Space TECHNICAL INFORMATION DIGEST

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

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IN THIS ISSUE

ROCKET FIRED IN SIMULATED SPACE. A "bob-tailed" rocket engine (Fig. 1) that produces steam instead of thrust is being developed to test other rocket engines at Rocketdyne, a division of North American Aviation, Inc.

The unique engine is the product of a new space age requirement: the test firing of rocket engines in the simulated atmosphere of near space. That takes vast quantities of steam--enough to spin the turbines of the electrical power generators of a city of 1,600,000 persons.

FIG. 1

Company engineers are answering this challenge with a sawed-off engine. They call it a Hyperflow Steam Generator, but it is the combustion chamber of a rocket engine minus the narrow throat that normally supports propulsive reaction.

Instead of a bell-shaped nozzle, the combustion chamber is attached to a pipeline 0.6 m (2 ft) in dia and put to work in this way: Liquid oxygen and alcohol are injected into the combustion area and burned under pressure. They reach a temperature of 3000°C (5500°F)--roughly twice as hot as molten steel. Into this heat, water is sprayed at the rate of 460 liters/sec (122 gal/sec). It is quickly and completely converted into steam. Through the piping system, the steam is channeled past the mouth of a huge tank in which the engine to be tested has been enclosed. As the steam passes by, it sucks air from the tank and the space engine is ready to be test fired in the semi-vacuum it will encounter as it pushes upward from Earth.

The steam generating device is being developed specifically to test the J-2 rocket engine. Being produced under the technical direction of the Marshall Space Flight Center, the J-2 is the hydrogen-fueled engine that will power the second and third stages of the giant Apollo-carrying Saturn V vehicle.

Before a manned spacecraft is placed atop the J-2 powered stages, the engine will be tested hundreds of times in the simulation chamber. (Source: Data supplied by Rocketdyne, North American Aviation, Inc.)

SOLID-PROPELLANT ROCKET TEST STAND DESCRIBED.

A multimillion-dollar rocket test stand, the biggest of its kind for solid-propellant rockets, has been built at United Technology Center's facilities at Coyote, California. UTC is a division of United Aircraft Corporation.

The vertical test bay is 27.5m (95 ft) tall and is designed to handle motors of up to 17.8 million newtons (4 million lb) thrust. About 9900 m^3 (13,000 cu yd) of concrete weighing almost 24 million kg (52 million lb), and more than 925 tons of reinforcing steel went into its construction. The test stand's instrumentation is capable of measuring more than 350 different features of a rocket motor's performance, including thrust, pressure and vibration.

The new test bay consists of a concrete thrust pad 4.6 m (15 ft) thick and three concrete walls 27.5 m (95 ft) tall. Rocket motors will be fired "nozzle up" inside the walls.

The first major test in the new facility will be the firing of a five-segment, 300 cm (120-in.) dia, solid-propellant rocket motor which UTC is developing for the Air Force Titan III-C standard space launch vehicle. Two of the first-stage motors will give Titan III-C a liftoff thrust of more than 900,000 kg (2 million lb). (Source: Data supplied by United Technology Center/United Aircraft Corporation)

REFLEX KLYSTRON TUNES 500 Mc WITH "CONSTANT REFLECTOR VOLTAGE". A new reflex klystron, the SRX-424, can be tuned over a minimum frequency range of 500 Mc without adjusting the reflector voltage, according to an announcement by Sperry Electronic Tube Division.

The new oscillator (Fig. 2) incorporates a novel development termed constant reflector voltage (CRV). With reflector voltage optimized at any center frequency between 8750 and 10,250 Gc (Fig. 3), the tube can be mechanically tuned a minimum of ± 250 Mc while delivering a guaranteed 20 mw. The klystron is matched for optimum CRV operation at a center frequency of 10 Gc with minimum tuning range of ± 500 Mc. Matching circuitry can be modified to optimize operation at lower frequencies.

Unlike normal gap-tuned reflex klystrons, the CRV klystron is reported to require relatively small changes in reflector voltage to remain at mode peak as the tube is tuned. Output power remains above the 20 mw power point of the mode, eliminating the need of special circuits to "track" the mechanical tuning by changing reflector voltage. (Source: Data supplied by Sperry/Electronic Tube Division)

ONE-MAN SPACE SCOOTER SHOWS VERSATILITY. A working experimental model of a one-man "space scooter" has been flight tested successfully at North American Aviation's Space and Information Systems Division.

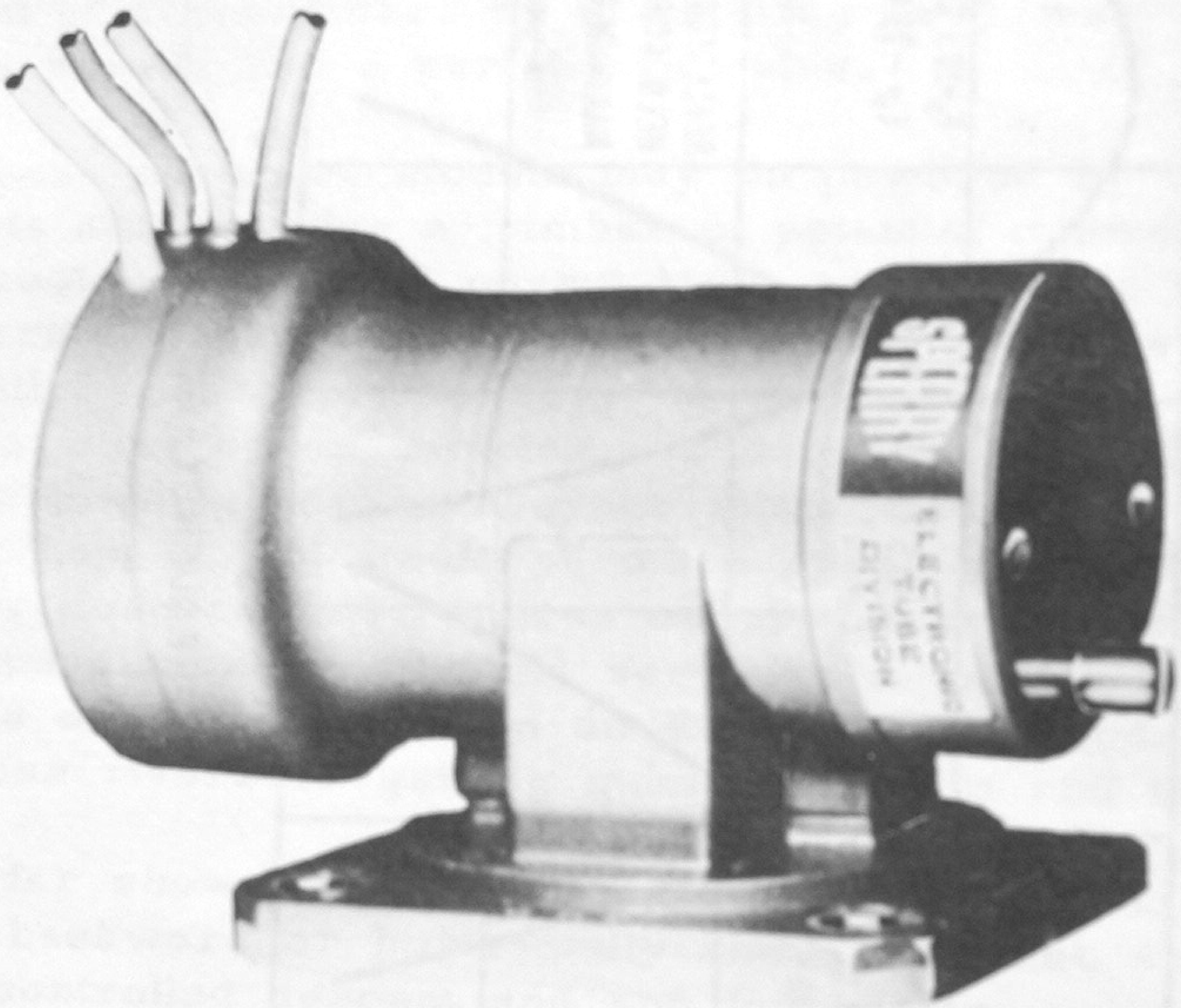

FIG. 2

CRV POWER OUTPUT VS FREQUENCY

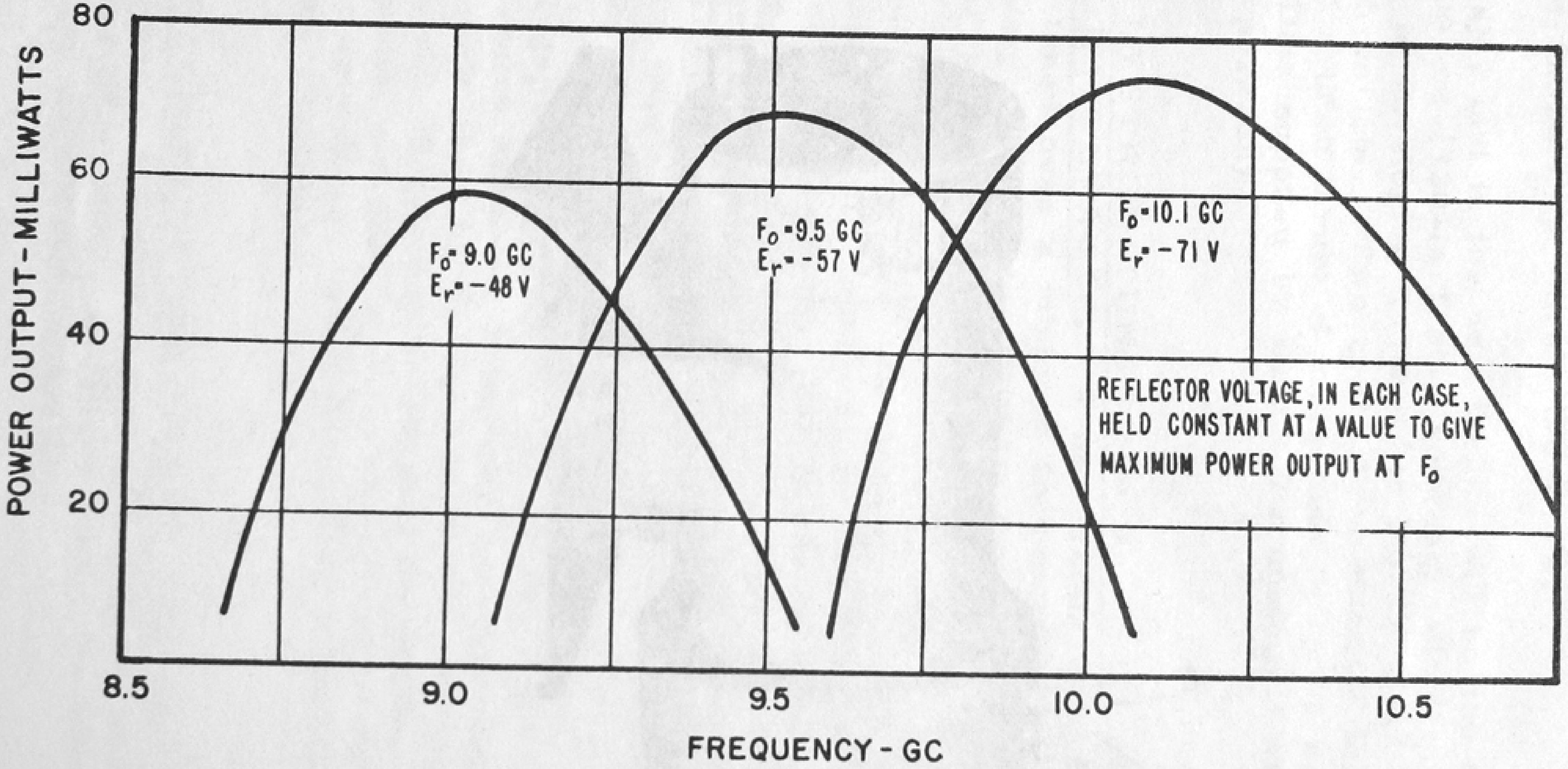

FIG. 3

The prototype vehicle (Fig. 4) and its 100 kg (210-lb) operator rose on a jet of air and performed horizontal and vertical maneuvers 6.1 m (20 ft) above the ground. Safety tethers and hoses carrying compressed air prevented it from rising higher.

The test vehicle which weighs 18 kg (40 lb) is made of aluminum tubing. The pilot stands on a 0.9 m (3 ft) circular platform and regulates the thrust with a twist-grip, scooter-like handle. The scooter has an exhaust nozzle and develops up to 120 kg (270 lb) of thrust with air supplied from a cluster of ground-based tanks. The jet of air directed downward supports the vehicle. Side movement is accomplished by shifting the body weight of the pilot, balancing himself like a surf-board rider.

Later, more advanced models may be powered by storable liquid propellants and promise a number of potential missions. As a "lunar scooter," it would permit Moon explorers to traverse flat, rough terrain where walking is difficult and where surface vehicles would stall. As a "shuttle bus," it could transport crew members between orbiting space vehicles, or it might be used to support man in assembling advanced space stations in Earth orbit. As a "crater hopper," it would permit a space-suited Moon explorer to span or descend into fissures or crevasses. Utilized as a "Lunescape climber," it would serve as a vehicle to scale steep cliffs. Its military application on Earth could include stringing lines across rivers or gaining quick access to cliff tops.

Tests so far show the vehicle can hover, rotate, accelerate forward, backward or horizontally and accomplish an accelerated climb or controlled descent and soft touchdown.

"Precision control of jet-propelled platforms can be learned in a few minutes' flight time," said an engineer. "The propulsive power (push) is utilized as a brake in forward motion by pointing the thrust in that direction."

A more advanced space scooter under consideration would contain a rocket engine powered by a mixed hydrozene based fuel and nitrogen tetroxide, described as good storable and stable propellants. The reaction control engine would weigh less than 2.2 kg (10 lb). Total estimated thrust would be 270 kg (600 lb), with a horizontal Earth speed of 32 km/hr (20 mph), and 40 km (25 mi) range.

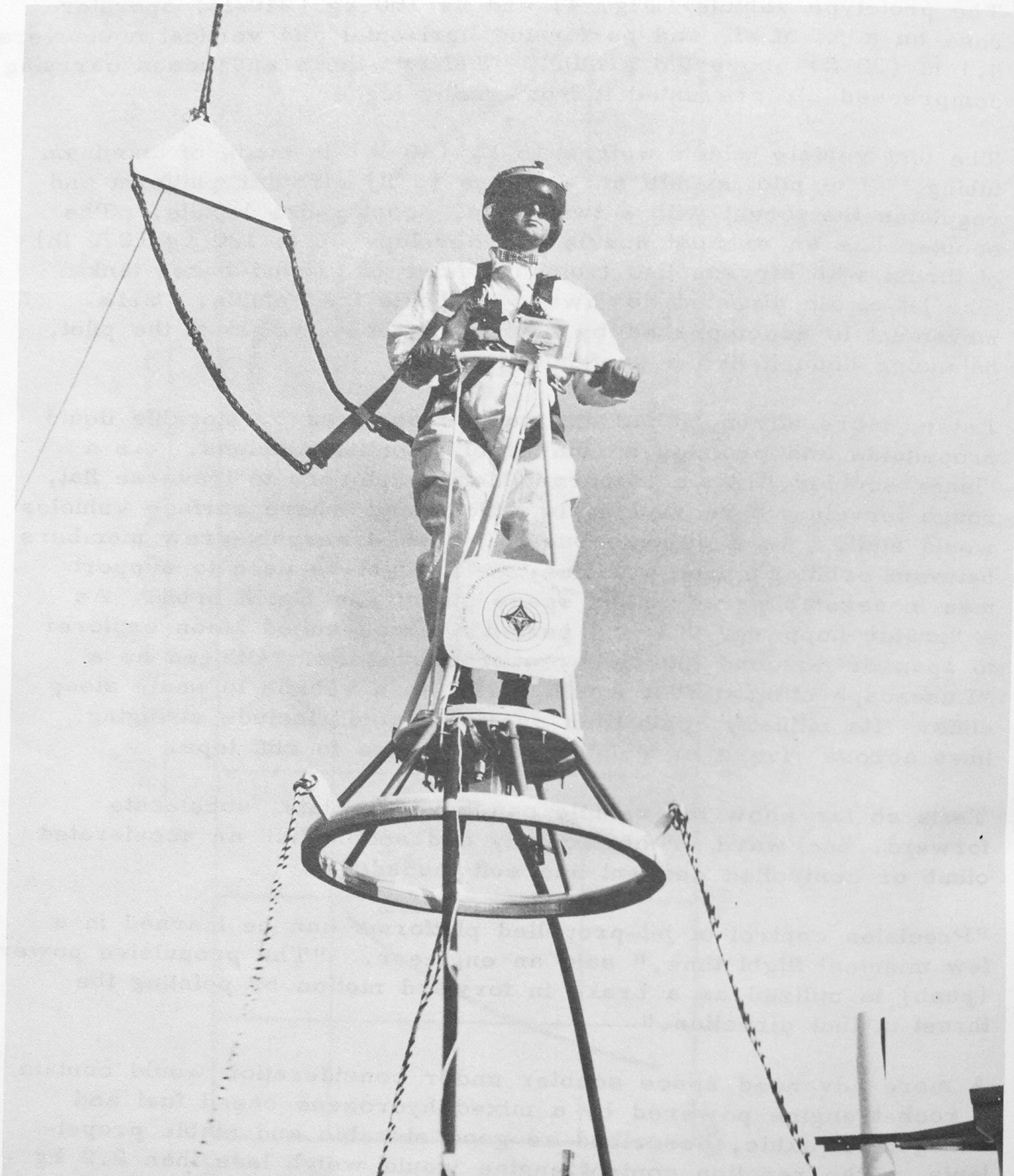

FIG. 4

The space pilot could operate the space scooter manually in free space or on the Moon. (Source: Data supplied by North American Aviation, Inc.)

POWER CONDITIONER DEVELOPED FOR SNAP-13 THERMIONIC NUCLEAR GENERATOR. The first thermionic nuclear power conditioner--a device for boosting characteristically low thermionic generator voltages and maintaining dc power at a constant level throughout the design life of the generator--has been produced by Martin Company's Electronic Systems & Products Division.

The conditioner, also called a "dc-to-dc converter," was developed for the SNAP-13 nuclear generator being built by the company for the Atomic Energy Commission. The conditioner steps up a low level and previously unusable 1-v input to a useful and steady 28-v output.

Company specialists claim 70 per cent efficiency for the conditioner, achieved by techniques that included the use of a special switching unit, a novel regulating system, and thermoelectric coolers that rid the device of excess electrical energy developed by the nuclear generator. The engineers also report they have devised ways of approaching 80 per cent efficiency in future conditioners of this type.

SNAP-13 (for Systems for Nuclear Auxiliary Power) is a proof-of-principle generator aimed at demonstrating the feasibility of applying radioisotopic heat sources to thermionic conversion. The 1.8 kg (4-lb) SNAP-13 is designed to produce 12 w, compared to 2 w/kg (1 w/lb) produced by existing thermoelectric generators. (Source: Data supplied by The Martin Company)

HIGH-SPEED EVENTS RECORDED WITH ROTATING MIRROR, KERR CELL CAMERA. High speed rotating mirror framing cameras are useful instruments for analyzing events such as explosions, shockwaves, and transient electrical discharges. Advantages include high image quality, a long sequence of frames, and speeds up to 8 million frames per sec. Disadvantages include a small optical opening, and the necessity that the event to be recorded is triggered by a signal from the camera, thus timing the event to occur when the mirror is in position to image the event onto the filmstrip. (These disadvantages have been overcome in part by developments that include camera openings up to f/4 and continuous access cameras.)

The need for a primary or gating shutter is another difficulty; assuming a mirror speed of 10,000 rps, the sequence of frames must be exposed in about 12 μsec if film strip length corresponds to 90 deg of the reflected light beam revolution, or to 1/8 of a mirror revolution. The gating shutter is needed to interrupt the light path after one exposure; otherwise, the rotating mirror will continue to expose the film on subsequent revolutions.

The conventional solution to this latter problem is the blast shutter: Plane parallel glass, mounted in the light path is shattered by explosives blocking the light in a few μsec. Other gating shutters use strong transient magnetic fields that either rapidly deform aluminum foil to close or open the light path or to turn a thin membrane into or out of the light path.

If it is desired to record a transient electrical discharge superimposed on a very bright continuous electrical arc, none of the above mentioned shutters meet the requirements. A shutter is needed that opens and closes during the interval of one mirror revolution. To eliminate unwanted mirror reflections, the "open" interval should not be longer than the recording time.

In an experiment at the Plasma Physics Research Laboratory (USAF Aerospace Research Laboratories), a Kerr cell shutter was used with the rotating mirror camera to record a transient electrical discharge. Light from the pulse discharge permitted the use of the Kerr cell shutter (light transmission through an open Kerr cell is only 6-7 per cent).

In operation, an exposure is made as follows: When the mirror reaches the desired speed, a mechanical shutter is released by an electromagnetic actuator. Just before the shutter opens fully, an electrical contact activates the main trigger circuitry that generates a gate pulse, indicating the time when the shutter is fully open. This pulse gates the inductive pickup pulses from the mirror; this indicates when the mirror is in recording position. The first mirror pulse passing the gate triggers the Kerr cell and also the event, such as a capacitor discharge, at the proper time. (Source: OAR Research Review (USAF), July 1, 1962)

TECHNICAL REPORTS AVAILABLE. The following listed technical reports can be requested through the NASA library, M-MS-IPL, Bldg. 4200.

NOTE: Those reports with an AD number may be on file in the local DDC 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. RESEARCH ON FOG-RESISTANT MATERIALS FOR HIGH-ALTITUDE HELMET VISORS, K. Gutfreund. AD 295 847
2. INVESTIGATION OF A PERSONNEL RESTRAINT SYSTEM FOR ADVANCED MANNED FLIGHT VEHICLES, H. E. Freeman et al. AD 296 896
3. RESEARCH AND DEVELOPMENT ON HIGH-PRESSURE-HIGH-TEMPERATURE METALLURGY, S. A. Kulin et al. AD 287 200
4. EFFECT OF BASIC PHYSICAL PARAMETERS ON ENGINEERING PROPERTIES OF INTERMETALLICS, J. H. Westbrook and D. L. Wood. AD 286 880
5. FRICTION AND WEAR AT ELEVATED TEMPERATURES, E. Rabinowicz and M. Imai. AD 287 458
6. INVESTIGATION OF INTERMETALLIC COMPOUNDS FOR VERY HIGH TEMPERATURE APPLICATIONS, Jonathan Booker, R. M. Paine and A. J. Stonehouse. AD 284 945
7. THERMAL DIFFUSIVITY MEASUREMENTS ON METALS AND CERAMICS AT HIGH TEMPERATURES, R. L. Rudkin, W. J. Parker and R. J. Jenkins. AD 297 836
8. THEORY OF THE THERMAL CONDUCTIVITY OF METALS, ALLOYS AND SEMICONDUCTORS, J. R. Madigan. AD 297 505
9. LITERATURE SURVEY ON LIQUID METAL BOILING, J. A. Clark and others. PB 181 478
10. REACTIVITY OF METALS WITH LIQUID AND GASEOUS OXYGEN. AD 297 124
11. PERFORMANCE CRITERIA FOR LINEAR CONSTANT-COEFFICIENT SYSTEMS WITH RANDOM INPUTS, R. Magdaleno and J. Wolkovitch. AD 297 805
12. ENGINEERING ANALYSIS METHODS FOR LINEAR TIME VARYING SYSTEMS, D. Graham et al. AD 298 062

13. WEATHER EXPOSURE DATA FOR HIGH TEMPERATURE COATINGS ON CHROMIUM HOT-WORK TOOL STEELS, G. W. Lawless. AD 293 219
14. CORROSION EVALUATION OF STAINLESS STEELS EXPOSED IN ICPP HIGH-LEVEL RADIOACTIVE WASTE TANKS, T. L. Hoffman. IDO 14600
15. FAILURE MECHANISMS IN SILICON SEMICONDUCTORS, H. J. Queisser. AD 297 033
16. FINAL REPORT FOR SEMICONDUCTOR RESISTIVE ELEMENT. AD 297 034
17. REVIEW OF ALUMINUM-IRON MAGNETIC ALLOYS AND ASSOCIATED SYSTEMS, H. H. Helms. AD 297 482
18. RESEARCH IN FERROMAGNETICS. AD 295 831
19. DYNAMICS OF WETTING IN BRAZING AND SOLDERING, C. M. Adams. AD 294 950
20. POWER CONVERSION BY ELECTRON CONVECTION, S. R. Hoh and W. L. Harries. AD 291 683
21. STATUS REPORT ON THERMOELECTRICITY. AD 290 222
22. DETERMINATION OF REQUIREMENTS FOR OVER-VOLTAGE AND OVERLOAD PROTECTION OF TRANSISTORS. AD 290 277
23. EFFECTS OF WEATHERING ON THE MECHANICAL PROPERTIES OF FOUR REINFORCED PLASTIC LAMINATES. AD 291 661
24. COMPARISON OF HIGH ENERGY RATE (DYNAPAK) AND CONVENTIONAL EXTRUSION OF REFRACTORY METALS. AD 288 019
25. VACUUM ARC MELTING OF A TUNGSTEN ALLOY (TUNGSTEN-MOLYBDENUM-COLUMBIUM). AD 290 635