Space TECHNICAL INFORMATION DIGEST

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

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IN THIS ISSUE

MICROWAVE GUIDANCE HAS MANY APPLICATIONS.

A flexible, mobile, and relatively simple guidance system called microwave command guidance (MCG) has been developed for the Air Force by Sperry Rand and may be adapted for use in future spacecraft. Originally developed for the Air Force during the early years of target drones such as the QF-80 and QF-47, the purpose of the system was to remotely control and to guide drone aircraft and vehicles within line of sight, over the horizon, and at altitudes above a few hundred feet. This objective was to be achieved without separate ground surveillance radar, radio-command, or telemetry receiving stations.

The MCG system was designed to be a transportable unit, a radar data link that integrated tracking, command, and telemetry within a single link that included data processing and display.

The central feature of MCG is a selective X-band radar digital data link. The system receives telemetry, and can detect, track, and command unmanned vehicles on a single link, enabling a controller to guide a pilotless vehicle by radar-derived data for guidance action; vehicle-derived telemetry data measures vehicle response.

Three functions make up the guidance subsystem: interrogation, command control, and display. The command control function is integrated into the director station-to-drone link by adding on a series of command pulses following the three-pulse interrogation code. Commands can be either single (up, down, right, left) or combinations, such as up-left.

Real-time readouts show the parameters of flight as they appear on standard aircraft instrumentation. Continuous plotting of the drone position is displayed by an X-Y coordinate computer driving a 75-cm-sq (30-in.-sq) vertically mounted plotting board. Radar slant range is computed to ground range, which is then resolved into X and Y components from angular antenna data. During usual missions, compensations are not required for atmospheric refraction and Earth's curvature.

Application for the MCG system is also seen in controlling the landing of the X-20 space glider. This space vehicle could be controlled by a modification that has been conceived for usage in the recovery operation by means of a larger MCG antenna for the director station to extend its range. The vehicle's velocity would be measured, and an altitude computer would be added to correct for atmospheric refraction and Earth's curvature. (Source: Sperry Engineering Review, April 1963)

OPTICAL TRANSISTORS ANNOUNCED. An optical transistor in which signals are carried by light rather than an electric current is revealed by IBM's Thomas J. Watson Research Center. While the new device is called a transistor and is made of gallium arsenide, it operates on an entirely different principle from that of the conventional transistor. A part of the input electrical energy is converted to light, which, after passing through the transistor, is absorbed. The electrons associated with the beam are then available at the collector as an output current, Fig. 1.

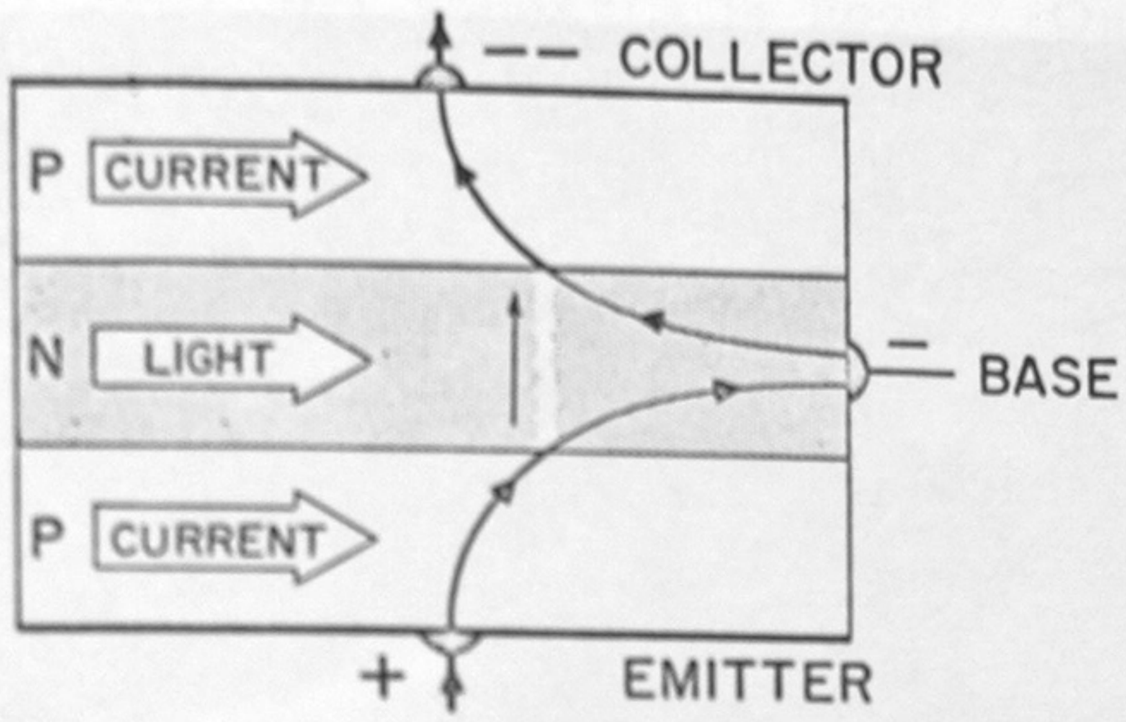

FIG. 1

The principle advantage of the new transistor is that it can be fabricated more easily than conventional transistors. Since the charges move through the base of the device at the speed of light, the base need not be very thin--as it is in conventional models.

The new optical transistor has been operated as an oscillator at a frequency of 1 Mc, but it is believed that operation in the kilomegacycle range is possible. Experimental models have also switched signals in 10 nanosec, with some power loss, in an inverting circuit.

Key to the development of the new transistor is the fact that gallium arsenide p-n junctions can absorb as well as emit light. Although they have very low current gains, such junctions at cryogenic temperatures show power gains up to 50 times. (Source: Computer Design, April 1963)

NEW LIGHTWEIGHT SILICONE ABLATIVE FOR EXTREME HEAT. A low-density, silicone rubber heat barrier material (Fig. 2) for use in missile, supersonic aircraft, and space vehicle applications has been announced by Dow Corning Corporation.

The material cures at room temperature to form a flexible blanket that bonds firmly to a wide variety of metals, plastics, and ceramics. The white substance forms a strong, dark-colored char when exposed to high heat fluxes. It swells as it chars, thus increasing the effective thickness of the shield. Resistance to accidental

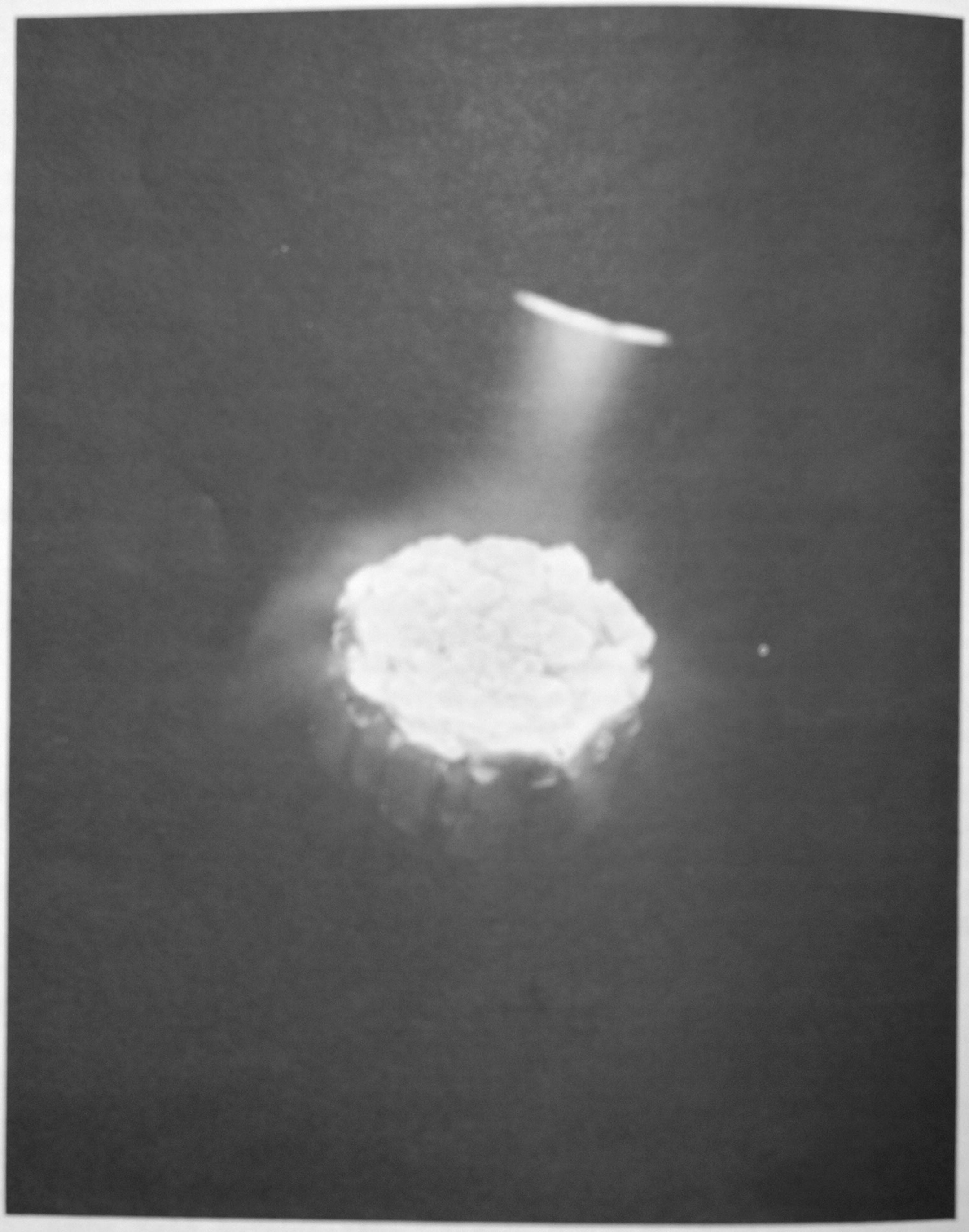

FIG. 2

splashes of fuels, oils, and oxidizers is good. Only slight swelling is noted on short term exposure to MIL-H-5606 hydraulic fluid or JP-4 fuel. Under splash conditions, the material is unaffected by short exposure to nitrogen tetroxide, unsymmetrical dimethyl hydrazine, and hydrogen peroxide.

The new substance has been selected for the heat shield on NASA's Gemini spacecraft. Selection came only after severe testing. Plasma jet tests covered a range of high to very high heat fluxes; other tests included exposure to fuels, oils, and oxidizers.

The material is called the most universally useful, effective, and reliable heat barrier tested for this installation to date. Per unit thickness, it weighs only about half as much as rigid reinforced plastics. Its flexibility protects it against thermally induced mechanical stresses that tend to destroy rigid materials. The substance is much easier to fabricate than rigid heat barrier constructions: it can be cast, troweled, or molded in place. (Source: Dow Corning Corporation)

NEW DIGITAL ENCODER ANNOUNCED. A new one-brush linear motion encoder--the first to provide absolute position output--has been developed by Perkin-Elmer Corporation, Norwalk, Connecticut. The compact unit (Fig. 3) is capable of converting any linear instrument movement to digital readout.

Used in a strip chart recorder, for example, the encoder can be easily mounted to pick off the absolute linear position of the recorder pen and convert pen movements to binary coded decimal signals for continuous digital readout. The new encoder provides 0-999 counts in its 28 cm (11-in.) length with an accuracy of better than one count.

Life of the unit is in excess of 4 million brush passes. Low starting force of the single brush permits attachment of the unit directly to recorders and other instruments without degradation of their performance.

Resolution is sufficiently high to permit use of encoder output for servo and control applications. High reliability is assured by simplified design based on a multi-layer printed circuit commutator.

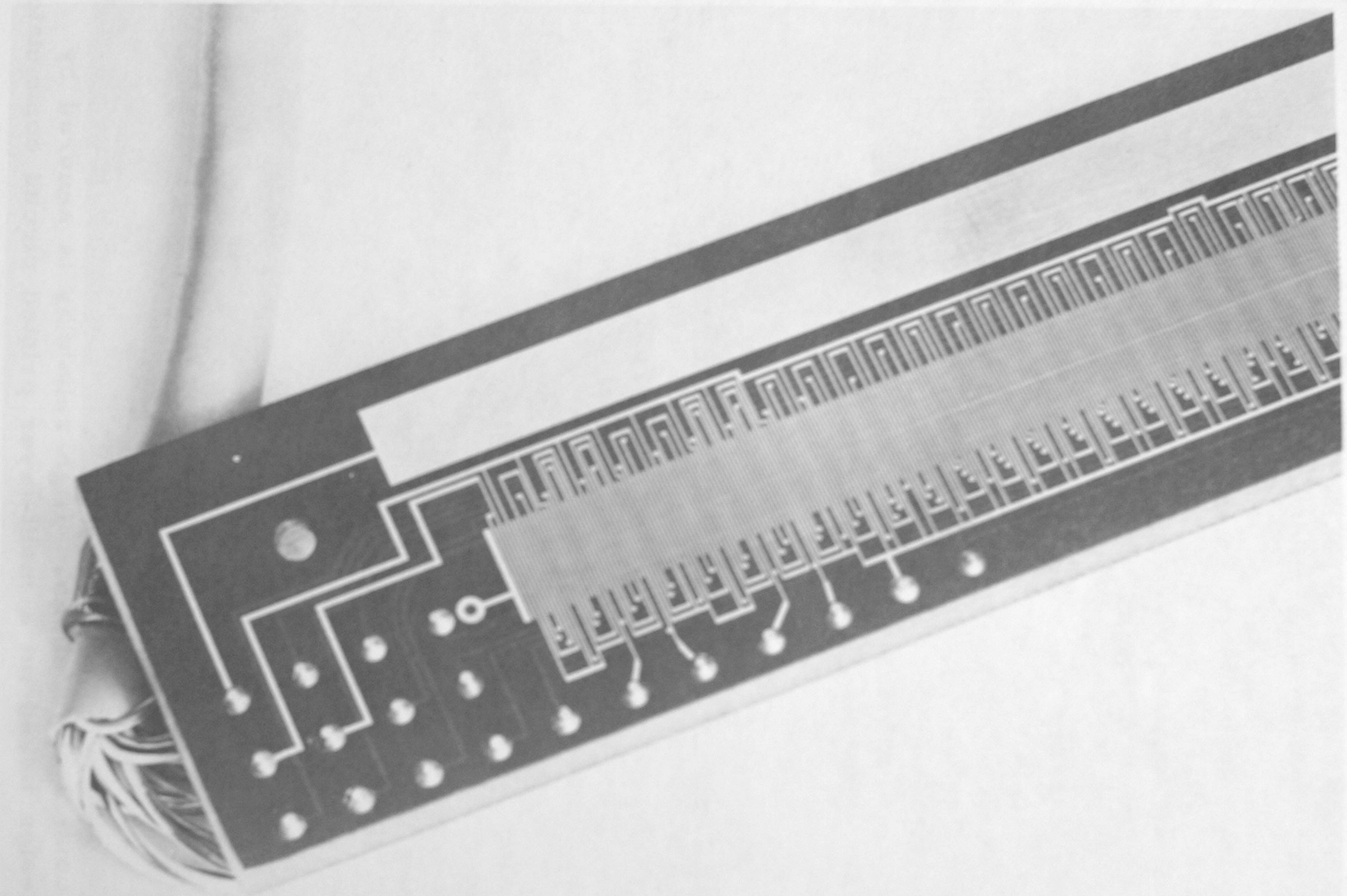

FIG. 3

Output of the encoder is generated at a solid state flip-flop register. Brush noise is eliminated as the moving brush has the sole function of changing the state of the bi-stable flip-flops within the register. These flip-flops are not subject to change because of contact bounce or other noise at the brush, and accurate linear indication is constantly assured. Starting force is extremely low (1 g) owing to the low mass of the single brush and holder.

The user has the option of locating zero at either end of the scale through toggle switch selection on the electronics package. Zero at scale center is available, and straight binary output also can be provided. (Source: Data supplied by Perkin-Elmer Corp.)

HUMAN FACTORS STRESSED IN TITAN 3-C DESIGN.

Ease of operation and maintenance for personnel who will work on the Titan 3-C missile are being provided by a United Technology staff headed by Dr. Steve Gale. The human factors group includes engineers, engineering psychologists, educators, social scientists, and an industrial designer.

How the team operates is illustrated by a specific problem: the best assembly procedure for the aft section of the rocket. Two alternatives were presented--attachment of the nozzle to the aft closure before slipping the aft skirt over the nozzle; and connecting the skirt and closure before the nozzle assembly.

The issue was approached by building a full-scale mockup of wood and cardboard to aid in determining:

1. Access to the aft skirt area for bolting the nozzle into position;
2. Hand- or foot-holds necessary for the technician while entering and leaving the work area;
3. Possible damage by the technician to components within the work area;
4. Working space needed to bolt the nozzle to the aft closure;
5. Illumination and ventilation requirements inside the enclosure;
6. The possible hazards caused by tools left behind;
7. The necessity of work platforms;
8. Alignment problems during the phase of lowering the nozzle over the aft closure.

During the mockup tests, it was necessary to find a man larger than 95 per cent of the future operators and maintenance crews; an average-size man would have represented only about 50 per cent of the potential workers.

Results of the tests indicated that the better assembly method was to attach the nozzle to the aft closure before slipping the aft skirt over the nozzle.

Human factors play an important role in the development of the 900,000-kg (2-million-lb) thrust vehicle. Each of the five-segment, solid-propellant rockets are designed with consideration for the men who will assemble, check out, maintain, and fire them. (Source: The Data Capsule, United Technology Center, May 1963)

NEW TEST CHAMBERS SAVE SPACE. Engineering in depth, incorporating a modular concept, with unusual reliability and space savings up to 30 per cent, is announced for the new line of environmental test chambers offered by Auto-Control Laboratories, Inc.

Units (Fig. 4) provide proved capabilities for temperature, humidity, altitude, space simulation, and combined environments with temperatures from -195°C to 520°C (-320°F to 1000°F), and a vacuum of 1×10^{-8} torr. All altitude chambers are capable of simulating 61,000 m (200,000 ft). Standard sizes are available in stock from 0.1 m^3 to 4.5 m^3 (1.6 ft^3 to 91 ft^3). (Source: Data supplied by Auto-Control Laboratories, Inc.)

WIRE FEEDER FOR WELDING OF ALUMINUM MARKETED. A new, low-cost compact wire feeder and control assembly (Fig. 5)--designed primarily for manual Aircomatic (gas-metal-arc) welding of aluminum--has just been announced by Air Reduction Sales Company. This new feeder combines rugged, lightweight construction with high wire-feed speed and scratch start option--features ideally suited for production line welding of aluminum. The unit can also be used for mild, alloy and stainless steel applications.

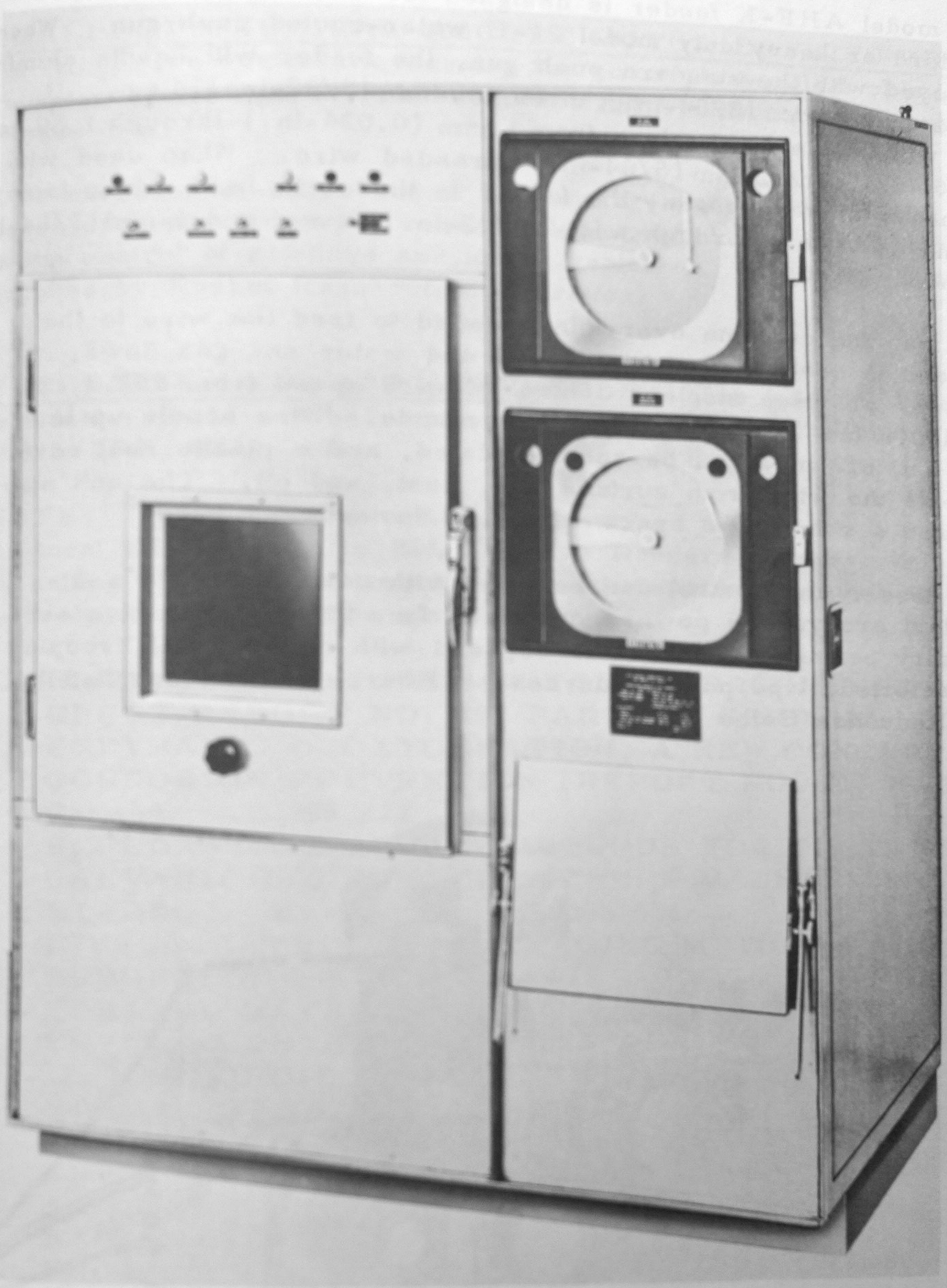

FIG. 4

The model AHF-K feeder is designed for use with either the standard or heavy duty model 21-B water-cooled push gun. When employed with the standard push gun, the feeder will handle aluminum wires from 1-mm (3/64-in.) through 2-mm (3/32-in.) diam. It also will handle hard wires from 1-mm (0.035-in.) through 1.59-mm (1/16-in.), and 2-mm (5/64-in.) stranded wire. When used with the heavy duty push gun, the feeder is limited to hard wires from 1-mm (0.045-in.) through 2-mm (3/32-in.) diam, and 2-mm (5/64-in.) stranded wire.

The machine contains everything needed to feed the wire to the gun and to control wire-feed speed and water and gas flows. The unit provides stepless control of wire speed from 292.1 cm to 1460.5 cm (115 to 575 in.) per minute. Wire spools up to 20.5 cm (12 in.) can be accommodated, and a plastic reel cover protects the wire from surface dirt, dust, and oil. The unit also features a solenoid to brake wire feed instantly.

Both feeder and control can be used with control voltage and constant arc voltage power sources. In addition, scratch start circuitry permits the feeder to be used with conventional drooping characteristic type power sources. (Source: Data supplied by Air Reduction Sales Co.)

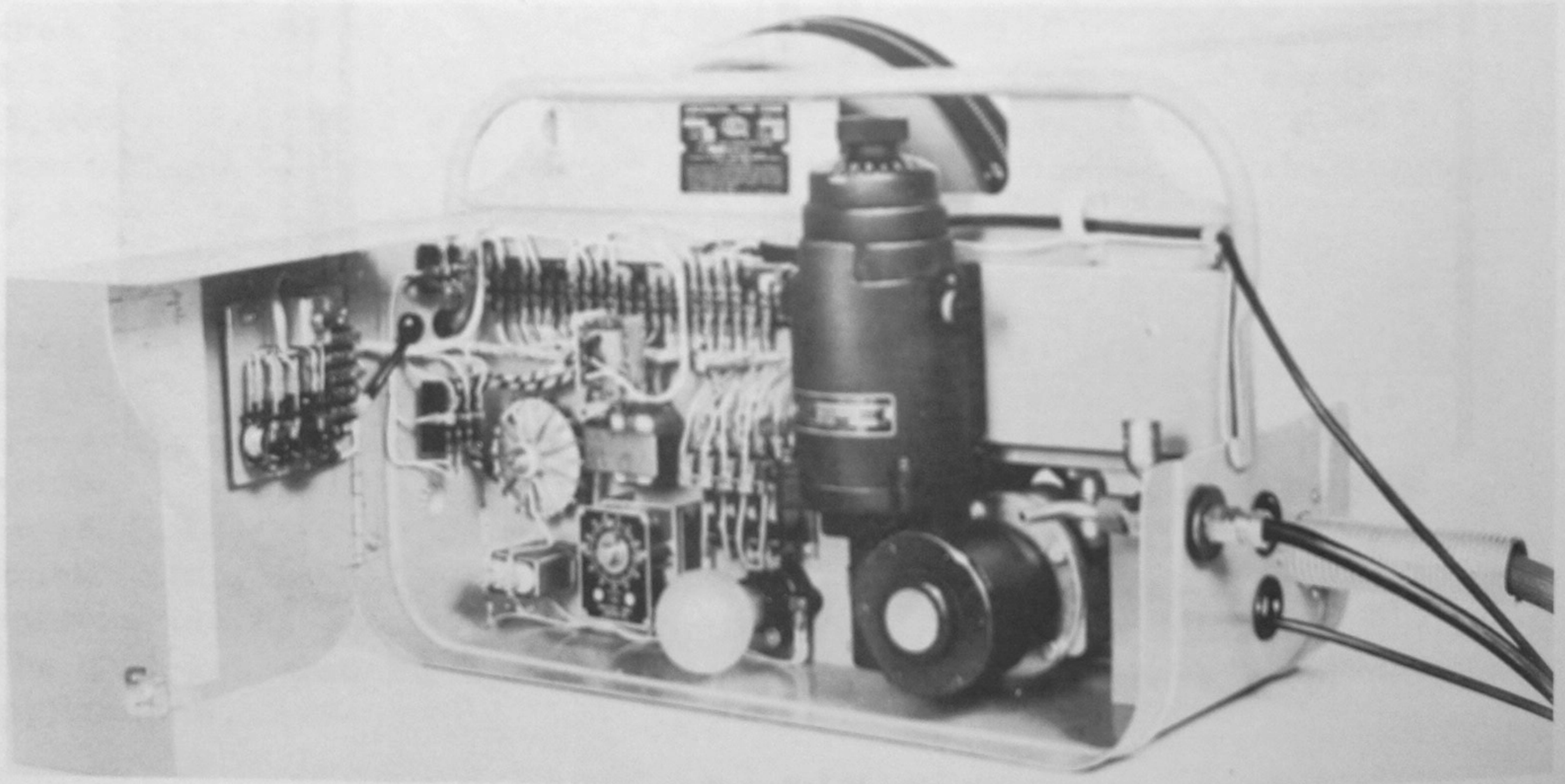

FIG. 5

SMALLEST CHEMICAL ROCKET MOTOR DEVELOPED.

An Air Force contract to develop the country's smallest chemical rocket engine (Fig. 6) has been received by Rocket Research Corporation.

This microrocket will use new high energy propellants and is based upon new concepts in rocket technology. Its intended use is the control of satellites and space vehicles. (Source: Data supplied by Rocket Research Corporation)

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 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. HIGH-TEMPERATURE MATERIALS PROGRAM, PROGRESS REPORT NO. 19, PART A. GEMP-19A
2. ENZYMATIC DEOXYGENATION, A NEW CONCEPT IN CORROSION PREVENTION (REPORT NO. 2), W. F. Garland. AD 296 824
3. EXPLORATION OF NEW METHODS FOR PREVENTING GALVANIC CORROSION BETWEEN MAGNESIUM AND STEEL, D. K. Stelling. AD 295 584
4. INVESTIGATION OF PACKAGING METHODS AND SUBMETHODS WITH VOLATILE-CORROSION-INHIBITOR TREATED MATERIALS, G. Pributsky. AD 295 474
5. ENVIRONMENTAL PROBLEMS OF SPACE FLIGHT, II, METEOROID HAZARD, J. R. Davidson and P. E. Sandorff. NASA N63-11986
6. THE ATMOSPHERE AS A PART OF THE SPACE ENVIRONMENT, R. A. Hord et al. NASA N63-12586
7. A MODEL OF THE QUIET IONOSPHERE, J. C. Seddon. NASA N63-12702
8. PROJECT SQUID, TECHNICAL REPORT CAL-86-P, COMBUSTION OF METALS, G. H. Markstein. AD 294 347
9. PROGRESS RELATING TO CIVILIAN APPLICATIONS DURING JULY, 1962, R. W. Dayton and R. F. Dickerson. BMI-1589

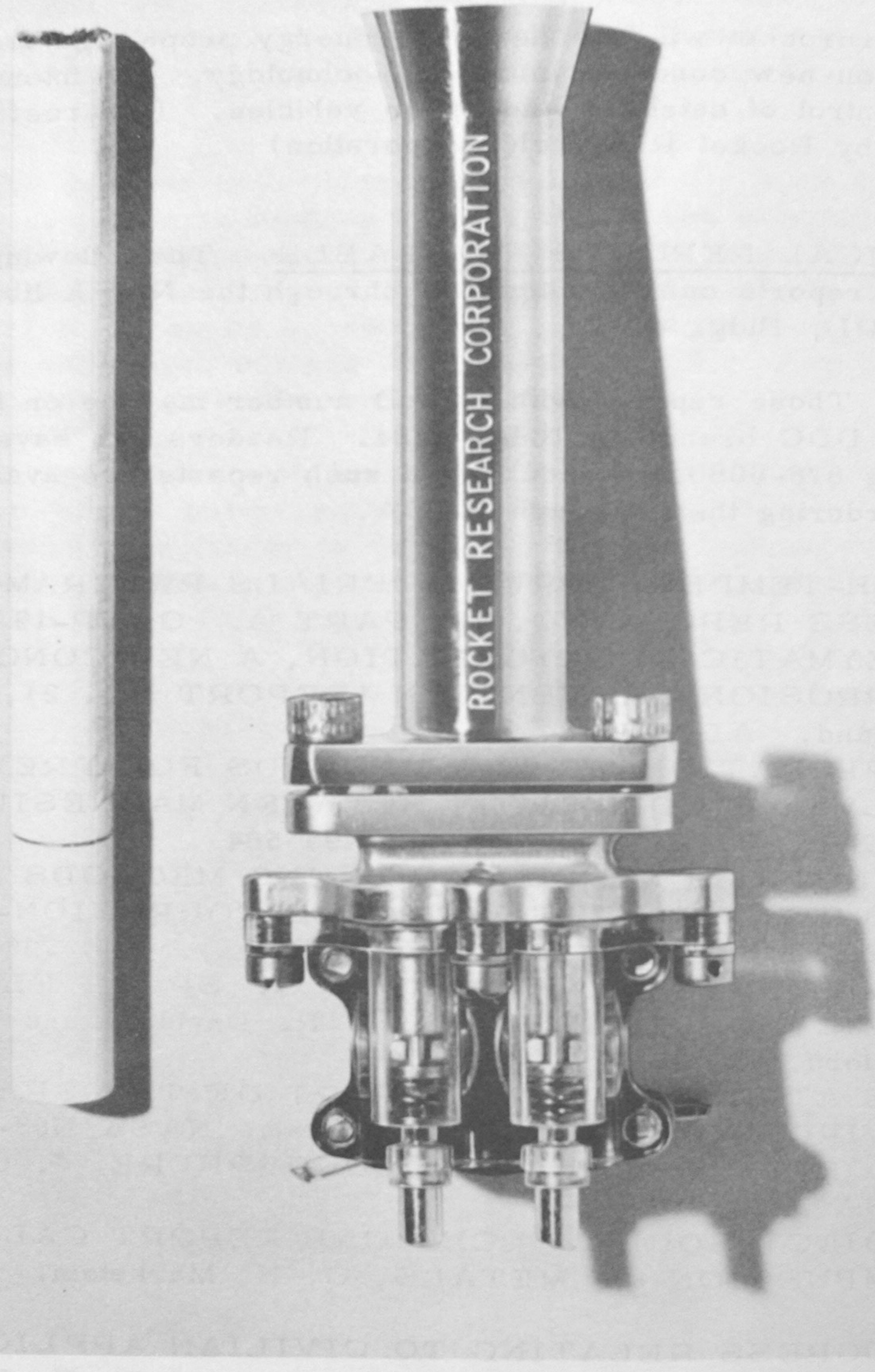

FIG. 6

10. PROGRESS RELATING TO CIVILIAN APPLICATIONS DURING OCTOBER, 1962, R. W. Dayton and R. F. Dickerson. BMI-1600
11. INVESTIGATION OF SELECTED HIGHER PLANTS AS GAS EXCHANGE MECHANISMS FOR CLOSED ECOLOGICAL SYSTEMS. AD 296 950
12. PHYSICAL AND CHEMICAL CHARACTERISTICS OF CHLOROPLAST FRAGMENTS, J. A. Gross et al. AD 296 951
13. STRUCTURAL ADHESIVES FOR METAL-TO-METAL BONDING (AN EVALUATION OF COMMERCIAL APPLICATIONS), W. A. Losoncy, Jr., and R. E. Greenlee. PB 181 405
14. EXPLORATORY INVESTIGATION OF PERFORMANCE OF EXPERIMENTAL FUEL-RICH HYDROGEN COMBUSTION SYSTEM, A. L. Smith and J. S. Grobman. NASA N63-12909
15. HAZARDS OF LIQUID HYDROGEN IN RESEARCH AND DEVELOPMENT FACILITIES, G. von Elbe and H. T. Scott, Jr. AD 294 451
16. STRUCTURAL METHODS IN THE THEORY OF CONTROL AND ELECTRIC AUTOMATION, A. S. Shatalov. 63-21759
17. STUDIES OF ON-STREAM PRODUCTION OF SHORT-LIVED INTRINSIC RADIOTRACERS FOR INDUSTRIAL PROCESS CONTROL, J. L. McFarling and others. BMI-1606
18. HANDBOOKS. A REPORT BIBLIOGRAPHY, E. H. Hall. AD 292 750
19. BIONICS AND RELATED RESEARCH. REPORT BIBLIOGRAPHY, K. M. Gibbs. AD 294 150
20. A STUDY OF ELECTRON BEAM WELDING, S. S. White. AD 294 585
21. DEVELOPMENT OF AUTOMATIC QUALITY CONTROL FOR RESISTANCE WELDS IN ALUMINUM ALLOYS, PHASE II, R. P. Hurlebaus, J. J. MacKinney and H. D. Van Sciver. AD 294 774
22. NAVY MICROELECTRONICS PROGRAM. AD 402 862
23. ALUMINUM HARD COATING OF ORDNANCE MATERIEL, R. H. Hill and T. M. Pochily. AD 293 275
24. AGING STUDY OF 2024 ALUMINUM BY DYNAMIC MODULUS TECHNIQUES, G. W. King. AD 292 269
25. A BIBLIOGRAPHY OF RUSSIAN LITERATURE IN THE FIELD OF MAGNETOHYDRODYNAMICS, F. Brown and R. Bernstein. AD 293 273

26. PARTICLE ACCELERATORS, PRINCIPLES, THEORY, AND DESIGN BIBLIOGRAPHY. AD 294 575
27. LITERATURE SURVEY ON SYNTHESIS, PROPERTIES AND APPLICATIONS OF SELECTED BORIDE COMPOUNDS, B. R. Emrich. AD 295 467
28. THE ROLE OF THE GRAIN BOUNDARY IN THE DEFORMATION OF CERAMIC MATERIALS, G. T. Murray, J. Silgailis and A. J. Mountvala. AD 295 551
29. SUPPLEMENT 1, COMPUTERS. SB-472
30. SUPPLEMENT 1, COMPUTER RELATED RESEARCH. SB-473
31. SUPPLEMENT 1, INFORMATION STORAGE AND RETRIEVAL. SB-475
32. MANAGEMENT PLANNING AND CONTROL TECHNIQUES; PERT, CPS, CPM, PEP, LESS, TOPS, CRAM, SCANS, COMET, PROMPT, ETC. SB-510