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RADIATION PARTICLE ACCELERATOR DEVELOPED.

Research scientists at Douglas Aircraft Company are duplicating space radiation hazards in the laboratory. Information provided by a long-barreled nuclear ray "gun" (Fig. 1) (a 150,000-v particle accelerator) is to help engineers design spacecraft and life support systems that will be able to withstand dangerous radiation showers.

Neutrons, protons, gamma rays, X-rays and electrons are being studied; protons and gamma rays are the product of solar flares, and protons and electrons are found in the Van Allen radiation belts.

Most knowledge about the effects of radiation is now obtained from rocket probes or satellites that pierce the cosmic ray and high-energy proton fields. Effectiveness of these data-collecting techniques will diminish, however, during the "Year of the Quiet Sun," which is a period of minimum solar activity that will begin in January, 1964. To help fill this data gap, the accelerator will be used to determine the effects of radiation bombardment on mammal tissue and metals and propellants, as well as the effects on space vehicle support systems, such as lubricants and electrical components. These data will be factors in selecting the most radiation-resistant materials for the design of rockets and spacecraft.

The particle accelerator will also be useful (1) as a neutron generator that will speed deuterons (heavy hydrogen) to 150,000 v to produce 14 Mev neutrons; (2) as a time-saver for measurements of strengths of gold-plating solutions needed to make printed circuits. The generator will irradiate the solutions with neutrons, and within minutes the potency of the solution will be determined by an analysis of the gamma ray activity emitted by the solution. A routine chemical analysis of these same plating solutions takes hours. (Source: Data supplied by Douglas Aircraft Company, Inc.)

RISKS OF WEIGHTLESSNESS AND RADIATION ON ASTRONAUTS DISCUSSED. Biologically, the main concern of sustained manned space flights is the effects of weightlessness and radiation. The long-term effects of radiation are assessable from terrestrial studies and satellite experiments to date on the effects of energetic particles in space. The radiation from intermittent solar flares especially constitute a real and considerable risk for manned space flights.

A recent international symposium in Paris, as reported by Dr. Peter Stubbs, resulted in some general conclusions on the potential dangers of solar flares to astronauts. Dr. Stubbs says that the symposium delegates' conclusions on the effects of radiation were complicated and involved numerous factors.

A summary of three types of radiation danger in space is presented: primary cosmic rays, the Van Allen radiation belt, and sporadic solar flares. The first two radiation problems can be handled adequately by proper shielding and correct selection of space travel parameters, including biological and optimum trajectory considerations. Solar flares then remain the really serious danger.

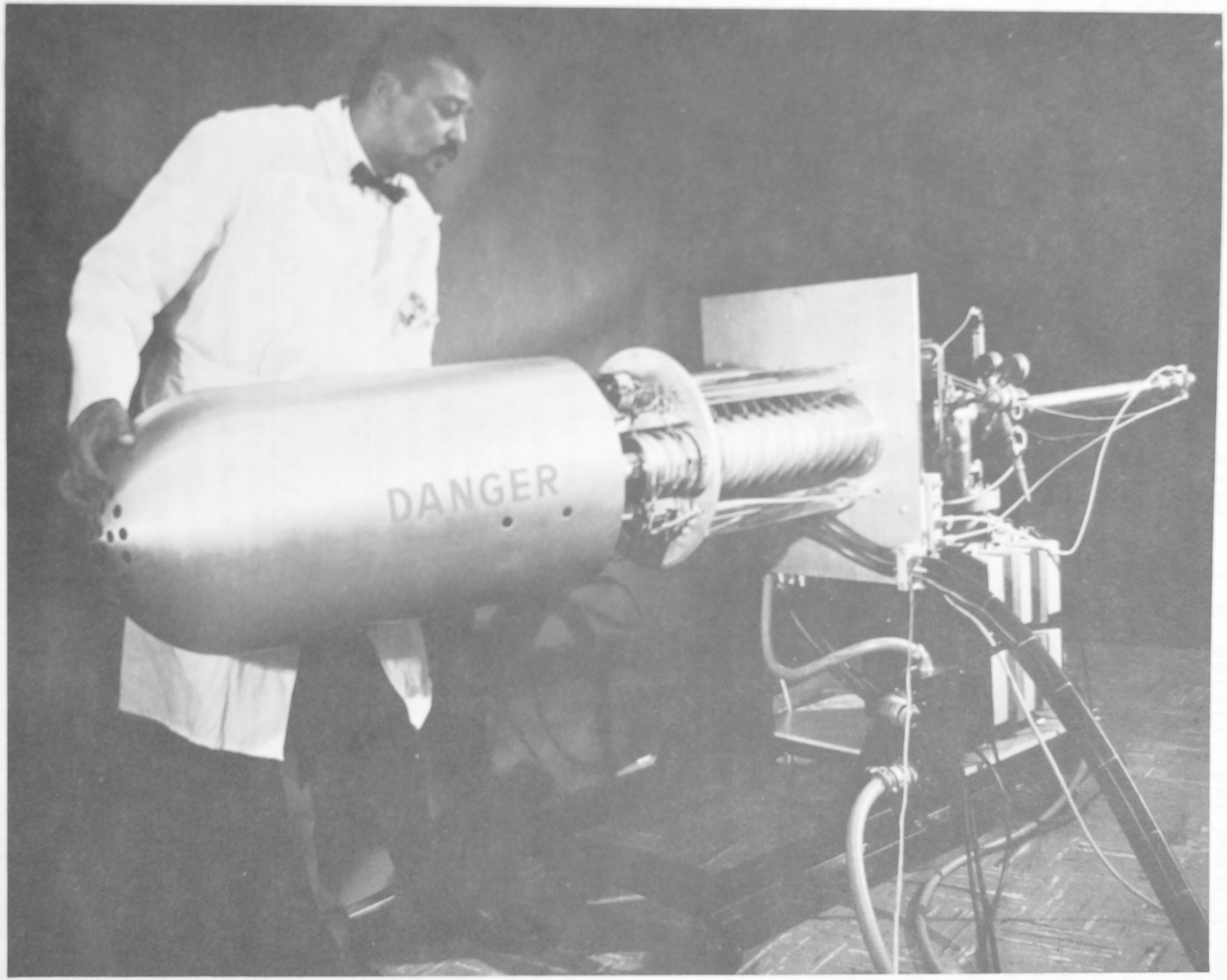

FIG. 1

Some figures given for major solar flares may result in a radiation dose of tens of thousands of rads (one rad is the dose resulting from the release of 100 ergs of radiation energy per gram of tissue). These figures indicate that with no prior knowledge of such flare activity, an astronaut on a week's trip to the Moon has about a 20 per cent chance of annihilation. Further, virtually nothing can be done for his protection in such instances. However, during periods of quiet solar activity (e.g. 1963-1964) it is conceivable that solar flare hazards may be reduced by approximately a factor of 20. The possibility of predicting the occurrence of these flares should also be considered.

Although there is no indication of any adverse effects as a result of weightlessness in manned flights to date, long-term effects of the condition may prove serious. Man orients himself on Earth with the assistance of his vestibular apparatus, a factor that depends on gravity for proper functioning. Even if the gravitational field is reduced to 0.0005 of its normal value, the vestibular apparatus will still function. If the gravitational field is reduced to zero, man must rely on his visual sense. However, it is generally believed that this will be only a relatively minor problem.

Perhaps the more serious problems of prolonged weightlessness will concern muscular atrophy and possible cardiovascular damage. The absence of a counterforce normally used in muscular activity may cause atrophy of the muscles. A different balance of stresses imposed upon the heart and blood vessels may possibly damage the cardiovascular system. These topics remain unresolved and speculative. (Source: New Scientist, November 15, 1962)

HIGH-VELOCITY SHOCK WAVES PHOTOGRAPHED WITH DISSECTING CAMERA. Motion pictures of shock waves with velocities exceeding 7 cm/μsec have been produced by an ultra-high speed image dissecting camera. The design is patterned after a similar camera design by M. A. Sultanoff.

A system based on a Sultanoff-type camera, with the results obtained, is reported by Earnshaw and Benedict in a recent issue of the Journal of Research (National Bureau of Standards). The discussion includes camera and film viewer design together with the techniques used.

The camera is adaptable to either streak or framing photography. Discussion of the camera design indicates the modifications of the original design that allow greater flexibility in the application. Several photographs of high-speed shock waves are presented that indicate various modes of operation. A variety of grids may be used to take a wide variety of self-luminous events throughout a broad range of framing rates.

Some disadvantages of the camera are mentioned. The camera and the event to be photographed must be synchronized. Further, the attainable camera speed is limited by time of luminosity decay that is appreciable at any given point of interest: events strongly luminous for long periods of time place serious limits on possible framing rates. Higher framing rates in such a case can be attained, but with further losses in resolution. Such speeds utilize a grid system having a wide spacing between slits, or by using a smaller enlargement of the event photographed. Nevertheless, the Sultanoff camera is particularly adapted to motion pictures of very high velocity shock waves. (Source: Journal of Research, (Engineering and Instrumentation) National Bureau of Standards, October-December 1962)

MICROMETEORITE SATELLITE PROPOSED FOR SATURN.

NASA has asked for proposals from industry for the design and construction of a large-surfaced micrometeoroid satellite to study further the hazards to space flight posed by meteoroids and micrometeoroids (tiny particles of solid matter traveling at high speed in space).

The new proposal involves an erectable satellite to be orbited in a near-Earth environment and to be of large surface size. It is to provide useful data for designing large operational manned and unmanned systems in space within a few hundred km of Earth.

The satellite will weigh more than 1800 kg (4000 lb) and the surface area will be more than 190 m^2 (2000 ft^2) when erected. It is expected that the satellite will have a useful life of at least one year.

The large size will permit investigation of skin thickness greater than that normally used in small spacecraft. It has the further advantage of providing more data on meteorites--the study of distribution and magnitude, of meteoroid particles.

NASA plans to conduct the experiment as a secondary mission for the 8th and 9th Saturn test flights, which will be under development with the Apollo service module on the rocket's second stage. The new micrometeoroid satellite will be many times larger than the Explorer 16, launched on a Scout rocket for the same purpose on December 16, 1962. (Source: NASA News release 62-274)

NEW SPACE VEHICLE STABILIZATION DEVICE DESCRIBED. A new way to hold space vehicles steady in their course has been announced by General Electric Company. Stabilization is achieved by pumping liquid-metal through closed loops to stabilize spacecraft on prolonged flights away from Earth. The "liquid-metal flywheel" (Fig. 2) is believed to be the first of its type for use outside laboratories.

The new system is capable of stabilizing space vehicles on long flights in which a large fuel supply is not practical. Conventional spacecraft are stabilized by jets of fuel. Erratic spacecraft motions have been experienced by some U. S. astronauts in their orbital flights around the Earth. In each instance, correction was made by jet expulsion of fuel. Some spacecraft exhibit pitch and roll without harm, but for those carrying men--as well as for weather and communications satellites that must point toward the Earth--an attitude control is essential.

An auxiliary jet-expulsion system requiring very little fuel must be considered as a part of the total attitude control. It would come into use only occasionally when the fluid in the liquid-metal flywheel had been accelerated to its maximum capability and yet further torque was needed.

The liquid flywheel operates on what physicists know as Newton's second and third laws of motion, the same principles as those governing the operation of ordinary motor-driven mechanical flywheels. The heart of the new system is a pump with no moving parts that circulates mercury around a closed loop of stainless steel tubing. A change of direction on any of three axes--pitch, yaw or roll--is signaled to the appropriate flywheel, which automatically exerts a torque to stabilize the spacecraft. The control torque is the equal and opposite reaction resulting from speeding up or slowing down the circulating mercury. The liquid-metal flywheel responds to directional changes 60 times faster than a conventional, motor-driven, mechanical flywheel.

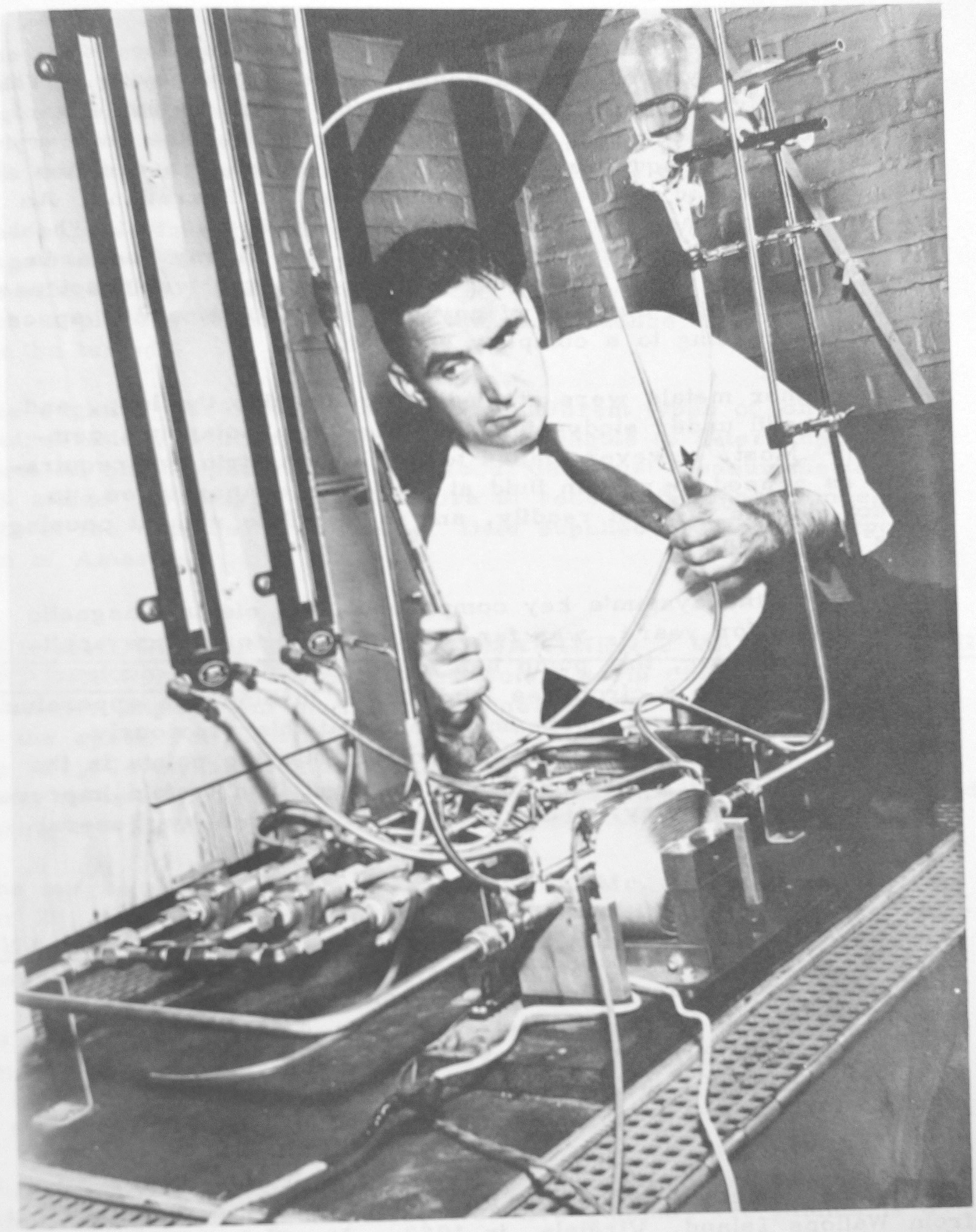

FIG. 2

For many applications requiring precise orientation, the new attitude control system offers a considerable weight saving. The liquid-metal flywheel makes possible saving of space inside a tightly-packed spacecraft. The loop through which the mercury circulates can be squeezed into otherwise unused areas of the vehicle and shaped to conform to almost any configuration. As it flows through the tubing, the mercury serves also as a "heat sink," helping to prevent concentration of heat in any one area. The mercury is tightly sealed inside the loop, and would not need replenishing for the duration of any presently-contemplated space mission, according to a company spokesman.

Several other metals were studied for use inside the loop, and some are still under study--including a sodium-potassium combination. Most, however, failed to meet such stringent requirements as a need to remain fluid at moderate temperatures, to conduct electric current readily, and to circulate without causing undue corrosion.

While one of the system's key components, the electro-magnetic pump, extant for years, was far too inefficient for space applications. However, this pump has found use in some nuclear installations where it circulates liquid-metal through the apparatus as a cooling agent. A spokesman said that this previously-developed technology served as one of the starting points in the 2-yr liquid-flywheel program, which resulted in a tenfold improvement in pump efficiency. (Source: Data supplied by General Electric)

SPACE VEHICLE TO TEST ENGINES FOR INTERPLANETARY CRAFT. A space vehicle for testing and gathering data on electric propulsion engines for interplanetary craft is being built at the Radio Corporation of America's Astro-Electronics Division, Princeton, New Jersey, RCA has announced. The vehicle--known as SERT (Space Electric Rocket Test)--is destined for the NASA Lewis Research Center, Cleveland, Ohio.

The space vehicle is scheduled to be launched by a Scout rocket from Wallops Island, Virginia, in 1963. It will be the first of a series of short-term ion rocket tests; its ballistic trajectory will take about an hour for completion.

The test capsule weighs about 155 kg (320 lb) and has a 76-cm (30-in.) diameter base plate on which are mounted two different engines. Also included are power supplies, command and control instruments and telemetry equipment necessary to obtain remote data on engine performance in space.

The capsule is spin-stabilized, with the engines mounted on hinged arms. When the payload is separated from the vehicle, centrifugal force will direct the arms outward where they will lock in place. In this position, the performance of each engine can be tested.

The engines' parameters, along with different types of ion beam neutralization, will be varied during the flights to determine the effect on engine performance. Accurate thrust measurements will utilize Tiros-type Sun sensors to record the change in spin rate of the capsule. (Source: Data supplied by Radio Corporation of America)

PRELIMINARY RESULTS OF MARINER 2 MAGNETOMETER EXPERIMENT DISCLOSED. Scientists in charge of the magnetometer experiment on board Mariner 2, which sent back readings as the spacecraft flew by the planet Venus at a distance of 34,800 km (21,594 mi) December 14, 1962, announced that they have found no evidence of a Venusian magnetic field that could be detected during the flight.

The magnetometer data was discussed by Mr. Coleman on December 26, 1962, in Philadelphia at a session of the American Association for the Advancement of Science on recent results of space research.

No rise in the average value of the magnetic field above the interplanetary value was observed, and the observed fluctuations in the field were, if anything, smaller in the vicinity of Venus than in the neighboring parts of interplanetary space.

The sensitivity, or lower limit of the field change that could be observed by the magnetometer, was five gamma. A gamma is a unit of magnetic measurement. During the planet encounter period, no changes were observed of this magnitude--five gamma--which might be attributed to Venus. The Earth has a magnetic field of approximately 30,000 gamma at the equator, 50,000 gamma at the poles.

This does not necessarily mean that Venus has no magnetic field. The solar wind, a low density ionized gas that continuously flows outward from the Sun, could confine a weak field to a limited region close to the planet.

All that can be concluded from the observations is that the field does not extend out to the Mariner trajectory, for which the distance of closest approach from the center of Venus was approximately 40,000 km (25,000 mi). The observations are consistent, however, with the possibility that Venus has no magnetic field.

Since the planetary field does not extend out to the Mariner trajectory, an upper limit for the source strength of the Venus field can be estimated. The estimate is based on an analogy with the Earth, the only planet from which data are available as to how far magnetic fields extend from the surface.

The Mariner measurements near Venus were compared with those made near the Earth by other spacecraft. The experimeters used the magnetic observations made on March 11, 1960, by Pioneer 5 in a region of the Earth's field that corresponds approximately with the Mariner-Venus-Sun angle of the Mariner spacecraft at its point of closest approach to Venus.

They conclude that the magnetic dipole moment of Venus, if it is approximately perpendicular to the Sun-Venus line, is less than 5 to 10 per cent of the Earth's magnetic dipole moment. If Venus has the same simple magnetic structure as the Earth, the magnitude of the surface field is less than 5 to 10 per cent of the Earth's field at the surface. If Venus has a complicated magnetic structure, the surface field in places could be larger than the Earth's field without increasing the strength of the field along the Mariner trajectory to an observable value.

If the average value of the magnetic field associated with Venus is much lower than that of the Earth's field, as is indicated by the Mariner measurements, the phenomena associated with the geomagnetic field are likely to be greatly modified and perhaps less important or completely absent on Venus.

These include the trapping of particles in radiation belts and auroral phenomena. The Earth's magnetic field keeps low and moderate energy cosmic rays away from the top of the atmosphere

except in the polar regions. Thus, on Venus, it is possible that the cosmic ray flux at the top of the atmosphere will everywhere correspond to the high level found on Earth only in the polar regions.

The Mariner data now adds Venus to the other members of the solar system whose magnetic properties are partially known. Measurements of the polarized radio noise from Jupiter recently have been interpreted as indicating that the surface field is considerably stronger than that of the Earth. Jupiter rotates rapidly, twice in an Earth's day, and is ten times as large as the Earth.

Other probes have shown that the surface field on the Moon, on the sunlighted hemisphere, is less than 0.33 per cent of the Earth's field at the equator. It is known that the Moon rotates slowly. Astronomical observations indicate that Venus, too, may be rotating slowly.

The observations thus far suggest that planets and satellites that rotate much less rapidly than the Earth have small magnetic fields. This is consistent with recent theories which ascribe planetary magnetic fields to a dynamo action inside the molten core of a rotating planet.

The magnetometer on board Mariner made measurements not only in the vicinity of the planet but reported almost continuously during the 109.5-day, 2.9×10^8 km (1.802×10^8 mi) flight from the Earth to Venus on directions and intensities of magnetic fields in space. It also reported for several days after the flyby on magnetic fields between Venus and the Sun.

The sensors of the magnetometer are housed in a metal cylinder six inches long and three inches in diameter. The instrument is located just below Mariner's omnidirectional antenna, to place the sensors as far as possible from any spacecraft components that may have magnetic fields associated with them.

Inside the cylinder are three magnetic cores, each aligned along a different axis. Each core has two windings of copper wire around it, much the same as some transformers. The primary winding leads from a frequency oscillator which produces a current. The secondary winding leads to an amplifier.

In the absence of a magnetic field, the current induced in the second winding has a special symmetrical wave shape. The presence of a magnetic field changes the symmetry of this wave and produces a component with amplitude in proportion to the field strength. (Source: NASA news release, 62-270)

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. EFFECTS OF MODERATELY HIGH STRAIN RATES ON THE TENSILE PROPERTIES OF METALS, D. P. Moon and J. E. Campbell. AD 270 167
2. EFFECTS OF SPEED AND TEMPERATURE ON CRACK TOUGHNESS AND YIELD STRENGTH IN MILD STEEL, J. M..Krafft and A. M. Sullivan. AD 275 295
3. PLANNING, SCHEDULING, AND EXPEDITING ENGINEERING PROJECTS WITH THE AID OF ELECTRONIC COMPUTERS, J. C. Pollock. ANL-6557
4. ON THE PRINCIPLES OF CONSTRUCTING A DIGITAL LOGICAL MACHINE, A. O. Slogniy. 62-11759
5. MAGNETIC ELEMENTS OF COMPUTER ENGINEERING EQUIPMENT, collection of articles. 62-11734
6. MAINTENANCE ENGINEERING GUIDE FOR ORDNANCE DESIGN. 181 321
7. HEAT TRANSFER AND THERMODYNAMIC MODELING, edited by G. M. Krzhizhanovskiy. 62-11604
8. SOME PHYSICAL PROPERTIES OF POLYCRYSTALLINE SILICON BORIDE, R. S. Feigelson. AD 277 686
9. INVESTIGATION OF ELASTIC AND THERMAL PROPERTIES OF CARBON BASE BODIES, J. F. Andrew and others. AD 282 006
10. MECHANISM OF WEAR OF NONMETALLIC MATERIALS, C. H. Riesz and H. S. Weber. AD 275 361
11. VAPORIZATION OF COMPOUNDS AND ALLOYS AT HIGH TEMPERATURES, R. Colin and others. AD 278 829

12. DEVELOPMENT OF METHODS FOR THE DETERMINATION OF ELASTIC CONSTANTS FOR SHEET METAL AT ELEVATED TEMPERATURE, D. P. O'Keefe. AD 275 963
13. RESEARCH INVESTIGATION ON STRAIN ANALYSIS OF METAL SHEETS WITH NOTCHES AND CRACKS, G. U. Oppel and others. AD 276 523
14. SURVEY OF IRRADIATION FACILITIES, M. J. Oestmann. AD 256 953
15. COMPARISON OF GAMMA IRRADIATION FACILITIES, B. L. Cash and R. D. Longley. AD 274 921