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Survival Beyond the Earth
THE SPACE MEDICS

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OUTWARD BOUND

In the nose cone of a three-stage rocket, a man lies on his back with his knees drawn up, waiting for the explosion that will thrust him into space. Blast-off. The roar swallows him; intense vibration courses through his shackled, layer-enveloped body. He is hurtling into the inky empyrean where the sun's rays give no light, where there is no such thing as height, where there is no up and no down—where, if he drops his guard for an instant, the irresistible forces of the cosmos will destroy him.

The drag of gravity forces (far more powerful than the earth's) from the rocket's acceleration piles up a crushing impact on the spaceman, whose normal weight—say 150 lbs.—multiplies to three-quarters of a ton. On the outer skin of his capsule, hurtling away from earth at 25,000 m.p.h., the friction of the atmosphere generates temperatures up to 1,600°F. Beyond the atmosphere, the outside temperature drops to −454°F.—close to absolute zero—and gone is the atmospheric pressure that keeps man's organs from exploding like a blood bomb.

From the heavens around, above and below—blue-black except for the myriad brilliant pinpoints of nontwinkling stars, the glow of the mist-shrouded earth and the hard white disk of the sun—invisible, cosmic radiation particles pierce the space capsule and riddle the pilot—harmfully or harmlessly, who knows? By then the space traveler is weightless—an unearthly state in which he may do himself injury with normal movements of his own muscles. He cannot smoke because of fire and explosion hazards; the cabin pressure is so low that he cannot even whistle to keep up his courage. Yet he needs courage of a very special kind. As great a menace as any lies in his own mind: a degree of isolation unknown to earth dwellers strains at the bounds of his sanity.

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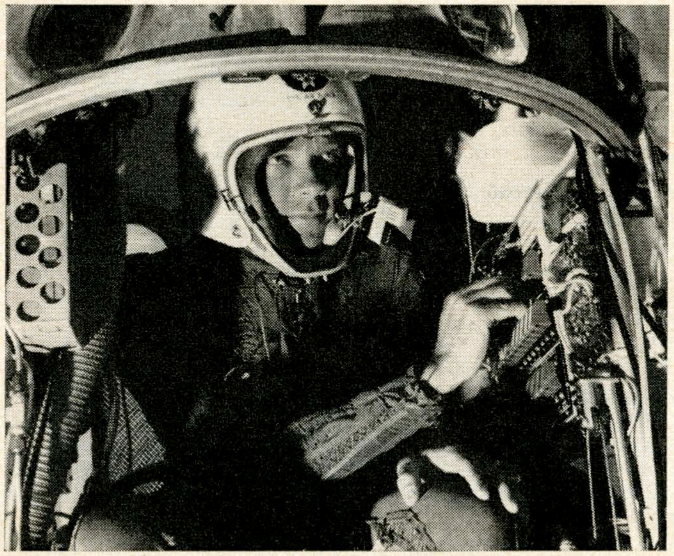
HOW soon man will come to grips with these challenges of space, no one yet knows. It may be within a couple of years. Last week's newly launched Sputnik III (*see* SCIENCE) was big enough to hold a human passenger but, as the Russians admitted, nobody is sure that a spaceman can re-enter the earth's atmosphere safely and get home alive. While rocketeers, engineers and physiologists work on that, the job of equipping man to survive and function in a space world never made for him is the specialty of space medicine. The space medics are at work on a major scale at four U.S. Air Force and four U.S. Navy installations, with special chores assigned to widely scattered civilian researchers in factories and laboratories.

Amazingly ingenious on its scientific side, this new branch of medicine is still an art calling for the exercise of vast imagination. A natural outgrowth of conventional aviation medicine, it got a rocket boost from Major General Harry G. Armstrong (TIME, Oct. 11, 1954), onetime surgeon general of the Air Force. Its intellectual father is Dr. Hubertus Strughold, German-born physiologist who began flights of fancy into space in the 1920s, came to the U.S. in 1947, was named last March as the world's first professor of space medicine, in the School of Aviation Medicine at Randolph Air Force Base, Texas. A tough question facing the first space medics was whether man could withstand the enormous accelerations (g forces) required to get him into orbit or beyond: the yes came from Air Medic John Paul Stapp (TIME, Sept. 12, 1955) in heroic experiments, with himself as guinea pig, on rocket-driven sleds.

Peter Marcus



SPACE MEDIC SIMONS: NONE SO CLOSE SO LONG

Bring 'Em Back Alive. Now space medics of a new generation are beginning to blast off into wider orbits. These younger men have actually clawed at the threshold of space. None has been so close to it for so long as a tall, balding Air Force medic, Lieut. Colonel David Goodman Simons, 35, who spent five hours at 102,000 ft. during the Manhigh II balloon ascent from Crosby, Minn. last year (TIME, Sept. 2).* Now successor to Stapp as director of the Aeromedical Field Laboratory at Holloman A.F.B. in New Mexico and onetime head of its space biology branch, Space Surgeon Simons is being shunted by the Air Force to work with Major General Bernard Schriever's California-based division of the Air Research and Development Command. In this role, Dr. Simons will be responsible for the creatures sent aloft and for recording on the ground (by telemetering devices) their physical reactions. First to go up, probably, will be mice, then monkeys and chimpanzees, finally men. It will be largely up to Dr. Simons to bring 'em back alive.

Mice & Men. No double-domed theoretician working out formulae, Dave Simons is a flight surgeon who is the son, nephew and cousin of physicians. A flier himself, he knows intimately the basic problems of fliers' health and survival. A tinkerer and gadgeteer who began cultivating a passion for photography, astronomy, physics and ham radio during his boyhood in Lancaster, Pa., he is enthralled by the electronic gadgetry essential to research before flight into space and to keeping a man alive after he gets there. He drives himself and his subordinates hard in fanatic devotion to his mission.

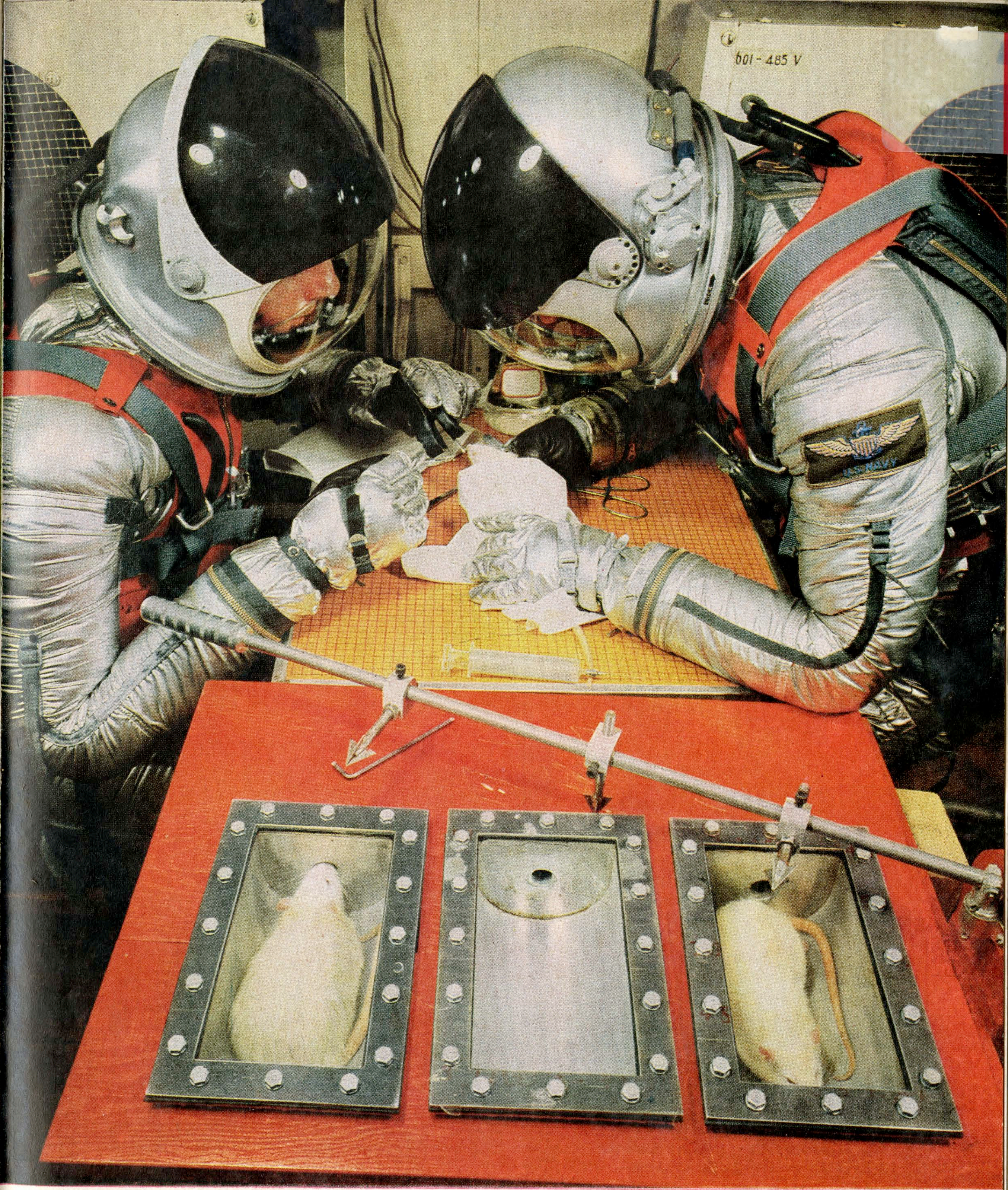
Assigned at his own request to medical instrumentation in 1947, Simons was sent to Wright A.F.B.'s Aero Medical Laboratory. There he studied how monkeys were affected by being fired up to the fringes of space in V-2 rockets. Back from Japan late in 1952 after training and duty as a flight surgeon, he was assigned to the Aeromedical Field Lab at Holloman to study the effects of cosmic radiation on animals at high altitudes. Rockets could not stay up long enough to give test animals extended exposure to the hazards of the upper atmosphere. So Simons became an enthusiastic balloonist, worked three years developing sealed cabins to carry aloft varied forms of life, dunk them in cosmic radiation, and bring them back alive. Between rockets and balloons, he has studied the effects of 65 high-altitude exposures on subjects ranging from the bread mold *Neurospora* and fruit fly *Drosophila* to mice, rats, hamsters, guinea pigs and rhesus monkeys.

Last August Simons added man—himself—to the list with his world-record balloon ascent in a capsule so cluttered with his beloved gadgets that he could barely move, but designed to produce data for 25 distinct scientific studies. These ranged from the intensity of cosmic rays to the hormones excreted in Simons' urine and his emotional reactions as confided to a tape recorder. (Some of the equipment functioned badly, is now being revamped for Manhigh III, later this year.)

Simons noted he was in "a completely hostile environment

* Holder of the world's altitude record is Laika, the dog put into orbit in Sputnik II, which reached a maximum distance of 1,056 miles from the earth. Highest U.S. travelers to have survived: two rhesus monkeys, Pat and Mike, sent to an altitude of 37 miles in a U.S. Aerobee rocket in 1952. Highest human: Captain Iven C. Kincheloe Jr., who got to 126,000 ft. (24 miles) in the U.S.A.F.'s X-2, for "a couple of minutes" in 1956.

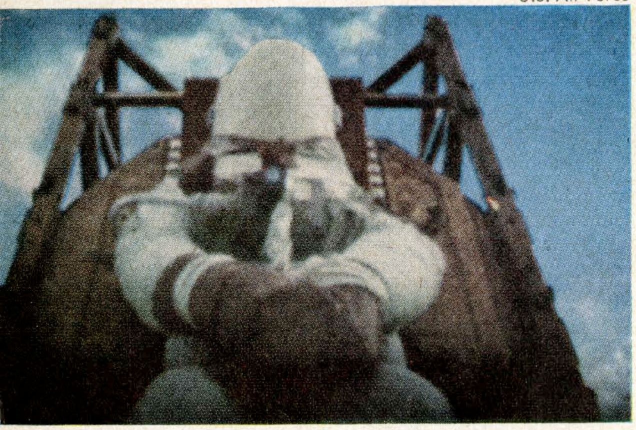
COLOR PHOTOGRAPHS FOR TIME BY WILLIAM VANDIVERT



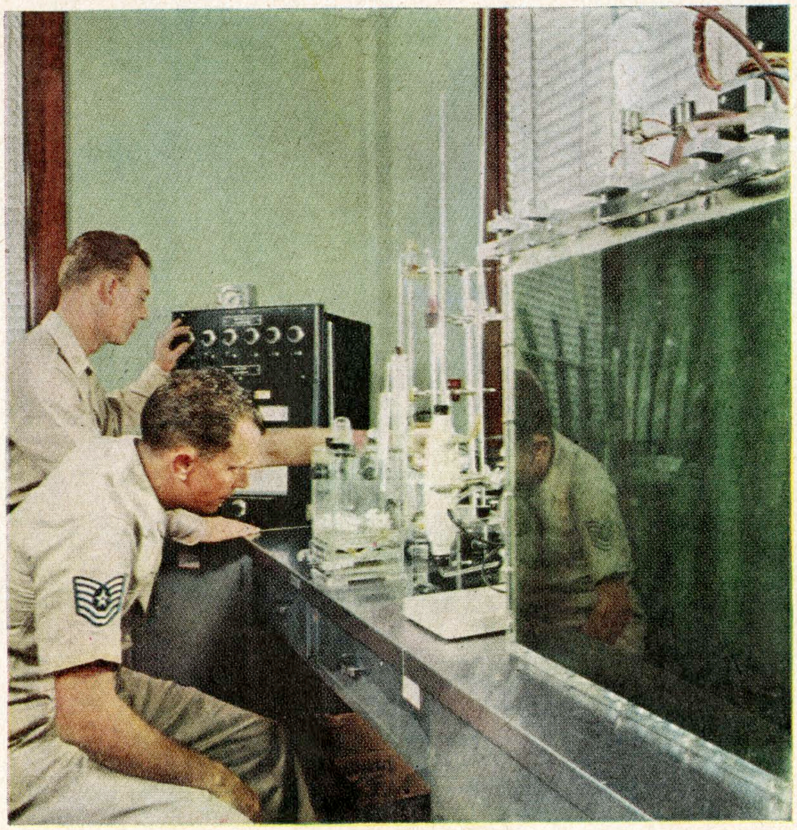
EXPLOSIVE DECOMPRESSION, sudden loss of pressure from possible accident in space, is studied with aid of rats by Navy doctors in sealed chamber at Air Crew Equipment Laboratory, Philadelphia. Protected by Goodrich full-pressure suits, doctors are taken to simulated 65,000-ft. altitude, where they pierce lids that have sealed rats at lower altitude pressures. Immediate study of damage to exploded organs of rats, killed by rapid drop in pressure, provides clues to space perils facing men.

WEIGHTLESSNESS of kitten, trying to right itself in absence of gravitational force, is observed by Dr. Siegfried Gerathewohl of Air Force's School of Aviation Medicine in cockpit of an F-94C interceptor over Randolph Air Force Base, Texas. Weightless state, which might disorient physical and mental processes of man in space, is achieved for 40 seconds by jet plane flying a carefully plotted parabolic arc in which centrifugal force counteracts gravity.

U.S. Air Force

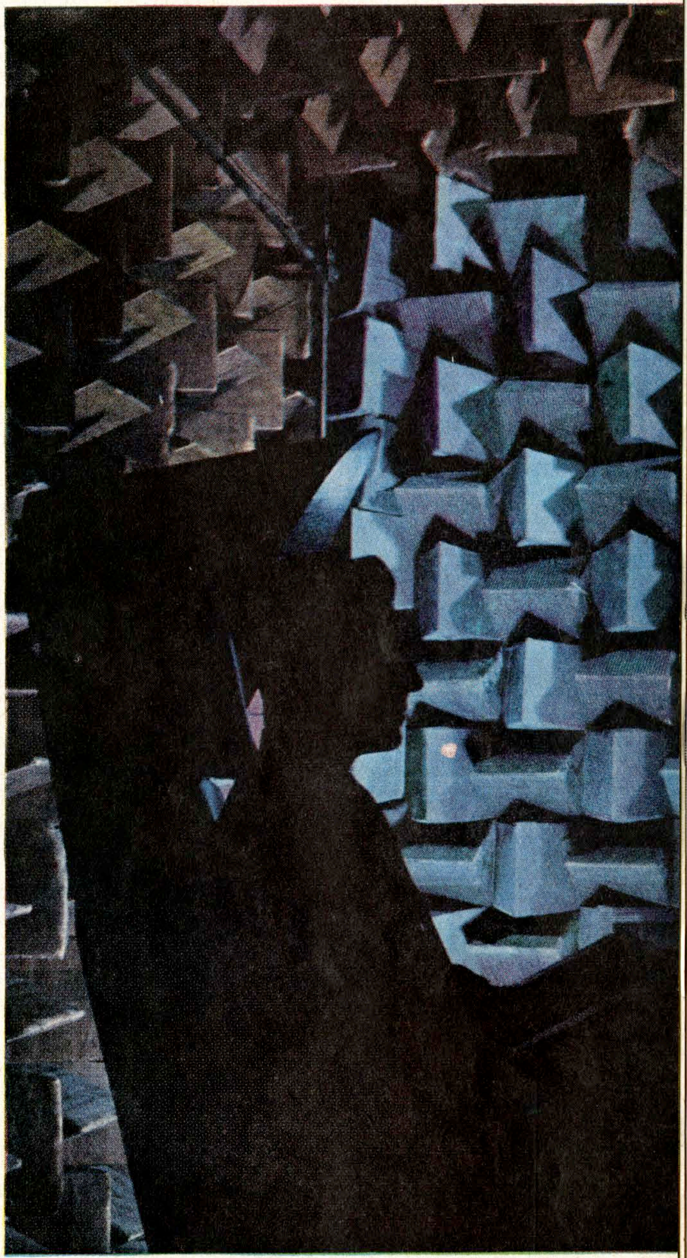


WIND BLAST, endangering men ejected into atmosphere at high speed from damaged capsule, may be countered by protective helmet and suit being tested on chimpanzee subjected by Northrop rocket sled at China Lake, Calif. to 1,337-m.p.h. speed and 4,000-lbs. per sq. ft. pressure.



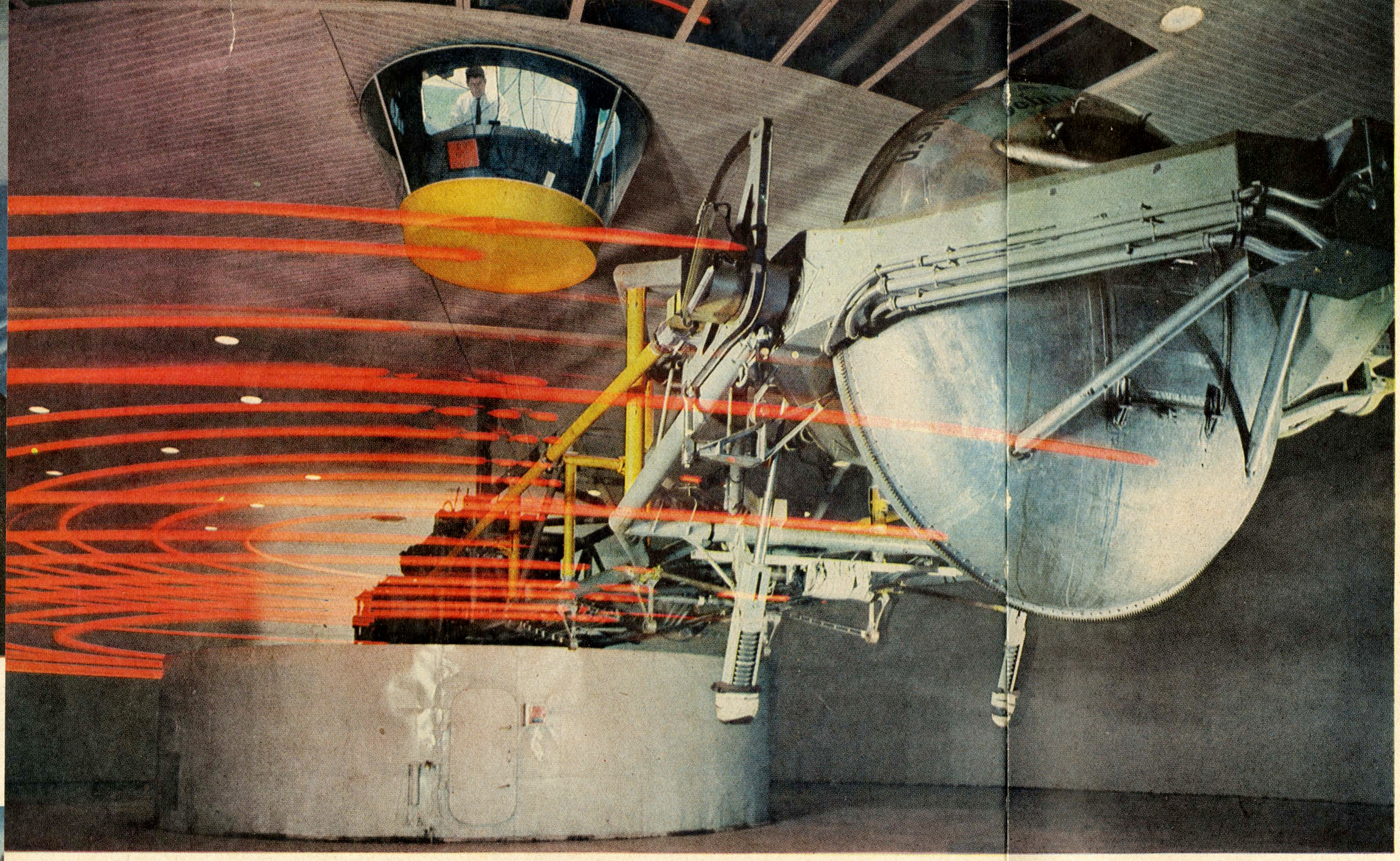
OXYGEN SUPPLY for space trip, provided by artificial photosynthesis, is a goal of Air Force studies of process by which algae convert carbon dioxide from the exhalations of mice into oxygen.

U.S. Air Force

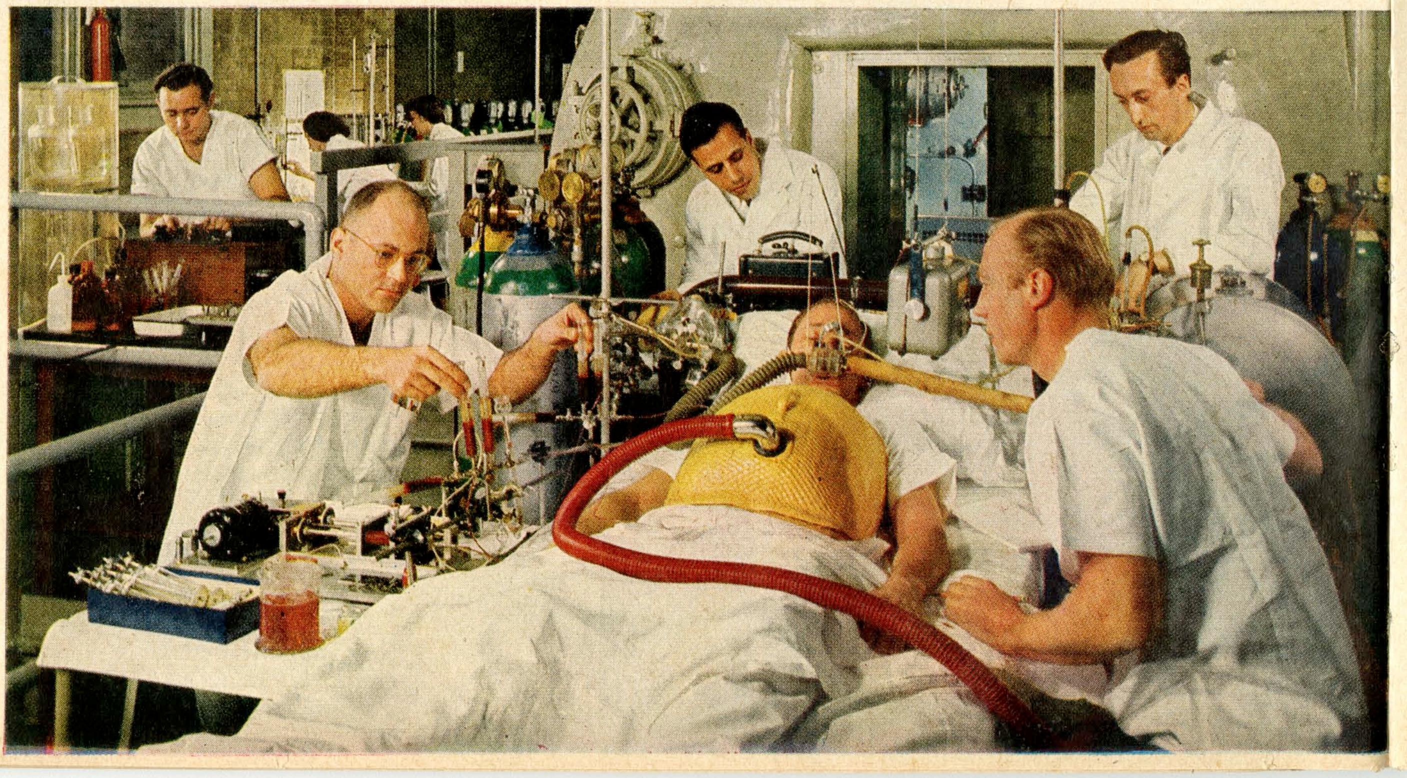


ISOLATION STRESS is recorded at Air Force's Wright Aero Medical Laboratory in Dayton, Ohio, using chamber that neither admits outside sound nor echoes any noise made by occupant.

RECORD BALLOON FLIGHT, which began from Crosby, Minn. open-pit iron mine, carried Colonel Simons aloft for 32 hours to 102,000-ft. altitude, provided knowledge of radiation effects, man's stress in space and suitability of sealed, Winzen-built aluminum gondola as capsule for rocket flight.

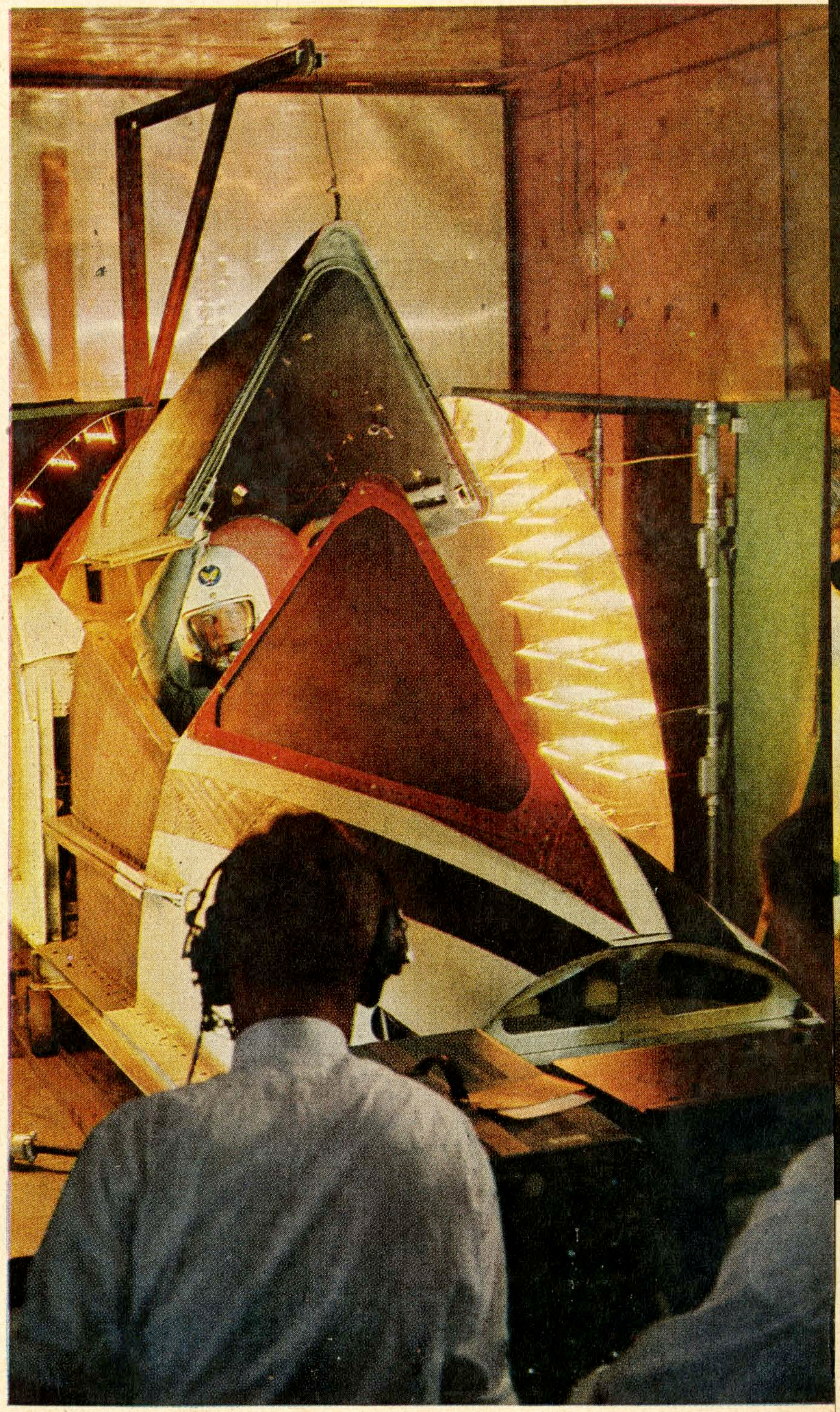


50-FT. HUMAN CENTRIFUGE (world's biggest), at Navy's Aviation Medical Acceleration Laboratory, Johnsville, Pa., records abilities of men in whirling gondola (*right*) to withstand high g-forces produced by acceleration and spinning of a space vehicle.



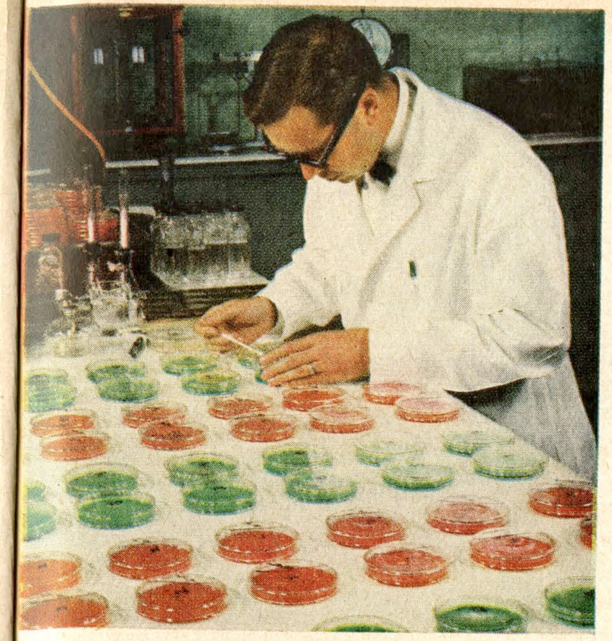
◄ EFFICIENCY OF BRAIN, affected by lowered oxygen supply during space flight, is studied at University of Pennsylvania's Pharmacology Department. Yellow pad, inducing excessive breathing, aids examination in oxygen-carbon dioxide interaction in regulating oxygen pressure in brain of subject, whose blood is sampled by doctor at left as it goes to and from brain.

HEAT CHAMBER, a modified F-102 cockpit flanked by infra-red lamps, generates up to 300° F. at Convair, San Diego, tests ability of man to perform functions normally under sudden and extreme peaks of temperature.

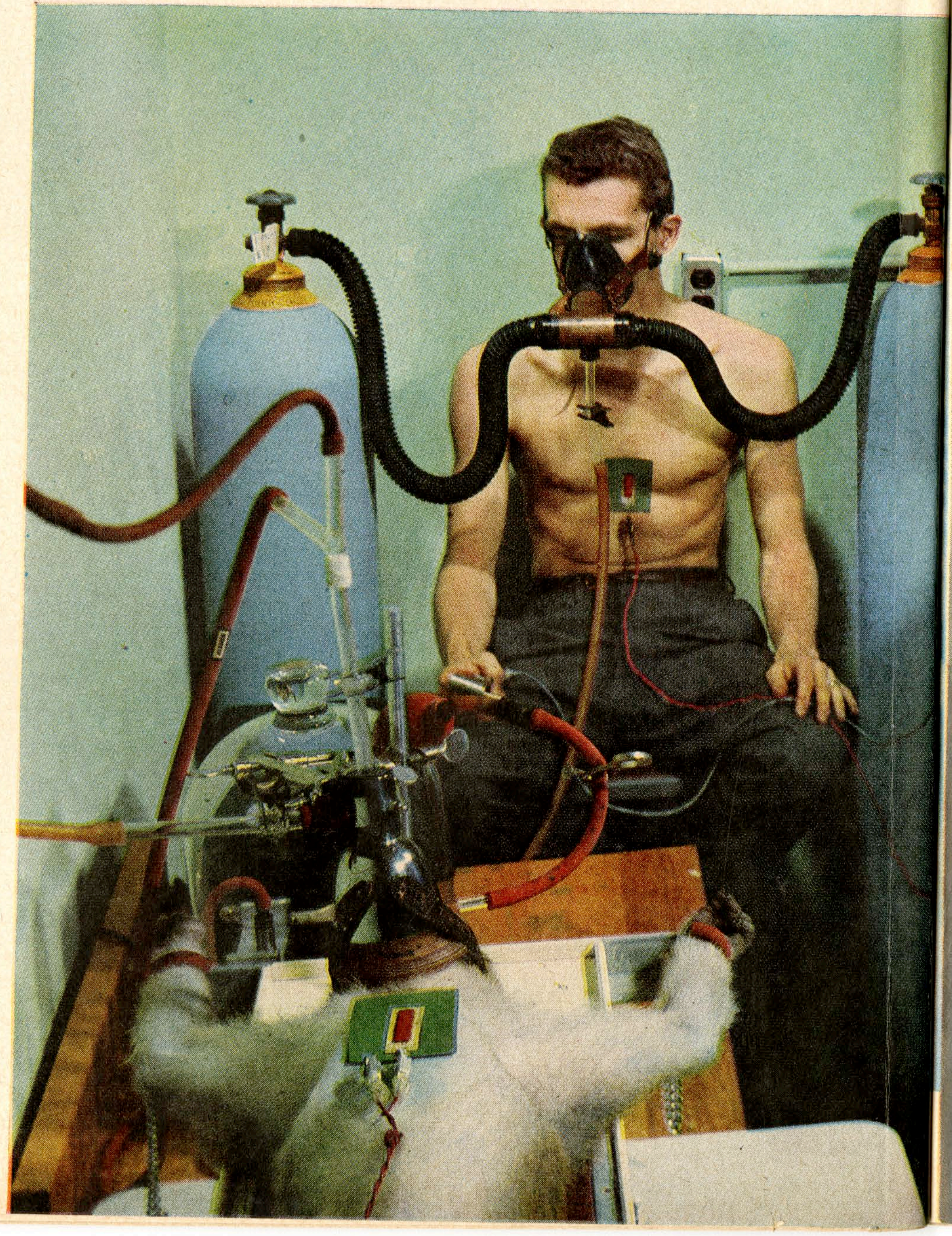


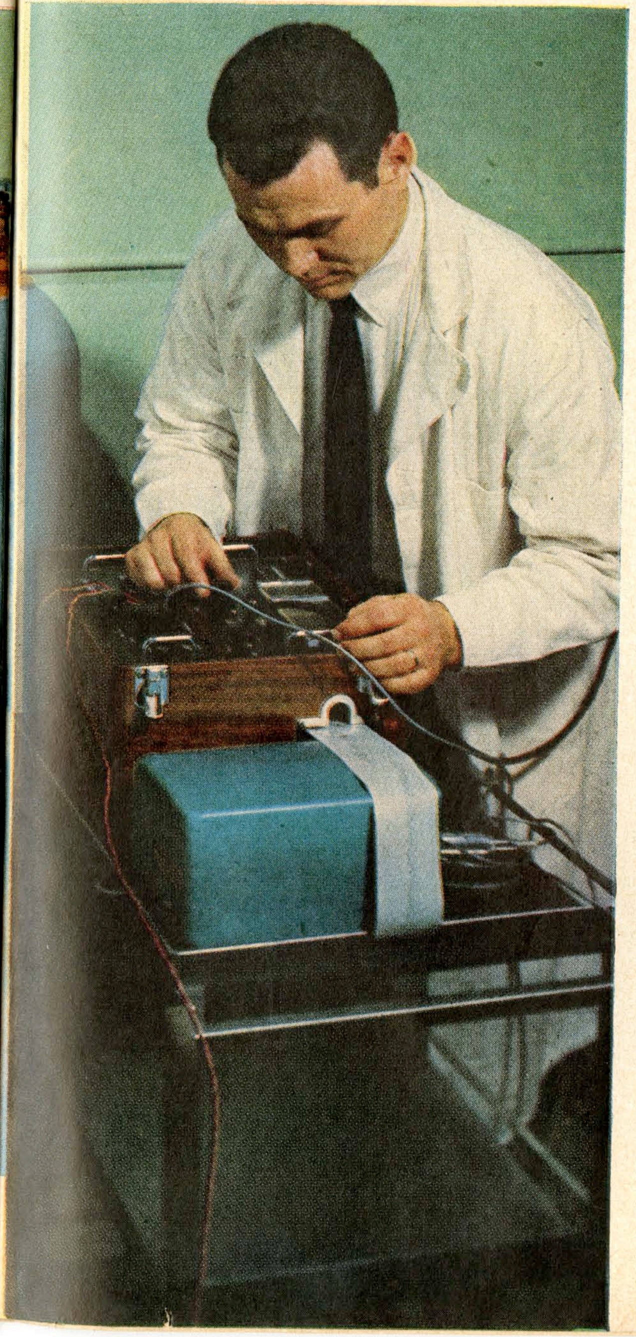
U.S. Air Force

SPACE CABIN at the Wright Aero Medical Laboratory tests how five men get along with one another housed in cramped quarters during a simulated 120-hr. flight through space. Electrodes (patches, *left*) send heart, brain, skin responses to doctors outside the cabin.

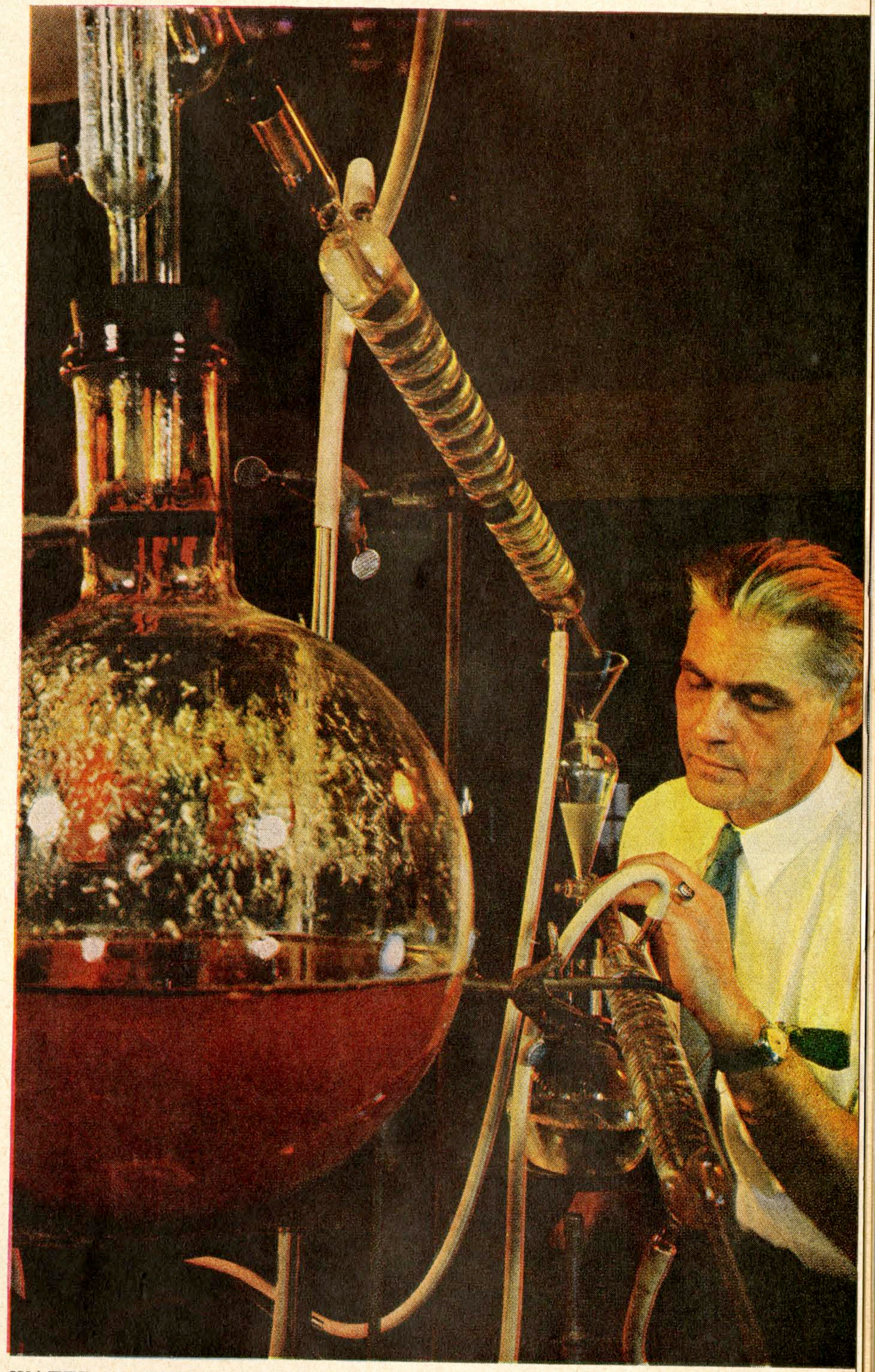


RADIATION HAZARD of space, threat to life from cosmic and other rays, is studied with damaged cells in test solutions by Dr. A. Gib DeBusk at Florida State University.

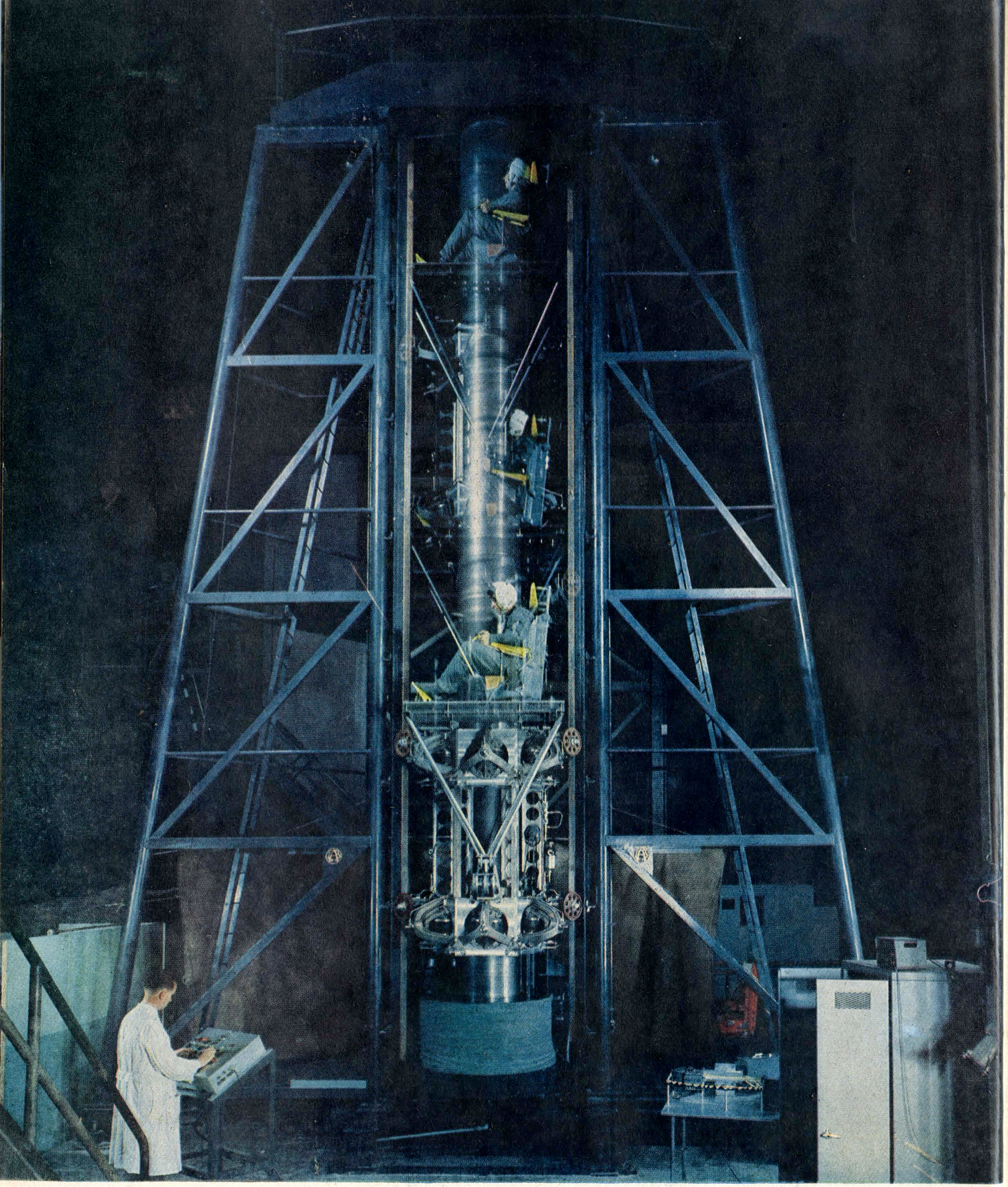




CONDITION DETECTORS, a wired cup (on finger of test subject's right hand) to record pulse and blood pressure, and Band-Aid-shaped strain gauges on chests of man and rhesus monkey (*foreground*) to measure breathing rate and volume, were developed by Universal Match Corp. in St. Louis, to transmit information to earth. Test compares man's reactions with those of monkey, which will probably be sent on space flight first. Mask records respiration by conventional means as check.



WATER-MAKING method for the occupants of the capsule during their long trip through space is sought in experiment at New York University's Sanitary Engineering Laboratory by Professor W. T. Ingram, who double-distills urine in attempt to recover pure water.



BUFFETING FORCES, expected to fling space travelers in all directions as speeding capsule is braked during re-entry of atmosphere on return to earth, are duplicated on 30-ft. vertical accelerator at Wright Aero Medical Laboratory. Test subject, shown in triple exposure as he rides apparatus up and down, can accelerate as much as 3 g, tries to perform given tasks while being subjected to violent vibrations and rotation at 300 r.p.m. of column to which chair is attached.

that would be most unforgiving of errors of commission or omission." He had one accident of the sort that threatens the life of every voyager who carries his own "microclimate": His air-filtering system faltered. The carbon dioxide built up to a hazardous 4%, and he began making errors in execution and judgment. Despite his medical training, he blandly reported to the ground that his breathing rate was 44 a minute (against his normal 17) and saw nothing unusual in it. Fortunately, he could still respond to orders from the ground, and poured on more oxygen. The crisis passed.

Asked last week whether, after this experience, he would like to be the first man in space, Dr. Simons said: "If it developed that I was the man best qualified, I'd like to do it—but not otherwise." With his broadening responsibilities, Dr. Simons will have to worry about the whole range of problems that vex the space medics in preparing any attempt to dispatch a man beyond the earth. Together with the researchers' latest thinking on how best to handle them, the problems are:

Clothing. The space pilot will be encased from top to toe in a suit of many layers. One part will keep the blood from flooding to his head or his feet under peak g forces during blast-off and re-entry. Another layer (actually two layers of clear plastic, with non-overlapping holes for air to get in and out) will cool him. An insulating layer is to save him from being grilled to a crisp in the inferno of atmospheric friction, both outbound and inbound. Yet another, with airtight linkage to his plastic-visored helmet, will maintain a comfortable atmospheric pressure all around his body, even if his space cabin should be punctured. This may serve also as an immersion suit in case he ditches in the ocean.

Walter Bennett

STRUGHOLD: THE PIONEER

Atmosphere. The space capsule, like the pressure suit within it, will be pressurized at about 7½ lbs. per sq. in.—the pressure normally found at 18,000 ft. Instead of ordinary air (21% oxygen), it will be filled with an artificial atmosphere containing at least 40% oxygen, to give the spaceman the same quantity of oxygen he would enjoy at sea level. During launching and re-entry, the space pilot will have his pressure suit inflated. In relaxed, straightaway flight, he will be able to deflate his suit, open his visor and rely on cabin air. The air will be filtered, probably through lithium hydride, to remove carbon dioxide and excess water vapor from breath and sweat. It will also be cooled and deodorized.

G Forces. The human body can stand travel at any rate of speed provided that it is constant. What hurts is a too-abrupt change in speed or direction. Standard of measurement for such changes is the g (from gravity), which is equal to the acceleration produced by the earth's pull at sea level. Unprotected and in normal sitting position, the body cannot stand more than about 3½ g for more than about 15 seconds. Semisupine, even without a pressure suit, it can stand 6 g for 4½ minutes, as much as 12 g for only six seconds. But in blast-off or re-entry, g forces build up; not only is speed sharply increased or decreased, but the rate of change is itself increased. This poses a worse problem. Man can stand the addition of one g every 4½ seconds for only 54 seconds up to a maximum of 12 g. Fortunately, from Dr. Stapp's work and other tests, researchers at Wright A.F.B. have found that a man quickly recovers his ability to withstand a new g onslaught: after first-stage burnout of a three-stage rocket, he coasts for several seconds at high but steady speed; when the second stage blasts off, he can take it, and his body is also ready for the acceleration of the final blast. On re-entry, the g forces loosed by deceleration are likely to be far more perilous. Impact of hitting even the thinnest outer layer of the atmosphere head-on at 18,000 m.p.h. is like driving a car through a blast furnace against a cliff at 60 m.p.h. To slow down, the pilot may have to glide in at an angle of no more than 4°, then skip out to cool off as soon as he has slowed down a bit. He may have to repeat this a dozen or more times, taking terrific punishment from buffeting in the process. Only after he has slowed down to about 3,000 m.p.h. will the pilot be able to set his air brake—open a stainless steel parachute. The shock that this produces may be the worst of all.

Weightlessness. Elusive, intangible, and therefore frightening, is the weightlessness, or zero-g state that the pilot will experience in orbital flight or true space travel. Quick movement of an arm in this state would spin him around or pitch him violently against the bulkhead if he were not buckled down. Randolph A.F.B.'s Major Herbert Stallings, who holds the world's record for zero or near-zero-g travel,* believes that weightlessness will actually help the space pilot. Says he: "A man can probably get as much rest out of four hours weightless sleep as eight hours on a feather bed, because there are no pressure points." He also finds weightlessness exhilarating, notes that the maneuvers he has to execute while flying a hot jet in this state are much tougher than a space pilot will have to do in straightaway flight.

But of 115 volunteers who have flown with Major Stallings, one-third suffered nausea, vomiting or vertigo to the point of incapacity. And even zero-g fans note some odd effects. Randolph's Dr. Siegfried J. Gerathewohl (Stallings' steadiest customer) reports what he calls the "oculo-agravic illusion": the weightless flier sees objects at a higher level than they really are. Two cardiologists, the Navy's Captain Ashton Graybiel and the Air Force's Dr. Lawrence E. Lamb, foresee possibly grave difficulties for both the circulatory and respiratory systems under long exposure to g-free conditions.

Temperature. The terrific heat built up in the skin of the space cabin after blast-off will soon be lost by radiation; on re-entry it will be a continuing problem. In orbital flight, dodging in and out of earth's shadow, with the capsule's insulating wall and the pilot's private, form-fitting air conditioning, this problem should be overcome. Flying to the moon or beyond, one side of the capsule will overheat, while the other will fall to the far-below-freezing temperatures of the void. It may be necessary to rotate the ship slowly. Still, no sweat: data from Explorer I showed a comfy inside temperature from 50° to 85°.

Food & Drink. The man in space will eat highly concentrated, nourishing pastes, squeezing them into his mouth from plastic containers that will stay depressed when squeezed, and not suck air in. Though he will be sitting still, exerting himself hardly at all with no gravity or friction to overcome, the Air Force thinks he will need 3,000 to 3,400 calories a day. If fliers' appetites go up with altitude, as some have reported, the only explanation is nervous tension.

Drinking is tougher: in the zero-g state, liquids slosh all over, or ball up in odd places: some of Stallings' passengers trying to drink from a plastic cup have succeeded only in soaking their suits, or having the water pour up into their nasal passages and sinuses. The answer: elastic containers, with polyethylene tubes for the pilot to suck the liquids out. Only after food has reached the stomach can the muscles in the digestive tract be relied on to keep things moving.

Elimination. The muscles and nerves controlling elimination should function normally even in long g-free flight. The space pilot will urinate into a "P-pipe" like those in airbound military planes today. Defecation is more of a problem. For a weekend trip, the pilot will be preconditioned by eating a low-residue diet (no bulky leaf vegetables, peas, corn or beans, no fat). As Captain William Bligh noted 169 years ago after he was cast away by the *Bounty* mutineers, some of his lifeboat companions went weeks with no bowel movement, had no lasting ill effects. For a trip to the moon, the

* About 38 hours, piled up in hundreds of missions and thousands of maneuvers (flying a Keplerian trajectory or parabolic outside-loop curve in high-speed jet airplanes), for periods from 30 to 43 seconds.

Air Force thinks it now has an airtight zipper-type fastening for pressure suits that will enable the pilot to function like a duck hunter opening the flap on his long-Johns; the fecal matter will go into plastic bags, be deodorized and stowed unobtrusively.

For longer space voyages, lasting weeks, months or years, all the difficulties of food, drink and elimination snowball. Weight is the first, worst foe of the rocketeer trying to get a manned capsule into space, so everything that can possibly be saved and re-used must be conserved. Hence the futuristic proposals that in addition to recycling his oxygen supply (perhaps with elaborate photolysis, to break down the accumulating carbon dioxide), the space pilot will have to recycle his body wastes. Extraction of palatable water, though still not perfected, might be practicable for space flight if the equipment weight could be cut down. One suggestion for maintaining a near-perpetual cycle of food: use the pilot's wastes as food for algae, which will convert them into something edible, also consume carbon dioxide and make oxygen. Another possibility is foreseen by the Navy's Biochemist Dr. Carl Clark, who offers the spaceman a diet of sugar water, enriched with vitamins, minerals and protein factors, and thickened with shredded paper towel. It would taste just as good, he says, every time around.

Cosmic Radiation. Space's swirling storms of atomic particles cause mutations (mostly undesirable for survival) in bread mold, probably will have the same effect in humans if they strike the genes in the reproductive system. Unsuspected until this month's report by Iowa Physicist Dr. James Van Allen was the intense radiation storm encountered 600 miles from the earth by Explorer satellites. Still to be learned is whether this danger zone stretches from pole to pole. If so, the space traveler may have to hurry through it, as Dr. Simons says, "like running fast through a grass fire."

Isolation. Loneliness is an appalling depressant by itself. For all his Navy training and lofty motivation, a six-month Antarctic night threw Rear Admiral Richard E. Byrd into depression. Airman Donald Farrell, after less than a week of far less severe isolation in a ground-bound cabin (TIME, Feb. 24), became not only irritable but hostile. His log for the seventh morning of his week-long simulated flight to the moon bristles with sputtering four-letter obscenities, includes the complaint that "the ------- won't even give me hazardous-duty pay for this ride. Chinchy slobs!"

Studies of airmen and other volunteers in such settings have shown, says the School of Aviation Medicine's Psychologist George Hauty, that a man studying a dimly lit instrument panel or radar scope in darkness and total silence soon begins to see blips where there are none. Airmen reported: "The instrument panel kept melting and dripping to the floor," and "On several occasions the bank indicator showed a hippopotamus smiling at me."

Walter Bennett

DR. STAPP: AFTER THREE, A MAN

One had to spend too much time "brushing away the little man who kept swinging on, and thereby obscuring, the airspeed indicator." The unanimous verdict of psychologists: the space pilot must have an abundant "sensory input" as well as work to do. He must be able to talk to the ground whenever he is awake, ask "Where am I? How am I doing?", and get reassuring answers. He must have music wherever he goes, perhaps a TV screen on which he can see where he is in relation to the earth.

Three Chimps First. With all these pressing medical problems to be solved, why does man feel himself impelled toward the dark unfathom'd caves of outer space? For one thing, despite his physical and emotional inadequacies, he is still a space-saving, weight-saving gadget compared with any electronic brain yet constructed. A cynical explanation favored in cybernetic circles: "Nowhere else can you obtain a self-maintaining computer with built-in judgment, which can be mass-produced by unskilled labor—and by people who like their work so well." To Dr. Simons, first man to have so long and clear a view of untwinkling stars, it is a matter of man's destiny: "This is one of the greatest challenges that has ever faced mankind—an external challenge, to conquer our environment."

But whatever his motives or apparent fitness, no man is likely to take off from the U.S. for outer space until Colonel Stapp, now head of Wright's Aero Medical Lab, is sure that he has a good chance to get back intact. Stapp plans to test the Air Force and Navy on finding and recovering a capsule dropped in the ocean, as it might drop a returning spaceman. Then he will try again, with a capsule fired downward at 3,000 to 4,000 m.p.h. from a high-flying missile. Next he will try to recover an orbiting satellite, to prove that the drag and heat problems on re-entry have been solved. He will send up and recover bigger and bigger animals, with chimpanzees on the top of the ladder, only one rung below man. Says Dr. Stapp: "When we've done the whole thing with three consecutive successes, getting the chimps back alive, then we'll be ready to send up a man."