JANUARY, 1966

VOL. B-13-27

SPACE WORLD

The magazine of space news

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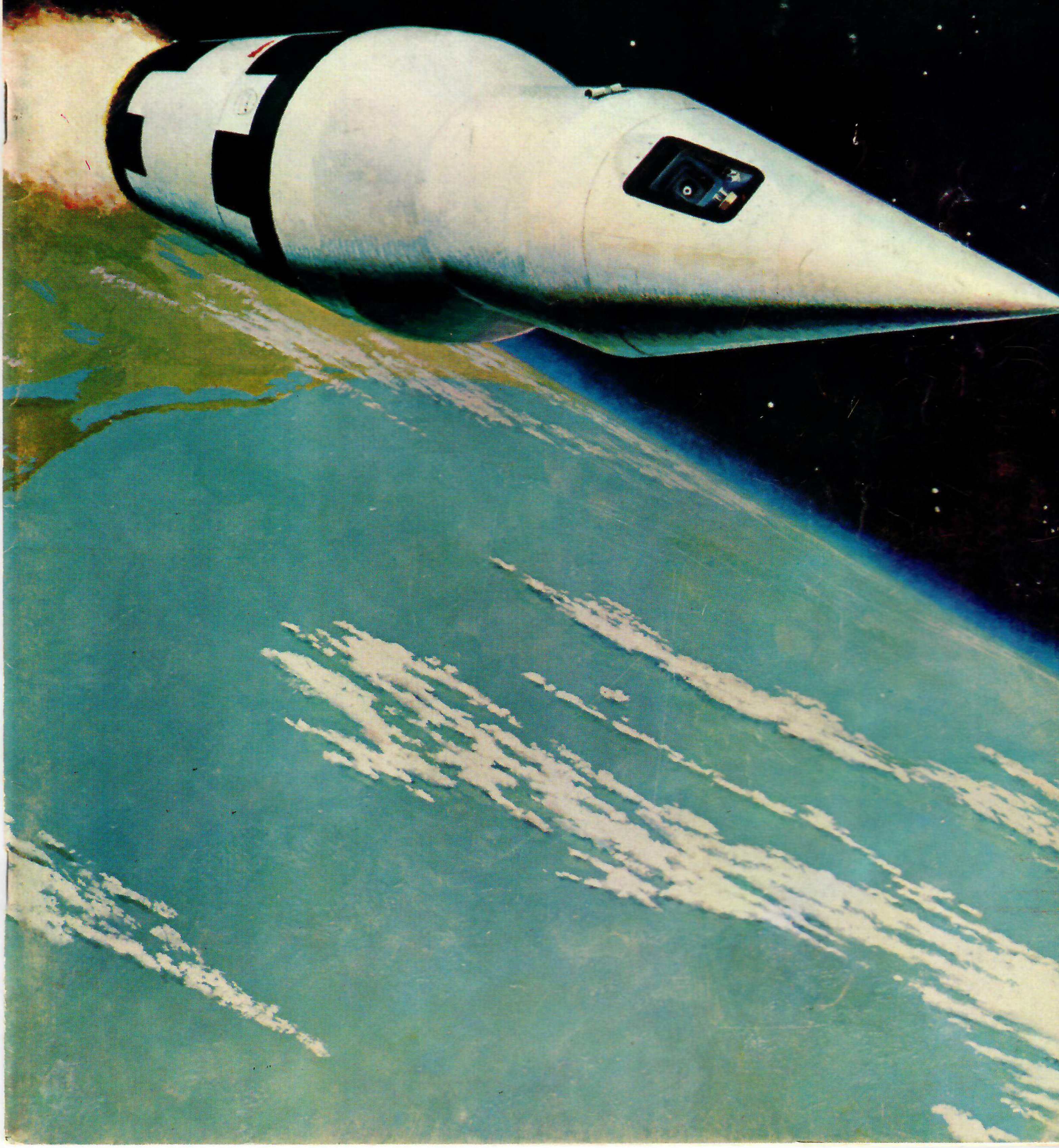

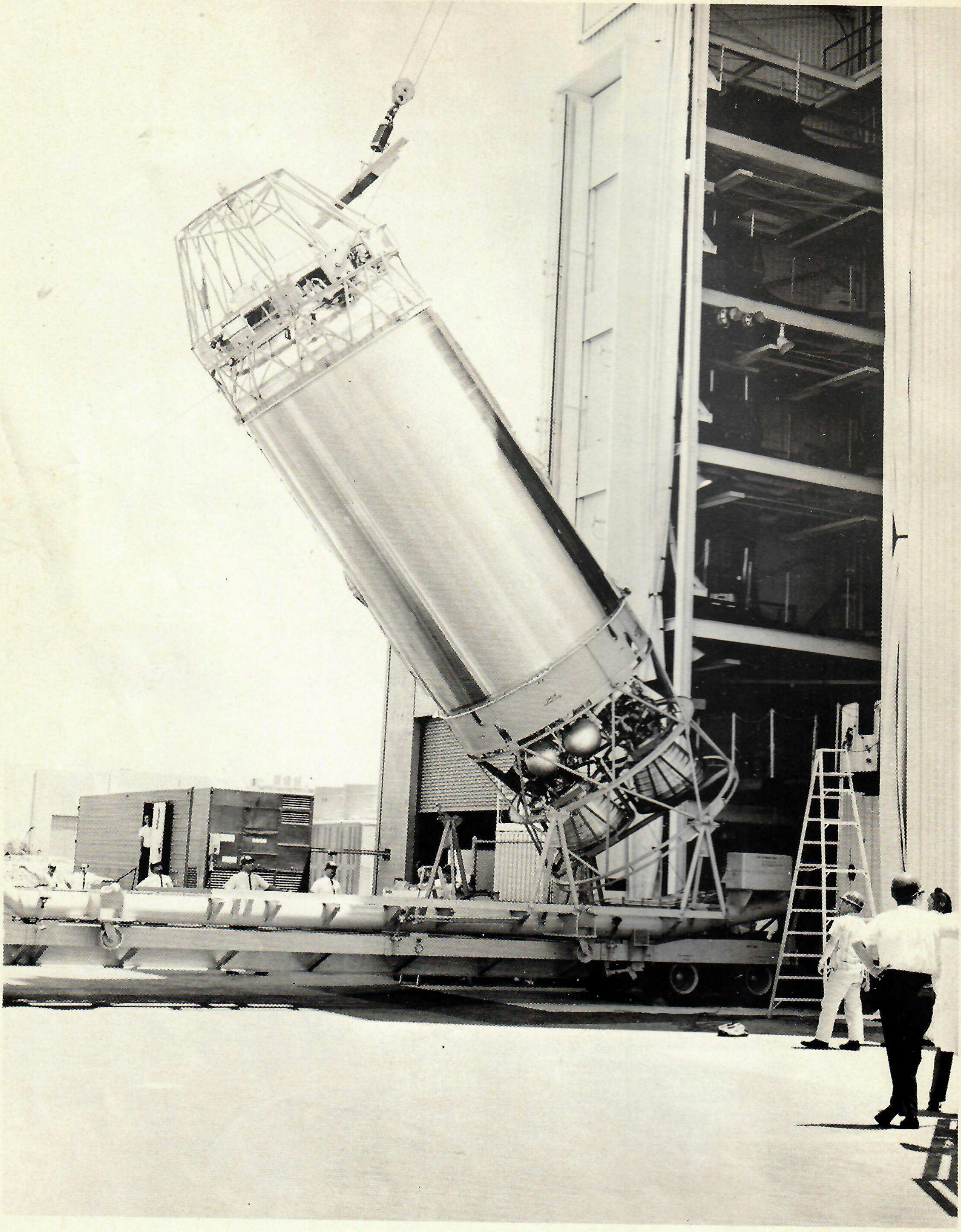

SPACE WORLD

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COVERS:

FRONT COVER - (Courtesy of General Precision, Inc.) Stellar Acquisition Flight Feasibility (STAFF) Program.

SECOND COVER - (Courtesy of General Dynamics) The Centaur high-energy space Vehicle scheduled for use in the first Surveyor spacecraft late this year is shown being lowered onto a transportation trailer prior to airlift to Cape Kennedy, Fla. This Centaur, designated AC-7, has completed its test program in the CSTS (Combined Systems Test Stand) at right. The Surveyor flight late this year will be the first of a series of missions intended to explore the moon prior to manned landings there.

CONTENTS

DEPARTMENTS

SPACEWORLD is published monthly by Palmer Publications, Inc., Amherst, Wisconsin. Second Class postage paid at the Post Office, Amherst, Wisconsin. Subscription rates: 12 issues $5.00 - 24 issues $9.00 - 36 issues $12.00.

GEMINI 7/6

Gemini 7, a long-duration flight, was scheduled (at this writing) to be launched no earlier than Dec. 4.

Gemini 6, which is to rendezvous with Gemini 7, is to be launched nine days later, Dec. 13.

Success in the two flights will represent:

1. The longest U.S. manned flight to date (Gemini 5 Astronauts L. Gordon Cooper and Charles Conrad were in flight 190 hours and 56 minutes, nearly eight days).

2. The first space rendezvous of two manned maneuverable spacecraft.

3. A minimum turn-around time for launch of two missions from the same pad.

Despite the rendezvous objective of Gemini 6, the two missions are to be carried out independently. That is, Gemini 7 is to be launched and carried out as originally planned. No major changes were made in the Gemini 7 flight plan.

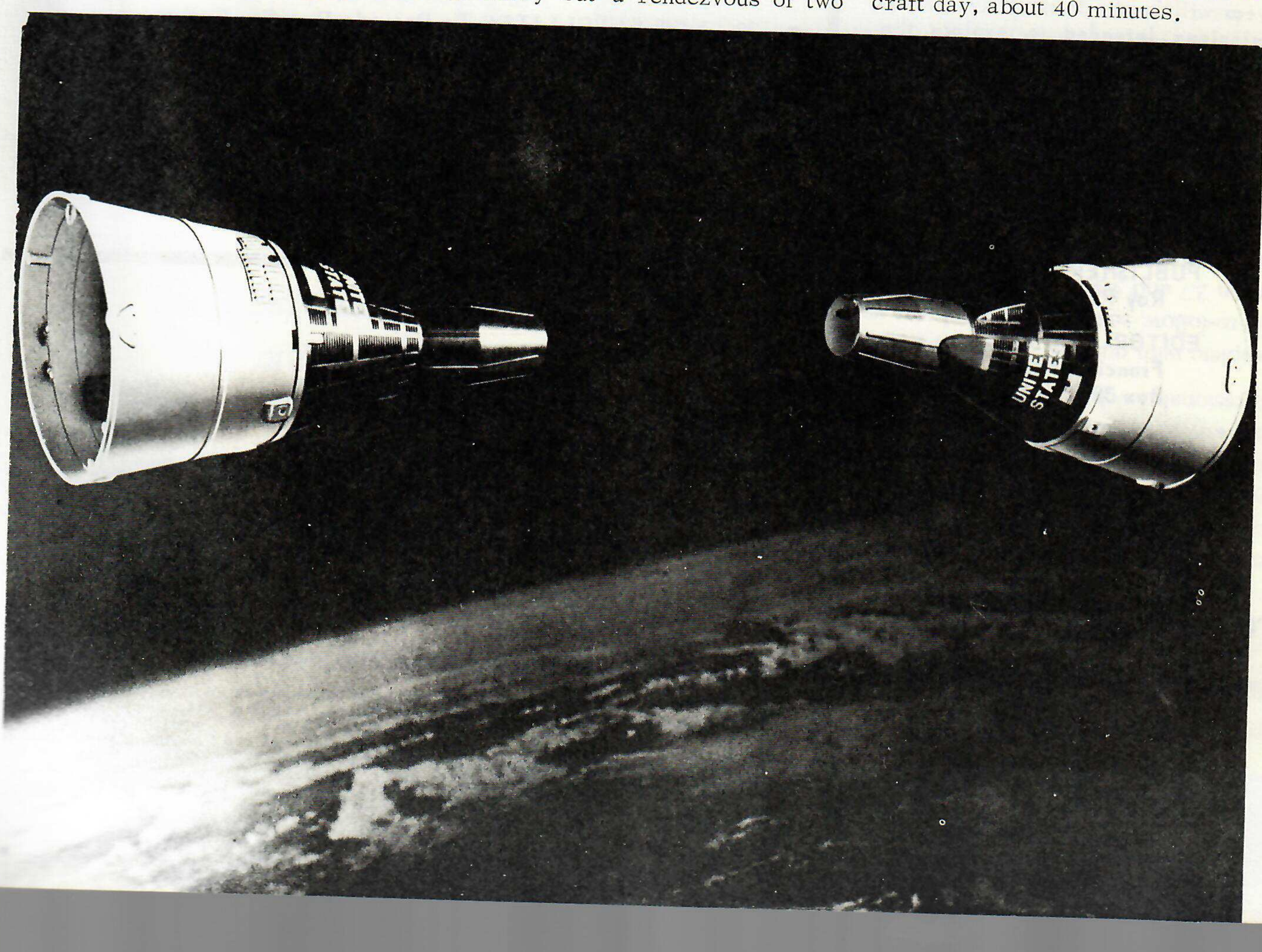
The Gemini 6 mission is to be carried out according to a flight plan which is nearly identical to the one prepared for the Oct. 25 launch which was postponed when the Agena Target Vehicle failed to achieve orbit. The only major change is that the Gemini 6 spacecraft was to have docked with the Agena.

In this flight, the two Gemini spacecraft will not be physically connected.

It was decided that the planned schedule of Gemini 7 and the availability of the Gemini 6 launch vehicle and spacecraft (already checked out on Pad 19) presented an opportunity to carry out a rendezvous of two manned vehicles.

The first several days of the Gemini 7 mission are to be devoted to carrying out experiments. At about five days the crew maneuvers the spacecraft into a target orbit for Gemini 6. During the rendezvous attempt by Gemini 6, the Gemini 7 crew maintains their orbit and spacecraft attitude, performing only those maneuvers required to make themselves a better target.

Following a successful liftoff, Gemini 6 immediately will begin maneuvers to achieve rendezvous which is planned for its fourth orbit. Following rendezvous, Gemini 6 will station keep (fly formation) on Gemini 7 for about two revolutions. Subsequently, Gemini 7 will fly formation on Gemini 6 for one spacecraft day, about 40 minutes.



Gemini 6 is planned for reentry in the Earth's atmosphere and landing in the West Atlantic Ocean after about 46 hours and 45 minutes, at approximately 8:20 a.m. EST.

Gemini 7 duration is planned for about 329 hours and 30 minutes, landing in the same area at approximately 8 a.m. EST, two days later.

NOMINAL MISSION PLAN
Gemini 7

Gemini-7 is scheduled to be launched from Complex 19, Cape Kennedy at about 2:30 p.m. EST, December 4. Planned launch is an elliptical orbit with an apogee of 210 miles and a perigee of 100 miles. The orbit will be inclined 28.87 degrees to the equator.

The spacecraft is to separate from the booster 30 seconds after sustainer engine cutoff.

Immediately following spacecraft separation, the spacecraft will turn around to blunt end forward, and begin station keeping on the booster second stage. Station keeping will continue for about 25 minutes ground elapsed time (GET) from lift-off. This time extends into about five minutes before the first darkness period.

At three hours, 50 minutes after lift-off as the spacecraft is at its third apogee, thrusters will be fired in a posigrade maneuver to raise the perigee to 124 miles. This maneuver establishes a spacecraft orbital lifetime of 15 days.

The next several days of the flight will be devoted to conducting assigned experiments.

At about five days in flight the crew will circularize the spacecraft orbit to provide the proper target orbit for Gemini 6. The exact maneuvers required will depend on the decay rate of the Gemini 7 orbit and the expected liftoff time of Gemini 6, now planned for eight days, 19 hours and four minutes following Gemini 7 liftoff.

Under present plans, circularization maneuvers will be performed 120 hours after lift-off of the Gemini 7 spacecraft. The crew will give the spacecraft a posigrade thrust at apogee. This will result in a change of velocity of 100 feet per second and circularization at 185 miles.

The rendezvous portion of the Gemini 6 and Gemini 7 spacecraft is described in the Gemini 6 Nominal Mission Plan.

The remaining Gemini 7 experiments will be conducted following completion of rendezvous activities. The Gemini 7 crew will initiate retrofire near the end of the 206th revolution. Landing will be in the West Atlantic recovery area at the beginning of the 207th revolution.

GEMINI 7 EXPERIMENTS

Twenty experiments are scheduled for Gemini 7. Fourteen are continuing experiments and have been carried aboard previous Gemini flights. In repeating these over a number of manned space flight missions, experimenters hope to gain data covering a number of subjects under varying flight conditions.

Results of the experiments carried aboard Gemini missions 3 and 4 were presented at a symposium in Washington early this fall. Similar symposia will be held periodically during the manned space flight program.

Experiments Flown on Earlier Missions

*1. Cardiovascular Conditioning (5)**

This experiment will determine the effectiveness of cyclic inflations of pneumatic cuffs on the thighs as a preventive measure of cardiovascular deconditioning (heart and blood distribution system) induced by prolonged weightlessness. The cuffs are built into the spacesuit around the thighs and inflated periodically to 80mm of mercury pressure, increasing blood pressure below the cuffs. The automatic pressurization cycle lasts two minutes out of every six and uses oxygen from the environmental control system.

2. In-Flight Exerciser (4 and 5)

The objective of this experiment is to assess the astronauts' capacity to perform physical work and their capability for sustained performance. The rapidity with which the heart rate returns to normal after cessation of exercise is an indication of an individual's physical fitness. A workload will be provided by specific periods of exercise at the rate of one pull per second for 30 seconds on an exercise device that requires a known amount of effort.

The exercise device consists of a pair of bungee cords attached to a nylon handle at one end and a nylon foot strap at the other end.

The in-flight data obtained will be compared with the control data to determine the capacity for work in space.

3. In-Flight Phonocardiogram (4 and 5)

In this experiment the fatigue state of an astronaut's heart muscle will be determined by measuring the time interval between the activation of a muscle and the onset of its contraction.

A microphone will be applied to an astronaut's chest wall at the cardiac apex. Heart sounds detected during the flight will be recorded on an onboard biomedical recorder. The sound trace will be compared to the waveform obtained from a simultaneous inflight electrocardiogram to determine the time interval between electrical activation of the heart muscle and the onset of ventricular systole.

4. Bone Demineralization (4 and 5)

The purpose of this experiment is to establish the occurrence and degree of bone demineralization influenced by the relative immobilization associated with the cockpit of the Gemini spacecraft and weightlessness.

Special x-rays will be taken of an astronaut's heel bone and the terminal bone of the fifth digit of the right hand. Three pre-flight and three post-flight exposures will be taken of these two bones and compared to determine if any bone demineralization has occurred due to the space flight.

The equipment to be used in this experiment will be closely calibrated clinical x-ray machines, standard 11-inch by 14-inch x-ray films and calibrated wedge densitometers.

5. Human Otolith Function (5)

A visual tester will be used to determine the astronauts orientation capability during flight. The experiment will measure changes in otolith (gravity gradient sensors in the inner ear) functions.

The tester is a pair of special light proof goggles, one eye piece of which contains a light source in the form of a movable white line. The astronaut positions the white line with a calibrated knurled screw to what he judges to be the right pitch axis of the spacecraft. The second astronaut then reads and re-

* indicates previous Gemini mission

cords the numbers.

6. *Proton-Electron Spectrometer (4)*

In order to determine the degree of hazard, if any, to which the crew will be subjected on space flight, it is necessary to project what radiation environment any given mission will encounter. Specifically, this experiment will make measurements outside of the spacecraft in a region where the inner Van Allen radiation belt dips close to the earth's surface due to the irregular strength of the earth's magnetic field. This region is usually referred to as the South Atlantic Geomagnetic Anomaly.

This measurement will be accomplished by means of a scintillating-crystal, charged-particle analyzer mounted on the adapter assembly of the spacecraft. Data from this experiment will be used to correlate radiation measurements made inside the spacecraft and to predict radiation levels on future space mission.

7. *Tri-Axis Magnetometer (4)*

The purpose of this experiment is to monitor the direction and amplitude of the earth's magnetic field with respect to an orbiting spacecraft. The astronauts will operate an adapter-mounted tri-axis fluxgate magnetometer as they pass through the South Atlantic Geomagnetic Anomaly. The magnitude of the three directions of the earth's magnetic field will be measured with respect to the spacecraft. The measurement will be performed in conjunction with the Proton Electron Spectrometer experiment to determine the field, line direction and pitch angle of the impacting particles.

8. *Celestial Radiometry*
Space Object Radiometry (5)

The results of these experiments will provide information on radiation intensity of celestial bodies and various objects in space. Instrumentation includes a three-channel spectro-radiometer, a dual-channel Michelson Interferometer-Spectrometer, and a cryogenically cooled spectrometer. The equipment can measure radiant intensity from the ultra-violet through the infrared region. The sensing units are housed in the Gemini adapter section and are directed toward the objective by orienting the spacecraft.

The objectives for these experiments are to determine the onset of sensitivity values for earth objects and sky background radiation and radiation signatures of various objects in space and on the ground.

Observations will include exhaust plumes of rocket vehicles launched from the Eastern or Western Test Ranges, rocket sled exhausts at Holloman Air Force Base, volcanoes and forest fires as well as contrasting background areas such as deserts and warm ocean currents.

9. *Simple Navigation (4)*

The capability of man to navigate in space and to provide a reliable navigation system independent of ground support will be tested in this experiment. Two special instruments have been developed for use on Gemini spacecraft to allow detailed manual-visual examination of the space phenomena thought to be best for space navigation purposes. These are a space stadimeter and a sextant. This flight will only carry the space sextant with which the astronaut will use to make star-horizon angular measurements for orbital orientation determinations. The results will be compared with actual measurements to determine the accuracy of the procedures.

10. *Synoptic Terrain Photography (4 and5)*

The purpose is to obtain photos of selected parts of earth's surface for use in research in geology, geophysics, geography, oceanography. This experiment has been flown on every flight since MA-8.

Experiment - - 70mm Hasselblad camera with 80mm Zeiss F2.8 lens; two packs of color film with 65 exposures each. Approximately ninety pictures will be taken over areas of the world. Primary areas are the shallow waters around the Bahamas, the Red Sea, and the west central portion of Mexico.

11. *Synoptic Weather Photography (3, 4 and 5)*

The Synoptic Weather Photography experiment is designed to make use of man's ability to photograph cloud systems selectively - - in color and in greater detail than can be obtained from the current TIROS meteorological satellite.

A primary purpose of the experiment is to augment information from meteorological satellites which are contributing substantially to knowledge of the earth's weather systems. In many areas they provide information where few or no other observations exist.

Experiment - - 70mm Hasselblad camera with 80mm Zeiss F2.8 lens; two magazines of color film with 65 exposures each. Areas of interest - - Squall line clouds, thunderstorm activity not associated with squall lines, frontal clouds, and views of fronts, jetstream cirrus clouds, typical morning stratus of Gulf states, coastal cloudiness, tropical and extratropical cyclones, intertropical convergence zone, cellular pattern in subtropical phenomenon, wave clouds induced by islands and mountain ranges, broad banking of clouds in the trade winds or other regions.

12. *Visual Acuity*
Astronaut Visibility (5)

The visual ability of the astronauts in the detection and recognition of objects on the earth's surface will be tested in these experiments. The spacecraft will be equipped with a vision tester and a photometer. The astronauts will use the vision tester to evaluate visual sightings from space relative to earthbound base-line values. The photometer will measure light attenuation of the spacecraft window due to scattering. While the spacecraft is oriented the astronauts will view a pattern of panels laid out near Laredo, Texas and record their findings. Viewings will be correlated with laboratory experiments and vision will be checked pre- and post-flight.

During passage of the spacecraft over the sites, the command astronaut shall be responsible for maintaining the proper spacecraft attitude while the second astronaut observes the target area and makes verbal comments to the principal investigator at the site.

For five minutes in each 24 hour period, each astronaut will use the on-board vision tester to test his own visual acuity on an opportunity basis.

Experiments to be flown for the first time

1. *Bioassays Body Fluids*

In this experiment the astronaut's reaction to stress during space flight will be studied by means of analysing body fluids. Pre-flight and post-flight blood samples will be taken. In-flight urine will be measured at each voiding and a portion of this stored in special bags.

From analysis of these fluids experimenters hope to measure body hormones, electrolytes, proteins, amino acids and enzymes which may be produced as a result of stress.

2. Calcium Balance Study

The rate and amount of calcium change to the body during the conditions of orbital flight will be evaluated in this experiment by means of controlled calcium intake and output measurements. In addition to calcium, other electrolytes of interest such as nitrogen phosphorous, sodium chloride and magnesium will be monitored.

The two astronauts will be maintained on a prescribed calcium diet for two weeks prior to flight, during and after flight. Careful recording of input-output will be accomplished and total fecal and urine specimens will be preserved for analysis. Sweat will also be measured by careful cleansing of the crew in distilled water following recovery. Undergarments will be similarly cleaned and the water analysed.

3. In-Flight Sleep Analysis

The objectives of this experiment are to assess the astronauts' state of alertness, levels of consciousness, and depth of sleep during flight. An electroencephalograph (EEG) on astronauts will be taken during weightless flight to establish the possible use of the EEG as a monitoring tool to help determine the state of alertness and depth of sleep. The electrical activity of the cerebral cortex will be monitored by two pairs of scalp electrodes and recorded on the biomedical recorder.

4. Optical Communication (Laser)

Laser is an acronym for Light Amplification by Stimulated Emission of Radiation. Stimulated emission is produced by greatly exciting the atom. When excited the atom will emit small quantities of light in phase or unison. Thus the light is "coherent," that is, it is directed in a constant steady beam in one precise direction.

This experiment is an attempt to demonstrate a new technique for communication between an orbiting spacecraft and a ground station. In doing this, a demonstration of optical frequencies for communications will be achieved and certain atmospheric data will be recorded and the value of an astronaut as a "pointing control" will be established.

The primary atmospheric data to be obtained are background radiance and attenuation. This data and the experience obtained from this experiment will be useful in designing future systems.

The experiment equipment consists of a flight transmitter and a ground-based receiver transmitter system.

The flight transmitter resembles and is about the same size as a home movie camera. It weighs about six pounds and is completely self-contained. It is made up of four injection lasers, a 10-volt power supply (eight rechargeable nickel-cadmium batteries), a d.c. (direct current) to d.c. converter, a telescopic sight and a microphone.

Four gallium arsenide injection lasers are the heart of the transmitter. They deliver a total of 16 watts of light power at a wavelength of 9,000 angstroms. The beams produced by the lasers form four lines of light arranged one above the other making a square pattern at distances of several feet to infinity.

Injection lasers were chosen for their compactness, light weight and efficiency in converting electric energy into light energy.

The ground-based receiver resembles a short, blunt telescope. It is 30 inches in diameter and consists of a collector and focusing unit with a photomultiplier (optical detector) located at the focal plane. An argon gas laser beacon is mounted atop the receiver barrel.

The argon gas laser has an output of three watts into a three milliradian beam spread or about 0.17 degree. At 300 miles the beam will be approximately 0.9 mile in diameter.

Receiver systems have been installed at White Sands Missile Range, Ascension Island and Kauaj, Hawaii. The receivers are slaved to FPS radars and always point toward the spacecraft when it is within range of the radar.

In operation the command pilot will maintain proper spacecraft orientation while the co-pilot aims the laser transmitter by sighting through the telescope at the ground-based argon laser. The argon laser beam will be visible to the naked eye.

When the spacecraft laser beacon is acquired by the ground receiver the ground-based argon laser will be flashed to indicate that contact has been established. Both beacons will be aligned and voice communications can begin. The co-pilot will switch to the voice channel and say, "1, 2, 3, 4, 5, testing 5, 4, 3, 2, 1."

Voice communications will be one way only - from spacecraft to ground.

During the experiment the astronauts will wear safety goggles for protection against eye damage which might be caused by stray or reflected light from the onboard laser. The glasses have shields for stopping radiation which enter the eye from the side and lenses that filter out the infrared energy emitted by the laser.

5. Landmark Contrast Measurements

The purpose of this experiment is to measure the visual contrast of land-sea boundaries and other types of terrain to be used as a service of navigation data for the onboard Apollo Guidance and Navigation system. Landmark contrast measurements made from outside the atmosphere will provide data of a high confidence level to effectively duplicate navigation sightings for Apollo.

Landmark measurements will be made of such areas as the Florida Coast, South American Chilean Coast, African-Atlantic Coast and Australian Coast. A photometric telescope sensor and equipment used for the Star Occultation Navigation experiment will be used.

6. Star Occultation Navigation

The feasibility and operational value of star occulting measurements in the development of a simple, accurate and self-contained orbital navigational capability will be investigated in this experiment.

The astronauts will determine the orbit of the Gemini spacecraft by measuring the time stars dip behind an established horizon.

As much of the existing Gemini onboard equipment as is possible will be used for the recording of photometric sensor output signal intensity and time. Nevertheless, certain special equipment will be necessary for the performance of the navigational studies. Included in the equipment is a photoelectric sensor.

The photoelectric sensor consists of a telescope, eyepiece, reticle, partially silvered mirror, iris, chopper, optical filters, photomultiplier, pre-amplifier and associated electronics. The instrument is hand-held to the astronaut's eye for viewing out the spacecraft's window.

As the astronaut views the horizon, he looks for bright stars about to be occulted. He then points the telescope at one and centers the star within a reticle circle. A portion of the radiation is then diverted to a photomultiplier. With a hand-held switch, the astronaut initiates a calibration mode in which the intensity of the star is measured automatically. He then tracks the star within the reticle as the star passes into the atmosphere and behind the edge of the earth. The tracking period for each star is approximately 100 seconds. During this tracking period the astronaut will manually indicate the passage of the star through the air glow, the 50% intensity level and complete occultation simply by momentarily depressing the calibration switch.

The astronaut plays an essential role in the procedure. First, he solves the star acquisition problem by locating the next star to be transited. Second, he uses his head to point the telescope thus eliminating a two-gimbal automatic tracking system which would of necessity be used if he were not onboard. Third, he records star occultation times manually for comparison with the automatic calibration mode. Finally, he notes peculiarities in the data as it is collected. In performing this latter function, the man is used to greatest advantage to advance the state of the navigational art as rapidly as possible.

NOMINAL MISSION PLAN
Gemini 6

Gemini 6 is scheduled to be launched December 13 at about 9:34 a.m. EST from Launch Complex 19 at Cape Kennedy, Fla. It will be launched into an elliptical orbit of 168 miles apogee and 100 miles perigee. Second stage booster yaw steering will be used to place the spacecraft into the same orbital plane as Gemini 7. Yaw steering provides up to 0.55 degree inclination increment change if needed. The spacecraft will trail Gemini 7 by 1208 miles at insertion.

Launch Windows (EST)

Nominal Day	9:34am to 10:21am
	11:09am to 11:24am
N - 1	9:38am to 10:25am
N - 2	8:07am to 8:54am
	9:42am to 10:14am
N - 3	8:11am to 8:58am
N - 4	6:59am to 7:25am
	8:14am to 9:01am

Rendezvous is planned for the fourth orbit of Gemini 6, if liftoff is on time. During the first 35 minutes of each launch opportunity each 100 seconds delay in liftoff delays rendezvous by one spacecraft orbit. If liftoff time occurs beyond 300 seconds, rendezvous will not be attempted until the beginning of the second day when better tracking coverage is available.

Should liftoff occur during the last 12 minutes of the maximum 47 minute window, a different intermediate sequence of maneuvers will be inititated to narrow the catch-up distance between the spacecraft. In this case, engine cutoff occurs earlier to reduce velocity by 50 feet per second. This causes the spacecraft to be inserted into a lower orbit than planned, with a perigee of about 100 miles and apogee of 138 miles. In this orbit the Gemini 6 catchup rate will be increased due to the greater difference in altitude between the two spacecraft.

Varying insertion velocity as described above has the effect of widening the launch window.

Following a successful, on-time liftoff and insertion the uncertainties of the effect of drag on the spacecraft during its initial orbit may require a one foot per second posigrade burn at first perigee to raise apogee. In the event of small insertion dispersions, the magnitude of this maneuver may vary but the resulting apogee will be 168 miles.

Near the second apogee a posigrade burn will add 53 feet per second to raise perigee to about 134 miles. This reduces the catchup rate from 6.7 degrees to 4.5 degrees per orbit and will provide the proper phase relationship between the two spacecraft for circularization at third apogee.

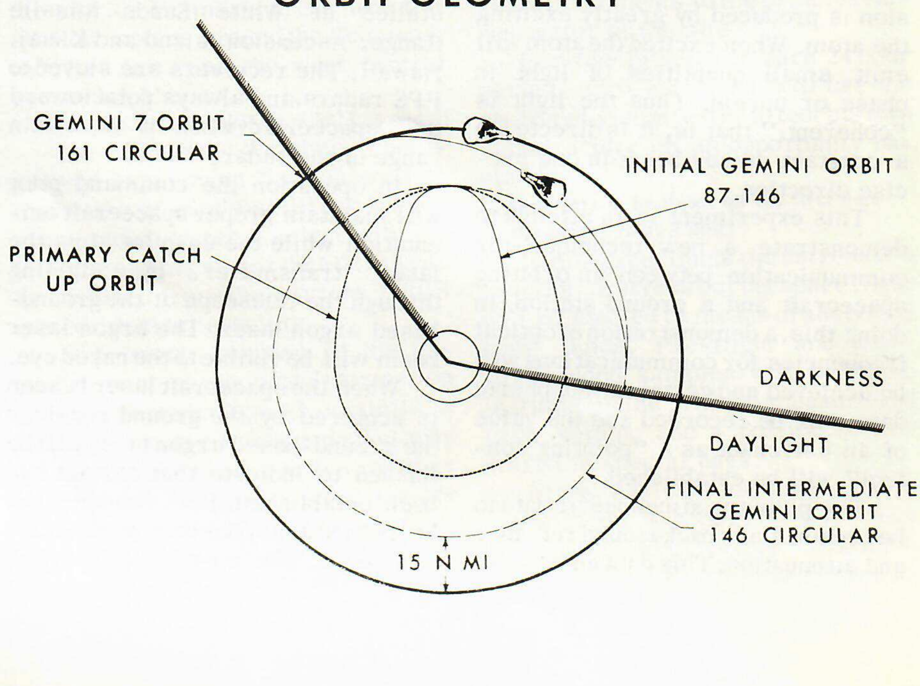
Should the two spacecraft be in different planes, a plane adjustment will be made by Gemini 6 at the common node (where the two spacecraft orbits intersect) following the second apogee posigrade burn.

At the third Gemini 6 spacecraft apogee, a posigrade burn of 53 feet per second will be made to circularize the orbit at 146 miles.

Gemini 6 will then be trailing Gemini 7 by about 184 miles. This is within range of the onboard radar and lock-on should have occurred.

A 32 feet per second posigrade burn will be made at terminal phase initiation along the line of sight to Gemini 7. This will be at a ground elapsed time of about 5 hours, 15 minutes - about one minute after entering darkness. The range between the spacecraft at this time is expect-

GEMINI 6 AND 7 RENDEZVOUS ORBIT GEOMETRY



ed to be about 39 miles.

Approximately 33 minutes following terminal phase initiation a posigrade velocity of 43 feet per second will be applied to Gemini 6. This places the two spacecraft into the same orbit and rendezvous will have been accomplished.

Should there be computer, platform or radar failure, the mission can still proceed using ground data and radar-optical or optical rendezvous modes.

Retrofire will occur at a ground elapsed time of 46 hours and 10 minutes, during the 29th revolution. Landing will be in the West Atlantic recovery area.

GEMINI 6 EXPERIMENTS

Three experiments will be performed during the Gemini 6 mission:

1. Synoptic Weather Photography
2. Synoptic Terrain Photography
3. Radiation in spacecraft

The photography experiments are repeats of those flown on all previous Gemini flights. A description of these appears in the Gemini 7 experiments section.

The radiation experiment is designed to measure radiation levels and distribution inside the spacecraft. Seven sensors are located throughout the spacecraft. One is shielded to simulate the amount of radiation the crew members are receiving beneath their skin. The shield will be removed as the spacecraft passes through the South Atlantic anomaly, the area where the radiation belt dips closest to the earth's surface.

This experiment was also flown on Gemini 4.

GEMINI SPACECRAFT

The Gemini spacecraft is conical, 18 feet, 5 inches long, 10 feet in diameter at its base and 39 inches in diameter at the top. Its two major sections are the reentry module and the adapter section.

Reentry Module

The reentry module is 11 feet high and 7 1/2 feet in diameter at its base. It has three main sections: (1) rendezvous and recovery (R&R), (2) reentry control (RCS), and (3) cabin.

Rendezvous and recovery section is the forward (small) end of the spacecraft, containing drogue, pilot and main parachutes and radar.

Reentry control section between R&R and cabin sections contains fuel and oxidizer tanks, valves, tubing and two rings of eight attitude control thrusters each for control during reentry. A parachute adapter assembly is included for main parachute attachment.

Cabin section between RCS and adapter section, houses the crew seated side-by-side, their instruments and controls. Above each seat is a hatch. Crew compartment is a pressurized titanium hull. Equipment not requiring pressurized environment is located between pressure hull and outer beryllium shell which is corrugated and shingled to provide aerodynamic and heat protection. Dish-shaped heat shield forms the large end of cabin section.

Adapter Section

The adapter section is 7 1/2 feet high and 10 feet in diameter at its base, containing retrograde and equipment sections.

Retrograde section contains four solid retrograde rockets and part of the radiator for the cooling system.

Equipment section contains electrical power source systems, fuel for the orbit attitude and manuever system (OAMS), primary oxygen for the environmental control system (ECS). It also serves as a radiator for the cooling system, also contained in the equipment section.

NOTE: The equipment section is jettisoned immediately before retrorockets are fired for reentry. The retrograde section is jettisoned after retros are fired.

Propellant

Gemini-7 - - 423 pounds
Gemini-6 - - 669 pounds

Gemini-7 Spacecraft Modifications

The following modifications have been made to the Gemini-7 spacecraft to support Gemini-6 rendezvous mission:

1. A transponder to receive and transmit signals from the Gemini-6 rendezvous radar system has been installed in the nose of the spacecraft.

2. Two acquisition lights have been placed on the adapter section 180 degrees apart. These are the same lights designed for the Agena target vehicle. They flash about 80 times per minute and can be seen for approximately 23 miles.

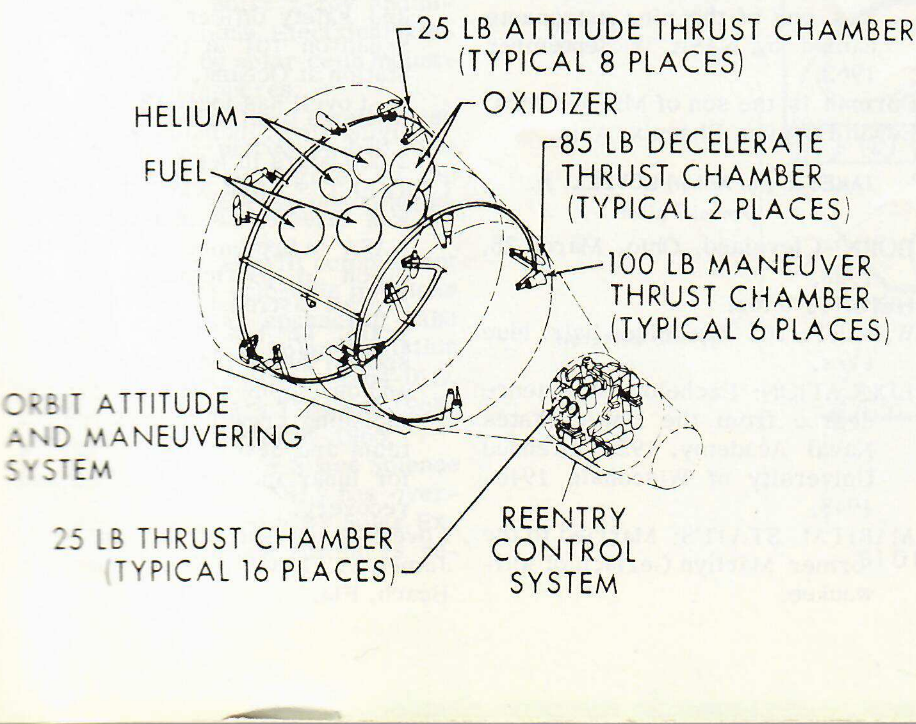
GEMINI LAUNCH VEHICLE

The Gemini Launch Vehicle (GLV) is a modified U.S. Air Force Titan II intercontinental ballistic missile consisting of two stages.

GLV dimensions are:

HEIGHT	
1st stage: 63 ft.	2nd stage: 27 ft.
DIAMETER	
1st stage: 10 ft.	2nd stage: 10 ft.
THRUST	
1st stage: 430,000 pounds	2nd stage: 100,000 pounds

LIQUID ROCKET SYSTEMS
GENERAL ARRANGEMENT



(two engines) (one engine)

FUEL

50-50 blend of monomethyl hydrazine and unsymmetrical-dimethyl hydrazine.

OXIDIZER

Nitrogen tetroxide (Fuel is hypergolic, ignites spontaneously upon contact with oxidizer).

Overall height of launch vehicle and spacecraft is 109 feet. Combined weight is about 340,000 pounds.

Modifications to Titan II for use as the Gemini Launch Vehicle include:

1. Malfunction detection system added to detect and transmit booster performance information to the crew.
2. Backup flight control system added to provide a secondary system if primary system fails.
3. Radio guidance substituted for inertial guidance.
4. Retro and vernier rockets deleted.
5. New second stage equipment truss added.
6. New second stage forward oxidizer skirt assembly added.
7. Trajectory tracking requirements simplified.
8. Electrical, hydraulic and instrument systems modified.

CREW BIOGRAPHIES

FRANK BORMAN

Gemini 7 command pilot

BORN: Gary, Ind., Mar. 14, 1928

HEIGHT: 5 feet, 10 inches

WEIGHT: 163 lbs. Blonde hair, blue eyes.

EDUCATION: Bachelor of Science degree, United States Military Academy, 1950; Master of Science degree in aeronautical engineering, California Institute of Technology, 1957.

MARITAL STATUS: Married to the former Susan Bugbee of Tucson, Ariz.

CHILDREN: Frederick, Oct. 4, 1951; Edwin, July 20, 1953.

EXPERIENCE: Upon graduation from West Point, Borman, now an Air Force Major, chose an Air Force career and received his pilot training at Williams Air Force Base, Calif.

From 1951 to 1956 he served with fighter squadrons in the United States and in the Philippines and was an instructor at the Air Force Fighter Weapons School.

From 1957 to 1960 he was an instructor of thermodynamics and fluid mechanics at the U.S. Military Academy.

He was graduated from the USAF Aerospace Research Pilots School in 1960 and later served there as an instructor. In this capacity he prepared and delivered academic lectures and simulator briefings, and flight test briefings on the theory and practice of spacecraft testing. Borman has logged more than 4,400 hours flying time, including more than 3,600 hours in jet aircraft.

CURRENT ASSIGNMENT: Borman was one of the nine astronauts named by NASA in September 1962.

Borman is the son of Mr. and Mrs. Edwin Borman, Phoenix, Ariz.

JAMES A. (for Arthur) LOVELL, Jr.

Gemini 7 pilot

BORN: Cleveland, Ohio, March 25, 1928.

HEIGHT: 6 feet

WEIGHT: 165 lbs. Blond hair, blue eyes.

EDUCATION: Bachelor of Science degree from the United States Naval Academy, 1952; attended University of Wisconsin 1946-1948.

MARITAL STATUS: Married to the former Marilyn Gerlach of Milwaukee.

CHILDREN: Barbara Lynn, Oct. 13, 1953; James A., Feb. 15, 1955; Susan Kay, July 14, 1958.

EXPERIENCE: Lovell, a Navy Lieutenant Commander, received flight training following his graduation from Annapolis.

He served in a number of Naval aviator assignments including a three-year tour as a test pilot at the Naval Air Test Center at Patuxent River, Md. His duties there included service as program manager for the F4H Weapon System Evaluation.

Lovell was graduated from the Aviation Safety School of the University of Southern California.

He served as flight instructor and safety officer with Fighter Squadron 101 at the Naval Air Station at Oceana, Va.

Lovell has logged 3,000 hours flying time, including more than 2,000 hours in jet aircraft.

CURRENT ASSIGNMENT: Lovell was selected as an astronaut by NASA in September 1962. In addition to participating in the overall astronaut training program, he has been assigned special duties monitoring design and development of recovery and including crew life support systems and developing techniques for lunar and earth landings and recovery.

Lovell is the son of Mr. and Mrs. James A. Lovell, Sr., Edgewater Beach, Fla.

IQSY EXPLORER

A satellite to measure and monitor solar x-ray emissions during the final portion of the 1964-1965 International Cuiet Sun Year is a joint project of NASA and the Naval Research Laboratory. The IQSY Solar Explorer was scheduled for launch from NASA's Wallops Station no earlier than Nov. 18, on a four-stage Scout.

The international scientific community has been invited to acquire data directly from the satellite. Information obtained will be correlated internationally by scientists conducting studies related to ICSY, a period when solar activity is at a minimum.

The ICSY Solar Explorer, by measuring and monitoring solar x-ray emissions and providing immediate data to interested scientists, has the potential for improving forecasts of ionospheric conditions that affect short-wave radio communications and for developing a warning system for major solar flares which produce intense proton emissions hazardous to manned activities in space.

The 125-pound spacecraft consists of two 24-inch hemispheres separated by an equatorial band in which are installed 12 photometers for measuring solar x-ray and ultraviolet emissions. Electrical power is supplied by solar cells mounted on the hemispheres.

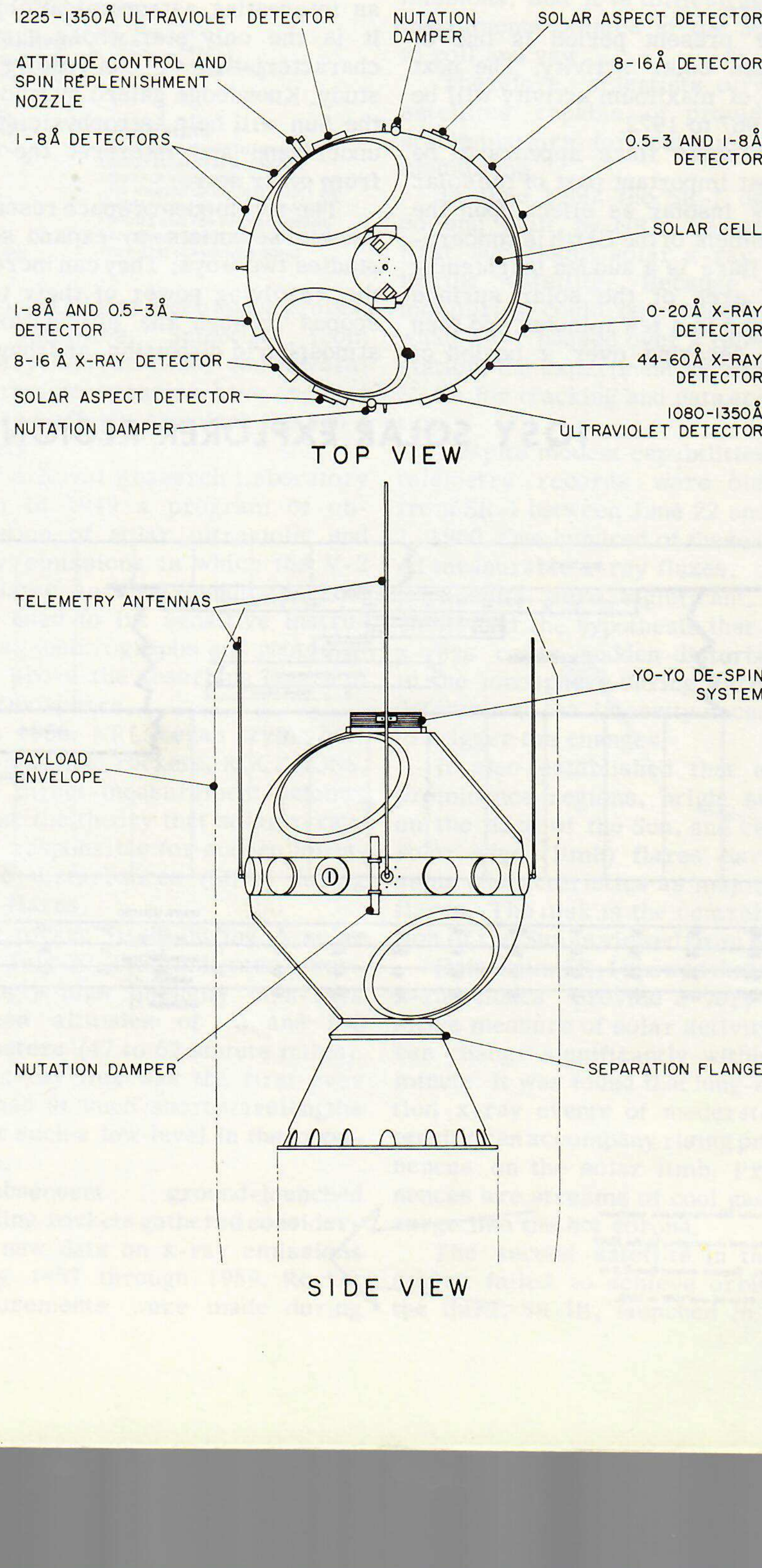
The spin-stabilized satellite was planned to be placed by-630 mile orbit inclined 60 degrees to the Equator. Expected active lifetime is one year.

The spacecraft will complement and continue the scientific missions of other NASA spacecraft and the NRL's two Solar Radiation (SOLRAD) satellites: 1964-01D, launched in January 1964 and 1965-16D, launched in March 1965.

NASA's Office of Space Science and Applications (OSSA) has overall direction of the ICSY Solar Explorer and Wallops Station is responsible for project coordination and launch operations.

Satellite commands and acquisition of scientific data will be carried out by NRL through its Tracking and Command Station in Hybla Valley, Va.

NASA's Goddard Space Flight Center, Greenbelt, Md., will be responsible for tracking the satellite during its useful life and will support NRL in acquisition of teleme-



tered data from the satellite.

The Scout launch vehicle is under the management of NASA's Langley Research Center, Hampton, Va.

The Earth is a body immersed in the atmosphere of a star - - the Sun. Radiation from the Sun controls the environment of Earth, of other solar system planets and of interplanetary space. Because most emissions of radiation from the Sun are variable, the environment of the Earth is variable.

This is a pattern to solar activity, with a maximum and a minimum occurring every 11 years, and a similar cyclic variation is evident in the properties of the Earth's atmosphere.

The present period is one of minimum solar activity. The next period of maximum activity will be from 1967 to 1972.

The solar flare appears to be the most important part of the solar activity insofar as effect upon the environment of the Earth is concerned. A flare is a sudden brightening of an area of the solar surface occurring in a few minutes and then slowly decaying over a period of hours.

The x-rays and enhanced ultraviolet light emitted during the life of a flare increase the ionization in the Earth's ionosphere and disrupt short-wave radio communications.

The largest flares also emit great numbers of high energy protons which increase the radiation levels in interplanetary space and over the Earth's poles. Greater knowledge of the radiation emitted by the Sun is required to understand these interactions between solar events and the Earth's upper atmosphere and ionosphere.

In addition to effects on interplanetary space, the Sun itself is an interesting astronomical object. It is the only star whose surface characteristics we can resolve and study. Knowledge gained by studying the Sun will help astrophysicists to understand and interpret the data from other stars.

The techniques of space research permit scientists to expand solar studies two ways: They can increase the resolving power of their telescopes through the elimination of atmospheric distortion, and they can observe many more decades (groupings) of the electromagnetic spectrum.

The Sun emits electromagnetic radiation (light, radio and infrared radiation) in 16 decades of wavelength or "color".

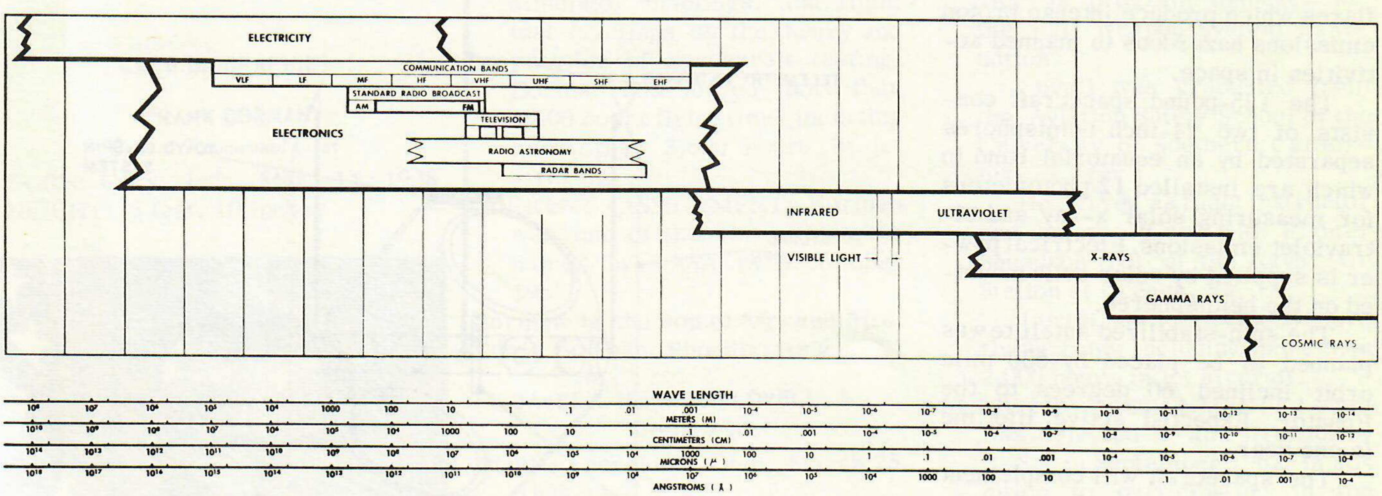
Of these 16 decades, only a fraction of one decade is the visible light that a human eye can see. Three other decades lie in the radio portion of the spectrum which can be observed on the ground.

The rest of the solar radiation is absorbed in the Earth's atmosphere and can be observed only with instruments above the atmosphere.

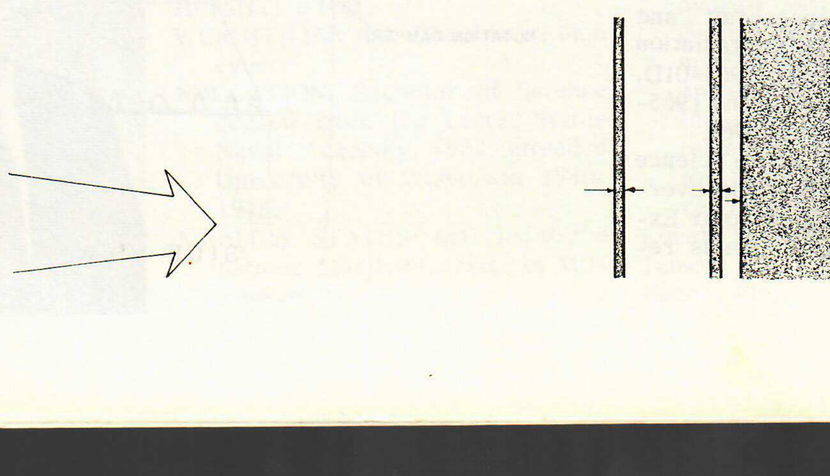
The absorbed portions of the spectrum are doubly important. They are the portions which vary with solar activity. In order to understand the mechanism of a solar flare, studies of the ultraviolet and x-rays emitted during a flare (both of which are absorbed in the atmosphere) must be made. Furthermore, since the radiation is absorbed in the upper atmosphere, these portions of the solar radiation control the nature of the upper atmosphere.

Satellites contribute to studies of

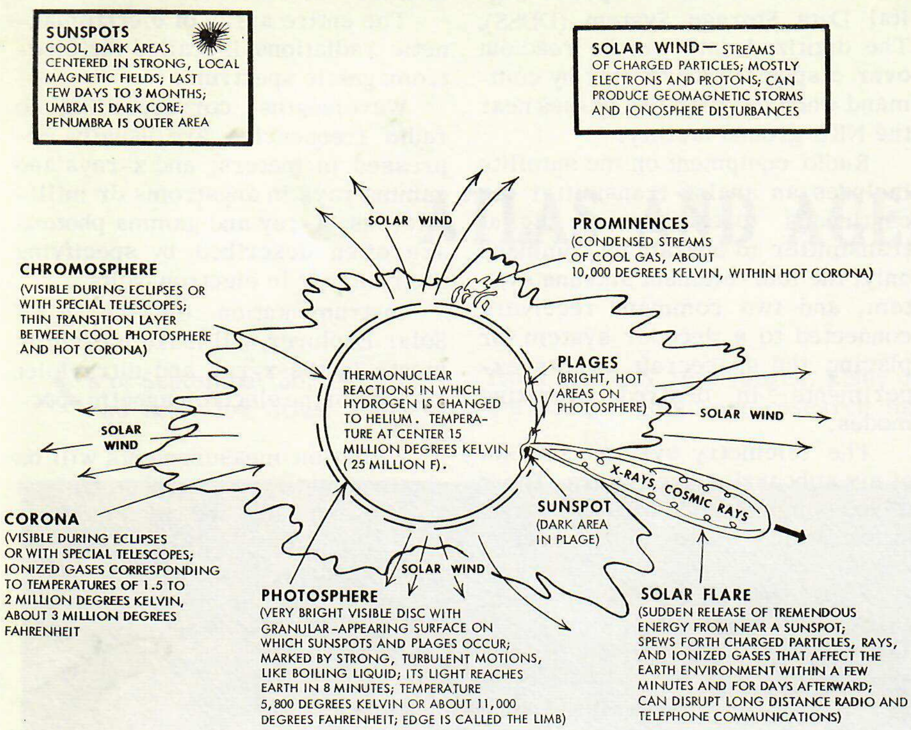
IQSY SOLAR EXPLORER REGIONS OF STUDY



Regions of solar electromagnetic spectrum to be monitored and investigated by the IQSY Solar Explorer. Regions extend from 0.5 to 16 Angstroms, 44 to 60 and 1080 to 1350.



SOLAR AREAS OF SCIENTIFIC INTEREST



solar phenomena in three major ways. They make possible the study of the ultraviolet, x-ray and gamma ray radiation which is absorbed in the atmosphere; they permit continuous monitoring of this radiation during solar cycles of activity; and they provide higher resolution than ground equipment through the elimination of atmospheric scattering.

The primary reason for the solar studies is to meet the overall objective to expand human knowledge of space phenomena. While these are exciting and important reasons for the work there are also practical benefits to be gained.

Knowledge of solar radiation and its effects on the terrestrial environment, together with continuous monitoring of the entire spectrum of solar radiation, should result in significant advances in the understanding of, and ultimate control over weather.

If significant advance signs of solar activity can be found and used to predict solar flares, this discovery will be a major contribution to the communications industry, meteorology and manned space flights.

In recent years portions of the solar spectrum of radiations have been observed by ground-based monitors, balloon-borne instruments, high-flying aircraft, sounding rocket flights, deep space probes, and satellites. Scientists from industry, universities, and several Government agencies have engaged in these efforts to unlock the Sun's secrets.

The Naval Research Laboratory began in 1949 a program of observation of solar ultraviolet and x-ray emissions in which the V-2 and, later, Aerobee sounding rockets were used to lift sensitive instruments (spectrographs and photometers) above the absorbing layers of the atmosphere.

In 1956, NRL began trying balloon-launched rockets, ROCKOONS, in a direct-measurement attempt to test the theory that solar x-rays were responsible for sudden ionospheric disturbances (SIDs) during solar flares.

A rocket fired during a solar flare July 20, 1956 indicated a surprisingly high intensity of x-rays between altitudes of 75 and 100 kilometers (47 to 62 statute miles). The x-ray flux was the first ever obtained at such short wavelengths and at such a low level in the ionosphere.

Subsequent ground-launched sounding rockets gathered considerable new data on x-ray emissions during 1957 through 1959. Rocket measurements were made during three solar flares each of which was accompanied by a large SID.

Sounding rocket experience by NRL, NASA and others provided the brief glimpses of the Sun's spectrum necessary to guide development of satellite instrumentation.

In the study of such spasmodic events as solar flares, however, the sounding rockets have three handicaps: They cannot be launched quickly enough to see the early phases of flare; they cannot stay above the Earth's atmosphere long enough to measure time variations of solar x-ray and ultraviolet emissions; and it is difficult to keep instruments pointed at the Sun due to roll and yaw.

Therefore, scientists turned to satellites capable of providing a stable platform for continuous solar monitoring.

In June 1960, the SR-I, designed and built by NRL, became the first successful solar x-ray monitoring satellite. Because x-ray monitoring could be conducted only when SR-I passed over a telemetry station, the experiment depended on NASA for tracking and data acquisition.

Despite modest capabilities, 577 telemetry records were obtained from SR-I between June 22 and Nov. 1, 1960. One hundred of these showed measurable x-ray fluxes.

Results were significant. SR-I confirmed the hypothesis that solar x-rays cause sudden disturbances in the ionosphere during flares and determined the intensity necessary to trigger the changes.

It also established that active prominence regions, bright surges on the edge of the Sun, and certain solar-edge (limb) flares have the same characteristics as major disk flares. The disk is the central portion of the Sun as viewed from Earth.

Data from SR-I showed that solar x-ray fluxes provide a very sensitive measure of solar activity and can change significantly within one minute. It was found that long-duration x-ray events of moderate intensity can accompany rising prominences on the solar limb. Prominences are streams of cool gas that surge into the hot corona.

The second satellite in the SR series failed to achieve orbit and the third, SR-III, launched in June

1961, went into a tumbling mode that made data reduction difficult. Nevertheless, some of the data from SR-III has been reduced and found useful.

The IQSY Solar Explorer, designed and built by NRL will continue the solar x-ray monitoring program begun by SR-I. Main objectives are to:

1. Monitor the Sun's energetic x-ray emission with standardized x-ray photometers;
2. Measure the time history of x-ray emission intensity and spectral equality of solar flare emissions and to correlate these measurements with those of optical and radio ground-based observatories; and
3. Provide real-time solar monitoring information to all interested participants in the IQSY program.

The spacecraft consists of two 24-inch diameter hemispheres separated by a 3 1/2 inch equatorial band in which are mounted 12 photometers with magnets to shield the photometers from saturation by Van Allen radiation belt electrons. Also mounted on the equatorial band are four antennas for telemetry purposes.

Six flat circular panels covered with solar cells are mounted symmetrically on the hemispheres.

Electric power converted from solar energy by the cells is available to charge the nickel-cadmium batteries and to operate all spacecraft electrical systems. The symmetrical arrangement of the 11-inch diameter panels assures adequate power regardless of the Sun angle.

The silicon solar cells will supply six watts of power. The portion of the shell not covered with solar cells is highly polished and has a thermal control coating applied. This will keep the internal temperature between 10 and 40 degrees Centigrade.

Two low-thrust vapor jets are located adjacent to the equatorial band to maintain spin rate and control of the spin axis. The spacecraft is planned to be spin stabilized at about one revolution per second. Two Sun sensors located 180 degrees apart generate properly timed jet pulses to process the spin axis as necessary.

Output of four photometers can be switched to the low-power Digital Data Storage System (DDSS). The digitized data can be read out over a special transmitter by command when the satellite passes near the NRL ground facility.

Radio equipment on the satellite includes an analog transmitter for continuous operation, a digital transmitter to operate on command only, the four-element antenna system, and two command receivers connected to a decoder system for placing the spacecraft and its experiments in desired operating modes.

The telemetry system consists of six subcarrier oscillators. Their mixed output modulates a transmitter which will send both housekeeping and x-ray data.

A magnetic core memory system will collect data from four x-ray detectors over a 24-hour period and then, on command, transmit the digitized data for five minutes to the NRL ground station. After that the system is reset to collect data for another 24-hour stretch.

All radiant energy, including that from the Sun, is emitted in many diverse forms and over a tremendous range of frequencies, or wavelengths. All these forms of radiant energy are electromagnetic in nature, obey the same basic laws and travel through space at the speed of light (about 186,300 miles per second). They differ in wavelength, origin and the ways in which they manifest themselves.

The entire array of electromagnetic radiations is called the electromagnetic spectrum.

Wavelengths corresponding to radio frequencies are usually expressed in meters; and x-rays and gamma rays in angstroms or millimicrons. X-ray and gamma photons are often described by specifying their energy in electron-volts.

Instrumentation on the IQSY Solar Explorer will make measurements in the x-ray and ultraviolet regions of the electromagnetic spectrum.

Radiation measurements will be obtained by two types of photometers - - ion chambers and Geiger counters. The latter will be used for measurements below eight angstroms. Ultraviolet photometers will measure the region from 1080 to 1350 A.

The satellite measurements will be as follows:

Wavelength (In angstroms)	Type of Emission	Number of Photometers	Type of Photometers
0.5 to 3	X-ray	two	Geiger counter and one backup
1 to 8	X-ray	four*	Geiger counter, 2 ion chambers and one backup for G counter
1 to 20	X-ray	one	Ion chamber
8 to 16	X-ray	two*	Two ion chambers
44 to 60	X-ray	one	Ion Chamber
1080 to 1350	Ultra-violet	two	Ion chamber (2 in parallel)
1225 to 1350	Ultra-violet	two	Ion chamber (2 in parallel)

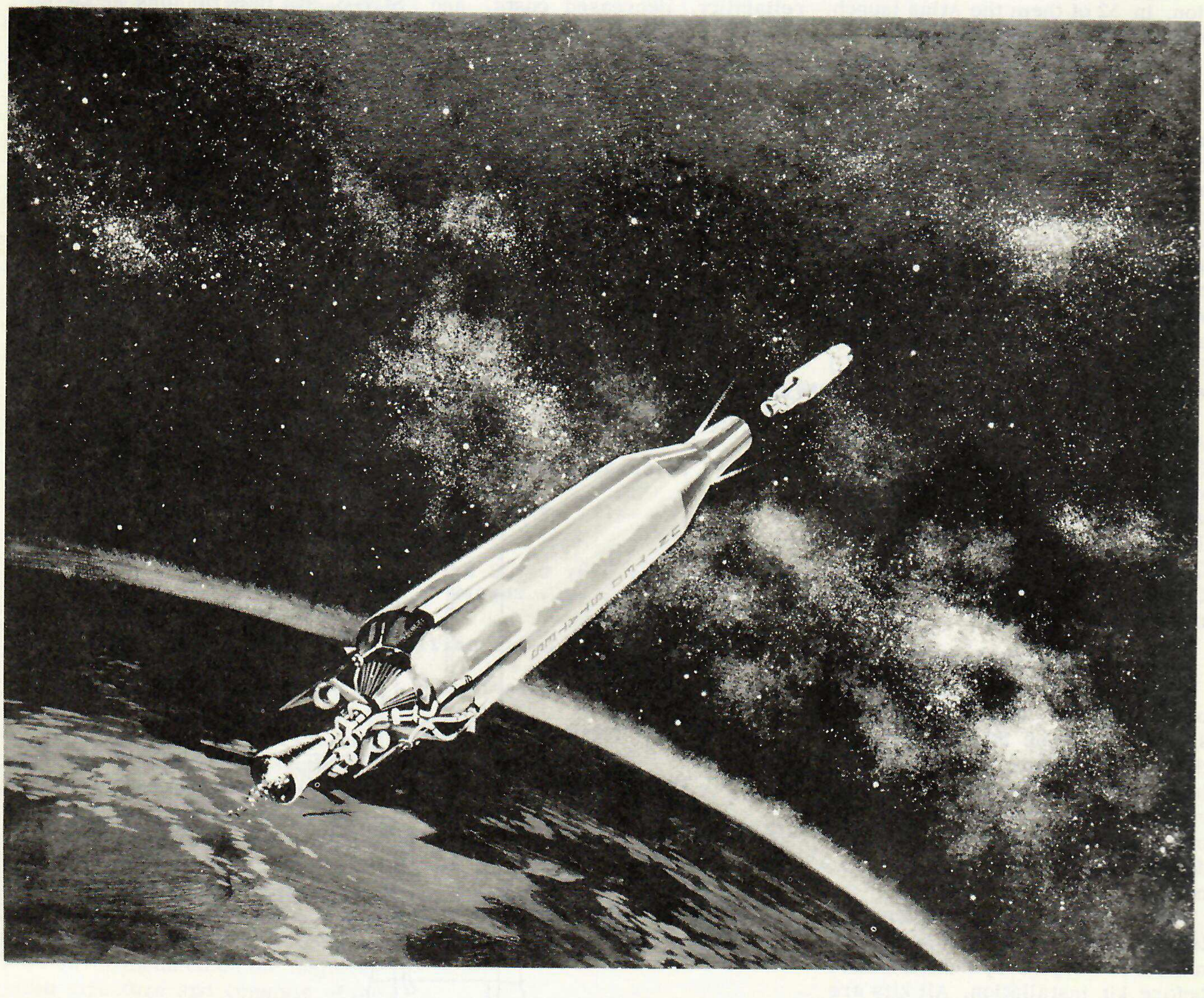
(* - Each 1-8A and 8-16A photometer has a different degree of sensitivity to cover a broad range of flux values and to permit the correlation and extension of similar measurements on earlier satellites.)

The measurements are made in different but overlapping x-ray bands so that comparison of the different photometer outputs can be employed to construct a model of the solar x-ray spectrum and to provide an instantaneous indication of spectral changes with solar activity.

Satellite-obtained data on the daily average x-ray flux will be provided to the Institute for Telecommunications Sciences and Aeronomy, Boulder, Colorado, for rapid publication.

ATLAS AND AGENA

As of September 30, 1965, there had been 263 Atlas launches from both U.S. test ranges. Many of the early flights were research and development tests to prove the Atlas concept and design for use as a weap-



HEADED FOR RENDEZVOUS IN SPACE - Artist's conception shows a specially modified Agena upper stage as it separates from its Atlas SLV-3 booster headed for orbit prior to launch of the two-man Gemini VI spacecraft carrying pilots Walter M. Schirra, Jr. and Tom Stafford. The SLV-3 has shed its two booster engines, and retrorockets located near the nose of the launch vehicle have just fired, backing the big booster away from its Agena upper stage. Once the Target Agena has been launched into circular orbit 161 nautical miles above the earth, ground stations will track the Agena, plot its orbit, and determine the orbital trajectory necessary for the two-man spacecraft. The SLV-3 booster used in the Gemini VI mission is a standardized version of the Atlas launch vehicle used successfully to boost the nation's first orbiting astronauts in Project Mercury.

on system for the Air Force.

In addition to the military test flights, Atlas launch vehicles were used to place the manned Mercury capsules in orbit.

But the workhorse of the unmanned space exploration programs of the nation has been the versatile and reliable Atlas-Agena combination which has accounted for many of the nation's spectacular successes in space.

The first launch of an Atlas with an Agena upper stage came on February 26, 1960. To date, there have been 59 Atlas-Agena launches for the U.S. Air Force and the National Aeronautics and Space Administration. In 52 of them the Atlas launch vehicle performed successfully.

Atlas-Agena vehicles successfully launched the Ranger spacecraft which sent back the first close-up photos of the surface of the moon, boosted the Mariner vehicles which successfully flew to the vicinity of the planets Venus and Mars, and launched the Vela nuclear detection satellites into highly eccentric earth orbits. Orbiting Geophysical Observatory (OGO) satellites were launched by Atlas-Agena vehicles, and the first nuclear reactor in orbit (SNAP) was launched by an Atlas-Agena.

Current planning calls for Atlas-Agena launches of OGO spacecraft, OAO (Orbiting Astronomical Observatory) satellites, Lunar Orbiter vehicles, and ATS (Applications Technology Satellite) payloads, plus Gemini target flights similar to the Gemini VI mission and classified missions for the U.S. Air Force.

ATLAS SLV-3 DESCRIPTION

The SLV-3 is composed of a basic airframe and standardized system kits. The basic vehicle and the ground equipment at each SLV-3 launch pad are designed so that all vehicles are compatible with all pads. The system kits can accommodate the peculiarities of the two U.S. missile ranges.

Each basic vehicle and each kit is a separate deliverable item which must be accepted by the Air Force before kit installation. All kits are installed and a final composite system checkout is performed before integrated launch vehicle acceptance. This is in addition to the individual inspection and checkout of individual parts, components and systems prior to their integration aboard the vehicle.

The Kit Concept

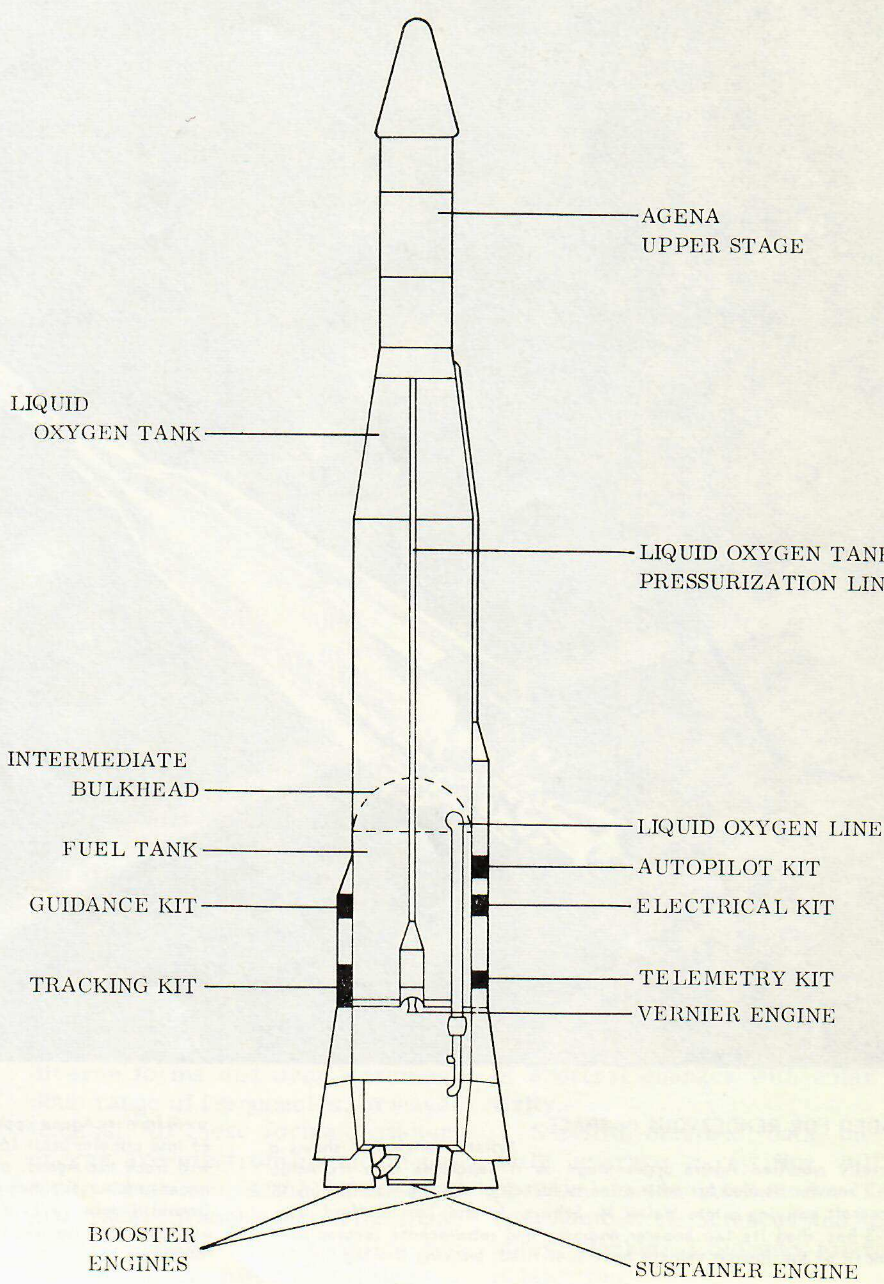
Standardized guidance, autopilot, tracking, telemetry, and electrical system "kits" are provided for the SLV-3 for installation on a basic air frame. Installation of the kits tailor each vehicle to its particular mission and its launch site. Required kits may be installed closer to delivery dates than ever before, offering greater flexibility in scheduling of launch facilities and flights.

Kit installation allows the economy and reliability of a standard design, improved countdown and flight reliability, decreased costs, and more flexibility for a variety of mission assignments.

Prior to development of the Atlas SLV-3, Atlas vehicles used for space launches were in many respects similar to the Atlas intercontinental ballistic missile. Only those modifications necessary to make the vehicles compatible with particular space missions were made.

Structure

The SLV-3 structure consists of a propellant tank section and the thrust structure. Atlas vehicles were first to use the integral tank principle. This concept is carried over into the design of new Atlas SLV-3. Its integral tank needs no



internal braces and is pressurized to maintain rigidity and structural integrity. Elimination of braces reduces weight, allowing greater range and heavier payloads.

The main propellant tank is made of cold-rolled stainless steel formed into a cylinder and welded, with a bulkhead at either end and an intermediate bulkhead to divide the tank into two compartments.

The lower (aft) compartment contains the fuel called RP-1, and the top (forward) tank the oxidizer which is liquid oxygen. Helium gas is used to pressurize the tank.

Propellants

The propellants used in the Atlas SLV-3 are liquid oxygen and RP-1, hydrocarbon fuel resembling kerosene. These propellants are supplied under pressure both to the engines, combustion chambers and to the pump gas generators. The gas generators deliver hot combustion product gases to the turbines driving the turbo pumps. RP-1 fuel is maintained at ambient temperature; the temperature of the liquid oxygen is minus 297 degrees Fahrenheit.

RP-1 fuel is pumped aboard the Atlas SLV-3 one day prior to launch at approximately 1,000 gallons per minute. Liquid oxygen is pumped into the forward tank of the Atlas SLV-3 about 30 minutes prior to liftoff at approximately 2,000 gallons per minute.

Engines

The SLV-3 is propelled by the most powerful engines developed for the Atlas program - the 390,000 pound-thrust Rocketdyne MA-5 propulsion system. The system is composed of two sections: the booster section and the sustainer-vernier section. The booster section includes two 165,000-pound thrust outboard engines. Booster engines are dropped from the vehicle during flight. The sustainer or center engine is installed on the propellant tank section.

The sustainer-vernier engine section is mounted on the main vehicle structure and consists of the 57,000 pound-thrust sustainer engine and two small vernier engines of approximately 670 pounds thrust. The sustainer and vernier engines continue to burn after the two-engine booster section has been jettisoned. After sustainer engine cut off (SECO), the two vernier engines continue burning for fine velocity control.

ATLAS SLV-3 STATISTICS

Launch vehicle	SLV-3 #5301
Length of Atlas SLV-3	66' 0"
Maximum diameter of Atlas SLV-3 at booster section	16' 0"
Diameter of Atlas SLV-3 at tank section	10' 0"
Minimum diameter of Atlas SLV-3 at tapered nose section	5' 10"
Weight at liftoff (without upper stage and/or payload)	More than 260,000 lbs.
Weight of liquid oxygen (upper tank)	More than 160,000 lbs.
Weight of fuel (lower tank)	More than 73,000 lbs.
Thrust at liftoff	390,000 lbs.
Liftoff with upper stage and payload thrust acceleration	1.4 g
Liquid oxygen temperature	Minus 297 degrees Fahrenheit
Fuel temperature	Ambient
Liquid oxygen and fuel consumption rate	About 1,500 lbs./second
Atlas SLV-3 operational environment	Minus 297 degrees Fahrenheit (LOX) to 1,000 degrees Fahrenheit
Atlas SLV-3 guidance	Radio-inertial
Launch site	Complex 14, Eastern Test Range
Atlas SLV-3 tank (airframe) skin gauges	.014 to .048 inch
Atlas SLV-3 period of powered flight	About five minutes
No. of stages	1½
Launch azimuth	80 to 105 degrees

SLV-3 PAYLOAD CAPABILITY*

Direct ascent	WTR	2,600
	ETR	4,100
With Centaur	WTR	---
	ETR	10,300
	Escape	2,500

*Payload to 100-nautical-mile circular orbit

APPLICATIONS TECHNOLOGY SATELLITE

A new type of satellite soon may imitate the man in the moon by keeping its "face" continually looking toward the earth.

This was revealed recently when the National Aeronautics and Space Administration gave details of previously-announced plans to orbit a new breed of scientific satellites, called Applications Technology Satellites (ATS), including several which will uncoil four tip-weighted booms to a "wingspread" nearly the length of a football field.

Dr. Fred P. Adler, vice president of Hughes Aircraft Company, El Segundo, Cal., provided the information that the booms, similar to a tightrope walker's balancing poles, will unreel more than 130 feet from the ATS to test a new "gravity gradient" concept for stablizing satellites. Hughes is building five flight vehicles and two prototype models of the ATS spacecraft under a $39 million contract for NASA's Goddard Space Flight Center.

The concept is similar to the principle that causes the moon to rotate once during each orbit and thereby keep its "face" facing the earth with never an about-face, he explained. This principle can be used to make the satellite keep its antenna facing earthward because the long booms, which carry weights on the ends, interact with the earth's gravitational field to keep the satellite stable. This means that, if successful, a gravity-gradient spacecraft could keep a fixed antenna aimed at the earth without requiring a gas jet control system.

The new satellite family will conduct about 20 experiments and studies on communications techniques, weather, ion engines, satellite stabilization, cloud photography and solar radiation damage.

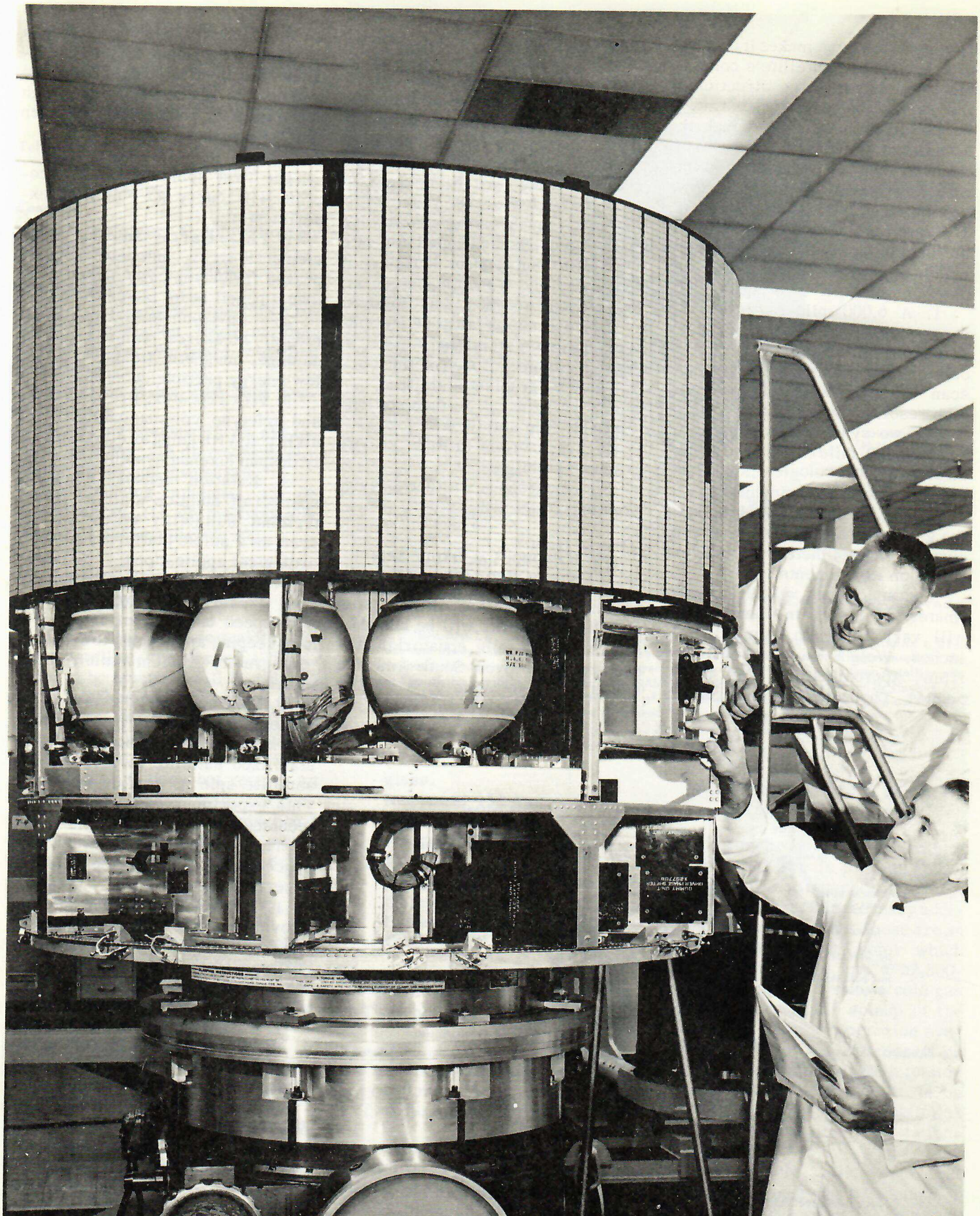
Only later satellites in the five-spacecraft family will be equipped with booms for carrying out the gravity-gradient experiments.

The first ATS, scheduled for launch in late 1966, and one later ATS, will use the technique of spin stabilization and gas jet control developed by Hughes for the Syncom and Early Bird communications satellites, Dr. Adler said.

"One of the main experiments on the first flight will be the use of a new type of communications antenna which has the effect of increasing the signal strength from the satellite," he said.

"The Hughes-developed device, called a phased-array electronical-

STRUCTURAL MODEL - A full-scale structural model of the Applications Technology Satellite nears completion at Hughes Aircraft Company where five flight models are being built for NASA's Goddard Space Flight Center. The ATS spacecraft will conduct some 20 separate scientific experiments aimed at advancing satellite technology in communications, satellite stabilization techniques and control, and gathering meteorological data. The spacecraft shown here is the spin-stabilized synchronous orbit satellite.



ly-despun antenna, makes it possible to concentrate a satellite's communications beam in the direction of the earth, instead of radiating it in all directions, even though the satellite is spinning."

ATS launches will occur at intervals of about six months following the first launch late next year. The satellites are expected to operate in orbit at least three years.

Three types of missions are planned for the ATS spacecraft:

1. A 6,000-mile earth orbit to experiment with gravity-gradient stabilization, measure radiation damage and particle detection, and scan the earth's cloud cover with high resolution cameras.

2. Two synchronous spin-stabilized 22,300-mile orbits for communications, meteorological, ion engine, and cloud-scan experiments.

3. Two synchronous orbits using the gravity-gradient system to conduct ion engine, meteorological, and radiation experiments.

The spacecraft will be approximately 56 inches in diameter and will vary in length from 53 to 72 inches. Weight in orbit will vary from approximately 650 to 775 pounds. The satellites will conduct approximately 20 major experiments, including investigation of gravity gradient stabilization techniques, studying advanced satellite communications concepts and making earth studies. The experimental payloads will be provided by NASA. The satellites are to operate in orbit for at least three years.

First launch, using a two-stage Atlas-Agena, is scheduled for late 1966, with subsequent launches at approximately 6-month intervals. The launch sequence is as follows:

1. Synchronous altitude stationary orbit, spin stabilized.

2. Medium altitude (inclined orbit) gravity-gradient stabilized.

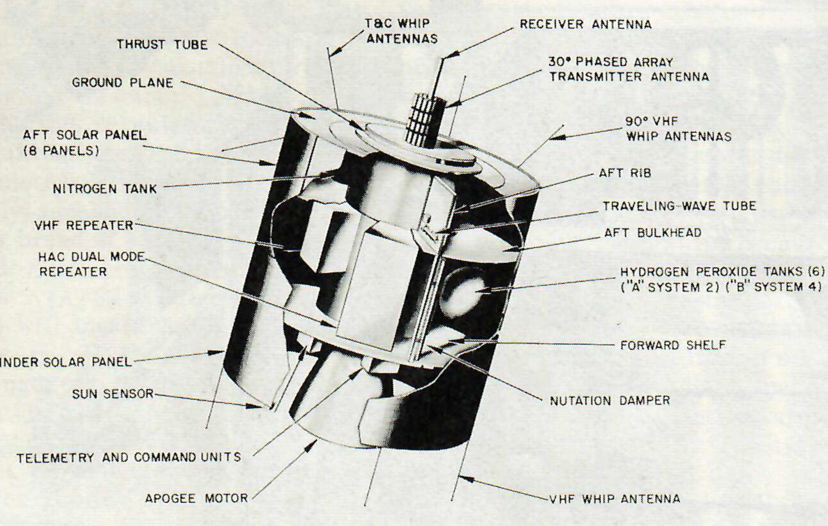
3. Synchronous altitude stationary orbit spin stabilized.

4. Synchronous altitude gravity gradient-stabilized.

5. Synchronous altitude gravity gradient-stabilized.

SYNCHRONOUS ALTITUDE SPIN STABILIZED SATELLITE

The synchronous altitude spin stabilized satellite will be launched into a 22,300-mile equatorial stationary orbit over South America and allowed to drift to a Pacific location. It will carry a hydrogen peroxide jet system to provide attitude and orbital control for three years. The spacecraft will weigh approximately 1600 pounds at launch and 775 pounds in orbit.



SYNCHRONOUS ALTITUDE SPIN-STABILIZED SPACECRAFT

SPINNING SPACECRAFT - Cutaway view shows systems and experiments to be carried by the spin-stabilized synchronous altitude Applications Technology Satellite. A major experiment is the evaluation of the Hughes Aircraft Company's phased-array transmitting antenna on top of the spacecraft. Two such vehicles will be built by Hughes in the ATS program, along with three others of different configurations, for NASA's Goddard Space Flight Center.

Payload

The first spin stabilized spacecraft will carry the following experiments:

1. Phased array antenna. A 16-element array antenna properly phased (electronically despun) so that a pencil beam is generated.

2. Environmental measurements. Measures solar radiation damage, magnetic fields, high and low energy particle detection.

3. VHF repeater. Provides voice and teletype communications capability at VHF using an electronically despun antenna system.

4. Nutation sensor. Evaluates spacecraft nutation stability to determine suitability of the spacecraft as a stable platform for meteorological applications.

5. Ion engine. Evaluates ion engine performance by measuring spin-speed changes for future station-keeping application to synchronous gravity gradient-stabilized vehicles.

6. Spin-scan cloud camera. The camera is designed for operation in a synchronous, equatorial, spin-stabilized satellite to make use of satellite spin to provide line scan. This experiment will evaluate this technique.

The second spin stabilized spacecraft will carry the following experiments:

1. Mechanically despun antenna. Provides a microwave communications antenna of high gain that continuously points at earth on a spinning vehicle by de-spinning through a mechanical phase-locked drive.

2. Ion engine.

3. Other experiments to be assigned later.

Control Systems

Five-pound thrust hydrogen peroxide system to get on station.

Five-pound thrust hydrogen peroxide system for stationkeeping.

Electrical Power

Solar cell array:

23,870 N on P silicon cells with ultraviolet filter cover glass.

187 watts maximum power.

Rated voltage 26.9 volts.

Maximum current 6.9 amps.
Batteries:
Two 22-cell nickel cadmium 6 amp/hour batteries.
Battery charge voltage 32.7 volts.

Telemetry

Four 2-watt transmitters.
Two encoders.

Command

Two receivers at approximately 150 mc.
Two dual-mode decoders.

Communications

Two triple-mode repeaters (frequency translation mode, multiple access mode, on-board wideband data mode).

4-watt traveling-wave tube power amplifier.

Receiving antenna: 8 db phased array antenna. (18 db mechanically despun on second spacecraft).

Transmitting antenna: 18 db phased array. (18 db mechanically despun on second spacecraft).

MEDIUM ALTITUDE GRAVITY GRADIENT SATELLITE

The medium altitude gravity gradient satellite, the second ATS vehicle to be launched will be placed in a 6,000-mile orbit at an orbit inclination of approximately 28.6 degrees. It will have the lightest launch weight of the three ATS vehicles since it does not require an apogee boost motor, hydrogen peroxide control system or spinup and despinning system. It will weigh 700 pounds at launch and in orbit.

Payload

The satellite will carry the following experiments.

1. Gravity gradient stabilization and instrumentation experiment. This experiment will assess and analyze a passive stabilization system, utilizing the earth's gravitational field at medium altitude.

2. Environmental measurements. Measures radiation damage and particle detection.

3. Meteorological experiment. Provides high and low resolution cameras to scan earth's cloud cover.

Control System

5 x 10-4 pound thrust subliming solid rocket system for inversion.

Electrical Power

Solar cell array:
22,080 N on P silicon cells with ultraviolet filter cover glass.
Net power 135 watts.
Rated voltage 28.3.
Net current 4.75 amps.
Batteries:
Two 22-cell nickel cadmium 6 amp/hour batteries.
Battery charge voltage 32.7 volts.

Telemetry

Four 2-watt transmitters.
Two encoders.

Command

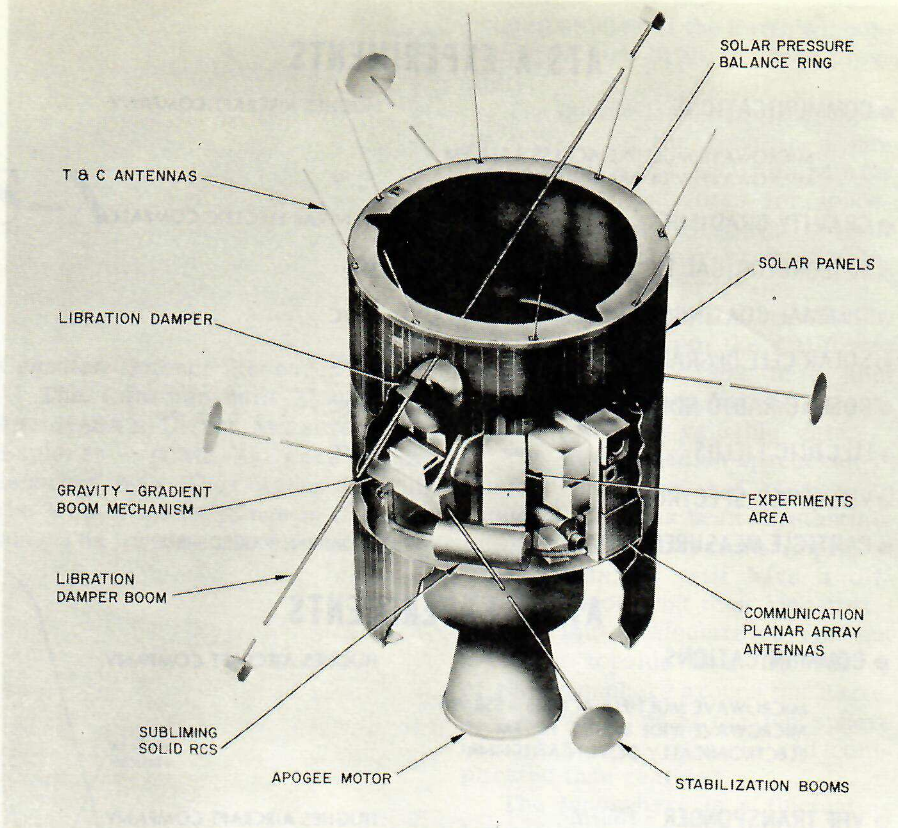
Two receivers at approximately 150 mc.
Two dual mode decoders.

Communications

Two triple mode repeaters (frequency translation mode, multiple access mode, onboard wideband data mode).

4-watt traveling-wave tube power amplifier.

18 db receiving horn antenna.
18 db transmitting horn antenna.



SYNCHRONOUS ALTITUDE GRAVITY - GRADIENT SPACECRAFT

SPACE 'BALANCER' - A new concept of stabilizing a satellite, so that it maintains a fixed attitude and always keeps one face toward the earth, will be one of the chief experiments on the synchronous-altitude gravity-gradient spacecraft of the Applications Technology Satellite program. Two of the vehicles will be built for NASA's Goddard Space Flight Center by Hughes Aircraft Company, along with three other types of ATS satellites. Booms with weights on the ends will extend some 130 feet out from the spacecraft for the gravity-gradient experiment.

SYNCHRONOUS ALTITUDE GRAVITY GRADIENT SPACECRAFT

The synchronous altitude gravity gradient satellite is similar to the medium altitude spacecraft except that it incorporates necessary additional control systems. These are an apogee boost rocket motor which injects the satellite into a 22,300-mile synchronous orbit, a cold gas nitrogen system for spinup of the satellite, a hydrogen peroxide system for placing the spacecraft on station, a despinning system to stop the satellite's spin once it is on station, and a low thrust subliming rocket for inversion and station-keeping.

The vehicle will weigh 1625 pounds at launch and 670 pounds in orbit, the large reduction in weight being due to the burning of the apogee motor fuel and the ejection of the motor case after burnout. After the spacecraft reaches near-synchronous altitude, it will be positioned

ATS-A EXPERIMENTS

• COMMUNICATIONS MICROWAVE MULTIPLE ACCESS - SSB/PM MICROWAVE WIDE BAND - FM/FM	HUGHES AIRCRAFT COMPANY
• GRAVITY GRADIENT	GENERAL ELECTRIC COMPANY
• METEOROLOGICAL TV	RCA
• THERMAL COATING DEGRADATION	GSFC
• SOLAR CELL DEGRADATION	GSFC
• COSMIC RADIO NOISE	GSFC
• ELECTRIC FIELDS	GSFC
• VLF POWER SPECTRUM	BTL
• PARTICLE MEASUREMENTS	U. MINN. - UCSD - BTL

ATS-B EXPERIMENTS

• COMMUNICATIONS MICROWAVE MULTIPLE ACCESS - SSB/PM MICROWAVE WIDE BAND - FM/FM ELECTRONICALLY DESPUN ANTENNA	HUGHES AIRCRAFT COMPANY
• VHF TRANSPONDER - FM/FM	HUGHES AIRCRAFT COMPANY
• METEOROLOGICAL TV	UNIVERSITY OF WISCONSIN
• NUTATION SENSOR	GEOPHYSICS CORPORATION OF AMERICA
• ION ENGINE THRUSTER	LEWIS RESEARCH CENTER
• MAGNETIC FIELD MEASUREMENTS	UNIVERSITY OF CALIFORNIA
• THERMAL COATING DEGRADATION	GSFC
• SOLAR CELL DEGRADATION	GSFC
• PARTICLE MEASUREMENTS	RICE UNIV. - TRW - UNIV. OF MINN. - BTL - AEROSPACE
• ELECTRON CONTENT OF IONOSPHERE & MAGNETOSPHERE	STANFORD UNIVERSITY

ATS-B VHF EXPERIMENTS

• COMMERCIAL AIRLINES	AIR-GROUND COMMUNICATIONS
• FEDERAL AVIATION AGENCY	AIR-GROUND COMMUNICATIONS & RANGING
• U. S. AIR FORCE	YET TO BE DETERMINED
• U. S. WEATHER BUREAU	COLLECTION & DISTRIBUTION OF METEOROLOGICAL DATA
• STANFORD UNIVERSITY	PROPAGATION, ELECTRON DENSITY
• GSFC	COMMUNICATIONS, RANGE & RANGE RATE, PROPAGATION
• OMSF	APOLLO AIRCRAFT COMMUNICATIONS

in longitude, its orbit made synchronous and it will be despun. The damper and gravity gradient booms will then be extended and the satellite will maintain station (except for inclination buildup) for a minimum of three years.

Payload

The spacecraft will carry the following experiments.

1. Gravity gradient stabilization and instrumentation. Provides and evaluates a passive stabilization system for utilizing the earth's gravitational field at synchronous altitude.

2. Meteorological. Provides zoom lens cameras to scan earth's cloud cover from synchronous altitude.

3. Environmental measurements. Measures radiation damage and particle detection.

4. Ion engine. Provides low thrust propulsion for stationkeeping.

Control Systems

5-pound thrust hydrogen peroxide system for initial orientation and stationkeeping.

5.4 x 10-4 pound thrust subliming solid state system for inversion. A 1 x 10-5 pound thrust subliming solid system for east-west stationkeeping.

Electrical Power

Solar cell array:

22,080 N on P silicon cells with ultraviolet filter cover glass.

Net power 135 watts.

Net current 4.75 amps.

Batteries:

Two 22-cell nickel cadmium 5 amp/hour batteries.

Battery charge voltage 32.7 volts.

Telemetry

Four 2-watt transmitters.

Two encoders.

Command

Two cross-strapped receivers at approximately 150 mc.

Two dual-mode decoders.

Communications

Two triple-mode repeaters (frequency translation mode, multiple access mode, onboard wideband data mode).

4-watt traveling-wave tube power amplifier.

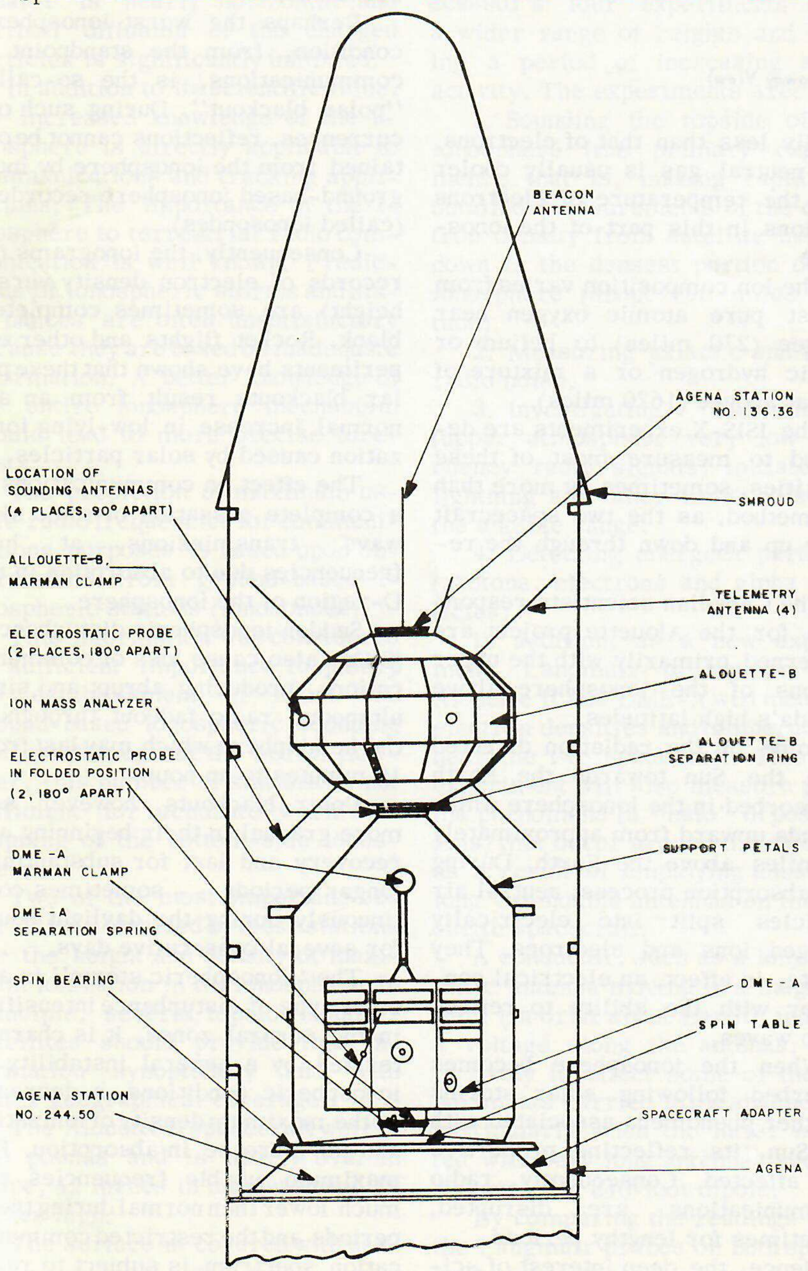
18 db receiving planar array antenna.

18 db planar array transmitting antenna.

ISIS-X

A second Canadian Alouette satellite and another United States Explorer satellite were scheduled for launch together no earlier than Nov. 23 as a joint project of the National Aeronautics and Space Administration and the Canadian Defence Research Board.

The Canadian-built Alouette II and NASA's Direct Measurements Explorer (DME-A) were to be launched by a Thor-Agena B from the Western Test Range in California. The two satellites will make related studies of the Earth's ionosphere as they orbit in close proximity.



ISIS-X

The double launch project, known as ISIS-X, is the first in a new cooperative NASA-DRB program for International Satellites for Ionospheric Studies (ISIS). Up to four Canadian-built spacecraft are involved in the ISIS program.

Canada's Alouette I, launched by a Thor-Agena from the California range Sept. 29, 1962 in a joint NASA-DRB project, still is operating and providing valuable data.

The new Canadian spacecraft is similar in design and purpose to Alouette I but has been substantially modified and carries improved experiments. It will have a different type of orbit than Alouette I.

The initial Alouette carried out the first topside sounding survey of the ionosphere around the Earth. The survey showed the ionosphere to be far more dynamic and complicated than realized.

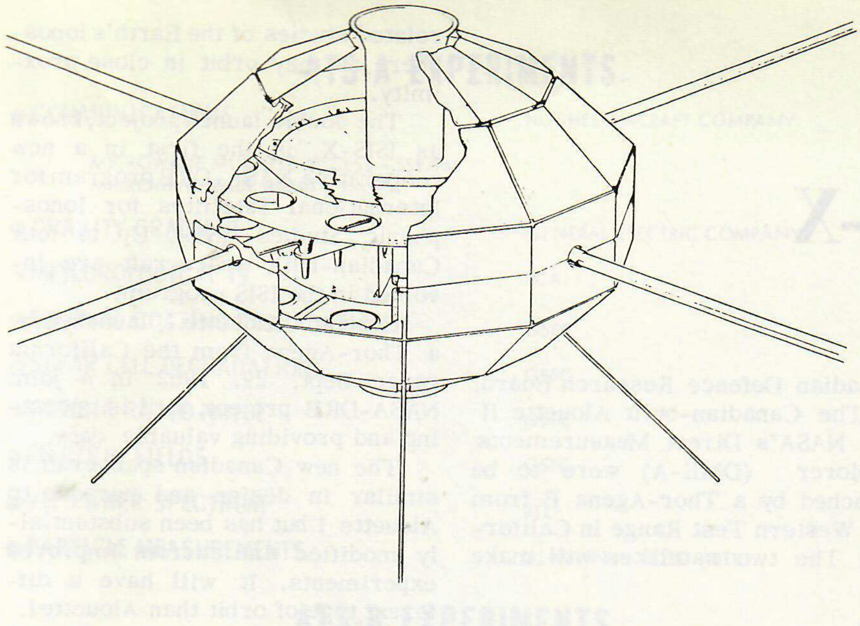
The ionosphere is a fluctuating ionized region of the upper atmosphere extending from about 35 miles above the Earth to thousands of miles into space. A major feature of the ionosphere is the number of free electrons present in it. These free electrons play a vital role in long-range radio communications.

The composition of the ionosphere varies markedly with time, altitude and latitude and it is the purpose of Alouette II and the DME-A during their lifetimes to measure many of these varying quantities between their orbital high points and low points - about 270 to 1620 miles.

The plane of the orbits will be inclined about 80 degrees to the Equator, bringing the satellites over the upper regions of the ionosphere above Canada's high latitudes, an area of particular interest to Canadian scientists.

The Alouette II was designed and built by DRB's Defence Research Telecommunications Establishment.

The DME-A was designed and built for the NASA Goddard Space Flight Center, Greenbelt, Md., by the Applied Physics Laboratory of John Hopkins University, Howard County, Md. This United Kingdom experiment will be carried on DME-A. APL also is responsible for final testing of the Alouette spacecraft.



Alouette-B Spacecraft (Cutaway View)

In line with the overall aims of the ISIS program to conduct simultaneous in-flight measurements of most of the important ionosphere phenomena, NASA proposed that a direct measurement satellite, DME-A, be launched at the same time into the same orbit.

Scientists of DRB supported this opportunity to obtain further information earlier in the ISIS program than would otherwise have been possible.

The eight experiments on DME-A will be correlated with the five experiments on Alouette II.

The induced voltage effects of the long antenna on Alouette II, for instance, will be observed in detail by comparing Langmuier probe data from Alouette II with that from DME-A which will be orbiting nearby.

For these reasons, it is planned that the two spacecraft will remain within 1,000 miles of each other for the first month they are in orbit.

Because both ionospheric temperatures and composition vary with height in a complex manner, ISIS-X experiments are designed to explore these variations from near the peak of the most dense layer of the ionosphere up to apogee, the high point of the orbits.

Through this region of the ionosphere, temperatures of electrons vary from 800 to 4000 degrees above absolute zero, but the temperature of ions is often different, usually less than that of electrons. The neutral gas is usually cooler than the temperature of electrons and ions in this part of the ionosphere.

The ion composition varies from almost pure atomic oxygen near perigee (270 miles) to helium or atomic hydrogen or a mixture of both at apogee (1620 miles).

The ISIS-X experiments are designed to measure most of these quantities, sometimes by more than one method, as the two spacecraft move up and down through the region.

The Canadian scientists responsible for the Alouette project are concerned primarily with the upper regions of the ionosphere above Canada's high latitudes.

Some of the radiation directed from the Sun towards the Earth is absorbed in the ionosphere which extends upward from approximately 35 miles above the Earth. During this absorption process, neutral air particles split into electrically charged ions and electrons. They create, in effect, an electrical conductor with the ability to reflect radio waves.

When the ionosphere becomes disturbed following solar storms or other phenomena associated with the Sun, its reflecting properties are affected. Consequently, radio communications are disrupted, sometimes for lengthy periods.

Hence, the deep interest of scientists in studying the upper atmosphere in order to find methods of overcoming the effects of ionospheric disturbances.

An unusual feature of the polar and subpolar ionosphere stems from seasonal variations of the polar atmosphere's sunlight - - continuous daylight during summer and continuous night during the winter. A second feature of the ionosphere at high latitudes involves effects on ionization created by charged solar particles.

The high-latitude ionosphere exhibits a wide variety of disturbed conditions. It resembles that in the temperate zones only during quiet conditions and then only on rare occasions.

Perhaps the worst ionospheric condition, from the standpoint of communications, is the so-called "polar blackout". During such occurrences, reflections cannot be obtained from the ionosphere by most ground-based ionosphere recorders (called ionosondes).

Consequently, the ionograms (or records of electron density versus height) are sometimes completely blank. Rocket flights and other experiments have shown that these polar blackouts result from an abnormal increase in low-lying ionization caused by solar particles.

The effect on communications is a complete cessation of radio skywave transmissions at high frequencies due to absorption in the D-region of the ionosphere.

Sudden ionospheric disturbances (SIDs) also cause loss of communications, producing abrupt and simultaneous radio fadeout throughout the hemisphere which may last from 10 minutes to an hour.

Polar blackouts, however, are more gradual in their beginning and recovery and last for substantially longer periods - - sometimes continuously during the daylight hours for several consecutive days.

The "ionospheric storm" is another type of disturbance intensified in the auroral zones. It is characterized by a general instability of ionospheric conditions, a decrease in the maximum density of ionization and an increase in absorption. The maximum usable frequencies are much lower than normal during these periods and the restricted communication spectrum is subject to rapid fluctuations in signal intensity.

The topside sounder technique is the only one known that can provide worldwide electron-density profiles above the height of maximum electron density of the ionosphere.

Such soundings permit the investigation of the physical properties of the ionosphere as a function of time and geographical location. The planned ISIS-X orbital inclination of 80 degrees will provide data on the little-known and very complex high-latitude regions (polar and auroral zones).

The profiles obtained in the equatorial regions are of interest because the magnetic field at the equator is nearly horizontal and vertical diffusion of the charged particles is significantly inhibited.

In addition to its scientific value, the increased knowledge of the ionosphere is directly applicable to communications and tracking applications. The importance of the ionosphere to terrestrial radio communication is well known. Predictions of ionospheric storms and disturbances are often unsatisfactory because they are based on inadequate information. A better knowledge of the entire ionosphere mechanism should lead to more precise forecasts.

The prediction of maximum usable radio frequencies for communications purposes is based upon observations from ground-based ionospheric stations (ionosondes).

This information was considered of sufficient importance to justify the establishment of about 150 ground-based ionospheric sounding stations throughout the world. However, this number of stations is not sufficient for accurate worldwide mapping of the bottom-side ionosphere.

Two of the most important observations obtained by these stations are the height and density of maximum ionization in the ionosphere. In principle, several topside sounder satellites should provide this information synoptically and with better geographical coverage.

The Alouette II spacecraft weighs 320 pounds and is nearly oval in shape, 42 inches in diameter and 34 inches high.

The surface is covered with panels of solar cells. The 6,480 n-on-p solar cells convert solar energy to electrical power and charge the nickel-cadmium storage batteries.

Two sets of long dipole antennas extend from the main portion of the spacecraft for use in the topside sounding of the ionosphere. One set measures 75 feet from tip to tip. The other is 240 feet, tip to tip, when extended.

A four-antenna array (whip type) is used for telemetry and command functions and a single whip antenna extends from the spacecraft top for the radio beacon aboard.

Two short electron probe rods extend from the base of the spacecraft.

Alouette II will repeat its predecessor's four experiments over a wider range of heights and during a period of increasing solar activity. The experiments are:

1. Sounding the topside of the ionosphere (the primary experiment); that is, making rapid and detailed measurements of the electron density from satellite heights down to the densest portion of the ionosphere (about 190 miles altitude).

2. Measuring galactic and solar radio noise.

3. Investigating "whistlers" (upper atmosphere very low frequency radio signals) initiated by lightning and other radio noises in the audible range.

4. Detecting energetic particles (protons, electrons and alpha particles).

In addition, as a new experiment, Langmuir probes on both Alouette II and DME-A will measure electron densities and temperatures near the two spacecraft. This fifth experiment will also measure plasma phenomena (a "halo" of positive ions) that occur around the satellite as a result of employing unusually long extendable antennas on the Alouette spacecraft.

A conductor, such as a long metallic antenna moving in a magnetic field (in orbit about Earth), induces a voltage along the antenna. This is likely to effect some of the experiments carried in the spacecraft, particularly when the latter is fitted with very long antennas such as Alouette II's 240-foot dipole.

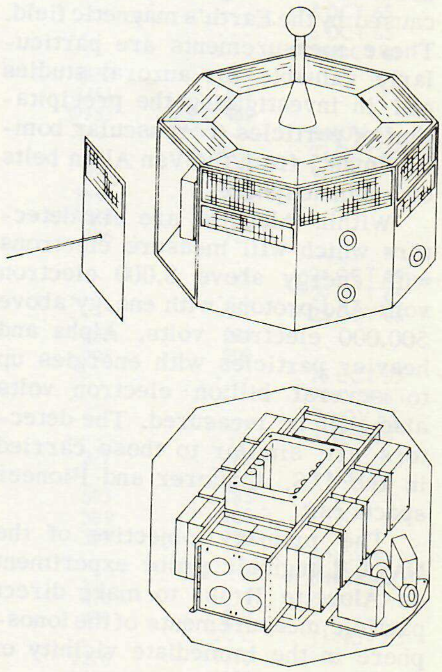
By comparing the readings from the Langmuir probes on both spacecraft, one with and one without long antennaes, it is hoped to provide a better assessment of the voltage effect.

The instrumentation designed for the Alouette topside sounder is a miniaturized version of a conventional ground-based sounder or ionosonde. A swept-frequency system is used in contrast to the fixed-frequency system employed in the U.S. Explorer XX launched August 25, 1964.

The sounder will transmit and receive pulsed radio frequency signals and the carrier frequency will be swept periodically over the frequency range from 0.2 to 13.15 megacycles. The time-delay versus sounding-frequency information will be transmitted to the ground stations via telemetry and will be recorded on 1/2-inch magnetic tape. Ionograms will be produced through subsequent playback and decoding of the tape at DRTE's central data processing facility.

As the DRB's second experiment, measurements of cosmic radio noise will be made at the satellite.

For this purpose, the background noise across the frequency band 0.2 to 13.5 megacycles will be measured. A signal derived from the swept-frequency ionospheric receiver automatic gain control circuit will be transmitted via the two watt telemetry system. Solar noise storms and the variation of radio



Artist's Conception of Final Configuration of the DME-A Spacecraft noise across the galaxy are measured by this experiment.

Objective of the third experiment will be to listen in the very low frequency (VLF) radio spectrum (0.05 to 30 kilocycles per second). A very low frequency receiver with a bandpass of cycles per second to 30 kilocycles per second has been included in the spacecraft instrumentation.

The input to the receiver is permanently connected with the 240-foot dipole antenna by means of a low-pass filter. The output, normally open, can be connected by means of the command system to the four-watt telemetry system. This signal will sometimes be added to that from the ionospheric sounder's receiver and recorded with it at the ground telemetry stations. Subsequently, filters will be used to separate the very low frequency information from that of the sounder.

Particle detectors in the sounder payload will measure one of the causative agents of ionization in the polar ionosphere at the same time and place as their effects. This experiment will measure primary cosmic ray particles outside the Earth's atmosphere, including the electrons, protons and alpha particles.

The polar orbit permits measurement of changes in particle flux caused by the Earth's magnetic field. These measurements are particularly valuable for auroral studies and in investigating the precipitation of particles (corpuscular bombardment) from the Van Allen belts or magnetosphere.

Within Alouette are six detectors which will measure electrons with energy above 3,000 electron volts and protons with energy above 500,000 electron volts. Alpha and heavier particles with energies up to several billion electron volts also will be measured. The detectors are similar to those carried in the U.S. Explorer and Pioneer spacecraft.

The primary objective of the NASA Langmuir probe experiment on Alouette II is to make direct particle measurements of the ionosphere in the immediate vicinity of the spacecraft.

Because of the uncertainty of the effects of the long antennas, most of the direct-measurement experiments are placed in DME-A. One type of experiment however, the Langmuir probe, is carried on both satellites to assist in resolving this doubt.

The Direct Measurements Explorer (DME-A) spacecraft is an octagon weighing 215 pounds. It measures 30 inches across the top and is 25 inches high. A spherical ion mass spectrometer protrudes 21 inches above the top surface, making the total height 46 inches.

The spacecraft consists of two parts: an inner assembly where electronic components and other instrumentation is mounted; and an outer shell on which solar cells, a single-element antenna, and sensors are located.

Solar cells cover about 15 per cent of the spacecraft's surface. The glass-covered n-on-p solar cells charge nickel-cadmium batteries.

The eight experiments, the transmitter and some of the telemetry will receive power from a main converter. The command system has separate converters, one powered from the solar cell charge nickel-cadmium batteries.

The eight experiments, the transmitter and some of the telemetry will receive power from a main converter. The command system has separate converters, one powered from the solar cell array for use when the satellite is in the sunlight, the other from the battery for use when in the dark.

All data acquisition is in real time and on command only. About two hours of data transmission each day are anticipated. Program timers automatically shut off a transmission 8.3 minutes after a command is executed.

The primary telemetry system is pulse code modulated (PCM), however, there is an alternate pulse amplitude modulation-frequency modulated (PAM/FM) mode of operation for acquiring housekeeping data only.

There is also a capability for operating experiments in two different modes, one with all experiments working simultaneously, the other with certain experiments in operation sequentially.

The telemetry transmitter, while transmitting data, will normally be used for tracking.

Primarily, the DME-A will measure, directly, density of ions and electrons encountered during its orbit, and their temperatures, composition of ions, and corpuscular radiation. These data will lead to a better knowledge of the physical causes of the phenomena being examined by Alouette II, nearby in a nearly identical orbit.

Another objective is to analyze sheath perturbations which may affect direct measurement experiments because of the long antenna on Alouette. Both satellites carry identical electrostatic (Longmuir) probe experiments for comparative purposes when the satellites are in close proximity.

DME-A's experiments are:

Thermal Ion Experiment, by J. L. Donley of the Goddard Space Flight Center. This experiment is to determine the number, density, mass and temperature of positive ions having thermal energies.

Thermal Electron, by J. L. Donley of the Goddard Space Flight Center. This experiment is to measure the number, density and temperature of electrons having thermal energies. It will also measure the spacecraft potential.

Electrostatic (Longmuir) Probe, by L. H. Brace of Goddard, to measure electron temperature and density.

Electron Temperature, by A. P. Willmore, University College, London, to determine the energy distribution function of ionospheric electrons.

Spherical Ion Mass Spectrometer Experiment, by A. P. Willmore, University College, London, to determine the distribution function of positive ions.

High-Resolution Magnetic Ion Mass Spectrometer, by J. H. Hoffman, U.S. Naval Research Laboratory, to measure the abundance of positive ions in the mass spectrum from 1 to 20 AMU.

Energetic Electron Current Monitor, by J. L. Donley, Goddard, to measure the total flux of electrons in the range 10^7 to $10^{10}/cm^2$ sec with energy discrimination up to 5000 ev.

Energetic Electron Current Monitor, by E. J. R. Maier, Goddard, to measure the total flux of electrons in the range 10^2 to $10^7/cm^2$ sec with energy discrimination up to 2000 ev.

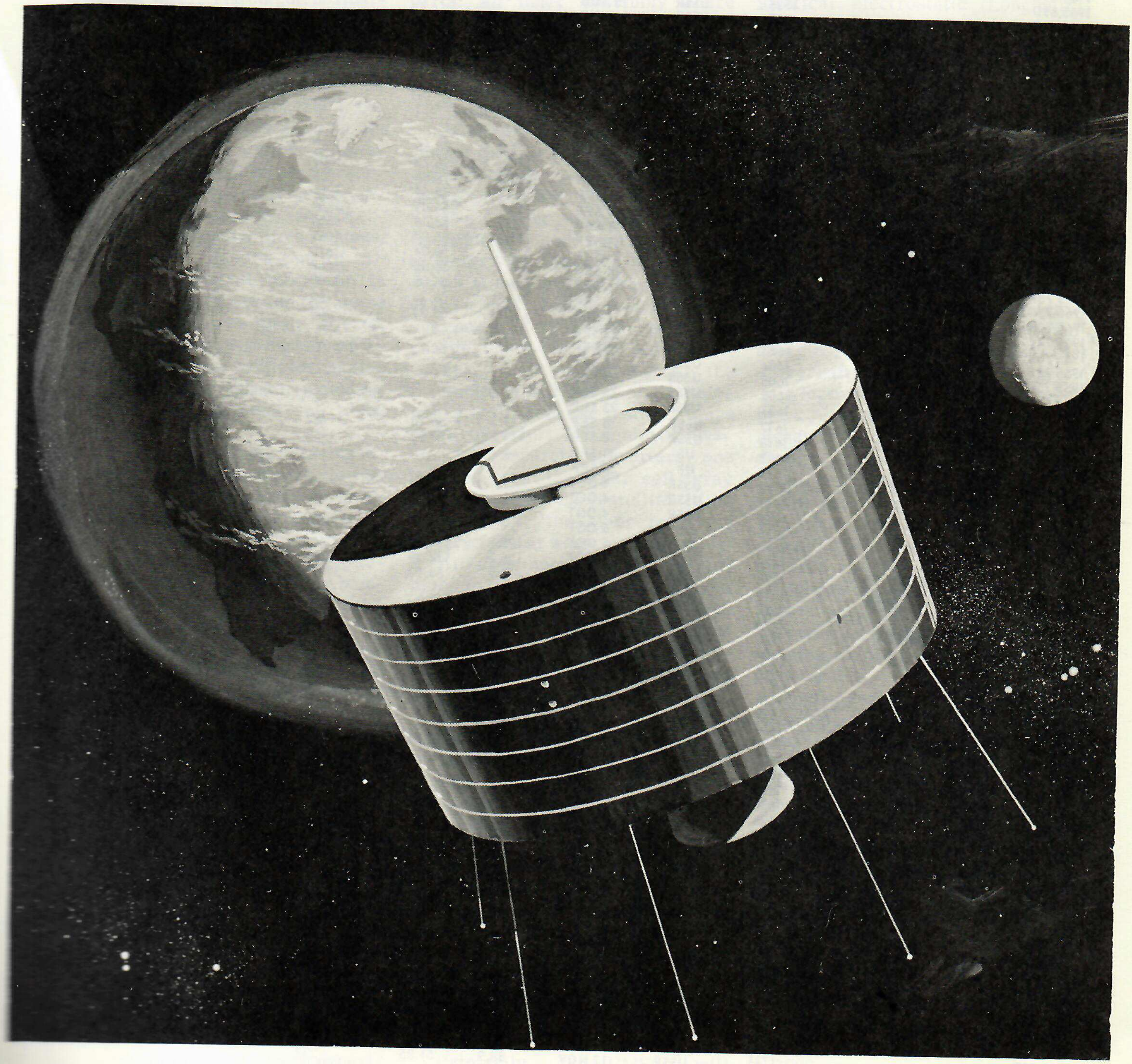
SATELLITE REPORT

OBJECTS ORBITED SINCE AUGUST 15, 1965

1965 67A		1513	US	17 AUG	90.3	70.04	389	179	
1965 68A	GT-5	1516	US	21 AUG	- - -	- - -	- - -	- - -	29 AUG 65
1965 68C		1518	US	21 AUG	- - -	- - -	- - -	- - -	27 AUG 65
1965 68D		1519	US	21 AUG	- - -	- - -	- - -	- - -	26 AUG 65
1965 69A	COSMOS 79	1523	USSR	25 AUG	89.7	64.93	337	187	
1965 69C		1525	USSR	25 AUG	- - -	- - -	- - -	- - -	26 AUG 65
1965 69D		1526	USSR	25 AUG	- - -	- - -	- - -	- - -	31 AUG 65
1965 69E		1527	USSR	25 AUG	- - -	- - -	- - -	- - -	31 AUG 65
1965 70A	COSMOS 80	1570	USSR	3 SEP	115.0	56.06	1552	1356	
1965 70B	COSMOS 81	1571	USSR	3 SEP	115.3	56.07	1556	1385	
1965 70C	COSMOS 82	1572	USSR	3 SEP	115.7	56.06	1563	1410	
1965 70D	COSMOS 83	1573	USSR	3 SEP	116.1	56.05	1569	1438	
1965 70E	COSMOS 84	1574	USSR	3 SEP	116.4	56.07	1576	1465	
1965 70F		1575	USSR	3 SEP	114.6	56.12	1512	1362	
1965 71A	COSMOS 85	1578	USSR	9 SEP	- - -	- - -	- - -	- - -	17 SEP 65
1965 71B		1579	USSR	9 SEP	- - -	- - -	- - -	- - -	18 SEP 65
1965 72A		1580	US	10 SEP	101.9	98.66	1050	654	
1965 72B		1581	US	10 SEP	101.6	98.72	1009	664	
1965 72C		1582	US	10 SEP	102.0	98.66	1055	652	
1965 72D		1583	US	10 SEP	101.9	98.65	1051	654	
1965 73A	COSMOS 86	1584	USSR	18 SEP	115.1	56.05	1639	1277	
1965 73B	COSMOS 87	1585	USSR	18 SEP	115.5	56.06	1650	1304	
1965 73C	COSMOS 88	1586	USSR	18 SEP	115.8	56.07	1661	1326	
1965 73D	COSMOS 89	1587	USSR	18 SEP	116.3	56.04	1673	1352	
1965 73E	COSMOS 90	1588	USSR	18 SEP	116.7	56.05	1688	1374	
1965 73F		1589	USSR	18 SEP	116.8	56.06	1700	1374	
1965 73G		1590	USSR	18 SEP	116.8	56.04	1716	1354	
1965 73H		1591	USSR	18 SEP	115.8	56.03	1664	1324	
1965 74A		1602	US	22 SEP	- - -	- - -	- - -	- - -	11 OCT 65
1965 75A	COSMOS 91	1603	USSR	23 SEP	- - -	- - -	- - -	- - -	1 OCT 65
1965 75B		1604	USSR	23 SEP	- - -	- - -	- - -	- - -	4 OCT 65
1965 75C		1605	USSR	23 SEP	- - -	- - -	- - -	- - -	29 SEP 65
1965 75D		1606	USSR	23 SEP	- - -	- - -	- - -	- - -	29 SEP 65
1965 75E		1607	USSR	23 SEP	- - -	- - -	- - -	- - -	29 SEP 65
1965 73J		1617	USSR	18 SEP	117.5	56.15	1754	1385	
1965 73K		1618	USSR	18 SEP	117.7	56.21	1768	1388	
1965 76A		1609	US	30 SEP	- - -	- - -	- - -	- - -	5 OCT 65
1965 76B		1614	US	30 SEP	- - -	- - -	- - -	- - -	3 OCT 65
1965 77A	LUNA 7	1610	USSR	4 OCT	- - -	- - -	- - -	- - -	7 OCT 65
1965 77B		1611	USSR	4 OCT	- - -	- - -	- - -	- - -	4 OCT 65
1965 77C		1612	USSR	4 OCT	- - -	- - -	- - -	- - -	5 OCT 65
1965 79A		1615	US	5 OCT	- - -	- - -	- - -	- - -	29 OCT 65
1965 78A		1613	US	5 OCT	125.7	144.30	3452	414	
1965 78B		1616	US	5 OCT	125.7	144.29	3451	411	
1965 80A	MOLNIYA II	1621	USSR	13 OCT	718.9	64.93	39951	462	
1965 80B		1619	USSR	13 OCT	- - -	- - -	- - -	- - -	8 NOV 65
1965 80C		1622	USSR	13 OCT	- - -	- - -	- - -	- - -	22 OCT 65
1965 80D		1623	USSR	13 OCT	90.1	64.82	278	185	
1965 81A	OGO 2	1620	US	14 OCT	104.4	87.35	1516	418	
1965 81B		1625	US	14 OCT	104.3	87.36	1510	417	
1965 82A		1624	US	15 OCT	100.0	32.29	786	727	
1965 82B-82CG			US	15 OCT					
1965 83A	COSMOS 92	1626	USSR	16 OCT	- - -	- - -	- - -	- - -	24 OCT 65
1965 83B		1627	USSR	16 OCT	- - -	- - -	- - -	- - -	29 OCT 65
1965 83C		1628	USSR	16 OCT	- - -	- - -	- - -	- - -	25 OCT 65
1965 84A	COSMOS 93	1629	USSR	19 OCT	91.5	48.36	450	206	
1965 84B		1630	USSR	19 OCT	90.5	48.35	295	209	
1965 84C		1631	USSR	19 OCT	- - -	- - -	- - -	- - -	25 OCT 65
1965 84D		1632	USSR	19 OCT	- - -	- - -	- - -	- - -	26 OCT 65
1965 85A	COSMOS 94	1636	USSR	28 OCT	- - -	- - -	- - -	- - -	5 NOV 65
1965 85B		1638	USSR	28 OCT	- - -	- - -	- - -	- - -	3 NOV 65
1965 86A		1637	US	28 OCT	90.1	74.97	377	172	
1965 86B		1639	US	28 OCT	- - -	- - -	- - -	- - -	1 NOV 65
1965 87A	PROTON 2	1701	USSR	2 NOV	92.5	63.45	593	185	
1965 87B		1702	USSR	2 NOV	92.5	63.46	58 9	183	
1965 87C		1703	USSR	2 NOV	91.0	63.45	369	176	
1965 87D		1704	USSR	2 NOV	- - -	- - -	- - -	- - -	8 NOV 65
1965 87E		1705	USSR	2 NOV	- - -	- - -	- - -	- - -	8 NOV 65
1965 88A	COSMOS 95	1706	USSR	4 NOV	91.7	48.40	494	211	
1965 88B		1707	USSR	4 NOV	91.4	48.41	430	212	
1965 88C		1708	USSR	4 NOV	- - -	- - -	- - -	- - -	11 NOV 65
1965 89A	EXPLORER 29	1726	US	6 NOV	120.3	59.36	2276	1115	
1965 89B		1729	US	6 NOV	120.3	59.37	2277	1113	
1965 90A		1727	US	8 NOV	- - -	- - -	- - -	- - -	11 NOV 65
1965 90B		1728	US	8 NOV	- - -	- - -	- - -	- - -	9 NOV 65
1965 91A	VENERA 2	1730	USSR	12 NOV	HELIOCENTRIC ORBIT				
1965 91B		1731	USSR	12 NOV	88.9	51.85	233	214	

NEW SATELLITES

To Provide Pacific Communications, Apollo Voice-Link



Plans for a two-ocean system of commercial communications satellites to link two-thirds of the world by television and telephone and to aid in America's attempt of land men on the moon moved ahead today when the Communications Satellite Corporation (Comsat) awarded Hughes Aircraft Company an $11.7 million contract to build four new satellites.

The satellites' function is to provide satellite communications for the first time in the Pacific area and provide instant voice contact between the Apollo moon astronauts, the Space Flight Center at Houston, Tex., and the various ground stations linked to the center during Apollo's earth-orbiting phase.

John H. Richardson, Hughes senior vice president and aerospace group executive, said the new satellites will have three times the transmitter power of Early Bird, the world's first commercial communications satellite, and will be twice its size (56 inches in diameter and 26 inches high).

Early Bird, which also was built for Comsat by Hughes, was launched from Cape Kennedy last April and has been in commercial operation between the United States and Europe since June. Among notable news events televised through Early Bird to Europe were the U.S. visit of Pope Paul and the launching of Gemini V with astronauts Gordon Cooper and Charles Conrad.

The new satellites, unlike Early Bird whose squinted antenna concentrated its beam between western Europe and the U.S., will have broader antenna coverage over a wider global area and will be able to carry multiple conversations among several ground stations simultaneously, engineers said.

Launch of the new satellite is scheduled for late next summer, when the spacecraft are sent, separately, into synchronous equatorial orbits 22,300 miles above the Atlantic and Pacific Oceans.

The Atlantic satellite will be placed in space above the Ivory Coast of western Africa and the Pacific satellite will be positioned near the International Dateline in the Pacific.

NEW SPACE VOICE - Artist's sketch depicts the new communications satellite being built for the Communications Satellite Corporation by Hughes Aircraft Company to provide the first commercial trans-Pacific communications by satellite and for use in the Apollo manned lunar program.

The global coverage of the satellites is expected to enable instant voice contact with the Apollo moon astronauts to be made directly from ground terminals in contact with the orbiting spacemen. These reports will be flashed directly to the National Aeronautics and Space Administration control center in Houston, Texas.

Satellite communications with the astronauts will be continuous via ships and ground stations deployed around the world.

An advanced satellite antenna design developed by Hughes will permit direct contact with several ground stations simultaneously and provide for greater commercial use without any degradation of loss of power in the transmitted signals, officials said.

The new Comsat satellite is a spin-stabilized synchronous communications satellite larger and heavier and with greater communications capacity than its predecessor, Early Bird, which was designed and built for the Communications Satellite Corporation by Hughes Aircraft Company.

The satellite will be 56 inches in diameter and 26 1/2 inches in height, exclusive of antennas and apogee motor nozzle. It will provide communication capability which will consist of multiple-access high-quality voice and digital data, television, or a combination of both.

Spacecraft design is based on the Early Bird communications satellite which was successfully launched by the Communications Satellite Corporation April 6, 1965, and is now in commercial operation between the United States and Western Europe.

Weight of the new spacecraft will be 345 pounds at launch. The outer surface of the satellite will be covered with 12,756 N-on-P silicon solar cells which will deliver 100 watts electrical power under normal operating conditions.

The additional power is used to add increased effective radiated power to provide greater geographical coverage. The additional weight is used in providing the additional electrical power and a long life control system.

The spacecraft structure consists basically of a central-stiffened tube which directly supports the apogee motor and communications antennas. An aft radial bulkhead and rib assembly will support the majority of the payload electronics while a forward bulkhead will provide support for lateral and radial loads.

Both ends of the structure are closed by thermal shields and the shield at the antenna end also serves as the antenna ground plane.

Four traveling-wave transmitter tubes are provided which may be used in any combination consistent with the available power. The normal communications mode of operation throughout the satellite lifetime will be three tubes in operation, even during the eclipse period.

With the increased weight of the satellite, 160 pounds in orbit, as compared to the 85-pound Early Bird, the hydrogen peroxide fuel supply has been doubled.

The communications basic system is comprised of two redundant linear repeaters with 125 mc bandwidth and 6 db noise figure and four 6-watt traveling-wave tubes of which 1, 2, 3 or 4 may be turned on in parallel. The transmitting antenna is similar to that on Early Bird except that it has a broader beam and is fixed and not folding. This reduces line losses and is a simpler, more reliable system.

The telemetry subsystem is also similar to that of Early Bird and consists of two encoders, the VHF transmitters, and eight whip antennas. The encoders modulate both the VHF transmitters and the 4 gc beacon signals. As in Early Bird, both VHF transmitters can be commanded on or off, whereas the beacons are always on and modulated with telemetry signals.

Telemetry will be transmitted by both 1.8 watt 136 mc transmitters.

The satellite will be launched into orbit by the improved Delta rocket to be built by Douglas Aircraft Company. The spacecraft's self-contained propulsion system (the Aerojet General Pathfinder apogee motor) supplies the velocity boost to inject the satellite into synchronous altitude. The apogee motor will impart a velocity of 6050 fps to the 345-pound spacecraft for injection into the synchronous orbit.

RUSSIAN REPORT

By Novosti Press Agency

SIGNAL ACHIEVEMENT FOR SOVIET SCIENCE

(Space World Exclusive)

NEW DATA ON MOON'S REVERSE SIDE

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Nearly eight years have gone by since the USSR started the break-through into outer space by orbiting the first man-made earth satellite, Sputnik. Today numerous sputniks are spinning in orbit around the earth, reporting back valuable scientific information. Meanwhile space probes are penetrating deeper into the solar system to yield fresh data on its structure. We have witnessed the breath-taking advance of cosmonautics, from Y. A. Gagarin's first space flight to the man's first emergence from the capsule into outer space as such a feat accomplished, when the Voskhod-2 crew of P. I. Belayev and A. A. Leonov went up.

A milestone on the trek to other planets was the first Moon shot, effected in 1959 by a Soviet space rocket which deposited the pennants with the Soviet coat of arms on our natural satellite and which gave us new essential scientific information about the Moon. Subsequently more terrestrial vehicles reached its surface. There is no question that in the next few years space probes will enable us to enravel more of its secrets.

What can the intrepid explorers of the future expect there, on this strange celestial object? What can we anticipate meeting in the unexplored world of the Moon?

Much information about it has been gleaned at earthborne observatories. As telescopes and instruments improved, more and more diverse information was obtained with their help, despite the obstacles of 400,000 kilometres separating us from the Moon could not prevent us from taking a measurement of its surface temperature. We learned that at lunar noon the equatorial temperature swings up to between 110 and 120 degrees C above zero while during the lunar night, it drops to between 150 and 160 degrees C below zero. Craters were discovered to have beds warmer than the surrounding surface, albedo peculiarities were investigated, etc.

For centuries particular heed was paid to the topography of the Moon's surface, with hundreds of thousands of details being discovered through visual and photographic observation. The most characteristic formations are the annular mountains, craters and vast dark depressions traditionally termed seas, though they are long known to have no water. In contrast to the "seas", the light mountainous regions have come to be known as "continents." To date we have detailed large-scale charts of that side of the Moon which is visible to us here on earth. On good photographs taken today from the earth, one will be able to distinguish objects with angual dimensions of not less than 0.4-0.6 angular seconds. For details located in the centre of the visible disc this corresponds on lunar surface to dimensions of between 700 and 1,000 metres and in other parts to dimensions of several kilometres.

The theoretical resolving capacity of modern telescopes with a five-metre mirror could enable us to photograph details but a fraction of this size if not for the untranquil character of the earth's atmosphere. High altitude astronomical observatories have the advantage of raising their telescopes above the denser, dustier and more disturbed atmospheric strata. Though this somewhat improves transparency it does not always result in a very "quiet" image. For that reason photographic observations need to be supplemented by visual observation.

In contrast to the photographic plate, the human eye is able to select the few short-lived intervals when the atmosphere is "quiet" and remember distinct images appearing during these intervals of at least a few details. However, attention is concentrated on good images, "forgetting" the blurred ones. Meanwhile the photographic plate "remembers" both the distinct and blurred images. As a result the overall image is less distinct. For that reason when compiling lunar charts both photographic and visual observations are employed, even though far much more time is spent on the latter.

Space flights have enabled us to switch to a new phase in lunar investigation.

The automatic Luna-3 moon station sent up in October 1959 enabled us for the first time to obtain information as to the structure of that side of the Moon which is invisible to us here on earth.

In 1964 and 1965 the photographs obtained by means of US Ranger vehicles of sectors of the visible side of the Moon had a far greater resolving capacity than it would have been capable of achieving here down on the earth.

However, we still know very little about the physical properties of the Moon's surface as, for example, the structure, hardness, and chemical composition of lunar soil. This, however, is all of tremendous importance for cosmogonic theories and future flights to the Moon.

The application of radio astronomical methods has enabled us to obtain more important information about the Moon. Thus, these measurements warrant the assumption that at more than one metre down beneath the Moon's surface the diurnal and nocturnal temperature remains constant. It has also been discovered that the fluctuation in the thermal emission of the outer layers does not coincide phasally with the emission of the subsurface layers. We have also been able, in addition, to ascertain the mean density of lunar matter, and obtain data on its electromagnetic properties as well as other valuable information.

Whereas optical and radio astronomical methods of research produced diverse information of the visible side of the Moon, the peculiarities of its hidden side remained absolutely unknown. Scientists were compelled to be content with purely speculative hypotheses.

A number of astronomers, for instance, advanced the supposition of different reliefs on both sides of the Moon caused by the difference in their temperature regimes. During lunar eclipses a sharp short change in the temperature takes place only on the side of the Moon turned towards us. The surface of the hidden side, however, is not subjected to such sharp overfalls of temperature. This effect, taking place in the course of many centuries, it would seem, should have led to a difference in the relief. But is this the case?

This, as well as many other hypotheses could have been checked only by studying the hidden side of the Moon. The task was to make a global study of our satellite for which it was necessary to receive information concerning almost 20 million square kilometres inaccessible to researchers conducting observations from the Earth. In our days the opportunity appeared for realising this task, that of sending to the Moon an automatic interplanetary station which would photograph the hidden side of the Moon and using radio television means to transmit the received pictures to Earth. This gigantic experiment required that enormous difficulties be overcome. Exceptionally intricate demands were placed not only on the station's apparatuses but also on the trajectory of its flight and the capacity of its booster.

The beginning was made in the Soviet Union on October 7, 1959 when the Lunik-3 photographed the hidden side of the Moon and transmitted the photos to Earth. The program was drawn up in such a way that the photographs also included the eastern marginal zone seen from the Earth. At the same time part of the hidden side of the Moon remained unphotographed. The identification of some 100 details with known coordinates in the eastern marginal zone on the photographs transmitted from outer space made all the 500 objects revealed on the hidden side correspond to a single (with the visible side) selenographic system of coordinates. Besides this the identified formations on the marginal zone served as specimens for deciphering new details.

For the first time in history TV pictures of another celestial body were transmitted from outer space to Earth. The results of their study have been published in the "Atlas of the Hidden Side of the Moon," put out by the USSR Academy of Sciences as well as in other publications.

On the basis of the first map of the hidden side of the Moon and other materials of the Atlas, the first globe of the Moon was made showing its hidden side. Translations of the Atlas and the globe have been published in Poland, Britain, the United States, France and in other countries.

Photographs of the hidden side of the Moon were not made for over six years.

On July 18, 1965 the Zond-3 automatic space station was launched with the aim of studying the physics of distant outer space, for the adjustment and testing of diverse onboard systems. In particular, the equipment on board the station for photographing planets and for sending the pictures back over great distances of hundreds of millions of kilometres.

After taking off from the artificial Earth satellite orbit, the Zond-3 station flying at a speed exceeding the second cosmic speed to its heliocentric orbit, within 33 hours after this take off, passed near the Moon. The photo-television equipment on board was used for taking pictures of those areas of the Moon which have up till now remained unknown. The photo television complex provides for the repeated transmission of each picture with its definition of 1,100 lines (it should be recalled ordinary television has a definition of 625 lines) and with a sharpness equal to 860 elements per line.

As the TV apparatus is designed for transmitting pictures over great distances of an order of hundreds of millions of kilometres, the transmission of one picture takes 34 minutes.

The transmission of the photographs of the Moon has been effected in the centimeter range of radio-waves with the help of the built-in narrow directivity parabolic antenna. During the periods of communication this antenna is directed to the Earth with high accuracy by means of the orientation system. The regime of the transmission of the photographs is determined by the commands from the Earth.

The period of photographing lasted 1 hour 08 minutes. The photographing began from the distance of 11,600 km from the surface of the Moon and ended after the passage of the minimum distance (under 10,000 km). During the period of photographing the attitude of the Zond-3 station in relation to the Moon changed by 60 degrees in longitude and by 12 degrees in latitude.

The transmission of the obtained photographs to the Earth began on July 29 from the distance of 2,200,000 km from the Earth when the angle of vision of the Earth from the station became small enough for the accurate direction of the station's antenna. In future such transmissions will be repeated from considerably longer distances.

The trajectory in relation to the Moon has been chosen in such a way as to place the areas of the reverse side of the Moon of major interest to scientists within the field of vision of photo-television cameras when orienting them.

The selection of the distance of the cosmic station to the surface of the Moon is optimal since, on the one hand, there was a possibility to photograph a considerable part of the Moon's surface and on the other, to obtain photographs of sufficiently large scale. As the station proceeded on its way there appeared areas of the reverse side of the Moon not photographed in 1959. The area of the photographing spread as far as up to the boundary of the illuminated part of the Moon. The morning terminator, the boundary between the illuminated and the dark parts of the Moon, was situated by the day of photographing -- July 20, 1965 -- close to the boundary of the reverse side area photographed earlier. Thus the newly obtained photographs practically cover the previously unknown part of the Moon's surface. Some photographs have overlapped the areas of the part seen from the Earth and others - - overlap the areas of the reverse side photographed in 1959.

During the photographing the Sun was at the zenith above the North boundary of the crater sea called Riccioli. Thus the known areas of the visible part of the Moon were in less advantageous light conditions. They were necessary only for identifying the photographs. The majority of the objects on the previously unknown part of the reverse side of the Moon were illuminated by the oblique rays of the Sun which emphasize more clearly the details of the relief.

The Zond-3 station has photographed the so-called Orientalis Sea - - the most characteristic formation at the Eastern side of the invisible hemisphere. Like many other lunar seas it is oval-shaped and to a considerable extent is bordered by two ranges of mountain ridges of the Cordilleras and Rocca between which lie the dark patches of the Autumn and Spring seas. Only a small part of the Orientalis Sea with its gulfs - - Big Rhomb and Small Rhomb - - can be observed from the Earth. Now it has become known that the Sea of Spring spreads beyond the boundary of the visible part of the Moon in the North and that the Orientalis Sea is bordered by mountain ridges from all sides.

South of Mare Orientalis are two earlier unknown small seas separated by a mountain range.

What draws attention is the similarity between the areas of Mare Orientalis and that of Mare Crisium which is opposite it on the visible side of the Moon. Both oval seas are surrounded by similar mountain ranges according to structure and situation among which are small ribbon-shaped seas: the Undarum, Spumans and Serpens around the Mare Crisium and the four above-mentioned seas around the Mare Orientalis. Very bright continental regions adjoin both one and the other sea.

With information on the surface of both hemispheres of the Moon it is possible to receive a picture of the distribution of black "seas" and bright "continents" of our satellite. Whereas the northern half of the Moon's hemisphere which is turned to the Earth is mainly occupied by seas, the northern part of the hidden side of the Moon is occupied by a gigantic continent. This continent considerably exceeds its antipode - the southern continent of the visible hemisphere. Incidentally, on the continental expanses of the side invisible from the Earth there are vast depressions, greatly damaged by super-imposed craters resembling the Delandr region on the visible side. The above mentioned formations, with diameters ranging from 200 to 500 km, are comparable in size to seas, but do not have the dark colour characteristic for the latter and also differ in structure.

A view of the reverse side of the Moon strikes one with the abundance of super-imposed craters. The total number of craters on the hidden side can be characterised by the following figures. On a territory of about five million square kilometres covered by only one of the pictures there are four craters with diameters of more than 200 kilometres, some 20 craters with diameters of 100 to 200 kilometres, 60 craters - - from 50 to 100 km, 100 craters - - from 20 to 50 and more than 400 craters with diameters from 10 to 20 km. The photographs show well numerous typical lunar craters with central peaks as well as craters with bright rays.

The most interesting of the newly discovered formations which are not found on the lunar hemisphere visible from the Earth are numerous chains of small craters extending for hundreds of kilometres and branching off, apparently, from the light continental area near the Mare Orientalis as well as the earlier mentioned huge sea-like formations on the continent (thalassoids).

After a thorough study of the 1959 photographs, conclusions were drawn concerning the asymmetry of the Moon in relation to the plane separating it on a visible and hidden parts: there are relatively few seas on the hidden part and, on the whole, it is more bright and mountainous. Incidentally, a similar asymmetry is observed on the Earth. The Pacific Ocean, with its deepest parts being depressed to more than 10 km and its average depth being more than four kilometres, accounts for 50 per cent of the Earth's water surface and is situated almost entirely in the Western hemisphere. The density of craters on the hidden side of the Moon also proved to be higher, etc. These conclusions are fully confirmed by the photographs taken by the Zond-3 station.

At present the new photographs of the hidden side of the Moon are being studied thoroughly and a preliminary catalogue of formations is being drawn up.

The materials of the experiment conducted by Zond-3 in photographing the Moon are of great scientific importance. The hidden side of the Moon has ceased to be a riddle.

COMETS AND LIFE

By NISON ROZENBLYUM
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Soviet scientist Academician Vasily Fesenkov has come to the conclusion that comets may have played a big role in origin of life on planets.

Recently, detailed studies have been made of conditions under which non-living matter gives rise to globules of the simplest living matter. Life must inevitably arise in favourable conditions. On Earth these conditions were available some 2,000 million years ago. An intensive stream of energy that was penetrating the Earth's atmosphere was saturated with carbon compounds, while the expanses of water provided a solvent, and the young Earth's crust metal compounds.

Scientists in detail traced, theoretically, the entire process of life emergence from non-living nature. In reproducing these conditions in a laboratory, the American scientist Stanley Miller managed to obtain, artificially, amino acids and some other constituent parts of living protein. These experiments were recently repeated with success in other countries, and also by Soviet scientists Tatyana Pavlova and Anatoly Pasynsky. Investigations of the likely chemical composition of the Earth in the past have disclosed that all the ncessary substances were available in sufficient quantities. All but carbon and its compounds. They were lacking.

Yet carbon is a wide-spread element in the Universe. It is present in sufficient amounts in some of the stars, and in the form of simplest compounds in interstellar space. Recent studies have revealed that some dust clouds of interstellar substance consist almost entirely of pure carbon.

It is difficult to imagine, however, that this carbon and its compounds could find way to the Earth. In that respect "comets" might prove handy. After all, they consist to a considerable extent of carbon and its simplest compounds - hydrocarbons, carbon dioxide, cyanogen. The "supply" of comets in the internal parts of the solar system is constantly replenished from its fringes where in the opinion of the Dutch scientist Oort a giant "reservoir" of cometary substance exists. The orbits of comets are so varied that their collisions with the Earth in 1861, 1882, and 1910. True, these collisions involved only the giant, but highly thin "tails" of the comets. This process could not evidently supply the planets with sufficient quantities of carbon compounds.

Although comet tails are enormous, and their dense cores relatively small, the probability of cometary cores colliding with the Earth is still not nil. According to the estimates of the American scientist Harold Urey, the Earth could collide with cometary cores once in several million years. It means that during 2,000 to 3,000 million years of the existence of the yet "lifeless" Earth this could happen several hundred times, and the Earth could get tremendous amounts of cometary substance.

Theory was confirmed by practice - - by the study of the so-called Tunguska body, which collided with the Earth on the morning of June 30, 1908. The detailed examination of the results of this collision and microscopic traces of the Tunguska body, conducted under the general direction of Academician Vasily Fesenkov, showed that this body was the core of a small comet. The Tunguska comet bumped into our planet sideways. The core of the comet experienced a thermal explosion in the air, and its substance, after being converted from solid state directly into gaseous, was scattered in the Earth's atmosphere. Refractory particles incorporated in the core settled on the planet's surface.

The Tunguska disaster is a typical example of how the Earth (and indeed all the other planets) could be enriched with carbon and its compounds due to collisions with comets.

MYSTERY PLANET

By PROF. N. SYTINSKAYA, D.Sc. (Phys. Math.)

More than 350 years have elapsed since the day when Galileo Galilei pointed his world's first and still very imperfect telescope at Venus and saw that it was nothing like a shining star but a spherical body illuminated and heated by the Sun.

Watching the passage of Venus before the sun disk, Mikhail Lomonosov, the great Russian scientist, made a very important scientific discovery: the planet of Venus is surrounded by an atmosphere. This discovery was later confirmed by many scientists in many countries. It also explained the homogeneous nature of Venus' aspect. The fact is that the planet's sky is overcast everywhere by a mist and there is misty weather prevailing everywhere on Venus, so through the telescope we can only see an endless white overcast of clouds.

Since there is an atmosphere on the planet it is necessary to determine its chemical composition. It was not before 1932 that scientists established that the atmosphere of Venus is rich in carbon dioxide which, according to some estimates, makes up up to 20 per cent of the total volume of the gaseous envelope. In the atmosphere of Venus there is at least 5 times as much carbon dioxide as in the terrestrial atmosphere, and according to some other data even 50 times as much.

Nevertheless making up the basic part of that atmosphere is some other gas whose nature has so far not been determined authentically. There are serious reasons to assume that it is nitrogen. Prof. V.K. Prokofiev, using the powerful spectral equipment of the Crimean astrophysical observatory, discovered the presence of a very small quantity of oxygen in the atmosphere of Venus. The study of the spectrum of Venus made from a high-altitude balloon and at alpine observatories shows that there are also water fumes in the planet's atmosphere, and these are also present in negligible quantities. However, in assessing such results one should always remember that when we watch Venus from the Earth we see only the transparent section of the atmosphere lying over the overcast, whereas the atmosphere sections below the overcast remain inaccessible to investigation.

One of the most important points in studying every planet is to determine what temperature it has. To answer this question it is usually necessary to measure the beams of the heat (infrared) rays emitted by different sections of the celestial body. The higher the temperature of a given section of the surface, the more powerful the emissions. The temperature proved to be the same both for the illuminated side of Venus and for its shade side. Moreover, it was very low - - about 40 degrees below zero. There is certainly nothing surprising in this, for the overcast covering Venus bars the penetration of not only visible but also of infrared rays. That is why the temperature determined by the method described is that of the upper border of the overcast.

There is also another method of determining temperature, and this based on a subtle analysis of the structure of the absorption lines of carbon dioxide. As a result of this method a temperature of 120 degrees above zero (C) was determined. Yet, this too is the temperature of some gas layer.

Quite unexpected results were obtained with the help of radio astronomical methods. It is common knowledge that a heated object emits not only heat waves but also radio waves whose intensity likewise rises with temperature. It was discovered that the beam of radio waves coming from Venus was much stronger than could be expected at a temperature of 40 degrees below zero (C) and even at a temperature of 12 degrees above zero (C). How can this be explained? So far there is no final explanation. Scientists make all kinds of hypotheses, and the most reasonable of these are the following two.

According to the first hypothesis the powerful radio waves are being emitted by the hard surface of the planet. The radio waves easily penetrate through the mist and overcast which are no obstacle for them.

If this hypothesis is true then the surface of the planet should be very hot - something like 300 degrees above zero (C). Such a conclusion is sensational, for if the planet's surface is so hot, then it can have no oceans, lakes or rivers and in general no liquid at all and, consequently, no life. In that case Venus should be like a hot, dry and dead desert.

The second hypothesis boils down to the assertion that the strong radio emissions from Venus have nothing in common with the surface of the planet but are generated in the upper ionised layers of the atmosphere. However, an intensity of radio emission such as the one coming from Venus can be produced, as calculations show, only by an ionosphere in which the density of electrons is something like 1,000 million particles per cu. cm. And that is 1,000 times as much as the average electron density of the ionosphere of the Earth; it is rather hard to explain how an ionosphere of such density could appear.

Which one of these hypotheses is the closest to the truth? To give an answer to this question it is necessary to make more investigations, and the most prospective method in this case is certainly offered by astronautics. It is common knowledge that the first space flight towards Venus was realised by the Soviet Union in 1961. Subsequently similar launchings were made by the United States. For instance, the space research station Mariner-2 launched by the USA in 1962 seems to have confirmed the "hot surface" hypothesis.

There is also an interesting hypothesis about the structure of the atmosphere of Venus. This hypothesis was made by Irish astronomer Epik, who assumes that there are strong winds blowing all the time and hurricanes and storms raging in the layer of the atmosphere close to the planet's surface. This layer is full of thick dust raised from the dry surface of Venus. The strong friction caused by the atmospheric currents is actually the source of the high temperature registered by radio astronomic observations.

Despite the substantial successes in the science about Venus its nature still remains a mystery to us. Let us hope that the flight of the Soviet automatic interplanetary station Venera-2 will help to unravel many mysteries of that planet.

THE MAN IN FREE SPACE

Released Materials On World's First Space Flight With Man's Emergence Into Free Space On Board "Voskhod-2" Spaceship

Materials on the world's first space flight on board the "Voskhod-2" spaceship with man's emergence into outer space have been submitted to the International Astronautical Commission of the International Aeronautical Federation (FAI) for certification as world space flight records.

Valery Lutsky, as APN science correspondent, asked Ivan Borisenko, secretary of the Commission on Astronautics' Sports and Technical Problems, USSR Aeronautical Sports Federation, to answer some questions relating to the record flight of "Voskhod-2" and released materials on in the world's first emergence of man into free space.

Question: What did the space vehicle "Voskhod-2" consist of?

Answer: According to the materials submitted to the FAI, it consisted of a multi-stage carrier rocket and a spaceship satellite. The latter had a cabin with hatches and portholes, accommodating the space crew and equipment; an instrumentation compartment with control and communication facilities; a system securing the cosmonaut's emergence into free space; a brake motor; a reserve brake motor; and a landing system.

Question: What can be said about the motors on board "Voskhod-2"?

Answer: There were 7 liquid motors on board the spaceship with a total thrust of 650,000 kilograms.

Question: What was the payload?

Answer: 5,682 kilograms. The payload was the spaceship satellite with space pilots Pavel Belyaev and Aleksei Leonov in space suits, put into orbit around the Earth. The weight of the last stage of the carrier rocket is, of course, not included in the payload.

Question: What were the range and total duration of the flight?

Answer: The range of the flight with the space crew on board "Voskhod-2" was 717,262.01 kilometers, and total duration - 26 hours 02 minutes 17 seconds.

Question: What was the maximum height of the spaceship's flight?

Answer: 497.7 kilometers, in the first turn. It is worth noting that so far not a single spaceship in the world with a space crew on board has ever soared to such a height.

Question: How much time did space pilot Aleksei Leonov spend outside the spaceship cabin in outer space?

Answer: 23 minutes 41 seconds. This historic event took place in the flight's second turn on March 18, 1965.

Question: How far did Aleksei Leonov move off from the spaceship?

Answer: In the process of free floating in outer space cosmonaut Aleksei Leonov moved off from the spaceship lock chamber to the full length of the life line, vix. 5 metres 35 centimeters. During the space walk, one end of the life line was attached to the cosmonaut's space suit and the other to the edge of the lock chamber. As is known, during the entire period of free floating in outer space cosmonaut Aleksei Leonov felt fine. Throughout the flight neither of the cosmonauts showed, on the whole, any departure from the norm in the condition of the breathing system, blood circulation, vetibular apparatus or central nervous system.

Question: What main conclusions can be drawn from the world's first emergence of man into free space?

Answer: They were formulated by cosmonaut Aleksei Leonov himself in his report on the flight of "Voskhod-2" spaceship, submitted to the International Astronautical Commission: man's emergence into free space is quite possible and there is nothing mysterious about it any more; a man dressed in space suit with a special autonomous life support system can not merely exist in outer space, but also perform purposive and coordinated operations; in outer space one may engage in physical work and make scientific observations.

Question: Until the flight of "Voskhod-2" and Aleksei Leonov's emergence into free space, the FAI's Code contained no provisions on the certification of space flight records. What has been done in this respect?

Answer: The FAI's International Astronautical Commission has recently adopted the suggestion made by the USSR on the certification of space records related to man's emergence into outer space. A special article has been included in the Code. Thus, the space flight of the "Voskhod-2" spaceship with man's emergence into free space is the FIRST WORLD RECORD in the length of cosmonaut's stay outside the spaceship while dressed in a space suit with an autonomous life support system. The same flight brought another record in the maximum height attained by a manned space vehicle.

The flight of "Voskhod-2" and Soviet space pilot Aleksei Leonov's emergence into free state were followed by the flight of "Gemini-4" spacecraft launched in the USA on June 3, 1965 with spacemen James MacDivitt and Edward White on board. During the flight, on June 4, 1965, spaceman White performed an experiment in emergence into outer space, as had already been done by Alexei Leonov.

The American spacemen are likewise the holders of a space record. But in the FAI's table of world records the name of a Soviet citizen Aleksei Leonov will stand first.

Question: When the world space flight records are going to be certified?

Answer: This must take place in January 1966 at the next meeting of the FAI's International Astronautical Commission.

A HUNDRED AND TWENTY DAYS IN SEALED CHAMBER

From Novosti Press Agency
(Exclusive for Space World)

An experiment with the purpose of studying the conditions of man's prolonged stay in a space which is cut off from the outside world - - in a sealed chamber - - was recently performed in the Soviet Union. There were five men taking part in the experiment which was conducted in the course of 120 days. The results obtained are quite important for future long space flights. Doctor Lev Iseev who participated in the experiment shares his experience during these tests.

Lev Iseev was born in 1935. He is married and has a two-year old daughter. After graduating an institute, he worked as practising surgeon and then went in for research into the physiology of breathing. He has written his thesis for the scientific degree of Dr.of Medicine.

Our experiment did not pursue the aim of studying the effects of "isolation" in the strict sense of the word as, for instance, the later experiment with B. Breen (The USA, 1963) did. One can see that from the fact that there were four more volunteers in the sealed chamber together with me. We had at our disposal a radio and a TV-set, a tape recorder, sound signals, and an arrangement for two-way communication.

The experiment pursued the aim of reproducing some of the conditions which might be in the cabin of a spaceship. There was a variety of problems to solve:

1. To determine man's capacity to stay for a long time in an absolutely sealed space, where he becomes, on the one hand, the main source of pollution and the basic forming element as regards the air medium, and on the other hand, an object of long-term effects of physical factors (noise, vibration, higher temperatures and radiation background) and factors of the psychological order (being divorced from the habitual way of life, existing in monotonous conditions, etc.)

2. To make an all-round study of physiological functions under the above conditions.

3. To test rations of foodstuffs canned by various methods, which may serve as rations for long-term space travel.

4. To study the changes occurring in the functions of the human organism when it returns to usual conditions of life - - "exit reaction."

The programme of the experiment was carried out in full. Convincing answers were obtained to all the questions of practical importance to space medicine, in general, and to the medico-biological support of long-term space flights, in particular.

The participants in the experiment led an active life: they adjusted the research apparatus, engaged in photography and film shooting, performed physiological and hygienic investigations, processed the information obtained and, on the days when they were on duty, took turns in keeping "house": cooking food, tidying the room, etc. Everything that took place in the outside world interested us, we listened every day to the radio and saw TV programmes. We spent our spare time playing chess, chequers and domino, reading fiction, adventure and fantastic stories being a particular success with us.

In general, we had rather strenuous days filled with a variety of activities. The sum total of the work performed in the active period of the day amounted on the average to 180,000 kilogram-metres, which corresponds to the average labour done at mechanised enterprises.

Being kept busy as much as possible throughout the day helped to preserve normal relations among ourselves, in spite of the fact that a higher degree of irritability resulted in misunderstandings arising more frequently than under usual conditions. Did we get tired of each other? Yes, especially towards the end of the experiment, however, not to the extent that we couldn't look at each other any longer. If necessary, the experiment could have been considerably prolonged.

Major importance was attached to the safety of the experiment, in which men living in the specific conditions of a sealed space were the object of investigation. Among those who were tested, there was another doctor in the sealed chamber besides myself. Comprehensive medical and physiological studies did not only yield scientific information, but also served as a means for continuously controlling the state of the men's physiological functions. The experiment could have been interrupted at the request of anyone of its participants in case he felt worse, even if no deviations in the state of his health were objectively recorded. In our experiment, just as in many other 20, 30, and 60 day tests, there was nothing of the sort and none of the participants requested to be released from the experiment. On the contrary, each one of us strove to carry out the testing as successfully as possible.

On the 53th day, one of the men complained of constant pains mainly localised in the right iliac area, which were now and then accompanied by nausea. It was diagnosed as chronic appendicitis. His general state was not dangerous, so we decided that he should go on with the experiment, though we relieved him of all physical work, duty, etc. and created for him the necessary protective conditions, the more so as such a situation might occur in the real conditions of space travel, as well. Twelve days after the symptoms of the disease appeared, the pain stopped and the man resumed his duties again.

In the course of the first month, the participants in the experiment felt well, though their sleep grew somewhat worse - - it became superficial and was frequently interrupted. On the 31st - 35th day there appeared aches and a sense of heaviness in the head, especially in the evening hours. Many complained of unpleasant sensations in the area of the heart and of eye fatigue during reading. By the time 42-45 days elapsed, our state of health was estimated as just satisfactory and no more.

The second half of the experiment was marked by greater fatigability at the close of the day, by a feeling of colic in the eyes, unpleasant sensations in the area of the heart - - stitching pains, palpitation, squeezing pains, all this being confirmed by changes in electrocardiograms. Our sleep, which was quite superficial as it was, grew still more intermittent due to vivid dreams.

The bacterial pollution of the air increased sharply. The microorganism count reached by that time 30,000 in one cubic metre of air. Little abscesses appeared on the skin and there were some unfavourable shifts in the various systems of the organism. That is why at the beginning of the fourth month measures were taken to improve the habitation conditions. The set of sanitation measures included additional purification of air of bacteria and harmful chemical admixtures, ultraviolet irradiation of the skin, more frequent baths, increase of vitamins in the ration, introduction of a special set of physical exercises and some medicines. The air became less polluted. The men under examination started feeling much better and their sleep became normal. There were much fewer complaints of fatigue, of unpleasant sensations in the area of the heart and headaches. Improvements in the various functions of the organism were objectively recorded.

In the 24 hours that followed the unsealing of the chamber, the men's state of health remained satisfactory. They complained mainly of the same sensations which they complained of in the last day of the experiment. The participants in the experiment started feeling better 2-3 days later. In those and the next days, when they had the chance of going outdoors and then started living in home conditions, they began feeling quite well. Thus, the set of sanitation measures carried out during the experiment justified itself fully. It permitted to complete the tests, the long duration of which did not affect their state of health seriously. Moreover, the "exit reaction" became considerably shorter and less prominent.

The state of the men was studied in detail for about three months following the experiment. The studies were stopped only when all physiological systems, which had been observed during the experiment and in the period of investigation, although they sometimes were quite prominent, were not of a pathological nature, because they were not due to organic malfunctions but were of a functional, transient nature. Detailed information on the reactions of the human organism in a sealed chamber are to be found in the report made by Andrei Lebedinski, S. Levinski and Julius Nefedov at the 15th International Astronomical Congress in 1964 and in other papers. The participants in the experiment are to this day under the observation of various specialists, they work, feel well, are quite healthy, and each of them dreams of taking part in space travel. The wives of three participants gave birth to healthy babies. Such tests are evidently necessary on the given stage of the development of astronautics. It is only with their help that we can obtain facts on and understand the mechanisms of physiological reactions, which will help to map measures essential for preserving man's health and capacity to work in conditions of long-term space travel.

MOON FLIGHT SIMULATED

Soviet scientists have reproduced on earth the radiation conditions that cosmonauts may encounter on the way to the Moon.

White mice were used in the tests. A special biological block with observation windows was designed for the experiment. The observations were made with the help of a television camera.

Along with irradiation, the mice were subjected to increasing G-forces.

It was established that preliminary irradiation by small doses, 50-60 roentgen, for example, reduces the biological effects of subsequent irradiation even in big doses.

In the opinion of Soviet scientists, the biological effects of ionising radiation are also reduced by G-forces.

The scientists simulated a solar flare during which the animals received the maximum dose of radiation. Several minutes before it, the mice received injections of a preparation protecting against radiation. After this the "ship" entered the danger zone and "flew" in it for 24 hours, bombarded by lethal radiation. The animals did not die. The preparation had cushioned the effects of penetrating radiation.

It is believed by specialists that in principle it is possible to model any space route, taking account not only of doses of radiation but also of the types of particles.

IN THE NEWS

Akron, Ohio; PAGEOS - A spacecraft that will be used to orbit a satellite designed to determine the relative location of masses on the surface of the earth from 2,650 miles in space is being developed for NASA by Goodyear Aerospace Corporation.

The spacecraft, a 26 1/2-inch hollow sphere made of machined magnesium, will contain a 100-foot-diameter Echo I-type inflatable satellite, which will be boosted to orbital altitude by a two-stage rocket.

Once in orbit, the spacecraft will be ejected from the nose of the rocket. Pyrotechnic devices then will separate the hemispherical halves of the canister, allowing the giant, silvery balloon-satellite to inflate - ready to function as the world's first passive geodetic satellite.

Under the contract awarded to Goodyear Aerospace, the spherical spacecraft will be designed, fabricated and qualified for its mission. Included are canister separation tests in the 60-foot space chamber of the National Aeronautics and Space Administration's Langley Research Center, Hampton, Va. The research center issued the contract to support the worldwide Geodetic Survey.

To be called Pageos, the new, 100-foot-diameter satellite will be used in connection with 36 ground stations around the world, to determine the boundaries of all countries in relation to one another. These measurements will be made to an accuracy not presently available by any other means. It is hoped the survey will provide a 10 to 100-fold improvement, compared with accuracies now obtainable.

As an example, Goodyear Aerospace officials pointed out, the distance between the West Coast of the United States and Japan is now known to an accuracy of only 400 to 500 feet out of a total distance of some 6000 miles. With the use of the Pageos satellite, map-makers hope to pinpoint this distance more accurately.

The satellite is scheduled for launching in the second quarter of 1966. The two-stage rocket that will carry it into orbit will consist of a thrust-augmented Thor missile for the first stage and an Agena "D" rocket for the second, Goodyear Aerospace officials explained. Pageos is expected to remain in orbit for at least five years, the length of time needed to complete the survey.

Photometric techniques developed by Goodyear Aerospace scientists were used in mid-1964 to measure the dimensional stability and solar-light reflecting characteristics of Echo I which was placed in orbit in 1960.

These measurements, company officials said, helped significantly in proving it was possible to use Echo I over long periods of time as a passive, specular, solar-reflecting target for geodetic triangulation.

Through synchronous timing between ground stations and the known geometry of the Pageos satellite, accurate measurements are assured, the company said.

Huntington Beach, Calif.; WALK IN SPACE - Engineers at the Douglas Aircraft Company's Space System Center here will "walk in space" - but on the earth.

This will occur when man-rating of the huge vacuum chamber at the Center is completed.

Clad in space suits, the engineers will pass through a man lock into the 39-foot-diameter chamber, where, in cold temperatures and low pressures equivalent to more than 100 miles above the earth, they will inspect and work on spacecraft undergoing testing.

In other phases of the space research program, they will bask in simulated solar rays projected into the man lock.

With connection of the man lock to the vacuum chamber, the Douglas facility will have the most versatile system in the nation for simulating the environment of outer space and will have an important new tool in its continuing program of space experiments, said J. L. Bromberg, SSC vice president-director.

The 39-foot-diameter vacuum chamber, which became operational in 1963, is used for testing space vehicle and spacecraft components but, when combined with the man lock, will be used to house complete spacecraft for tests simulating long-duration missions through outer space.

The man lock is being developed under a $280,000 contract awarded by the Douglas Missile & Space Systems Division to the Pittsburgh-Des Moines Steel Co. It is scheduled to be ready for qualification testing next Fall.

Consisting of two air locks in tandem - a 13-foot-long primary lock and an 8-foot-long secondary lock - the man lock will be built of stainless steel in the form of a 10-foot-diameter cylinder. A pressure bulkhead will separate the air locks.

An engineer, wearing a space suit and pre-conditioned from breathing pure oxygen, will pass through the secondary lock into the primary lock. After the pressure is lowered there to equal that in the vacuum chamber, he will enter the chamber and go to work.

The procedure is reversed for departure from the chamber, with the pressure being gradually increased while the engineer is in the air locks.

A pressure door, measuring 4 by 7 feet, seals off the secondary lock from the outside. Similar doors separate the two air locks and the primary lock from the vacuum chamber.

In addition to serving as a passageway to the vacuum chamber, the primary lock also will be used as a separate vacuum chamber for testing men and equipment in a space environment. As such it will function independently of the huge vacuum chamber and will accommodate up to 20,000 pounds of equipment.

Each of the air locks will have a pumping system. In the primary lock the pumping system will be capable of reducing the pressure to a level equal to that at 150 miles altitude in eight hours or less.

Mechanical pumps will be used to achieve a simulated altitude of 40 miles in 15 minutes. A diffusion pump system then will take over for the final stages of air removal. The system will automatically maintain any pre-selected pressure.

Versatility of the man lock system is increased by the capability to project a 4-foot-wide solar beam into the primary lock. The beam, having all the characteristics of sunlight, will be used to test the effects of solar rays on materials used in space equipment.

The rays also can be directed onto persons taking part in space experiments in the primary lock.

Source of the solar beam will be a large solar simulator recently developed by Douglas. A 6 1/2-foot-wide opening in the top of the lock will accommodate either the solar simulator or a heavy cover from which up to 5000 pounds of instrumentation and/or test specimens can be suspended.

In case of an emergency in the vacuum chamber, an independent repressurization system will quickly restore normal earth conditions. In 15 seconds the pressure level of 150 miles altitude will be lowered to that at 27,000 feet.

If further reduction is necessary, sea level conditions will be attained in an additional 40 seconds. Pure nitrogen and oxygen gas under high pressure will be used for the first phase of emergency repressurization, with air being used for the final phase.

As a safety precaution while an engineer is in the hugh vacuum chamber, a technician wearing an oxygen face mask stands by in the primary lock, where pressure has been increased to a level equivalent to 27,000 feet altitude, while another man is in the secondary lock.

Houston, Texas; ASTRONAUTS on future space missions may become space gourments through the efforts of food technologists at the Manned Spacecraft Center here and the U.S. Army Natick Laboratories in Massachusetts.

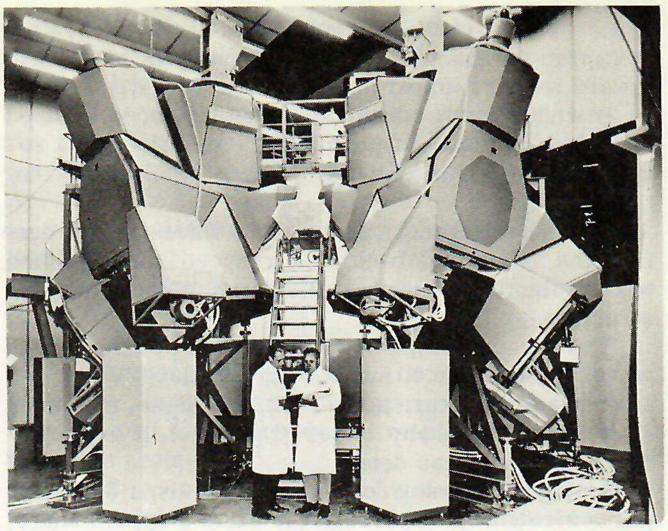
A compressed ice cream is high on the list of items under evaluation . Tablets are prepared like other dehydrated foods now carried by astronauts. Ice cream is frozen and the water content is drawn out. Then the mixture is made into a powder, and compressed into a tablet.

Comments on its flavor by a taste panel at MSC have been favorable. The majority compare it in taste with a malted milk tablet. It comes in two flavors, chocolate and vanilla.

Barbecued meats are also being evaluated for future menus. They include beef and pork barbecue bites and veal with barbecue sauce. The first two are bite-sized, the third is rehydrateable, and water must be added before eating.

Space food experts say that if the new foods prove feasible for spaceflight, they could appear as entrees sometime during the Apollo program.

Other bite-size items considered include bacon, pork sausage, scrapple, lobster, oyster, shrimp, salmon, and fish chowder.



APOLLO MISSION SIMULATOR - The first shipment of equipment for the Apollo Mission Simulator, the primary training system in which astronauts will prepare for their round trips to the moon, left Binghamton, N. Y. recently for NASA's Manned Spacecraft Center in Houston, Texas.

The simulator equipment was produced by General Precision, Inc., Link Group, under contract to North American Aviation Space Division. Equipment for the complete simulator were scheduled to arrive in Houston on December 1 for assembly. Fourteen large moving vans and a C-133 aircraft were used to transport the simulator equipment.

An integral part of the United States space program to land men on the moon, the Apollo Mission Simulator is designed to familiarize crews with the equipment, crew tasks, mission procedures and emergency flight situations. Programmed on three digital computers, the system employs mathematical models for simulation of the Apollo spacecraft and its subsystems during mission phases. Visual systems will present simulated space conditions to the astronauts inside the command module simulator. The simulator stands thirty feet high and weighs approximately forty tons.

A second Apollo Mission Simulator is under construction at Link for use at the Space Flight Center, Cape Kennedy, Florida.

Two other mission simulators are being built by Link for the Lunar Excursion Module (LEM) and will be shipped to Houston and to Cape Kennedy. The LEM will take the astronauts on the final phase of the moon-landing mission, transporting them from the Apollo spacecraft to the Lunar surface and back to the mother-ship for return to earth. Use of both the Link Apollo and LEM simulators will provide complete flight training.

General Precision, Inc. is the principal operation subsidiary of General Precision Equipment Corporation, Tarrytown, New York.

Stanford; WHAT'S THE MOON MADE OF? - Probably of the same stuff as earth and the other planets, says a young Stanford University geophysicist, except that the moon stuff gets hotter, stickier, and lighter toward the center.

"You might compare the moon with a ping-pong ball,'' said 31-year-old Prof. Robert L. Kovach, ''but of course the moon isn't hollow. It just gets less dense toward its core, apparently. And hotter. And gooier.''

His unorthodox conclusion about the moon is based on seismic studies of the earth, he explained at a recent meeting of the School of Earth Sciences Journal Club.

Earthquake-generated seismic waves travel deep into the earth and back. Their speed and direction tell scientists much about the globe's internal structure.

The denser the material, the faster seismic waves travel. Down about 60 miles, where the earth's heat and pressure almost turn solid rock into liquid, the waves slow down. When any material gets hot, it expands - which makes it less dense.

Rising temperatures dominate for about 300 more miles straight down through the earth's upper mantle. Then pressure again becomes dominant and the waves once more begin to travel faster.

''The known internal structure of the earth is the logical starting point for speculations about the terrestrial planets and the moon,'' said Prof. Kovach.

''Until we have direct data, the most reasonable assumption regarding these bodies is that they are similar in composition to the earth.''

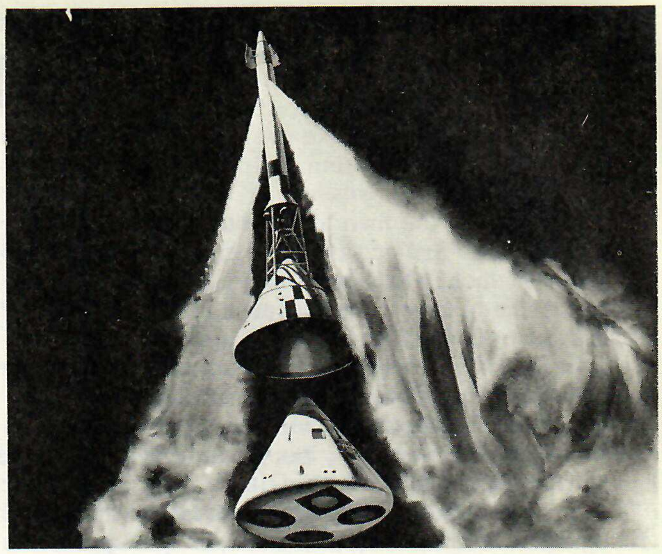
The pressure at the center of the moon is approximately 50,000 atmospheres, or around 7,000,000 pounds per square inch, he said. This corresponds to the pressure at a depth of about 100 miles in the earth's mantle.

At this depth, and in fact on down for another .260 miles to the point where pressure again begins to dominate, the material of the earth becomes less dense because of increasing heat. It is logical to expect the same conditions to prevail in the interior of the moon, says Prof. Kovach.

''The moon probably has an irregular silicate crust, approximately six miles thick in the highlands, and overlying a more basic mantle,'' he said.

What about the loosely packed dust or cottony structure predicted by other scientists for the moon's surface?

''That's only on the surface,'' answered Prof. Kovach. ''At most it should be only about 100 feet deep.''



APOLLO JETTISONS ''COAT'' - Its work done, Apollo spacecraft 002's boost protective cover is pulled free in this North American Space Division drawing of mid-flight phase of abort test. This step is reached after launch escape rocket ''rescues'' command module from a staged malfunction aboard a Little Joe II booster playing role of a Saturn in trouble. Upon abort signal, the Lockheed launch escape motor powers 11,000-pound cargo to safety. Canards, wing-like objects atop the rocket, stabilize the spacecraft heat shield forward. Then, the Thiokol power jettison motor, with twin exhaust nozzles, fires for one second to remove tower and cover. Command module's nose cone is jettisoned and three Northrop parachutes lower spacecraft to earth. Test is to be conducted by NASA's Manned Spacecraft Center at White Sands Missile Range near Las Cruces, N. Mex. Spacecraft principal contractor is North American Aviation's Space Division, Downey, Calif.

San Diego, Calif.; THE CONVAIR DIVISION OF GENERAL DYNAMICS is preparing 12 test tanks that will be tested for two years or more in an experiment to determine if different metals can withstand the corrosive action of storable liquid rocket propellants.

The tanks will be fabricated by General Dynamics under a $55,000 contract with the Air Force Systems Command's Rocket Propulsion Laboratory. The storability experiment will be conducted at Edwards Air Force Base.

Two different oxidizers, both known to be highly corrosive, will be tested against four different metals.

The tanks, 18 inches in diameter and 18 inches long, will contain nitrogen tetroxide and chlorine trifluoride. All will be stored at 85 per cent relative humidity and 85 degrees Fahrenheit.

Six of the tanks will be of different aluminum alloys, three of stainless steel, and three of titanium alloy. The metals to be tested are: aluminum alloy 2014-T6; aluminum alloy 6061-T6; stainless steel AM 350 SCT; and titanium alloy 5AL2.5 Sn.

MOON ''BLINKS'' IN COLOR - A group of amateur astronomers working on a lunar research project for the National Aeronautics and Space Administration reports it has observed unusual color glows on the Moon and has made photographs of this phenomenon.

The group told NASA it saw the color in the crater Aristarchus during a four-hour period before daylight Nov. 15 through a 16-inch telescope at Port Tobacco, Md.

Although such events have been observed several times since the Russian astronomer N. Kozyrev first recorded observations of red glows on spectrograms, this was the first time photographic equipment was used successfully to record the sightings in the crater Aristarchus.

The observation was a culmination of a 16-month vigil by members of a ''Moon-Blink'' team from Annapolis, Md. The team made two previous confirmed sightings, including one in the crater Alphonsus last year, but they were much shorter and were not photographed.

Other teams of the "Moon-Blink" network were asked to assist in confirming the unusual occurrence, and the Fels Planetarium, Philadelphia, reported seeing unusual "cloudiness" in the exact spot under observation.

"Moon-Blink" takes its name from the principle that when alternate colored filters are rotated over a source of light of the same color as one of the filters, the human eye will see it as a blink, in black and white.

The team, operating under NASA contract, developed the instrument from an idea conceived by Dr. James B. Edson, technical assistant to the Associate Administrator for Advanced Research and Technology.

The contract was handled through NASA's Goddard Space Flight Center, Greenbelt, Md., with Trident Engineering Associates, Annapolis, Md.

The "Moon-Blink" apparatus is used with a 16-inch telescope and observatory built and operated by Lyle Johnson, a physicist and leading amateur astronomer.

The first sighting came shortly before 1 a.m., EST, Nov. 15 when two members of the team confirmed the possibility of a "blink" in the central region of the crater Aristarchus.

Thirty-six photographs were made - 12 each through the red and blue filters and 12 with no filter. The blink unit was reinstalled, and the blinking activity was more pronounced, probably because seeing conditions improved with the rising of the Moon.

The observers said they were unable to see the phenomenon with the unaided eye, even through the telescope. It was so faint that it was only caught by the sensitive Moon-Blink instrument, and by the camera using special film, made and processed to be very sensitive to red and blue color.

Throughout the night attempts were made to observe similar occurrences at different portions of the Moon but none were seen, adding greater confidence to the Aristarchus sightings. Additional photographs were made and the phenomenon was monitored until shortly after 5 a.m., when the morning light precluded any further observations.

There is strong difference of opinion among scientists as to the cause of lunar coloring. One theory is that the Moon has active gas fields, from which gas sometimes escapes through fissures suggesting that the Moon is not a "dead" object but contains some sources of energy. Other authorities maintain that spots on the Moon are caused by fluorescence of its surface when bombarded by radiation from solar storms.

During the Nov. 15 event, there appeared to be an enhancement of the blue portion of the spectrum. However, the scientists say it is too early for conclusive interpretation of the latest observations.

SATELLITE PHOTOS CAUSE CHANGES TO ANTARCTICA MAPS - Mahomet the prophet couldn't move a hill but a weather satellite called Nimbus moved a mountain.

Nimbus didn't move Mount Siple in the literal sense, but photographs taken by the 830-pound satellite show that present relief maps are in error.

Mount Siple, a 10,000-foot-high Antarctica mountain used by pilots as a navigational aid, will be repositioned 45 miles further west on future relief maps.

This is just one of three major changes planned by the U. S. Geological Survey as a result of months of studying approximately 300 pictures taken over the Antarctica by the Nimbus weather observer.

Another significant change involves the Kohler Range area. Nimbus I pictures indicate that a mountain group thought to be in the Kohler range area doesn't really exist.

It seems that two different expeditions sighted the mountain group and positioned them in two different locations. Both groups now appear on present maps but will be changed on future maps to show only one mountain group.

The third change planned for future maps is the updating of ice front information in the Filshner Ice Shelf, Weddell Sea and Princess Martha Coast areas. Nimbus pictures provided topographic engineers with a much better definition of the ice shelf's shape.

Engineers at the NASA/Goddard Space Flight Center and industry designed Nimbus as a platform to study the earth's weather behavior from space.

Although future Nimbus satellites will primarily study meteorological phenomena, it now appears that Nimbus pictures can be used for other sciences according to Dr. Paul Lowman, a geologist at Goddard.

"Photos from a satellite like Nimbus," said Lowman, "can be used in geologic reconnaissance, topographic mapping, forestry, ice pack reconnaissance, hydrology and oceanography."

Some experts believe that infrared pictures could be helpful for predicting volcanic eruptions and floods.

"Pictures of the earth from Nimbus are extremely useful to a geologist," added Lowman, "because they cover such a tremendous area. One Nimbus photo covers 1-million square miles. It would take teams of geologists years to cover that much territory. And Nimbus sees the entire 200-million square mile area of the earth every day," he said.

Nimbus I took some 27,000 day and nighttime pictures before it stopped operating last September due to a power failure. The National Aeronautics and Space Administration plans to launch another Nimbus next year.

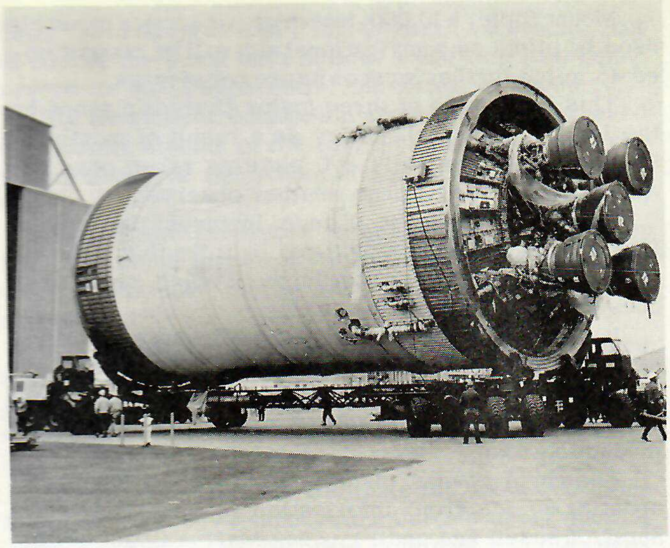
Huntsville, Ala.; THE FIRST COMPLETE TEST MODEL of the second stage of the giant Saturn V launch vehicle is wheeled out at Seal Beach, Calif.

The NASA-Marshall Space Flight Center's Mississippi Test Facility via the Panama Canal.

Designated the S-II-T, the stage is a flight-weight, all-systems test vehicle which nearly duplicates the actual flight stages slated to be launched from the NASA-Kennedy Space Center beginning in 1967.

The S-II-T's primary mission is to provide development testing of integrated S-II flight systems and hardware under static firing conditions.

S-II firings are slated to begin early next year on a test stand (A-2) now nearing completion at MTF. Other missions of the S-II-T include the verification of ground support equipment capabilities, aid in the transition from testing heavy battleship-type test



models to flight-weight structures and to serve as the vehicle used to activate the test site.

The S-II is 81 1/2 feet long and 33 feet in diameter. It is powered by five J-2 engines developing a total thrust of one million pounds. The J-2 uses high energy liquid hydrogen liquid oxygen propellants.

The stage was expected to arrive at the Marshall Center's Michoud Assembly Facility during the second week of October. There it will be transferred to a barge for the short trip to MTF.

EXPLORER XXIII ACCOMPLISHES MISSION - The National Aeronautics and Space Administration today announced that the Explorer XXIII spacecraft, designed to gather data on meteoroid penetration rates near Earth, successfully completed the one-year lifetime for which it was designed on Nov. 6.

The 295-pound satellite, launched from Wallops Island, Va., Nov. 6, 1964, carries detectors to measure the rate at which the spacecraft is penetrated by meteoroids at altitudes ranging from 300 to 600 miles above the Earth. As of Sept. 30, the satellite had reported 122 punctures by meteoroids in stainless steel sensors of two different thicknesses.

The results obtained, with other data obtained by its predecessor meteroid satellite, the Explorer XVI have established with good confidence the penetration frequency in very thin spacecraft materials. The results indicate that a spacecraft with an exposed area of 10 square feet made up of metal one-thousandth of an inch thick would experience penetration by a meteoroid about once a week.

The information from Explorer XVI and XXIII and the three large Pegasus meteoroid detection satellites will be studied by the designers of spacecraft intended to operate for long periods of time in the near-Earth environment.

Explorer XXIII was developed by NASA's Langley Research Center, Hampton, Va.

The meteoroid technology satellite program is under the NASA Office of Advanced Research and Technology.

EXPLORER XXIX SETTLES IN FINAL POINTING MODE - Explorer XXIX, the geodetic satellite launched by the National Aeronautics and Space Administration Nov. 6, is pointing its instrumentation toward the Earth as planned.

Project officials at the NASA Goddard Space Flight Center and the Applied Physics Laboratory of John Hopkins University reported four Explorer XXIX geodetic measurements systems had been checked out and were performing as expected. The fifth system, using laser beam reflectors, will be tested when the spacecraft completes its stabilization phase.

The spacecraft is the first NASA satellite to use the gravity-gradient system for stabilization. This system is designed to keep one end of the satellite always pointed at the Earth as it orbits along a path inclined 59 degrees to the Equator.

The final stabilization phase was initiated Saturday at 11:42 a.m. EST when a command was sent from the NASA ground station in College, Alaska, to retract the gravity-gradient boom from about 40 feet to 15 feet.

This action was successfully performed and caused the spacecraft to begin a slow tumbling motion. Thirty-two minutes later, as the spacecraft completed half a revolution in this tumbling mode, a command was sent from the APL Injection Station in Howard County, Md., that extended the boom to 50 feet. The effect of this action was to halt the tumbling and freeze Explorer XXIX in a position that keeps its instrumentation pointed Earthward at all times.

Minor oscillations will persist for several hours or days but will be gradually dampened out by an energy conversion and dissipation process.

The key to success of this turnover maneuver, which was directed by APL, was proper timing of the ground commands. The boom is extended or retracted at the rate of 4 1/2 feet per minute.

Achievement of the desired Earth-pointing attitude was confirmed by magnetic and solar sensors and by a marked increase in the strength of radio signals.

Gravity-gradient stabilization is accomplished by maneuvering the long boom with a copper-encased magnet (eddy current damper) at the end.

Partial extension of the boom has the effect of halting the tumbling motion imparted to the satellite upon its separation from the launch vehicle.

Further extension of the boom freezes the spacecraft in an attitude where either the boom or the instrumented base is pointed toward Earth. If the boom should be pointed Earthward, the boom can be retracted and the extension process repeated. This was done once with Explorer XXIX.

With the spacecraft frozen in the Earth-pointing attitude, the boom is then extended 40 to 60 feet for final stabilization.

Gravity-gradient stabilization is based on the tendency of an Earth-orbiting object with concentrations of mass a distance apart to keep one end of the axis connecting them pointed toward Earth.

The differing pull of gravity between the two connected mass points, although very small, tends to stabilize their oscillations about the total object's center of mass and along the axis between the two.

This process of dampening out Explorer XXIX's small oscillations after boom deployment is aided by the eddy current damper at the end of the boom.

The damper removes the oscillations by converting their energy to electrical current and then to heat which can be dissipated into the space environment.

The dampening system for the Explorer XXIX gravity-gradient stabilization system was designed and developed by the General Electric Co. The system eliminates the need for powered attitude-control devices.

Calibrated solar cells provide ground stations with information on the satellite's attitude with respect to the Sun-line, a direct line from the spacecraft to the Sun. Magnetometers provide information the spacecraft attitude relative to the lines of force in the Earth's magnetic field.

Together, these two sources provide complete data on the satellite's attitude and tell when to initiate the gravity-gradient stabilization steps and how well they were performed.

Houston, Texas; THE FAMILIAR WHITE SPACE HELMETS are on the way out, due to the efforts of a psychologist and a mechanical engineer in Crew Systems Division of the Manned Spacecraft Center.

Dr. Robert L. Jones and James O'Kane have developed a "bubble" helmet which is smaller and lighter than previous helmets, and yet is more comfortable and provides more visibility.

The helmet, which is made from a plastic material called polycarbonate, is transparent except for a small section at the back of the head. Hence the name, "bubble" helmet.

The Apollo suits which will be used for the moon landing will have this new type of helmet design.

The helmet started as a development project, but its design offered so many advantages over the other helmets that it was incorporated into the Apollo suit, and will be worn by astronauts exploring the surface of the moon.

The first consideration in designing a new helmet was the fit, or headspace inside the helmet. If the helmet did not rotate, it was necessary to find out just how much room a man needed to move his head freely inside the helmet. The results of head motion studies revealed that a smaller and lighter helmet could be designed and the viewing area of the astronaut actually increased.

A pattern for the new helmet was cut and a mold made by personnel of the Technical Services Division. The first helmet was almost round, but in later designs, the sides were flattened to give an even better shape and fit.

Other features were added to the helmet. A new design of the neckring where the helmet connects to the torso of the suit permitted donning or removing the helmet in a few seconds.

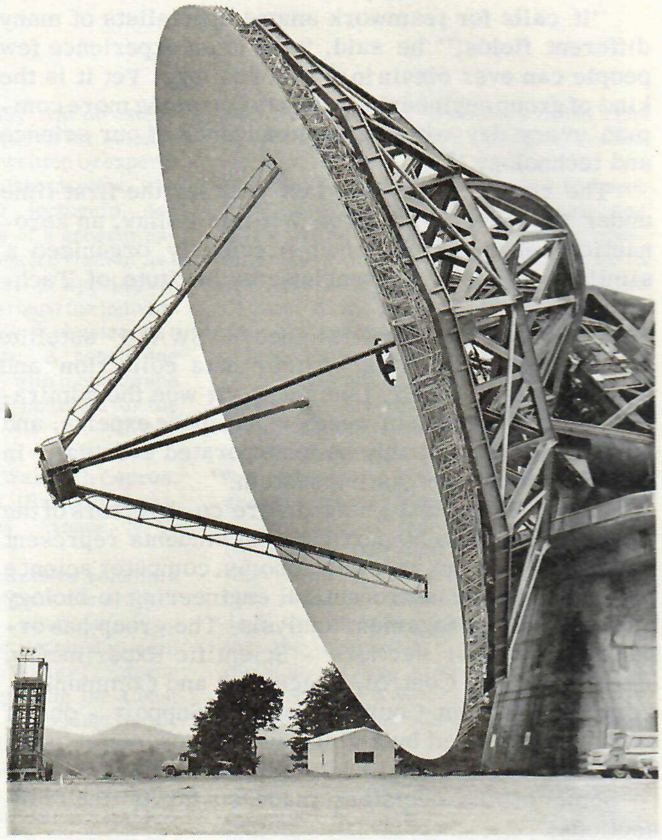
Protection pads made of a foam material were molded to fit on the inside and outside of the back of the helmet to protect the head against buffeting, vibration and impact during launch and reentry. They are removable during flight.

Three adjustable visors on the outside of the helmet will provide protection from heat, radiation and glare. The visors move independently.

After assembly, the helmet was tested by mounting it in a drop rig and subjecting it to various g forces caused by impact. The helmet received as many as 34 g's without damage in these tests.

Other evaluation tests included visual field measurements, carbon dioxide build-up, and ease of operation.

The features of the helmet were reviewed by members of the astronaut group and Center management, and adopted. The "bubble" helmet has taken its place as the latest development on the Apollo suit for the lunar landing.



IN SERVICE POSITION, National Radio Astronomy Observatory's new 140-foot-diameter radio telescope dwarfs buildings and vehicles. The huge instrument is the most accurate in the world, according to the National Science Foundation, under whose auspices the NRAO operates. The extreme aiming precision of this new 'scope is achieved through the use of two sets of "U" spring industrial brakes which grip the ring gears on which the 2,700-ton movable portion is rotated. The giant brakes were custom-designed by Goodyear's Aviation Products Division to hold the dish antenna in position with an accuracy of .003 of a degree.

Stanford; MARS VEHICLES - Plans to send several unmanned, instrumented space vehicles to Mars in 1971 - one to orbit the red planet and one or more to land on it - are being worked out by a task force of 50 Stanford University graduate students.

Project consultants include some of the most famous names in space science, among them Dr. William Pickering of the Jet Propulsion Laboratory, Dr. Howard Seifert of United Technology, and Nobel Prize winner Dr. Joshua Lederberg.

Now in their third month of planning, the team recently sent a contingent of 24 to Southern California for a two-day inspection trip and consultations with scientists at the Jet Propulsion Laboratory, Hughes Aircraft, Northrop Space Laboratories and North American Aviation.

It is all part of a special course designed to give graduate students the "feel" of working together in a team to plan and design a major engineering project, explained Prof. Bruce Lusignan, on electrical engineer and co-director of the program.

"It calls for teamwork among specialists of many different fields," he said, "and is an experience few people can ever obtain in or out of college. Yet it is the kind of group engineering which is becoming more common every day with the rapid advance of our science and technology."

The course was given last year for the first time under the direction of Prof. William Bollay, an aeronautical engineer who had previously organized a similar course at Massachusetts Institute of Technology.

"Last year's team designed a 'SWAMI' satellite system for world-wide weather data collection and forecasting," said Dr. Lusignan. "It won the admiration and close study of weather and space experts, and parts of it will probably be incorporated eventually in global weather forecasting system."

Profs. Bollay and Lusignan are co-directors of the 1965 project. The 50 participating students represent varied fields from radar astronomy, computer science and aeronautical-astronautical engineering to biology and cost and management analysis. The group has organized into four sections - Scientific Experiments, Trajectory and Control, Spacecraft and Communications, and Design Coordination and Support - one of which has been led by a girl physicist now majoring in electrical engineering.

Some of the decisions made so far by the team sections:

"1. An orbiter and one or more landers are required. The orbiter will carry much of the storage and data reduction equipment and will also house several scientific experiments. The lander will contain scientific instruments to perform the life-detection, atmospheric and geological measurements.

"2. In 1971 Mars will be within one AU (astronomical unit - 93 million miles) of earth from April 9 to Dec. 5. A vehicle should get near Mars as early in this period as possible. The earlier it arrives, the longer the communication time available before Mars passes too far away, but the less payload it can carry. However, a payload of about 2500 pounds could be delivered sometime before midsummer - to arrive any earlier the payload would have to be drastically reduced."

In addition to the classroom and laboratory studies under the project faculty, the student team is getting top-flight advice from their expert consultants in a series of 20 lectures. The subjects include such exotic titles as "Solid Propellant Rocket Systems," "Upper Stage and Braking Rockets," "Atmospheric Re-entry," "Multivator Life Sensors," "Bistatic Radar Measurements," "Stellar Stabilization," and "The Automated Biological Laboratory."

The course project extends over two quarters of Stanford's academic year. During the 1965 winter quarter the team has evaluated the mission's characteristics and determined which of the alternative approaches is best.

In the upcoming spring quarter the students will carry out detailed design and build models of components. The best of these designs will be "frozen" for the final mission, and a full report will be made in June to industry and government representatives.

Besides the directors, other Stanford faculty contributing to the course are Profs. Robert Hemmes, Von R. Eshleman, Owen K. Garriott, Robert H. Cannon Jr., Peter Z. Bulkeley, John V. Breakwell, Anthony E. Siegman, Drs. Elliott Levinthal and Daniel DeBra, and Lecturer William Lapson.

NEW INJUN - The National Aeronautics and Space Administration has awarded a contract to the State University of Iowa for preparation of an Injun spacecraft to be used in a dual satellite launch in 1967.

The Injun Explorer will be teamed with a 12-foot inflatable Air Density Explorer and flown on a single Scout launch vehicle in the same way as Explorers XXIV and XXV were orbited Nov. 21, 1964.

Langley Research Center is managing the project under the general direction of NASA's Office of Space Science and Applications.

The contract with the State University of Iowa is valued at $1,070,488 and covers construction of the Injun spacecraft, the preparation and integration with the Air Density Explorer spacecraft as a single Scout payload. Dr. James A. Van Allen of Iowa State is the principal scientific investigator.

The 12-foot polka dotted Air Density Explorer will be built by Langley.

The Injun satellite will be used in orbit to measure corpuscular radiation streaming into the Earth's upper atmosphere from space, and to determine how the radiation affects conditions in the upper atmosphere. Measurements also will be made of very low frequency radio emissions in the ionosphere.

The 12-foot inflatable sphere will be used to measure atmospheric density by observing drag effects on the balloon.

The dual experiment will extend the body of scientific knowledge gathered by Explorers XXIV and XXV into a period of increasing solar activity.

The new Air Density Injun Explorers will be orbited at a higher altitude and in a more nearly polar orbit than the first pair. Like the earlier satellites, they will be launched from the Western Test Range, Lompoc, Calif.

As a contractor to NASA, the State University of Iowa will provide complete construction, test, reliability and quality control, and launch support services. An Air Force Cambridge Research Laboratory experiment to measure low energy electrons and ions will be included as part of the spacecraft.

BOOK REVIEWS

ARTILLERY THROUGH THE AGES, by Phillip H. Stevens, Maj., U.S. Army, (Franklin Watts, Inc., 575 Lexington Avenue, N. Y., 197 pages, $5.95).

Artillery in warfare has been in existence since ancient times, when catapaults were used to hurl stones or other objects at enemy forces. Gunpowder was introduced into Europe in the 13th century, and crude, muzzle-loading cannon were developed soon afterward. Today, artillery is even more potent a weapon, for the need to reach targets at greater distances in shorter time has given birth to rocket-propelled projectiles.

Major Phillip Stevens has traced the history of artillery since its earliest times to the nuclear artillery of the present day. From a cumbersome, inaccurate weapon, artillery became an instrument that caused more battlefield casualties than any other weapon. Major Stevens spotlights for the reader such historic developments as the famous "six-pounder" used by the Continental Army in the American Revolution; the deadly Swedish field-piece used by Gustavus Adolphus to scourge Europe; the French "75" of World War I fame, and many more. Here also are explained the technical aspects of artillery-rifling, muzzle-velocity, mortars and howitzers, smokeless projectiles, time fuzes, flat and high trajectory, limbers, and fragmentation shells. Famous artillery actions are treated in colorful detail - Frederick the Great at Leuthen; Napoleon at Lutzen; Manassas and Gettysburg in the Civil War; St.-Mihiel; and World War II and Korea.

ASTRONAUTICS FOR SCIENCE TEACHERS, Edited by John G. Meitner, Stanford Research Institute. With nine co-authors. (John Wiley & Sons, Inc., New York, London, and Sydney,).

This is the first and only text on astronautics specifically prepared for science teachers. The book was written by experts in the various fields of astronautics, who are also experienced lecturers and writers. Three chapters of a general nature sweep across the entire field of astronautics. Six chapters, of specialized contents, are organized around the individual scientific disciplines - physics, biology, mathematics, etc. A concluding chapter deals extensively with methods and aids for introducing the material in the classroom.

U.S. COAST GUARD, by Walter C. Capron, Captain in USCG, Ret. (Franklin Watts, Inc., 575 Lexington Avenue, N. Y. $5.95, 218 pages).

In this fact-filled and reflective volume, a veteran Coastguardsman tells the story of his own armed service - smallest among those of the United States, yet surely one of the most valiant. Captain Walter C. Capron (USCG, Retired), in detailing the Coast Guard's story from its beginnings in the early days of the Republic to the present day, stresses that its duties and missions (except in wartime when it operates under the U.S. Navy) are basically humanitarian. Saving lives, protecting U.S. property, and enforcing basic quarantine and other laws is the Coast Guard's everyday business.

But the course charted by the Coast Guard during its evolution was a stormy one - as Capt. Capron makes clear in this volume. Today's U.S. Coast Guard is really the end result of four earlier services - the Revenue Cutter Service (first urged and sponsored by Alexander Hamilton as the "Revenue-Marine"); the U.S. Life Saving Service; and the Bureau of Marine Inspection and Navigation. Eventually the government created the Coast Guard which, in time of peace, operates under the Treasury Dept.

Personal accounts as well as exciting events in Coast Guard annals come under Capt. Capron's scrutiny as he recalls Coast Guard activities in capturing "rummies" during Prohibition, effecting such rescues as that of Morro Castle, searches on the high seas, amphibious operations during World War II, and many others.

SCIENCE: U.S.A., William Gilman (The Viking Press, 625 Madison Avenue, N. Y., $7.95).

The middle of a revolution is a bad spot from which to get one's bearings. And that's where we stand. The scientific revolution is in full swing; its importance to our lives is beyond exaggeration. William Gilman, acting as a scout, set out to survey the field and answer the question: What is science today and what is it up to?

Frank and comprehensive, Gilman's report is an inside look at science, research, and technology - their triumphs and shortcomings, and the meaning of both for our society. From representative research centers - university, governmental, private, and industrial - all over the country he has assembled a picture of what modern research and development have already accomplished and what they seek to find at new frontiers. Disregarding the specialists' arbitrary lines of division, he has made the life sciences illuminate the physical sciences, and both aid in explaining the intricasies of technology.

But outside the laboratory, science becomes a social responsibility and the scientist becomes an ordinary citizen. With the growing wealth and power of the scientific establishment and its enormous

CREDITS

Pages 4, 8, 9, 10: NASA.
Page 15: General Dynamics.
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Page 43: Good Year.

influence on economics and politics, occasions for malfeasance and corruption multiply - often hidden by the scientific halo. "Frankness about the failings of today's science is overdue," writes Mr. Gilman, and where he feels criticism is called for he makes it.

By clarifying the nature of today's science this book contributes substantially to our knowledge of the world and the direction in which it is moving.

PHYSICS OF THE LOWER IONOSPHERE by R. C. Whitten and I. G. Poppoff, (Prentice-Hall, Inc., Englewood Cliffs, New Jersey, $7.50).

Although men long have used the ionized layers of earth's atmosphere to propagate radio transmissions, solid efforts toward a fuller understanding of the lowermost layer - between 50 and 150 kilometers above the earth - are relatively recent. Sparked by the advent of improved instruments and more effective experimental techniques, this area of atmospheric physics is enjoying significant progress.

R. C Whitten and I. G. Poppoff of Stanford Research Institute, bring together the most recent work on the subject. They treat, for the first time in a single volume, the results of current studies in ion kinetics, the interactions between solar disturbances and atmospheric constituents, and such related topics as ionic reactions, ionization processes and atmospheric structure.

Among the features:

- Develops ionospheric processes clearly and logically - without cumbersome, extraneous material.
- Presents, in a concise manner, the current thinking on lower ionospheric structure.
- Includes a thorough and up-to-date guide to the literature.
- Presents many related aspects of atmospheric science, including ionic reactions, ionization processes, etc.

R. C. Whitten is a senior physicist on the staff of the Stanford Research Institute in Menlo Park, California.

I. G. Poppoff is chairman of the Institute's Department of Atmospheric Sciences.

THE QUESTION AND ANSWER BOOK OF SPACE, by Ruth A. Sonneborn, illustrated by John Polgreen, (Random House, 501 Madison Avenue, N. Y., $1.95, 70 pages).

An excellent book for grade school children, well illustrated with drawings easily understood. About half the illustrations are in color.

Answered are such questions as: How will men get to the Moon?, Why can't an airplane fly in space?, How the communications satellites work?, How does a satellite get into space?, etc.

GUIDE TO AMATEUR ROCKETRY - U.S. Army Artillery & Missile School, Fort Sill, Okla., (free, 54 pages).

An excellent guide for all amateur rocket enthusiasts. Available from the above address.

Rocket Clubs

Dear Sir:

I have just finished reading a newspaper article about an amateur rocket club in Jacksonville, Illinois. I'm disappointed and I sympathize with them.

This club has been trying for a year and a half to find a site to test their newest rocket, to no avail.

Our country needs young people such as these, who are interested in rockets and our country's space program. Yet no one will offer them any encouragement or assistance. Why encourage the youth of today to become aware of and interested in space exploration and then leave them stranded after working so hard and so long on such a worthy project?

Would you do me a personal favor and get in touch with these boys if you have any ideas as to launching sites available to them?

I appreciate your help very much, and incidentally, enjoy your magazine tremendously. Perhaps they haven't heard of you and the magazine.

R. W. Matthews
P. O. Box 663
Copperhill, Tennessee

P.S. Their Address: Mr. Dave Witte, President, Morgan Amateur Rocket Society, Jacksonville, Illinois.

• We don't have a list of sites. Perhaps your appeal will reach some enthusiasts that can help them. We also suggest they write to Guided Missile Dept., U.S. Artillery and Missile School, Fort Sill, Okla.

Dear Mr. Bremmer:

First let me say that your magazine is excellent! I think it is of excellent quality compared to the newspaper type of publication that it used to be.

I have recently formed an organization called Minnesota Rocket Research. In this organization we practice the field of several types of rocketry: Model Rocketry, Amateur Rocketry, our own type which is called Research Rockets, and the professional field. Most of our work is done with model rockets and research rockets. We use amateur and professional rocketry as references or for bettering our knowledge of space.

The reason this organization came into being is because we feel there should be an in-between program. One that is not as limited as the Model Rocket program and yet as safe as it. And still, one that is capable of surpassing Amateur Rockets in performance. Our Research Rocket is a product of this new program. It uses safe, prepacked engines in a light weight body similar to those of Model rockets but can obtain 6 to 10,000 feet. We are not restricted to NAR or ARA rules, only by the FAA. Clearance papers take about an hour to get. With this type of rocket, we can lift the payloads we want; ones with complicated instruments, movie cameras, or replicas of professional models that functions similar to the real ones. This type of rocketry is going to give the serious minded rocketeer a chance to develop his skills instead of flying toys or blowing his head off. We believe that this program could become just as popular as NAR or ARA.

Right now, we are building a rocket that weighs about 60 pounds, is made out of paper, carries an 8mm movie camera, tape recorder, transmitter, and a variety of experiments. It also has a parachute recovery system and is powered by a cluster of commercial engines. The rocket has a range of 20 miles. This rocket is being built now but won't be flown till we get major support from a sponsor or company. This rocket in design is almost like a Model Rocket, and it will be just as safe.

Minnesota Rocket Research is full of possibilities. We need any one, anywhere, someone that is experienced in rocketry and is interested in working toward a state wide and nation wide basis. We want to hear from anybody connected with rockets or any scientific program that we could use in connection.

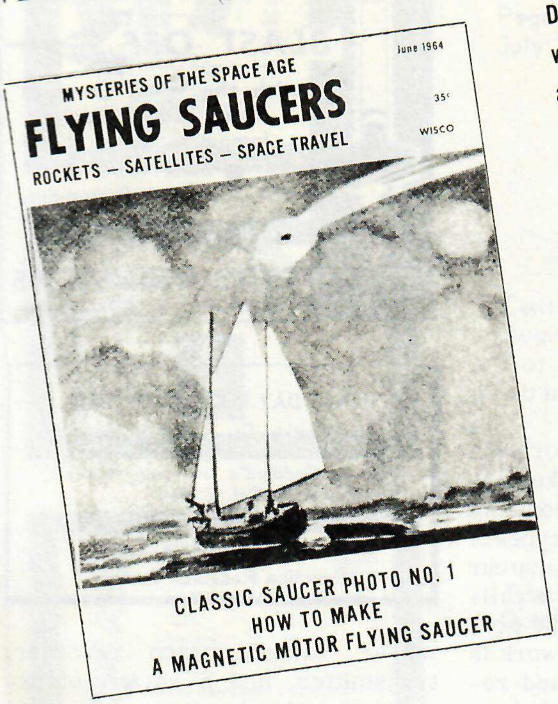
In summary, Minnesota Rocket Research enables rocketeers to do bigger and better things with rockets that they can't do with the excellant but restricted NAR program, and a lot safer than the ARA.

We want to hear from any one across the nation about their club or ideas and projects. Please write to Robert C. Matson, Minnesota Rocket Research, 4170 McKnight Road, White Bear Lake, Minnesota. All letters will be answered.

Robert C. Matson
4170 McKnight Road
White Bear Lake, Minnesota

HAVE YOU EVER SEEN A U.F.O.?

(Unidentified Flying Object)



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Are they fact or fiction?

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The Publishers of SPACE WORLD have a magazine devoted entirely to the mystery of UNIDENTIFIED FLYING OBJECTS, or Flying Saucers, as they are popularly termed. Rightly, SPACE WORLD does not deal with them, because SPACE WORLD is in another field. But, many readers have asked for U.F.O. information. To them, we suggest that they subscribe to FLYING SAUCERS, published every other month, for $2.00 for one year (6 issues). Or send for a sample issue at 35¢. If you have a bump of curiosity, you'll be in for a pleasant surprise, and quite an amazing adventure into a modern mystery.

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Oct.	1958	July	1962
Dec.	1958	Sept.	1962
Feb.	1959	Nov.	1962
May	1959	Jan.	1963
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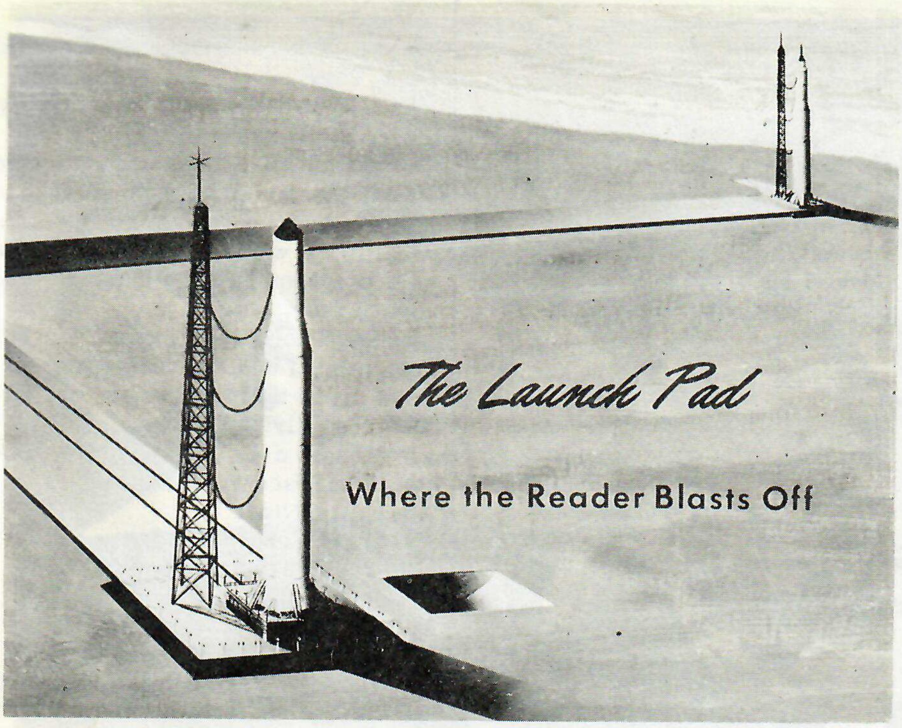


Dear Editors of Space World:

Since I am a junior this year in high school, we are expected to make a term paper. I chose for my title, "U.S. Astronauts of 1965." This will only include, "The Walk in Space," "Gemini 5," and the "Gemini 7" space flights.

In your November '65 "Space World," you had the coverage of the "Gemini 5" flight. I would appreciate it very much if you could send me 2 sets of the following information:

1. Pages 4-9 inclusive.
2. Pages 23-31 inclusive.

I would be willing to pay for the references listed above.

If you have any further information or references on these flights, I would really appreciate it.

Thank you very much for your trouble.

Sincerely yours,
Karen Schmit
R.R. 3
New Ulm, Minnesota 56073

• Above being sent under separate cover. No charge.

Dear Sirs:

I would like to say that Space World has been of a great personal help to me. This year, the French network of the Canadian Broadcasting Corporation was having a contest on the conquest of space on a very popular T.V. quiz program. Since I had every issue of Space World dating back to June 1961, it was possible for me to increase my knowledge in the field of astronautics to a point where I was chosen as one of the three finalists for the program. Unfortunately for me, one of my two opponents obtained a slightly higher score than I and I lost the opportunity to aim for the $5,000.00 award. Nevertheless, I enjoyed going back through my collection of Space World and I am certainly grateful that those magazines, especially the most recent issues, gave me the opportunity to be chosen as one of the three finalists.

I would, now, like to give you a few suggestions for future issues since a progressive magazine must always look ahead no matter how fine a publication it is. Keep up the pictorial reports on the Gemini flights. (Years from now, we will look back on these reports as priceless historical documents.) You should have an annual report on the progress of the X-15 program. This should include the flights over 50 miles, special experiments, etc. How about a pictorial essay on the history of rocketry showing the steps that took us to today's powerful boosters. I also hope that you will stick to your policy of presenting us with articles of NASA's most recent achievements, both in the manned and unmanned space programs.

Richard Cliche
110 Quest Grnde-Allee
App. 301
Quebec 6, P.Q., Canada

Dear Sirs:

I am a SW subscriber. Since I generally get my issues one month (issue date) in advance of the actual month I have been looking for my December SW for some time now - has it been printed yet? If so, why haven't I received an issue?

Thank you.
Erich Aggen Jr.
457 Morse Ave.
Liberty, Mo. 64068

• For benefit of all. Conditions beyond our control put us a little behind in publications.

Dear Sir:

I am in 8th grade and I am preparing a Science Fair Project pertaining to the topic of "Life on Mars."

I have obtained numerous newspaper and magazine articles and I have undertaken the task of creating an artificial Martian environment which I plan to keep low forms of plant life alive.

I would deeply appreciate any assistance you could extend to me to further my project.

Thanking you for your help, I remain,

Yours very truly,
Steven Neudorf
6239 N. Ridgeway Ave.
Chicago, Ill. 60645

• Under separate cover we are sending you tear sheets of any material on Mars which has appeared in Space World. Perhaps you can get the school library to purchase a very good book recently published, "Mars" by Richardson and Bonestell. This is published by Harcourt, Brace and World. The purchase price is $8.50.

Dear Sir:

I have been enjoying Space World two years and think it is great.

I am in high school and very interested in rockets.

I would like to know how you go about becoming an astronaut and what education you must have to qualify. I would also like to know the progress Italy is making in the Space race.

One more thing, could you tell me where I could get some information from the government on Unidentified Flying Objects.

Thanks a lot and keep up the good work on Space World magazine.

Jim Niger
236 Seneca Road
Rochester 22, N. Y.

● Write direct to NASA, Manned Spacecraft Center, Texas, for information on becoming an astronaut. Afraid you won't get much from the government on UFO's.

Italy has made some progress in space. Only recently they launched a satellite with the cooperation of NASA.

Dear Mr. Bremmer:

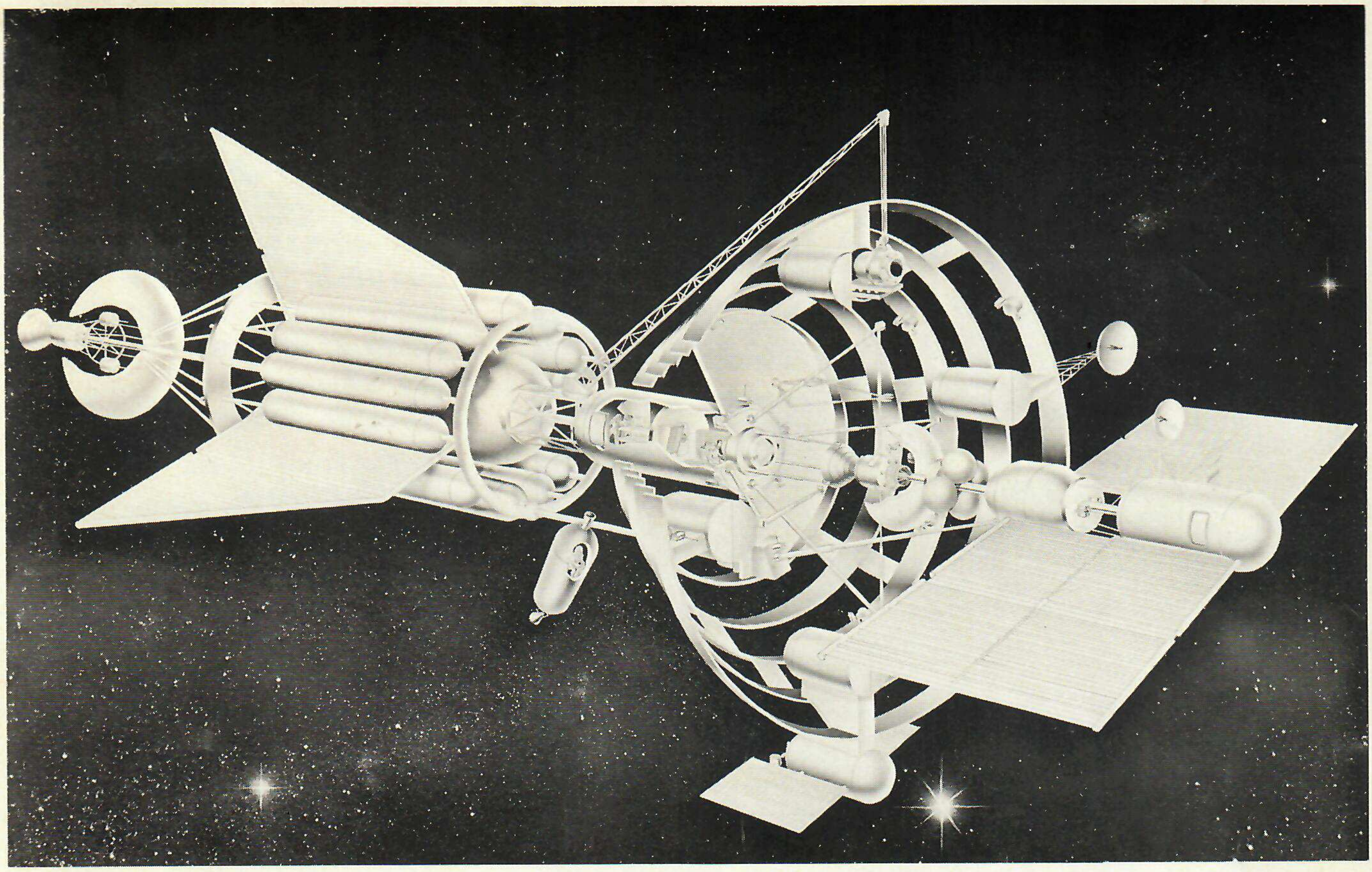
I have subscribed to your magazine since it was published and I think it's the best thing that has happened to the space enthusiasts of America.

But I am wondering why you didn't publish a picture of the Vostok spacecraft exhibited at the Le Bourget Air Show last summer.

However, that's beside the point. What I wrote to say was: I read Albert Coughlin's letter in the November issue of Space World and I, too, am very interested in obtaining models of the many spacecraft, rockets, and missiles in use today. Up till now I have had to make my own. In your reply to his letter you said there was a company tooling to manufacture these models. When you can, please let us "space nuts" in on more information on this "wonderful" company.

Robert M. Young, Jr.
% Lt. Col. R. M. Young
Hq., 7th Bn., 16th Arty.
APO, New York, 09034

● Par Tool Co., Model Eng. Div., Sun Valley, Calif., also Atkins and Merrill, Inc., Boston Post Road, Sudsbury, Mass.



Man will require nuclear powered rockets for his exploration of the universe and there will be a need for nuclear maintenance space craft such as this, engineers with Westinghouse Electric Corporation's astronuclear laboratory said here recently. Speaking at the Seventh Symposium on Ballistic Missile and Space Technology, they said these maintenance stations would remain in space permanently to maintain, repair and refuel atomic-powered space craft. The highly versatile, self-propelled repair shop for radioactive equipment is shown here with another space vehicle docked for maintenance (right). Shielded personnel quarters are in the center and the maintenance station's propulsion system is at left.