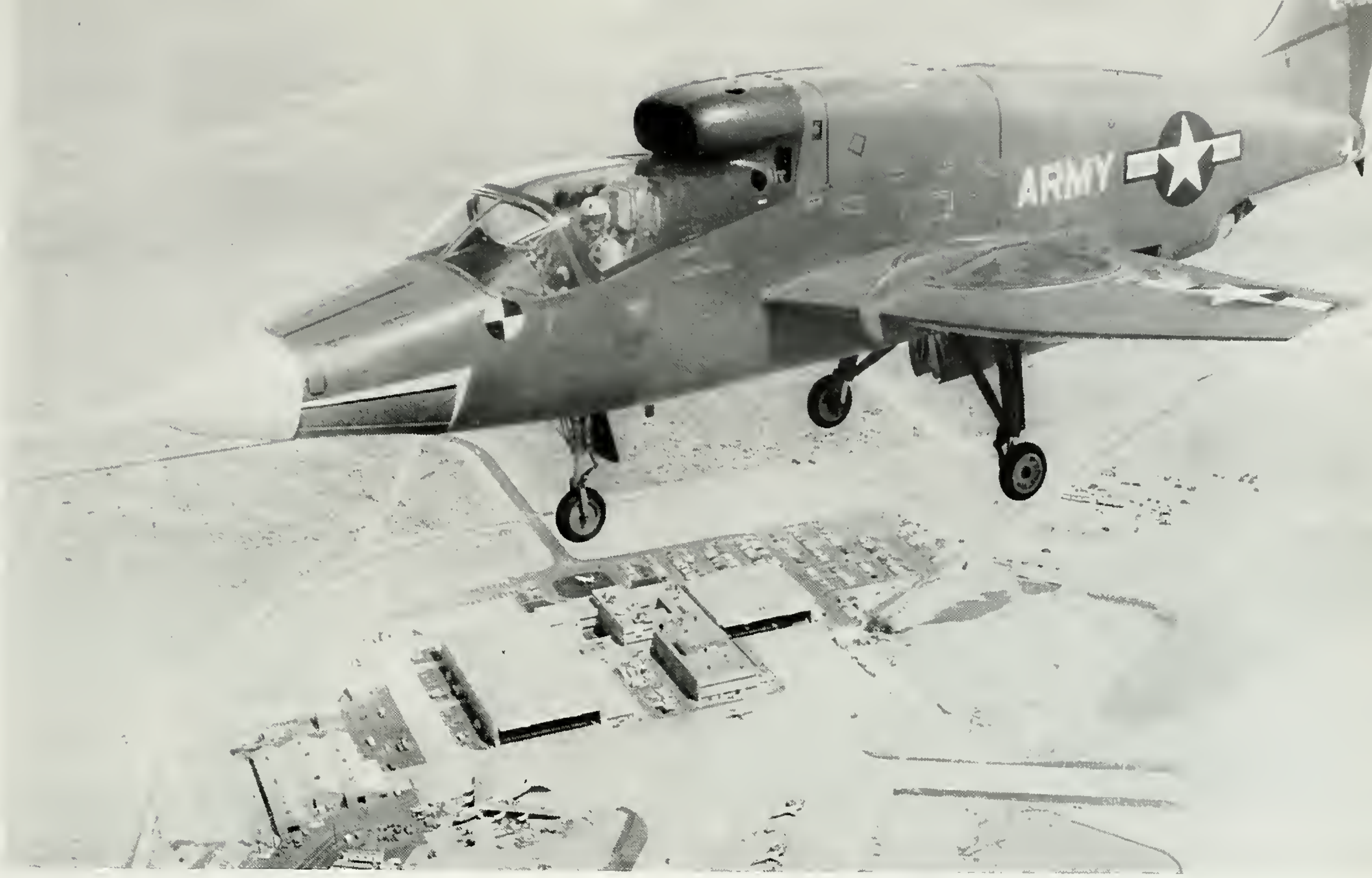
FLIGHT TESTING of the U.S. Army XV-5A research aircraft is proceeding at an accelerated pace at Edwards Air Force Base in the Army's Phase II program of evaluating the unique lift-fan VTOL (vertical take-off and landing) concept.

As many as three flights a day are being performed by Army and Ryan pilots in a variety of conventional and vertical modes, including the full transition cycle.

At the controls are Val H. Schaeffer, Jr., Ryan Chief Engineering Test Pilot and Captain William Welter, U.S. Army test pilot.

More than 215 flights have been made in the XV-5A flight testing program since it was launched last year, comprising over 90 flight hours, of which approximately 20 hours have been during vertical take-offs and landings. There have been more than 85 vertical take-offs and landings, and over 100 airborne conversions from conventional flight to VTOL or from VTOL to conventional mode.

An indication of the stepped-up activity at Edwards AFB is the most recent flight testing.



Ryan XV-5A, now well into its final stages of Phase II flight testing at Edwards Air Force Base, is undergoing accelerated flight schedule. More than 200 flights have been logged since mid-1964.

Since May 10, more than 50 flights were made, representing flight time in excess of 20 hours, including 5 hours in the VTOL mode.

The six-month Phase II test program, scheduled for completion late this year, followed the highly successful Phase I testing, during which 100 flights were made by Ryan personnel. The Army Aviation Materiel Laboratories, formerly the Army Transportation Research Command, formally accepted the XV-5A early this year after a rigorous series of technical demonstration flights.

During full-cycle transition from hover to conventional horizontal flight, speeds have ranged from zero at perfect hover to more than 400 knots in conventional mode during the current testing program, including full cycle transition.

"Capability of the lift-fan concept embodied in the XV-5A has been dramatically demonstrated during the flight tests," T. Claude Ryan, company Board Chairman, declared.

The Phase II program is expected to yield valuable data and design criteria for application to future VTOL development projects.

Val H. Schaeffer, Jr., first man to fly XV-5A and Ryan's Chief Engineering Test Pilot today, climbs from cockpit beaming over aircraft's performance.

1

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3

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1. *Clean lines of high-performance fighter plane are illustrated by XV-5A in jet mode.*

2. *Vertical take-off is demonstrated in lift-fan mode. The plane rises on cushions of air.*

3. *Plane moves forward under jet thrust during its conversion from fan-to-jet mode.*

4. *Lift-fans hold XV-5A motionless in hover mode revealing unique view of louvered fans.*

The lift-fan concept was pioneered a decade ago by Ryan and General Electric on the principle of using fans submerged in the aircraft wings for vertical lift. Feature of the XV-5A's propulsion system is a set of five-foot diameter lift fans mounted horizontally within the wings, powered by the exhaust of two G.E. J85 jet engines to provide the lift for vertical take-off and hovering.

The fans within the wings and a nose fan for pitch control augment the thrust from the conventional jet engines, providing three times the lifting power of the jet thrust alone.

The XV-5A is capable of taking off vertically from an area no larger than a tennis court. This type of aircraft could accomplish military missions at high subsonic speeds and return, hover, and land vertically in remote, rugged areas, such as small jungle clearings, thus combining relatively high speeds with helicopter versatility. ■

Solar Arrays Study Launched . . . Ryan Aeronautical Company has been selected by the Jet Propulsion Laboratory of California Institute of Technology to develop a unique flexible solar array to capture the sun's energy for space vehicles.

The structure to support solar cells would utilize a flexible substrate together with structural beams along the edges that roll up into a drum for deployment, and extend from the drum to form the solar panel as it assumes a semi-rigid configuration.

The Ryan study is aimed at developing concepts and technology for designing and fabricating a flexible solar array that can be packaged in a small area for launch and provide rigidization in space after deployment. Several types of flexible materials will be investigated for the substrate.

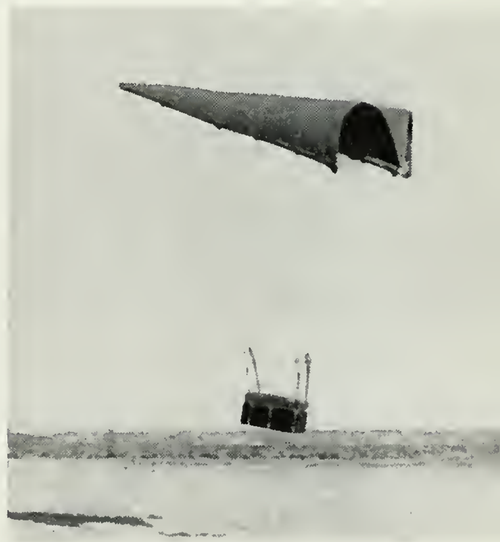
Ryan recently completed a preliminary development program for NASA's Goddard Space Flight Center on foldable, roll-out, pleated and other concepts of solar arrays. Such arrays must be lightweight while providing large areas for solar cells, and must maintain dimensional integrity while spinning on spacecraft bodies.

They must also be capable of reliable operation in the hard vacuum of space, and be able to withstand shock, vibration and accelerations as might be experienced during launch.

Ryan has built solar panel structures for a variety of space vehicles. At one time recently, such components were on three spacecraft simultaneously as they headed toward distant celestial bodies—Ranger 8 en route to the Moon on its photo mission; Mariner 4 on its 8½-month journey to Mars; and Explorer B, making global measurements of the ionosphere.

Precision Drop Glider Contract Awarded . . . Ryan's world-pioneering effort in development of Flex Wing delivery systems won for the San Diego company a $1,090,000 contract in mid-August for construction of Precision Drop Glider systems to be used by DOD's Advanced Research Projects Agency (ARPA).

Awarded by the Army Aviation Materiel Laboratories, the contract authorizes construction of a quantity of systems that will deliver 500-pound high priority military cargoes. Its designed purpose is for tactical re-supply and assault operations.



The Precision Drop Glider system has been under development at 300-pound payload capacities over the past several months, achieving over 100 successful guided flights at the Army's Yuma Test Station.

The all-weather PDG system can be launched by helicopter or fixed-wing aircraft at speeds of up to 150 miles per hour, providing a 3-to-1 glide ratio. It has a designed altitude capability of 30,000 feet, offering launch points many miles from its predetermined landing site.

The system utilizes Ryan's flexible delta wing, fabricated from lightweight material that provides a large areodynamic lifting surface.

Extensions of its Flex Wing delivery systems testing has included simulated tactical re-supply missions which would be operationally encountered in remote, austere environments.

A control platform, housing the required electronic and control equipment, enables the system to pinpoint cargo delivery under either manual or automatic homing modes.

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