Space TECHNICAL INFORMATION DIGEST

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

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IN THIS ISSUE

APOLLO LAUNCH ESCAPE MOTOR FIRED. Lockheed Propulsion Company has successfully test-fired an Apollo launch escape motor (Fig. 1), which is the rocket designed to safeguard astronauts during the launch phase. Ignition under near-vacuum conditions simulated firing at the highest altitude expected in an actual manned flight. The company announced the firing on January 31, 1963.

Four previous successful firings, conducted in recent weeks, have duplicated other expected environmental extremes. These firings were all conducted at normal atmospheric pressure of

FIG. 1

the test base, which is located about 610 m (2000 ft) above sea level. The motor temperatures were 22° C (70° F), -5° C (20° F), 60° C (140° F), and -5° C (20° F), respectively. The fourth firing followed weeks of cycling through temperature extremes of 60° C (140° F) and -30° C (-20° F).

The test firings are part of a series aimed at "man-rating" the launch escape system well in advance of the first manned Apollo flight. Firings of motors after vibration and drop tests are scheduled to gain information on performance after subjection to these severe conditions.

In addition to the series of firings in a nose-down position (Fig. 1), the motor will be tested in a tethered, nose-up condition. Attachment to the Apollo operational spacecraft will be duplicated by a mounting atop an escape tower bolted to a steel plate which in turn is affixed to the concrete apron of the test bay.

The big new motor, 4.6 m long (15 ft long) and 66 cm (26 in.) in diameter, weighs over 2 tons. It is designed to thrust the three-man Apollo command module to safety in the event of trouble during initial launch or climb-out. (Source: Data supplied by Lockheed Aircraft Corporation)

THERMOELECTRIC CONVERTER UNDERGOES TEST FLIGHTS. A tiny thermoelectric converter, recently tested in orbital flight, shows promise as a new means of powering future spacecraft equipment, the Air Force Systems Command has announced.

Signals from the converter, received by ground telemetry stations for 4 days, confirmed that the converter was entirely successful in absorbing solar energy and changing it into electrical energy.

Comprising the converter are 36 thermoelectric elements, 0.1 x 0.1 x 0.25 cm (0.04 x 0.04 x 0.1 in.), sandwiched between two thin metal sheets. One sheet collects solar energy; the other operates as a waste heat radiator. (The thermoelectric elements are made of P-type zinc antimonide and N-type lead telluride.)

In operation, the collector sheet absorbs solar energy and then produces heat. The heat travels through the thermoelectric elements where part of it is converted into electrical energy. Excess heat is emitted into space by the radiator.

In explaining the test, Charles Glassburn, a project engineer, said: "The electrical energy generated in the experiment was small because of the limited size of the converter, but the test was considered a major step in proving this concept of converting solar energy into power for use in aerospace vehicles.

"The thermoelectric converter offers advantages over presently-used silicon solar cells. Resistant to radiation damage, it will not be affected by radiation belts which surround the Earth. In addition, cost and weight probably will be less than for the silicon type." (Source: AFSC news release (USAF))

PER "ATTO" AD "TERA." The National Bureau of Standards (NBS) has announced a revised list of prefixes for numerical multiples and submultiples. The new list follows the 1962 action of the International Committee on Weights and Measures, and is shown below.

OFFICIAL DESIGNATION FOR DECIMAL PREFIXES

Order	Prefix	Symbol
10^{12}	tera	T
10^{9}	giga	G
10^{6}	mega	M
10^{3}	kilo	k
10^{2}	hecto	h
10	deka	da
10^{-1}	deci	d
10^{-2}	centi	c
10^{-3}	milli	m
10^{-6}	micro	μ

10^{-9}	nano	n
10^{-12}	pico	p
10^{-15}	femto	f
10^{-18}	atto	a

The above list (with the exception of "nano"), as it appears in February's International Science and Technology, is commented on thusly: "The list seen on page 91 is about 2.1 atto-parsecs long (i.e. 0.6 gigaangstroms); in terms of the still well-entrenched fathom-furlong-fortnite system, this is about 0.37 micro miles or 123 nanoleagues.

"Still not on the official list (but we don't know for how long) are George Gamow's google [sic] (10^{100}) and googleplex (google ^{10})." (Source: International Science and Technology, February 1963)

3-YEAR STUDY MADE OF TEKTITES. A 3-yr tektite research program is described by G. S. Hawkins (Boston University, Smithsonian Astrophysical Observatory, and Harvard College Observatory) in a recent issue of the Journal of Geophysical Research.

At the program's inception in 1959, published information on tektites was plentiful but inconclusive. The locations of many tektite fields were known--a new location was later found at Martha's Vineyard (1961). Tektites were known to have the gross chemical characteristics of silica and alumina fused into an inhomogeneous glass; they were known to be of many shapes (spheres, teardrops, and others), suggestive of solidification in free fall or suspension; and they were also known to have a mass very rarely in excess of 1 kg (2.1 lb). The theoretical origin of tektites ranged from the astronomical to the terrestrial.

A field survey was made in Texas, Georgia, and southern states along the Jackson formation. C. Kaye et al. (Bulletin of the Geological Society of America, Vol. 72, p. 339) reported the discovery of a tektite at Gay Head, Martha's Vineyard, where exposed sediments range in age from 1×10^6 to 6×10^7 yr.

A glass was fused from sandstone taken from some of the tektite fields, the intense heat having been provided by a solar furnace producing an average energy of $1.6 \pm 0.3 \times 10^4$ joules/g. The glass that was produced resembled tektite material in many respects; however, the bulk density was significantly different, and was attributed to the bubble content.

In ablation experiments carried out in a plasma jet, it was found that a stable flange could not be produced at the relatively low Mach number of 0.47. (The molded shape of some tektites suggest forms characteristic of hypersonic flight through the Earth's atmosphere.)

The new evidence is combined with existing data in a logic table for an evaluation of tektite origin. On the basis of these data, interpretations are adduced to show that tektites originate from terrestrial impacts caused by meteorites. (Source: Journal of Geophysical Research, February 1, 1963)

FUTURE OF LARGE EARTH-BOUND TELESCOPES DISCUSSED. Astronomers may well ask whether the 508-cm (200-in.) reflector-telescope at Palomar Mountain in California represents the limit in size of the "great reflectors." An answer may be forthcoming in the planned 600-cm (236-in.) reflector to be built somewhere in the USSR before 1975.

Optical difficulties caused by the atmosphere increase with the telescope's size; astronomy may benefit from future telescopes that are to operate above the Earth's atmosphere. If the instruments of space astronomy outperform Earth-bound telescopes, perhaps larger reflectors will be unnecessary (also see STID, January 14, 1963, Vol. 4, No. 2). However, telescopes of more optimum dimensions will probably continue to be constructed on Earth for practical reasons.

It has been suggested that Britain's 250-cm (98-in.) telescope, now under construction, be installed in Australia. Very few observatories with instruments of significant size exist in the Southern Hemisphere (see STID, January 28, 1963, Vol. 4, No. 3). The southern skies feature many celestial objects of special importance to astronomers, and invaluable information may be forthcoming through studies of this region.

Rapid progress in space research has provided astronomy with a new and most promising means for realizing goals that were regarded as fiction a few decades ago. The first launchings of relatively small space-telescopes, followed by the landing of a telescope on the Moon, are a likely possibility for the "more or less immediate future." (Source: Discovery, January 1963)

ENVIRONMENT CHAMBER SIMULATES CONDITIONS ON MOON. An environment chamber that is designed to simulate the lunar environment has been placed in operation at the Air Force Cambridge Laboratories. The cylindrical chamber is 61 cm (24 in.) long and has a diameter of 36 cm (14 in.).

The Moon's near-vacuum surface environment is simulated by chamber environment pressures of less than 2×10^{-10} torr (2×10^{-10} mm Hg); temperatures within the chamber can range from -150° to +134° C (-240° to +270° F). Three ports in the chamber permit the introduction of X-rays, alpha particles and ultraviolet radiation. The simulated environment closely approximates that on the Moon, although the radiation component exceeds solar radiation to accelerate the expected radiation phenomena.

It is also hoped that something may be learned about the properties of materials expected to be found on the Moon. Tektites, basalt, granodiorite, dunite, and serpentine will be studied; chondrites are already under investigation.

The materials are crushed to form a very fine powder before they are placed in the chamber--the particles will measure about 10 microns. Emphasis will be placed on studying the materials' emission and absorption spectra, their thermal conductivity, and their mechanical properties. (Source: OAR, Research Review, February 11, 1963)

LUNAR SURFACE ROVER DESCRIBED. Chrysler Corporation scientists have described "a practical approach to surface exploration of the Moon." A roving 2-passenger lunar vehicle was recently detailed at the national meeting of the Society of Automotive Engineers in Detroit. The description included the propulsion system, power sources, protective measures, mobility and reliability.

Company spokesmen said that a six-wheeled vehicle, powered by liquid hydrogen and oxygen, would be able to climb across crevasses and travel over the Moon's "powdery" surface. The vehicle would contain a life-support system for two men for up to 24 hr.

The design and shape of the lunar vehicle was determined after hundreds of tests under conditions that are believed to exist on the Moon. A rectangular cab is provided for two astronauts and contains the power sources and climate conditioning to keep them alive and safe. The front of the cab has two circular openings for viewing the Moon's surface. A periscope on top would turn 360 deg for additional visibility. Two radar and radio antennas would be used for communication. Four wide metal wheels extend from the four corners of the cab on simple axles; two other wheels on movable arms at the sides are individually powered.

The model shown at the meeting (Fig. 2) is one-quarter the size of the proposed lunar vehicle (approximately 3.7 m (12 ft) long; 230 cm (90 in.) wide from wheel to wheel; 218 cm (86 in.) to the top of the cab; and 3.4 m (11 ft) to the top of the radar towers).

The capsule would have ample room for two astronauts in space suits. A large front doorway, with two visual ports with controls for dimming light, provides exit and entry. The rotatable periscope is coupled to a camera and a spotlight. Vehicle control would be provided by a single center-mounted lever moved laterally for steering and forward and backward for acceleration and braking. Navigation, communication and scientific equipment, and other components to provide Earth atmospheric conditions would be placed in the crew compartment for easy servicing. Fuel, oxidizer and power plant would be placed in separate compartments. Safety shielding would account for a high percentage of the total weight. The Moon car would weigh 1800 kg (3800 lb) on Earth, but only about 295 kg (650 lb) on the Moon's surface because of reduced gravity.

Extensive tests of mobility over simulated lunar soils were made by powered models of both wheeled and tracked vehicles, it was reported. Each of the four corner wheels would be 1.55 m (5 ft) in diameter. The disks are silvered on the outside and black on the inside to dissipate heat generated in the wheel motor

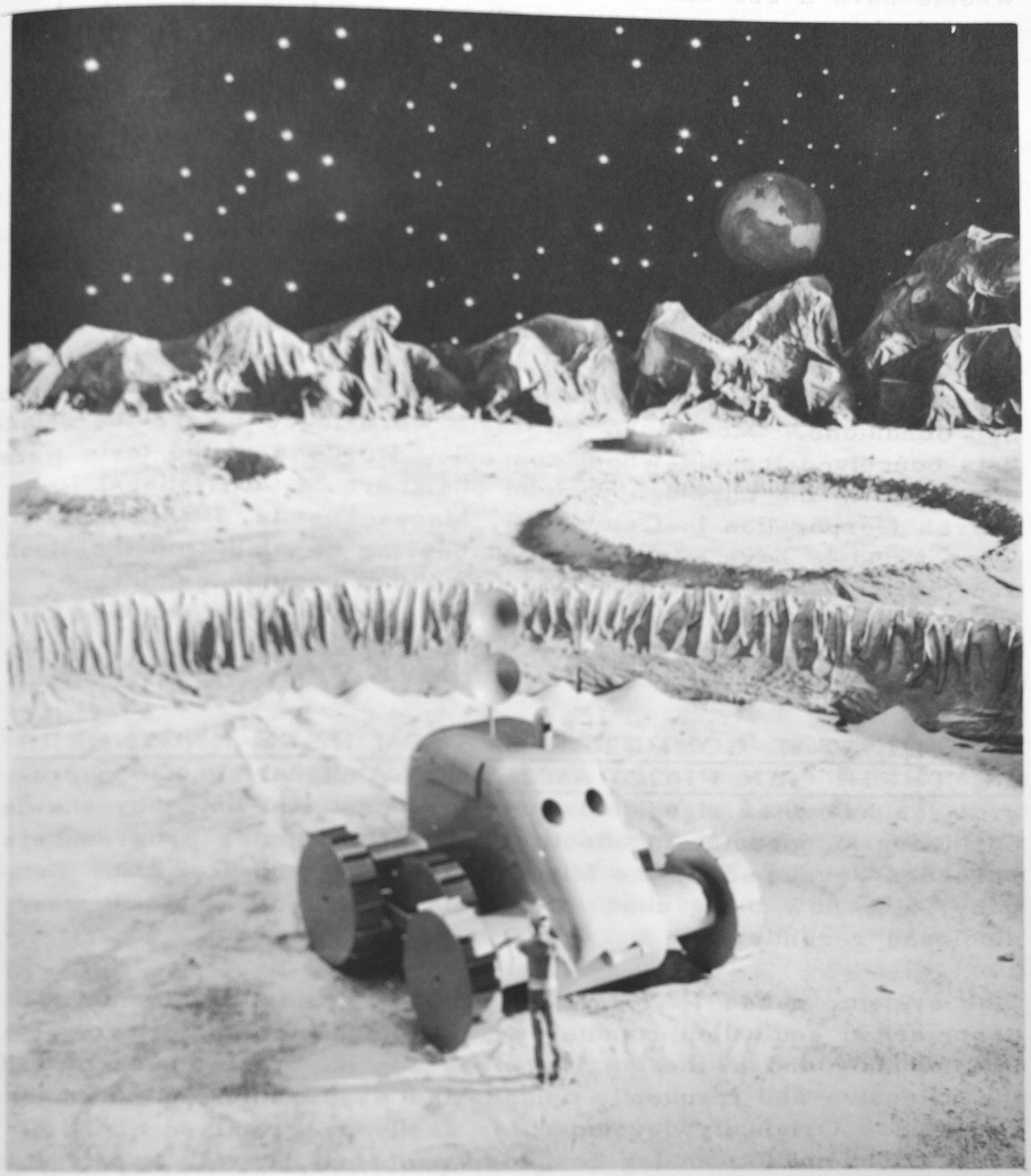

FIG. 2

and in the reduction gearing. Wheel rims attached to wide rings with multiple paddles would minimize the effort of its motion. The wheels have a 220-cm (80-in.) wheel base and a 46-cm (18-in.) ground clearance for mobility. The two smaller center wheels, mounted on arms, could be extended to raise the vehicle over obstacles and to aid in crossing crevasses. The engine is to be operated by liquid hydrogen and oxygen; it would provide 3 hp to the wheels and 1 hp to the accessories. Maximum speed would be 16 km/hr (10 mph).

A comprehensive study was made of soils most likely to be found on the lunar surface. These included basalt, pumice, rhyolite, scoria and volcanic tuff. Each of these rocks was crushed and pulverized to form the testing surfaces. Special equipment was constructed to test the soils under various loading conditions and the ability of various types of wheels and tractors to negotiate such soil conditions. More than 100 tests were made before the scientists conceived the six-wheel concept. Portions of the tests were conducted in the ultrahigh vacuum chambers of the National Research Corporation in Cambridge, Massachusetts. Soft soils were found to have a greater load bearing capability on the Moon than on the Earth. It was also found that vacuum conditions have marked effects on materials. (Source: Data supplied by Chrysler Corporation)

NEW DIGITAL COMPUTER SYSTEM LETS ENGINEERS BE THEIR OWN PROGRAMMERS. A digital simulation program said to offer significant savings in cost and time "by allowing engineers to become, in effect, their own computer programmers" has been developed by the Minneapolis-Honeywell Regulator Company; it is now being used extensively by that company, it was disclosed recently.

The system, called PARTNER (proof of analog results through a numerical equivalent routine), permits engineers to write problems quickly and in the language they can understand, thus avoiding the extensive and frequently complicated preparation that often is required. Originally developed for easily programmed digital check-solutions for analog computer problems, it was important to provide a PARTNER solution to a given problem before its analog simulation. Much better analog scaling was accomplished and problem checkout time was reduced. In addition, it gave increased confidence in analog results.

Advanced control systems often require simulation equipment such as a combined analog-digital computer. It was noted that such equipment is not always available to potential users. Another application of PARTNER was cited that was said to offer a fast and relatively inexpensive alternative: simulation by using only a digital computer.

This technique has solved many problems that could not be handled by analogs for a variety of reasons, such as the amount of equipment required, unusual types of nonlinearities, or time limitations imposed, for instance, by "one-shot" problems that don't justify an analog setup.

Among other features cited:

1. Short computer "turn-around" time because the system is a "load-and-go" program requiring only one computer pass.

2. Allowance for a group of PARTNER programs to be run in a batch.

3. Modification of a basic problem easily accomplished by adding necessary punched cards to the basic problem deck.

4. Simplified instruction codes to provide greater readability.

The Honeywell PARTNER program was described as being essentially a series of subroutines with each subroutine representing a particular transfer function or nonlinearity. The subroutines are combined into the program as called for by the specific problem at hand. Only one instruction is required for any function; the program solves the problem on a point-by-point basis with the output appearing as a listed time history of the selected variables. (Source: Data supplied by Minneapolis-Honeywell Regulator Co.)

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

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. REINFORCED PLASTIC COATINGS FOR THE PROTECTION OF STEEL SURFACES. FINAL REPORT. M. E. Phelps. AD 281 866
2. REINFORCED PLASTIC COATINGS FOR THE PROTECTION OF STEEL SURFACES, PROGRESS REPORT, M. E. Phelps. AD 281 865
3. DEVELOPMENT OF METHODS AND EQUIPMENT FOR BALANCING FLEXIBLE ROTORS. AD 276 476
4. WIDE-TEMPERATURE-RANGE SPRINGS, H. Gascoigne and others. AD 278 801
5. ORGANIC SEMICONDUCTORS, B. S. Wildi and E. R. Biehl. AD 277 494
6. AN INSTRUMENT FOR RESISTANCE MEASUREMENT OF SEMICONDUCTORS HAVING A LARGE SEEBECK COEFFICIENT, P. Shannon and K. E. Glick. PB 181 313
7. LASERS FOR AEROSPACE WEAPONRY, J. Sirons. AD 278 521