Dr. Rudolf Hermann
University of Alabama Research Center
P. O. Box 1247 West End Station
Huntsville, Alabama

Space TECHNICAL INFORMATION DIGEST

SPACE SYSTEMS INFORMATION BRANCH, GEORGE C. MARSHALL SPACE FLIGHT CENTER

These notes have been extracted for their potential value as new information to various segments and personnel of this Center. No responsibility is assumed for their authenticity nor for the reliability of their source.

February 4, 1963 Vol. 4 No. 5

IN THIS ISSUE *Page*

* PRECAUTIONS AGAINST RADIOACTIVITY DISCUSSED 1
* DIAMETER OF MARS REMEASURED 3
* STARFISH HIGH-ALTITUDE NUCLEAR TEST EFFECTS DISCUSSED 3
* NEW TEST SERIES OF UNMANNED VEHICLES SCHEDULED FOR LAUNCH IN MID-1963 5
* NEW CORK COMPOSITION PROTECTS MISSILE COMPONENTS FROM HEAT 7
* NEW HIGH-VACUUM GETTER-ION PUMP ANNOUNCED 9
* NEW MANUAL GUN FOR CO_2 WELDING OF THIN GAGE METALS 9
* TECHNICAL REPORTS AVAILABLE 9

PRECAUTIONS AGAINST RADIOACTIVITY DISCUSSED.

The AEC is presently developing systems for nuclear auxiliary power (SNAP) for the Department of Defense and NASA. These systems convert heat into electricity by either the thermoelectric principle or by a turboelectric generator. The AEC has already provided two isotopic-powered thermoelectric generators for the Navy's Transit navigational satellites. Future plans include a joint AEC-Air Force effort during 1963 to launch the world's first nuclear reactor into space.

A military surgeon in the Air Force, Lt. Col. Charles M. Barnes, D.V.M., Ph.D., has concerned himself with the problem of protection for mankind as a result of this application of nuclear energy to space. As the author of a paper entitled "Safety of Nuclear Systems in Space Applications," Dr. Barnes points out that several health and safety features were incorporated into the design of the first two nuclear-powered generators. These included:

(1) Nuclear heat was derived from 1600 C Pu-238, which emitted almost pure alpha. Because of the low gamma component, no large shield was placed around the generator, and no shielding was required for the personnel installing and checking out the nuclear power source. Personnel handling the generator were required to wear asbestos gloves to protect them from the generator's 93° C (200° F) surface temperature upon removal from the storage container.

(2) A container was provided at all times for the Pu-238 to prevent human contact and inhalation, or either; to withstand the shock of missile launch and extremes in pressure and temperature; and to withstand fire, explosion, and impact associated with booster malfunction. An experimental demonstration was conducted to simulate trouble spots of launchings.

(3) U. S. launch areas are located adjacent to the Atlantic and Pacific Oceans because the low population density makes ocean impacts an acceptable risk.

Cape Canaveral's AFMTC has initiated several precautions of its own against the hazard of nuclear releases, such as: prelaunch environmental samples of air, water, soil, etc., were to serve as references of background radioactivity; a survey of the wind patterns was made so that downwind dispersion of radionuclide can be determined, if necessary; constant air sampling was effected; health physicists familiar with alpha monitoring procedure were imported from Air Force and AEC installations for the launch countdown; an emergency evacuation plan was devised for all personnel; and a nuclear recovery Air Force team was alerted and on standby to recover the generator.

The safety concepts incorporated into reactor design are also unique. The reactor will be launched "cold" so that in case of a mishap at launch, the results should not be much greater than what occurs to non-nuclear components. Startup of the reactor will occur only after a stable and long-lived orbit has been achieved. Radiation from the reactor operation will not be harmful, because the orbit path is unoccupied. At the end of its useful life the reactor will be turned off and the accumulated fission products will be allowed to decay during the balance of its orbital life.

The reactor is designed to disassemble and disintegrate when it becomes heated by its reentry into the Earth's atmosphere. The fission products will be only a minute fraction of those produced, and will not add materially to the contamination of Earth. (Source: Paper presented at the 69th Annual Meeting of the Association of Military Surgeons on November 12, 1962)

DIAMETER OF MARS REMEASURED. Largely because of optical interference caused by the atmosphere of Mars, no measurement of the planet's diameter has been regarded as precise to date. A new approach was recently reported in Comptes Rendus de l'Academie des Sciences. At the Observatoire de Paris (Meudon), A. Dollfuss and his colleagues used a double-image micrometer of high separating power and the Pic du Midi telescope. During the 1954, 1956, and 1958 oppositions, they chose particularly favorable terrestrial conditions for observation.

In 1956, observations showed that the Martian atmosphere was clouded by yellow dust; corresponding estimations of the planet's apparent diameter were about 30 km (18.5 mi) greater than in previous years. With the necessary corrections and on the basis of over-all observations, the authors believe that the best value for the equatorial diameter of Mars is 6790 km (4219 mi); its polar diameter is taken as 6710 km (4169 mi). These measurements yield an average density of 4.09 (Earth average = 5.52) for Mars. The authors believe the planet probably consists of a dense core surrounded by a less dense layer, thickest at the equator. (Source: New Scientist, December 20, 1962)

STARFISH HIGH-ALTITUDE NUCLEAR TEST EFFECTS DISCUSSED. ("The following material is based closely on a joint status report prepared by the U. S. Atomic Energy Commission, Department of Defense, and National Aeronautics and Space Administration concerning the geomagnetically trapped electrons from the Starfish high-altitude nuclear test. The test involved a nuclear device in the megaton yield range detonated in the ionosphere at an altitude of hundreds of kilometers in the vicinity of Johnston Island (17.0° N, 191.7° E), in the Pacific Ocean, at 0900 UT, July 9, 1962.")

It was believed prior to the Starfish test that some particles might be ejected from the inner Van Allen belts. However, the predominant effect was found to be the injection of beta particles into the Earth's field caused by the decay of charged or uncharged fission products. In this manner, a new electron belt is formed, superimposed upon, but extending somewhat below the natural Van Allen belts.

Data on the artificial radiation belt was first provided by the Injun satellite; data from other satellites included the Ariel, Traac, and Telstar. Distribution and persistence of the electrons injected by Starfish as measured by the satellites are not completely consistent; the measurements from different satellites disagree by a factor of from 2 to 4. Although showing fluctuations up to a factor of 10, the data provided by Telstar gave the most extensive coverage of the new belt. However, the greatest fluctuations were at the greatest distances from Earth where the artificial belt merges with the natural one.

By August 28, 1962, contour maps were constructed from the particle-detector data available. Maximum intensity appears, on the average, at an altitude of about 4000 km (2480 mi); the electron flux contour of $10^9/cm^2/sec$ is about 5000 km (3100 mi) thick and extends 6000 km (3720 mi) in the north-south direction. This peak flux is about ten times the highest maximum ever observed in the outer Van Allen belt. The intensities in the natural Van Allen belt, however, are even less known than those of the artificially created belt.

Computed radiation doses of 2.8×10^{12} electrons/cm^2/day for the Ariel satellite and 4.5×10^{12} electrons/cm^2/ day for Traac-Transit 4B correlate fairly well with the rapidly falling power available from the vehicles' solar-cell power supplies. The power systems for these satellites were designed for natural radiation and effectively had no shielding; this could result in a 25- to 30-per cent reduction of output, which could seriously impair performance, or lead to the loss of useful transmissions before the design lifetime had been realized. Telstar was equipped with a different type of solar cell (n on p silicon, coated with 0.076 cm (0.030 in.) of sapphire); the more conservatively designed power supply system allowed Telstar to function correctly, although the increased radiations were present.

With relation to manned space flight, the external radiation intensity that would cause a dosage of about 1 r to an astronaut's skin, as estimated, is "well below the mission limit previously established by NASA for the Manned Flight program." This estimation is based on the observed distribution of electron flux from the stored electrons of the Starfish test as applicable to the manned project Mercury flights.

Although more electrons were trapped by the Starfish test than had been expected, the increase in radio noise was about as anticipated. Radio-noise observations made at various locations in a spectrum from 18 to 120 Mc/sec showed the noise to be decreasing with time; in August 1962, the rate was about 10 per cent per week. With the use of special techniques, the radio noise will be detectable at lower latitudes for some time, although "it is not a significant problem to radio astronomy." (Source: International Geophysics Bulletin, October 1962)

NEW TEST SERIES OF UNMANNED VEHICLES SCHEDULED FOR LAUNCH IN MID-1963. The first of six non-orbiting, unmanned test vehicles will be launched from Cape Canaveral, Florida, about the middle of 1963, the Air Force Systems Command has announced.

Officially known as ASSET (Aerothermodynamic/elastic Structural Systems Environmental Tests), the first program will last about 13 months.

ASSET will verify aerodynamic theories, vibration conditions, materials, and design and structural approaches used in hypersonic (five times or more the speed of sound) aircraft and advanced reentry vehicles being developed by AFSC.

The primary purpose of the program is to correlate actual flight test data with theoretical and ground test data. Configuration, materials, component systems and recovery systems for ASSET already have been studied and evaluated in ground facilities.

Reentry tests will provide information on environmental control, guidance and control, instrumentation, recovery techniques and equipment, structural cooling, and radar tracking under ion sheath conditions. (Ion sheath is interpreted as the ionized atmospheric layer surrounding a vehicle when it reenters the atmosphere.)

All vehicles will feature stubby, delta (capital "A" shaped) wings, a flat bottom, and a cone-cylinder body. They will be built of refractory metals and ceramics, super alloys, and have titanium floors.

Four of the vehicles will weigh about 500 kg (1100 lb) and travel more than 21,000 km/hr (13,000 mph) at altitudes of slightly over 70 km (43 mi). The other two will weigh about 540 kg (1200 lb) and travel at about 14,000 km/hr (9000 mph) at an altitude of more than 22 km (35 mi).

Provisions for the recovery of all vehicles have been made. Each will be fitted with a conventional recovery system such as a parachute, flotation system, and location aids. Recovery of the vehicles has been planned in the Atlantic Ocean east of Cape Canaveral, Florida, by modified World War II liberty ships with the aid of search planes.

Four vehicles will be used for aerothermodynamic/structural (ASV) tests; the other two will have aerothermodynamic/elastic (AEV) objectives. Specific ASV objectives are to verify environmental predictions regarding extreme temperatures, pressures and heat transfer rates; to correlate aerodynamic heating, lift, drag and pressure prediction methods and theories; and to evaluate advanced structural design concepts such as heat shields, insulated and cooled structures, and hot structures. More than 140 measuring devices will collect data on each flight.

Theoretical peak temperature expected to be encountered in the nose tip region of ASV vehicles is about 2200° C (4000° F) or about 275° C hotter than the temperature of an internal combustion engine. Nose caps, leading edges and lower surface test shields will be made of refractory ceramics and metals.

AEV tests will be conducted to investigate unsteady aerodynamics (flutter). Other studies will focus on structural response and possible dynamic instabilities resulting from the combination of rapidly varying aerodynamic loads and temperatures.

Each vehicle will fly a different trajectory to give scientists various data in the field of reentry. Each also will be fitted with a self-destruct system that provides for the activation of a liquid explosive if the vehicle deviates from the planned trajectory.

The system was incorporated into the vehicles because command destruct from the ground is impossible upon reentry because of the ion sheath or atmospheric layer surrounding the vehicle at that time. Such was the condition that made communications impossible during the reentry of NASA's Friendship 7 and Aurora 7 space capsules. (Source: AFSC news release (USAF))

NEW CORK COMPOSITION PROTECTS MISSILE COMPONENTS FROM HEAT. A new material for protecting experimental missile engines from heat has been developed by the Armstrong Cork Company. Known technically as an "ablation" material, it is a specialized cork composition that absorbs aerodynamic or exhaust heat; it forms a tough char-layer or protective outer skin, which gradually "ablates" or erodes.

The cork composition is being produced for experimental third-stage engines of the Minuteman (Fig. 1) as well as for the aft dome of experimental second-stage engines of the Polaris. On the Minuteman, the material protects the engine, fuel supply, and other portions from the heat caused by atmospheric friction; on the Polaris, it is used to protect the engine from exhaust heat.

The success of cork composition in the problem of aerodynamic heating can be traced to the natural properties of cork, which burns and conducts heat very slowly. The material will absorb large amounts of heat over a broad range of environmental temperatures and transfer it very slowly towards the areas to be protected. The use of cork also results in weight-saving.

Manufactured under rigid specifications and control, production of the material begins when prime cork is ground to an exact particle size. It is weighed, blended with special binders, and baked in sheet molds by a dielectric heating process. Finally it is cooled, cut, and sanded to precise uniform thicknesses. The binder components can be varied for usage in many other heat insulation applications. An adhesive has also been developed for applying the cork to missile engines. (Source: Data supplied by Armstrong Cork Company)

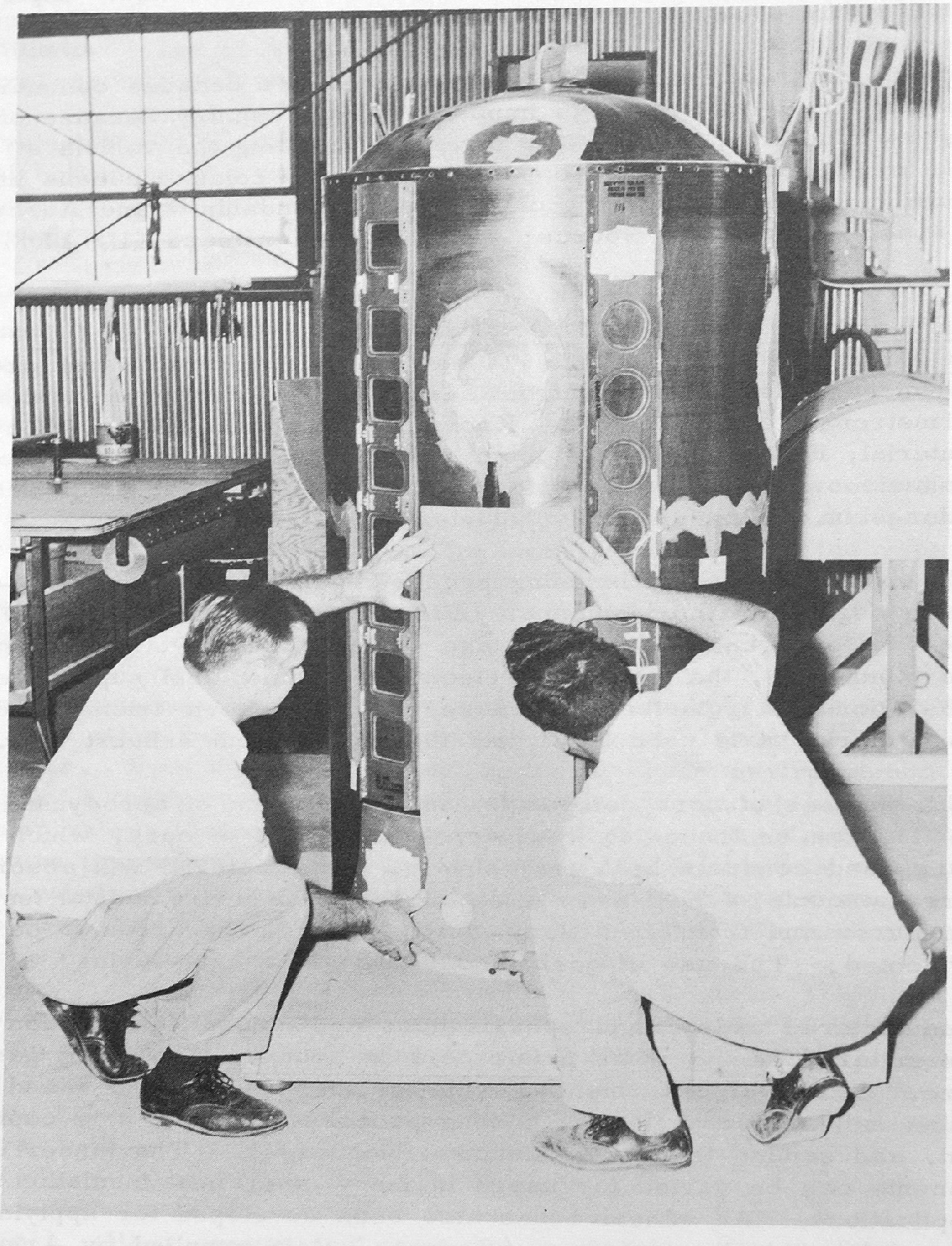

FIG. 1

NEW HIGH-VACUUM GETTER-ION PUMP ANNOUNCED. A new high-vacuum getter-ion pump is announced by Consolidated Vacuum Corporation. With a capacity for pumping air at 100 liters/sec, the pump is particularly useful in applications requiring systems free of organic vapors, continuous pumping, ultra-high vacuum, and high reliability or fail-safe features.

The new pump (Fig. 2) has a unique triode design and can handle inert gases five times as efficiently as slotted-cathode diode pumps, and twenty-five times as efficiently as diode pumps with plane cathodes.

The device has rapid recovery from short-duration, high-pressure gas loads, and can pump at speeds 50 per cent to 100 per cent greater than its rated speed for 2- or 3-min periods.

Power regulation is automatic for efficient operation during pressure fluctuations. A circuit breaker provides protection against short circuits or accidental exposure to high pressure. (Source: Data supplied by Consolidated Vacuum Corporation)

NEW MANUAL GUN FOR CO_2 WELDING OF THIN GAGE METALS. A new and improved air-cooled welding gun--designed specifically for "dip transfer" CO_2 welding of thin gage metals--has been announced by Air Reduction Company. This new manual gun (Fig. 3) offers qualities well suited for automotive and other mild steel fabricator applications.

The new low-cost welding gun has a 60-deg "gooseneck" design. It is light in weight, reducing operator fatigue through the ease of access to difficult welding locations. For greater flexibility, the gun hose and cables have been extended to 3.6 m (12 ft) in length. The manual gun can handle 3 steel wire sizes 0.075, 0.089, and 0.115 cm (0.030, 0.035, and 0.045 in.) in diameter, and is rated at 200 amp dc reverse polarity at 100 per cent duty cycle. (Source: Data supplied by Air Reduction Company, Inc.)

TECHNICAL REPORTS AVAILABLE. The following listed technical reports can be requested through the NASA library, M-MS-IPL, Bldg. 4481.

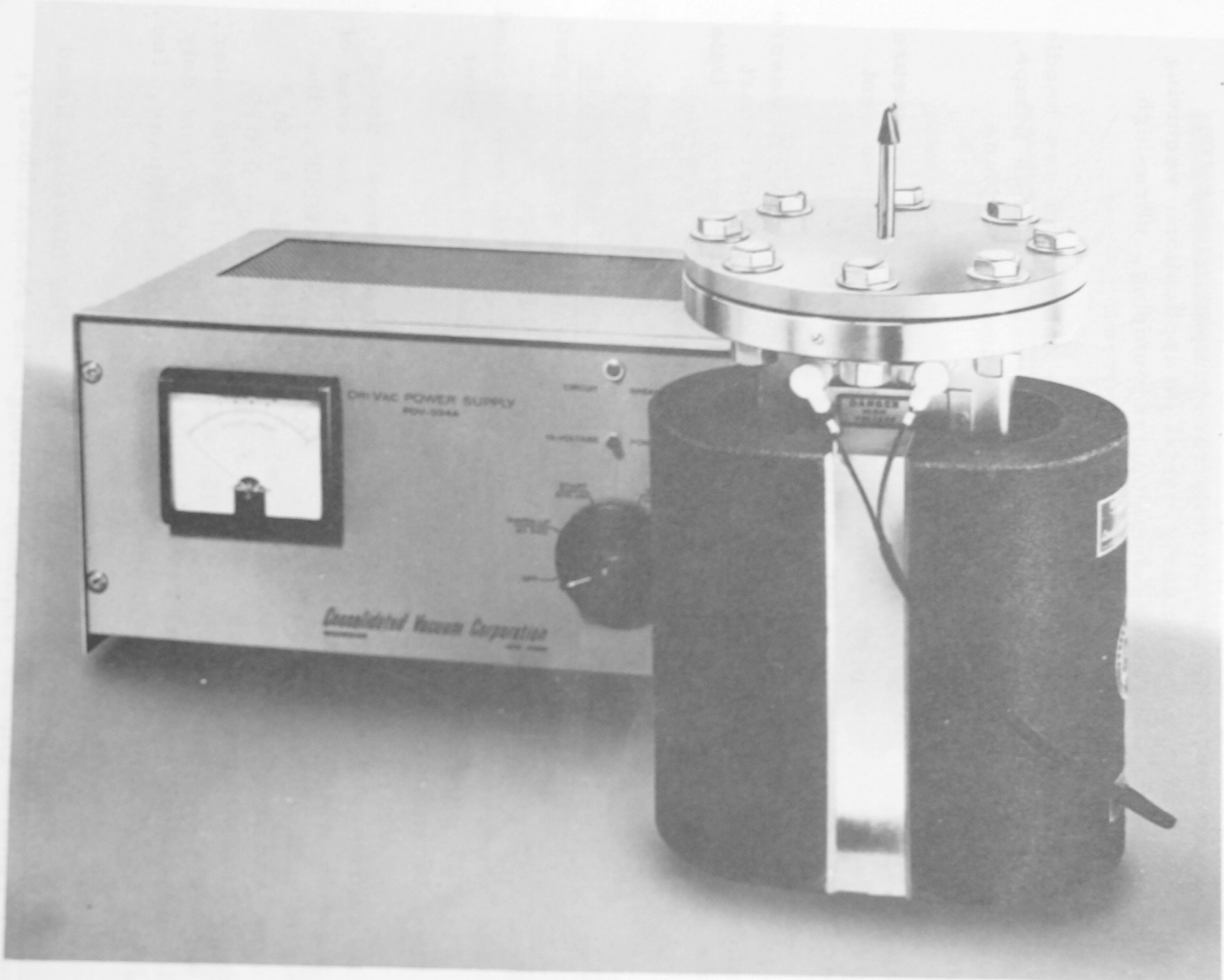
DRI-VAC POWER SUPPLY
Consolidated Vacuum Corporation
DANGER

FIG. 2

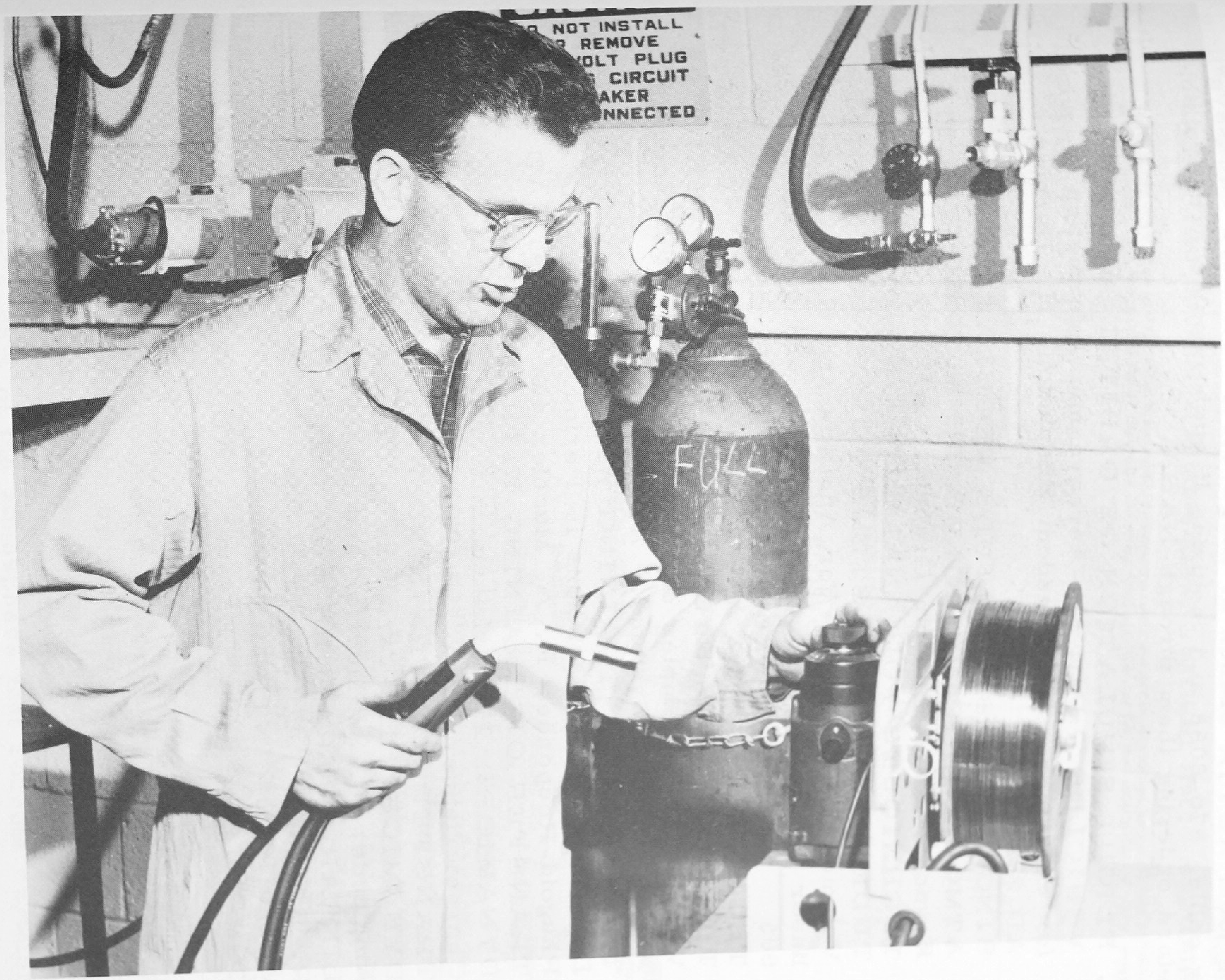

FIG. 3

NOTE: Those reports with an AD number may be on file in the local ASTIA branch in Bldg. 4484. Readers can save time by calling 876-6088 and inquiring if such reports are available before ordering them through NASA.

1. FLIGHT SIMULATION OF ORBITAL AND REENTRY VEHICLES. Part II--Aerodynamic Information Required for Six Degrees of Freedom Simulation, H. Burning. AD 282 995
2. SINGLE AXIS ATTITUDE REGULATION OF EXTRA ATMOSPHERIC VEHICLES, R. A. Peters, V. J. Kovacevich and Dunstan Graham. AD 277 221
3. TECHNIQUES FOR ANALYSIS OF NONLINEAR ATTITUDE CONTROL SYSTEMS FOR SPACE VEHICLES. Volume II, Techniques for Analysis and Synthesis of Nonlinear Control Systems, E. I. Ergin and others. AD 282 805
4. TECHNIQUES FOR ANALYSIS OF NONLINEAR ATTITUDE CONTROL SYSTEMS FOR SPACE VEHICLES. Volume III, Examples of Analytical Design of Spacecraft Attitude Control Systems. AD 282 706
5. TRANSFER OF TRAINING WITH SIMULATED AIRCRAFT DYNAMICS: I-Variations in Period and Damping of the Phugoid Response, F. A. Muchler and others. AD 278 627
6. TRANSFER OF TRAINING WITH SIMULATED AIRCRAFT DYNAMICS: II-Variations in Control Gain and Phugoid Characteristics, F. A. Muckler and others. AD 278 613
7. TRANSFER OF TRAINING WITH SIMULATED AIRCRAFT DYNAMICS: III-Variations in Course Complexity and Amplitude, F. A. Muckler and others. AD 278 623
8. LINEAR OPERATORS FOR DATA PROCESSING, R. E. Lane. AD 278 143
9. MULTIPLE INTEGRATIONS ON A REAL TIME ANALOG COMPUTER, Arthur Hausner. AD 282 524