

Early US Satellites

W2DU Satellite Development from 1949 to 1980
Presented to the Cherokee Amateur Radio Society

Richard A. Maxwell, W8KHK
April 10, 2021

It all started with my grandfather, W8YNG



Amateur Radio Station W8YNG

William W. Maxwell,
W8YNG, made his
shack from an old
chicken coop, and the
three element Yagi
was supported by a
recycled windmill
tower.



Walter Maxwell
W8KHK

Licensed at 14 years
old in 1934

Actually my father
got his license
before my
grandfather!



W8KHK Shack

He set up his rig
behind his father's
house.

Why do you think
they call it a
“SHACK”, anyway?



W8KHK Transmitter

Eimac 250-TH Final
modulated by a
quad of Taylor TZ-40
triodes



W4GWZ Shack in Daytona Beach While Chief Engineer at Radio Station WMFJ



Walt (W2DU) was W4GWZ in 1940

W8VJR Shack in Allegan, Michigan While working at FCC Monitoring Station



W2DU Shack - 1968
Dayton, New Jersey

Member of the
RCA Employees Single
Sideband Network







DAVID SARNOFF RESEARCH CENTER

Clarence Denton "C. D." Tuska

(August 15, 1896 – June 30, 1985) was an early radio experimenter and [amateur operator](#), who also became one of the first radio receiver manufacturers. He is best known as the co-founder, along with [Hiram Percy Maxim](#), of the [American Radio Relay League](#) (ARRL). He was also the original editor and owner of the amateur radio publication [QST](#), which he subsequently sold to the ARRL in 1919, as part of his reorientation toward professional activities within the radio industry.

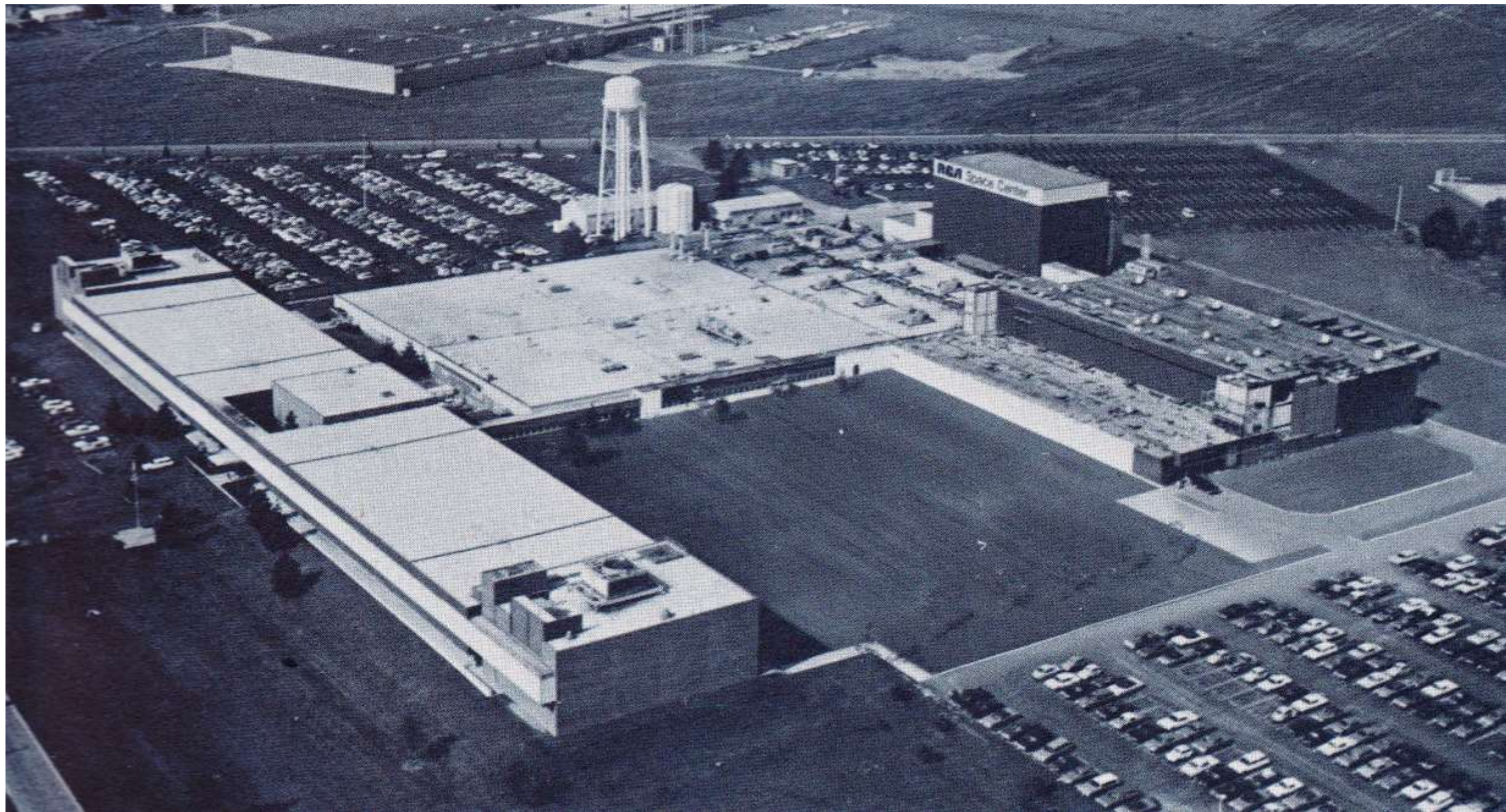
Clarence D. Tuska (1916) ^[1]



RCA Astro Space Center - Locust Corner, East Windsor, NJ July 1962

Photo from the Collection of Peter Stern







QST March 1965

Bottom photo:

Amateur Radio Operators employed
by RCA Astro Electronics Division

Enlarged version on next slide



...ance requirements, for going from a ...n't be allowed to reach the antenna.

... but is probably as versatile as ... formed by L_1 and C_1 is tuned to frequency. If the line is the or (balanced) type the wires at equal numbers of turns from loading is adjusted by changing these taps. L_2 couples the power yes you a means for tuning this coax line goes from here to your tput terminal. Between these two a can transform a wide range of lances into 50 or 70 ohms (which of the coax line from the trans-

... used for coupling to a coax line ... ensa is shown at B. It is very y difference being that the outer e line is connected to the center only one tap is used. The coax be transmitter remains the same. hoid of adjustment.

... of the transmatch circuit do ... you have to fix things so L_1C_1 each band you want to use. This that L_1 is a plug-in coil. L_2 is part of the same coil assembly, antagonistic to change it, too, for The same capacitors can be used though, over at least the 3.5-30

... ent of a transmatch is easy if you such as the Monimatch. Such a pensive and is an almost indis- n necessary. However, you can asonably satisfactory adjustment ing the tap positions, along with the two capacitors, while perform- tuning and loading operations on er. After a little cut-and-try you'll atch settings that let you load up fer to the input you want. **QST**

QST for

Strays



Dr. R. B. Jones, of RCA Electronic Components and Devices, lectures to a group of interested RCA people and ARRL Hq. staffers during a recent symposium on The State Of The Art Of Semiconductors, held at the RCA Semiconductor plant, Somerville, New Jersey. Included in the day's activities were a tour of the laboratories and technical sessions dealing with diodes, transistors, SCRs, MOSs (metal-oxide semiconductors) and other semiconductor devices. Heads, left to right: Ken Altlin, W2OUY, John Spooner, K2JCG, George Grammer, W1DF, George Handsh, W2YMA, Marty Bell, W2JSX, Laird Campbell, W1CUT, Dick Baldwin, W1KE, John Huntton, W1LVQ, Ken Bucklin, W2CDP (foreground), Lee Aurick, K3QAX, John Wilhelm, W3SNL, Ed Tilton, W1HDQ, Harold Vance, K2FF, Watley Pond, WA2JXO, and Dr. Jones.



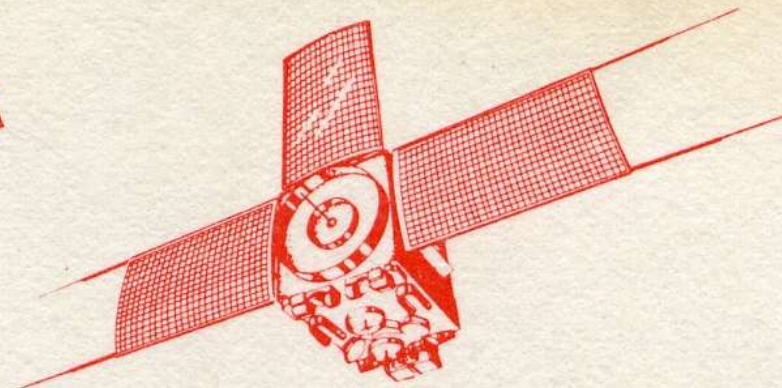
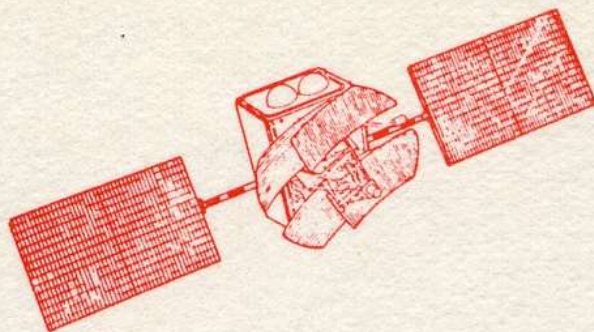
This group picture bears evidence that an amateur radio background plays a significant part in the ability to design, develop, build, and to orbit, U.S. space hardware. Out of a technical force of 600, there are about 50 hams at the RCA Astro-Electronics Division, Princeton, New Jersey. These space-center hams have participated in projects that are enough to make the space enthusiast's mouth water. Relay, Tiros, Score, ComSat, Nimbus, Lunar Orbiter, Ranger, SERT and Air Force projects are on the list of projects, with such fascinating jobs as NASA tape Camera, Nimbus Tape Recorder, Nimbus battery, and Environmental Simulation all in a day's work. First row, right to left: W2FCY, K2ENW, W2PCS, K2OHU, K2PAY, W2UAS. Second row: K2UKM, WA2VEQ, W2PQY, K2EJK, W2KPH, W3ZMC, WA2ZYU, W82QMS, K2GQX, K2VLC, W82BHW, K4PCP, W3YQG. Third row: WA2WFM, K3IUV, K2KPA, W2VJN, K3UDH, WA2KHY, WA2SDJ, K2ZFD, W82FGJ, K2THS, W2NQS. Fourth row: WA2THH, W2RHD, WA2TDR, W2ABG, W82JSX, W2HTD, K3JXH, WA2HIR, W2PGI, WA2VLL, W2WGH, K3NPQ. Not present for the picture taking: W2KKM, K2DZS and W2GGT.

March 1965

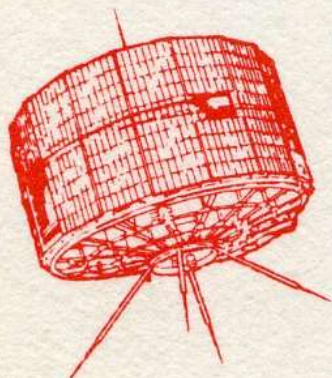
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RCA



W2DU



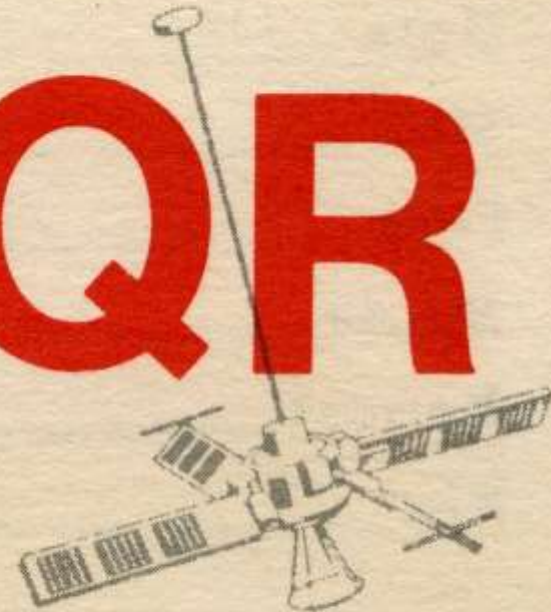
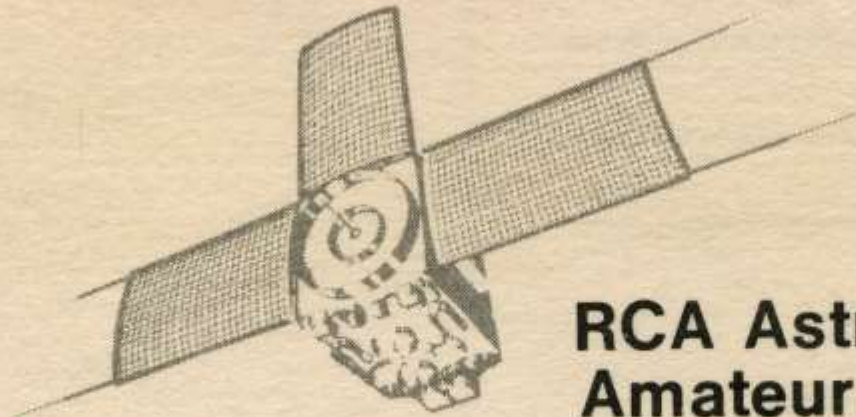
**Walter Maxwell
P.O. Box 215 Georges Rd.
Dayton, N.J. 08810 USA
Middlesex County**



WB2JQR



RCA



**RCA Astro-Electronics
Amateur Radio Club
P.O. Box 800
Princeton N.J. 08540 USA**

Astro Electronics Pioneer Employees From 1958 In 1978



Two gentlemen were not present; their photos are on the wall. The next slide shows individual photos (1958)



REFLECTIONS III

Transmission Lines and Antennas



By M. Walter Maxwell, W2DU



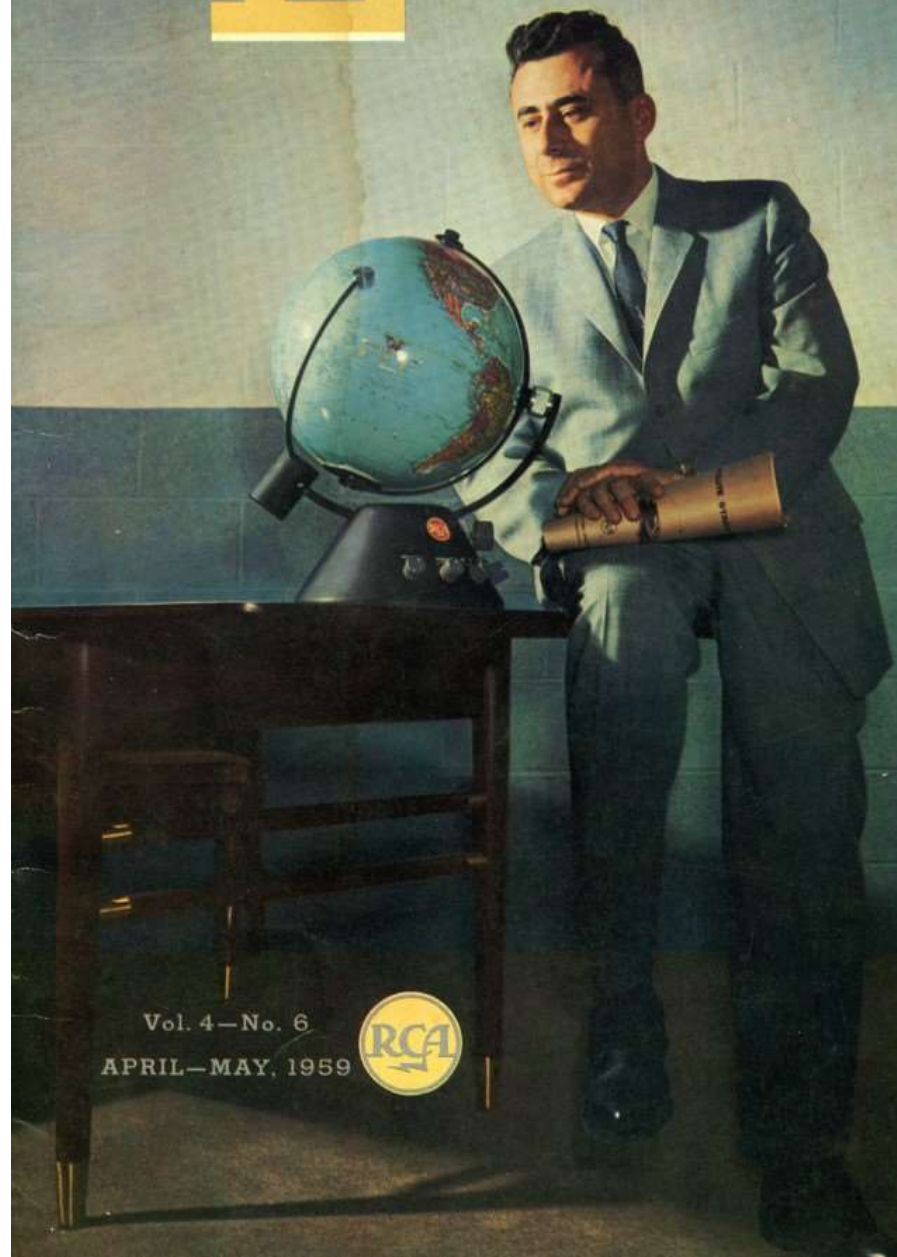
Let's think about the available tools/resources?

- Integrated Circuits?
- Computers?
- Excel, MathCad?
- Calculators?
- Internet?
- Email?
- Search Engines?????
- Special Interest Forums?
- Network Analyzers?
- CAD / CNC?
- Printed Circuit Design Tools?
- 3D Printing?

We did have:

- Libraries
- Telephones
- FAX
- Western Union Teletype Messages
- Slide rule
- Logarithm Tables
- Smith Charts
- Pencil and Paper
- In-Person Meetings
- Germanium Transistors
- Ham Radio!

RCA ENGINEER



Vol. 4—No. 6
APRIL—MAY, 1959



ELECTRONIC DEVICES FOR SPACE

by E. A. GOLDBERG, K. G. MacLEAN, M. MESNER, J. ZENEL, J. R. STANISZEWSKI

*Engineering
Astro Electronic Products
Princeton, N. J.*

BECAUSE OF THE nature of the environment, electronic components for use in satellites and space vehicles must meet specifications more rigid, in some respects, than those of similar components meant for use in ground installations or aircraft. The space vehicle generally subjects these components to considerable vibration and acceleration during periods of thrust which they must withstand without being damaged. Once in orbit, vibration and acceleration cease, the components become weightless, and a high vacuum surrounds the vehicle. Radiation environment is different in space than on the earth's surface and at altitudes where aircraft fly. Electrical, electronic, and mechanical devices in the space vehicle must be constructed to survive and operate satisfactorily in

this environment for the useful life of the vehicle.

The ratio of fuel plus structure weight to payload for rockets used to place satellites into orbit is very large. Economically, this means that each pound of payload requires the expenditure of a considerable sum of money to put it into orbit. Consequently, all components should be designed for minimum weight consistent with meeting performance requirements. The energy of electrical power sources suitable for satellites is, in general, a direct function of weight. Batteries, solar cells, or rechargeable batteries in combination with solar cells are frequently used. The electrical

and electronic system and associated components should be designed for a minimum power consumption in order to minimize the required weight for the electrical power supply.

A most important factor in satellite equipment is reliability. The requirement of reliability is especially severe, since it is impossible to service the satellite once it has been launched. A satellite mission costing hundreds of thousands of dollars could conceivably become useless through the failure of just one relatively insignificant component. All designs should be carefully reviewed, and components and workmanship painstakingly inspected and tested to insure high reliability.

Several different types of electronic components for satellites have been designed and built to meet the aforemen-



tioned requirements by the Astro-Electronic Products Division. Some of these items have been successfully operated in orbiting satellites, while others will be used in future satellites. The communication gear, television camera, and tape recorder to be described are typical.

COMMUNICATIONS EQUIPMENT

An example of the type of equipment used in satellite vehicles is illustrated in Fig. 1. This is a completely transistorized, frequency modulation receiver that has been operated in a satellite. A commercial, "Personal-fone" type CPC-R3 receiver designed by RCA Industrial Electronic Products was modified by IEP to meet

AEP electrical and environmental specifications. Modifications included adding a low-noise radio-frequency amplifier stage, substitution of temperature-stabilized components, and repackaging of modules with conformal coating to endure vibration and shock.

The circuitry of this receiver includes a double conversion superheterodyne with two crystal-controlled conversion oscillators and a battery-saver circuit that switches the receiver on 0.3 second out of every three seconds. During the 0.3 second of on time, the reception of a tone signal locks the receiver on continuously.

This type of receiver is used for reception of voice or teletype tones. The



Fig. 1—Transistorized FM receiver for satellites; weight, 0.7 pound.



Fig. 2—Phase-modulation transmitter as used in a satellite package.



Fig. 3—Typical satellite beacon transmitter; weight 0.6 pound.



Fig. 4—Magnetic-tape transport for video storage on board a satellite. Tape speed is 30 ips, with a 1½-minute running time.

EDWIN A. GOLDBERG received the degrees of B.S. in Electrical Engineering in 1938 and M.S. in Electrical Engineering in 1940 at the University of Texas. He joined the RCA Manufacturing Company in 1940 and was assigned to the Research Division in 1941. He became a member of RCA Laboratories Division when it was established in 1942, where he engaged in the development of electronic analog computers and computer components for fire control, missile simulation, and guided missile control. He also did circuit development work in color television. He is presently serving as Manager, Design and Development Engineering in the Astro-Electronic Products Division.

Mr. Goldberg has twenty issued patents. He is a member of Sigma Xi, Tau Beta Pi, Eta Kappa Nu, and the American Institute of Electrical Engineers.

KENNETH G. MacLEAN received the B.S.E.E. degree from Northeastern University in 1928. From 1929 to 1931 he was assigned to the RCA Transmitter Development Laboratory at Rocky Point, N. Y., where he did experimental work on circuits, transmitters, and HF directive antennas. From 1931 to 1936 he worked as an engineer for the RCA Communications Division. From 1936 to 1952, he worked in the Radio Reception Laboratory at Riverhead, N. Y., on design, development and research in the fields of VHF-UHF, which included PSK system tests, SSB receivers, and frequency-division diversity receivers. In 1952, he joined the RCA Laboratories at Princeton, where he worked on HF propagation and SSB communications systems studies for a classified BuShips project, and on a communications system analysis on Project Janus, Phase II. Upon the formation of Astro-Electronic Products, he joined that Division, where he is presently supervising the development and design of communication equipment for a military satellite vehicle. Mr. MacLean is a senior member of the I.R.E.

JOSEPH A. ZENEL received the B.S.E.E. degree from Bucknell University in 1949, and the M.S.E.E. degree from Princeton University in 1956. He joined the RCA Laboratories in 1949 where, for 9

years, he did research work in the audio-frequency field. He received the RCA Achievement Award in 1954 and in 1957 for outstanding work in research on video tape recording. In March 1958, Mr. Zenel transferred to the Astro-Electronic Products, where he is presently a project engineer in charge of the development of video recording equipment for satellite applications. He is a member of Pi Mu Epsilon, Tau Beta Pi, and Sigma Xi; the AIEE, and the Acoustical Society of America.

J. STANISZEWSKI received the B.S. in Physics from the Carnegie Institute of Technology in 1950 and is currently taking graduate courses at the University of Pennsylvania for an MS degree. From 1950 to 1953 he worked as a field engineer attached to the Military Assistance Advisory Group in the Netherlands where he was an instructor on radar, fire control computers, and field radios. In 1953 he joined RCA-DEP and engaged in the design and development of automatic tracking circuits for Mod. II Shoran. He also participated on the design and development of a closed loop television system for airborne (military) application utilizing a sensitive image orthicon. Recently his activities have been directed toward a miniature television camera for use in space vehicles.

MAX MESNER received his B.S.E.E. degree from the University of Missouri in 1940. That same year he joined the RCA Manufacturing Company in Camden as a radio engineer assigned to airborne radar equipment. In 1942, he went with the RCA Laboratories in Princeton as a research engineer. There, he did research and development work on television cameras, studio equipment, and color TV receivers as well as storage and computer devices. Mr. Mesner joined Astro-Electronic Products upon its formation, and has been engaged in the development and design of TV cameras for satellite use. He currently is the project engineer in charge of TV camera design for a satellite project.

Mr. Mesner is a member of Sigma Xi, Tau Beta Pi, Eta Kappa Nu, and the Association for Computer Machinery. He is a senior member of the I.R.E.

Space Projects 1950s – 1980s

- **SCORE: December 18, 1958**
Signal Communication by Orbiting Relay Equipment
- **TIROS 1: April 1, 1960**
Television InfraRed Observational Satellite
- **ECHO 1: August 8, 1960**
100 Foot Diameter Aluminized Mylar Passive Reflector Balloon
- **RELAY: December 13, 1962**
Active Repeater for Television and Telephone Communications
- **OSCAR 7: November 1974**
1.6 GHz Quadrafilar Antenna
- **Apollo Moon Buggy Dish Antenna: 1970s**
3.6 GHz Folding Dish Antenna

SCORE

- Signal Communication by Orbiting Relay Equipment
- Launched December 18, 1958
- Active for 12 days until batteries were exhausted
- Re-entered atmosphere and burned up on January 21, 1959
- Processed 78 real-time and store-and-forward messages, voice and RTTY

Saturday, December 18, 2010 Orlando Sentinel

TODAY IN HISTORY

■ **In 1865**, the 13th Amendment to the Constitution, abolishing slavery, was declared in effect by Secretary of State William H. Seward.

■ **In 1892**, Tchaikovsky's ballet "The Nutcracker" publicly premiered in St. Petersburg, Russia.

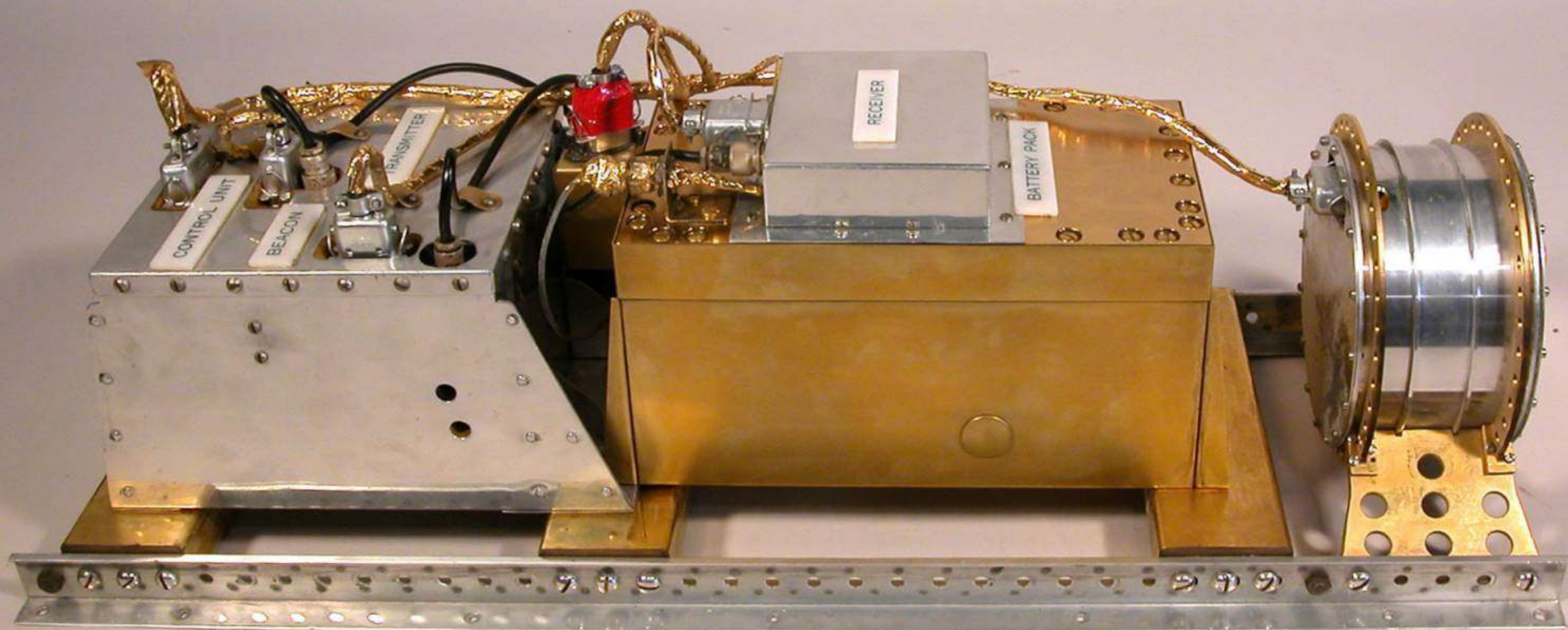
■ **In 1940**, Adolf Hitler ordered secret preparations for Nazi Germany to invade the Soviet Union. (Operation Barbarossa was launched in June 1941.)

■ **In 1958**, the world's first communications satellite, SCORE (Signal Communication by Orbiting Relay Equipment), nicknamed "Chatterbox," was launched by the United States aboard an Atlas rocket.

■ **In 2009**, the infamous iron sign bearing the Nazis' cynical slogan "Arbeit Macht Frei" ("Work Sets You Free") that spanned the main entrance to the former Auschwitz death camp in Poland was stolen.

■ **In 2009**, Jon and Kate Gosselin officially divorced after 10 years of marriage, eight children and a year of tabloid headlines.

— **The Associated Press**



SCORE Project Components

- Payload included a receiver, two tape recorders, transmitter, antennas, control system, and batteries
- 5 Mobile Ground Stations included RCA CarFone Receiver/Transmitters, modified VHF 1KW Amplifiers, and RadiQuad Antennas on a military V-51van platform
- Ground stations went to Cape Canaveral FL, Ft Stewart, GA, Ft Sam Houston, TX, Ft Huachuca, AZ, and Ft MacArthur, CA



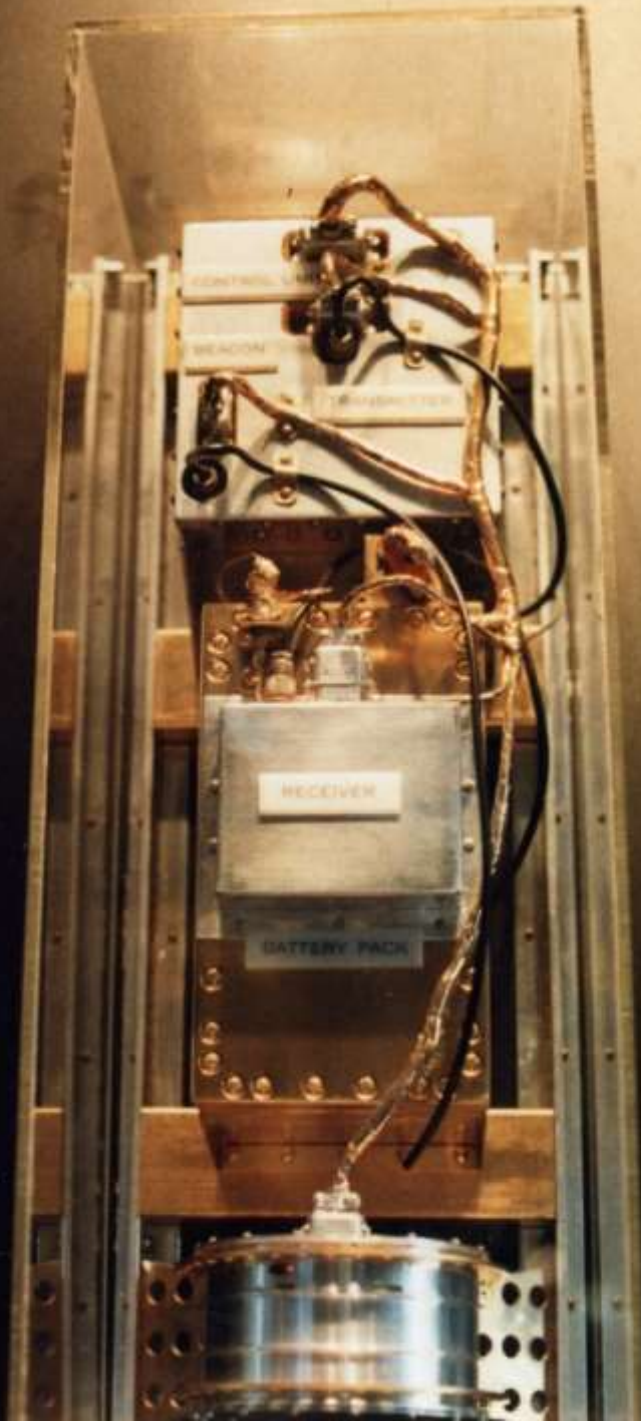
Project Score Echo 1

Project SCORE, the Signal Communication Orbit Relay Experiment, was launched to study the ability of a satellite to relay voice and message communications. SCORE was orbited on Dec. 16, 1959. The first voice transmission from a satellite in space was accomplished when SCORE transmitted a pre-recorded Christmas message from President Eisenhower to the people of the world. The project was a major stepping stone toward the development of the operational system of communications satellites.

Weight: 40 kilograms (88 pounds)
Power: 177 kilowatts (230 watts)
Range: 100 kilometers (62 miles)
Period: 100.0 minutes
Launch Vehicle: Atlas 508
Launch Date: Dec. 16, 1959

The Echo satellite balloons were passive communication relays. Echo 1 was launched on August 12, 1960, and placed into orbit 1000 kilometers (620 miles) above the Earth. Because of its nearly visibility from the ground, it became one of the best known satellites of the period.
 The Echo satellites were inflated into cells in a deflated condition, packed in special containers. When released in space, the balloons were inflated by chemicals packed inside which adhered to produce gases. Echo 1 had a diameter of 28.3 meters (93 feet) when inflated. It was constructed of chemically treated nylon plastic, only about half as thick as the wallpaper on a package of cigarettes.

Structure: 100 kilometers (62 miles)
Weight: 10.2 kilograms (22.5 pounds)
Power: 100 kilowatts (13.4 watts)
Range: 100 kilometers (62 miles)
Period: 100.0 minutes
Launch Vehicle: Thor-Delta
Launch Date: Aug. 12, 1960



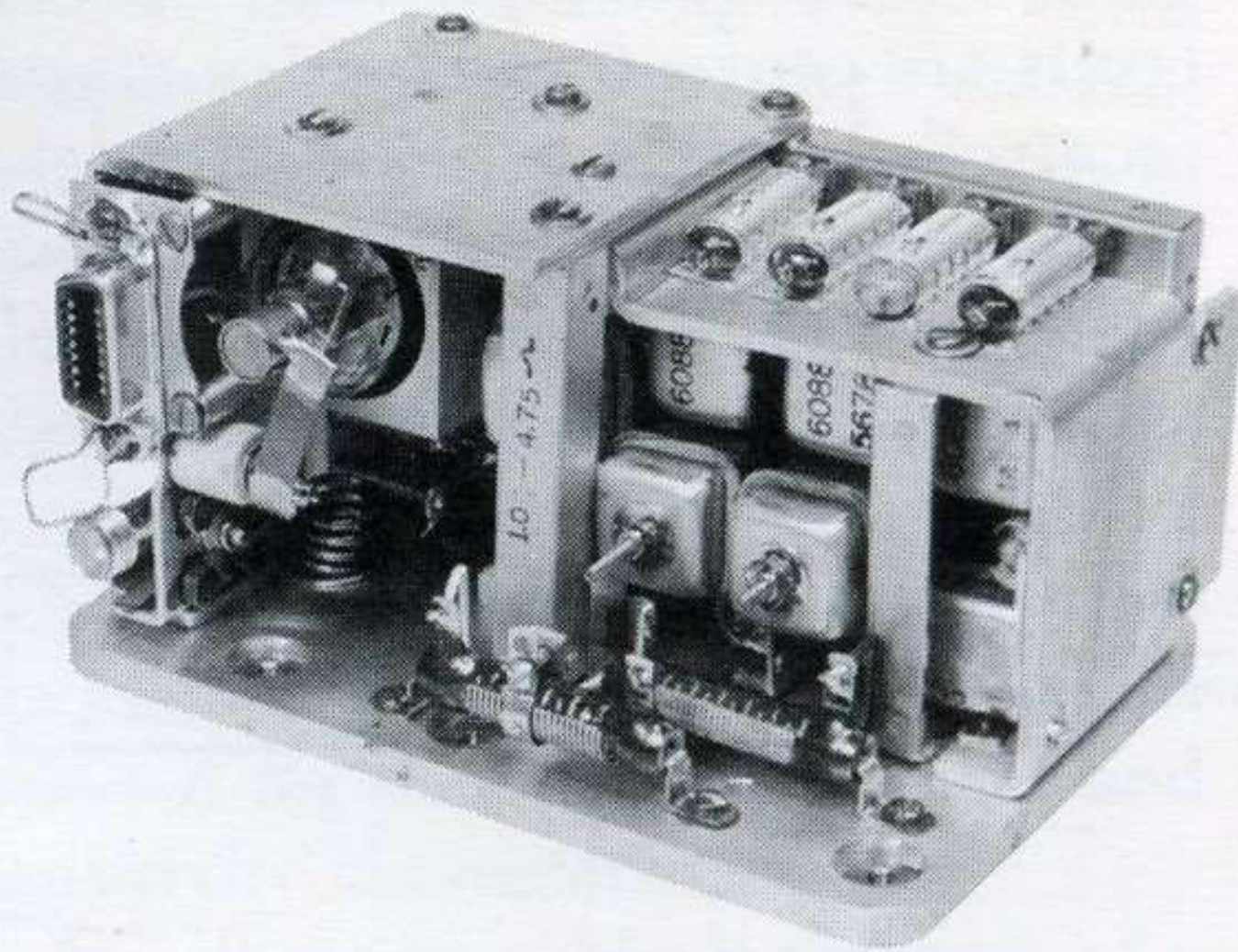


Fig. 2—Phase-modulation transmitter as used in a satellite package.

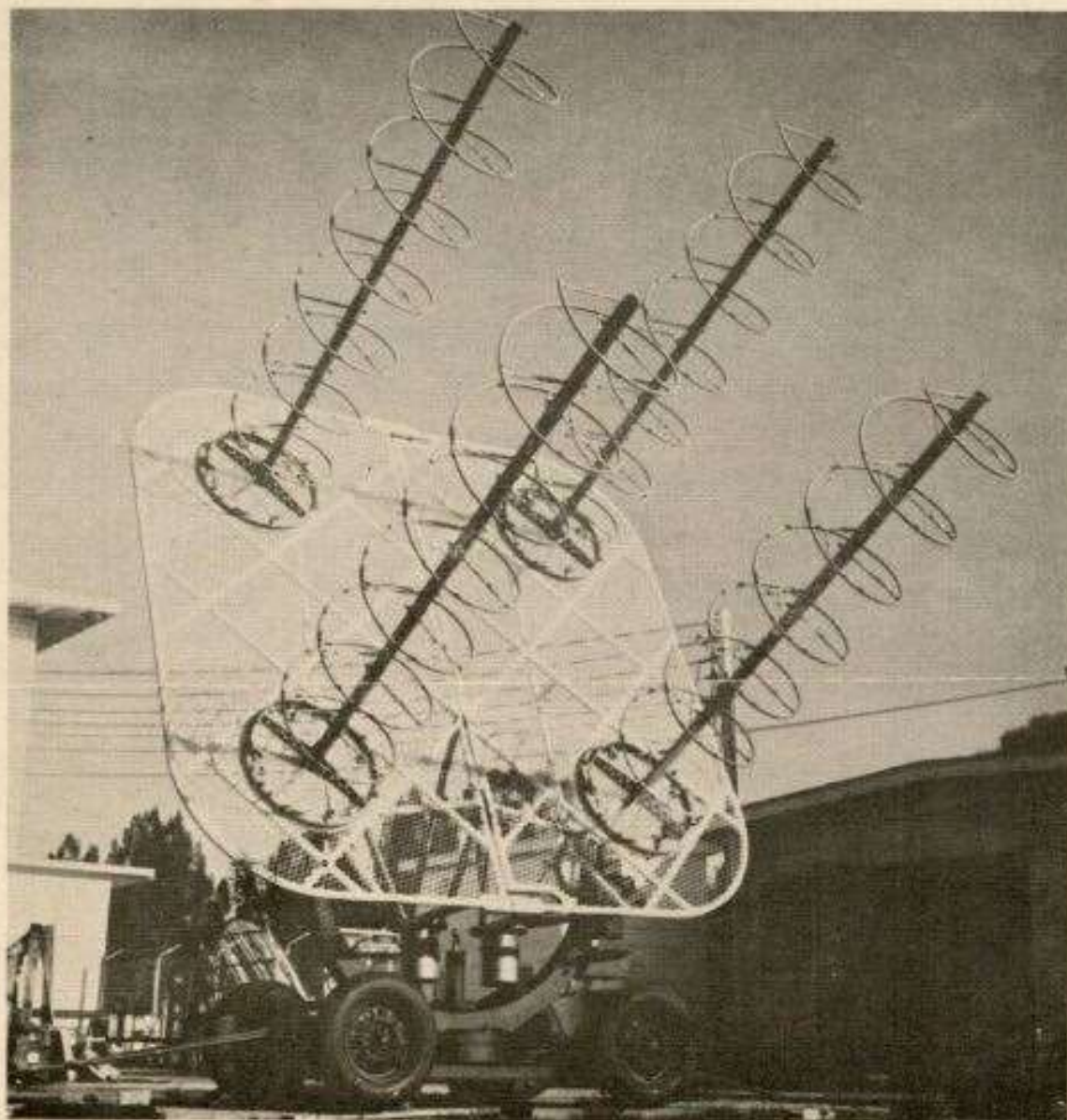






Ground Stations

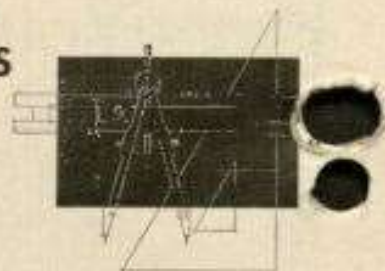
- Uplink 150MHz, Downlink 132 MHz
- RCA calculated 100 watts would be sufficient
- SRDL was skeptical, demanded more power, as follows:
- Dual Eimac 4-400A amplifier, 1000 W out
- Radi-Quad consists of 4 helical 10db gain antennas, 16db overall gain, (40x power gain)
- 1KW out, produced 40KW ERP (40,000 watts)



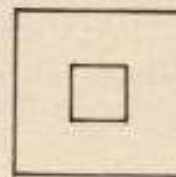
Radiquad pictured in its first few moments of operation.

RADIQUAD—NEW PRODUCT

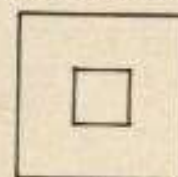
ENGINEER'S PUZZLER



HERE'S AN easy one—it concerns drafting:



Top View

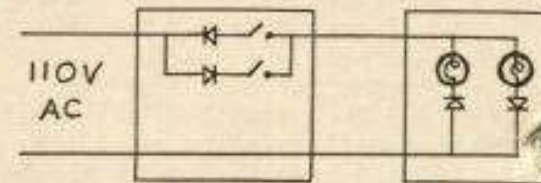


Front View

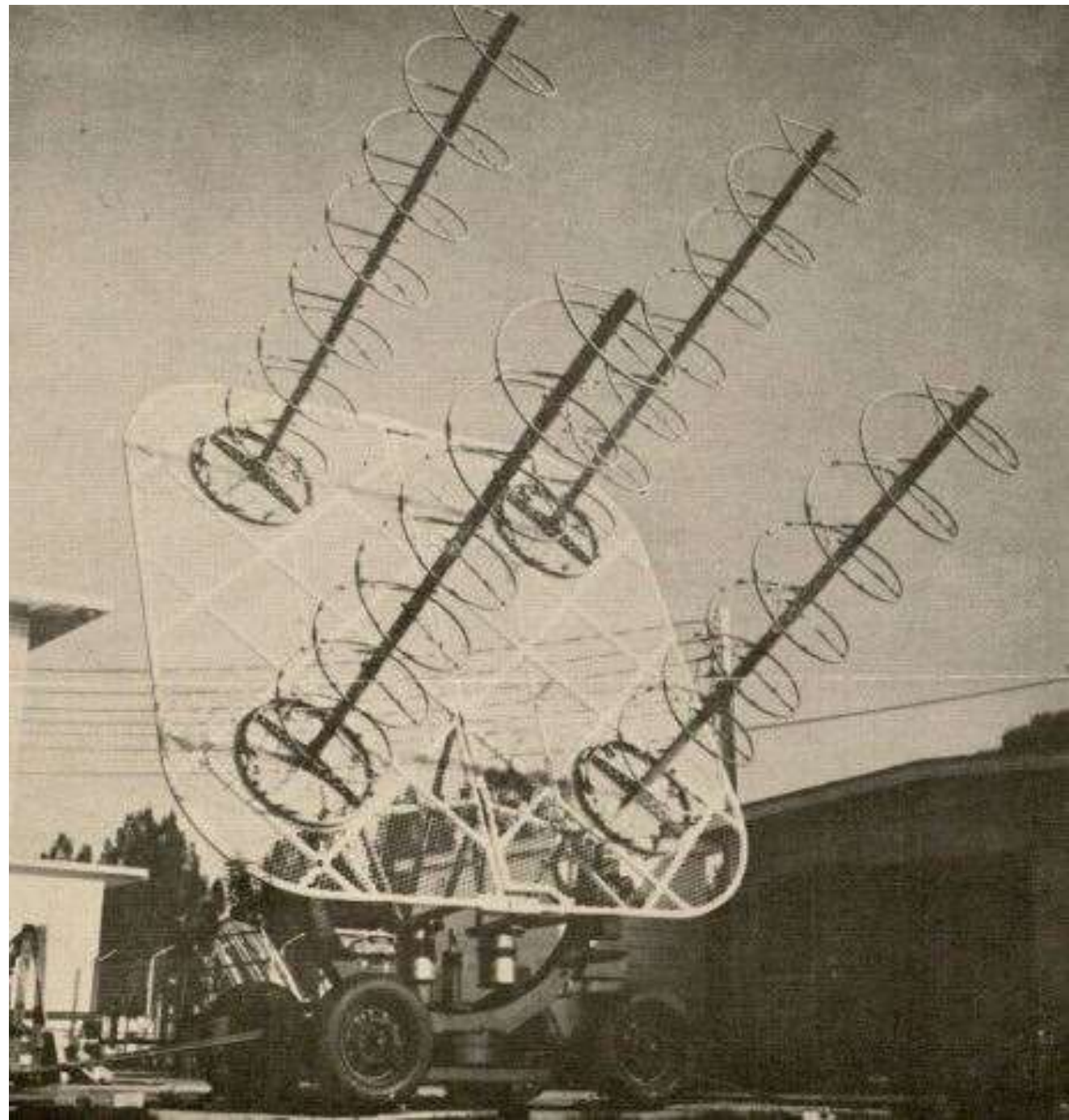
Now, you draw the side view! (The object drawn is a solid mass, and there are no hidden lines.)
C'mon now, send in your answers!—to Puzzle Editor, Radiation Ink, Melbourne.

Answer To Last Month's Puzzler

Correct solutions to the little wiring problem were submitted by: 1. Floyd Griffin, 2. Tom Allen, 3. Walt Masters. Now for the solution—this is the simplest. There are other variations.



Security Sidelights

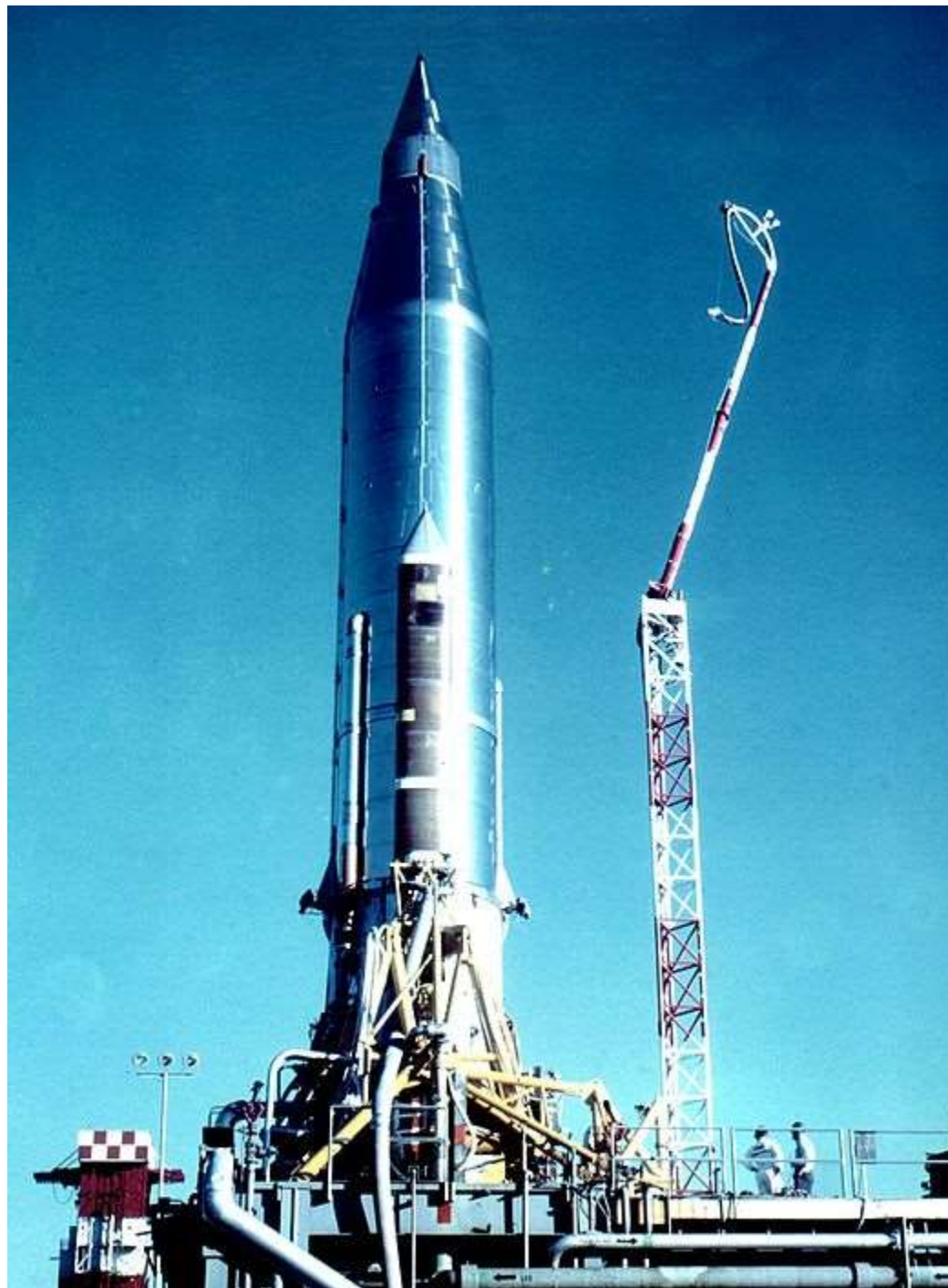


SCORE Security Concerns

- Sputnik I and II launched October 4 and November 3, 1957
- Many US launches ended in failure
- SCORE was not to be made public until it was deemed a success!
- Only 88 people on the “need to know” list
- Success! Public is now aware!
- SCORE carried President Eisenhower’s “Christmas Message for Peace on Earth” via magnetic tape – Project now public knowledge!!!

President Eisenhower's Christmas Message

- "This is the President of the United States speaking. Through the marvels of scientific advance, my voice is coming to you from a satellite circling in outer space. My message is a simple one. Through this unique means I convey to you and to all mankind, America's wish for peace on Earth and goodwill toward men everywhere."





JANUS Project

- Janus was intended to perform clandestine video spy operations over the Soviet Union
- When Congress learned about the project, they demanded that it be cancelled.
- The following are some early details of the JANUS project, TIROS' predecessor.







The $\frac{1}{2}$ " Vidicon is approx six inches long and $\frac{1}{2}$ " in diameter.



TIROS I

- Launched April 1, 1960
- The TIROS Program (Television InfraRed Observation Satellite) was NASA's first experimental step to determine if satellites could be useful in the study of the Earth.
- TIROS Program tested various design issues for spacecraft: instruments, data and operational parameters.
- The goal was to improve satellite applications for Earth-bound decisions, such as "should we evacuate the coast because of the hurricane?".

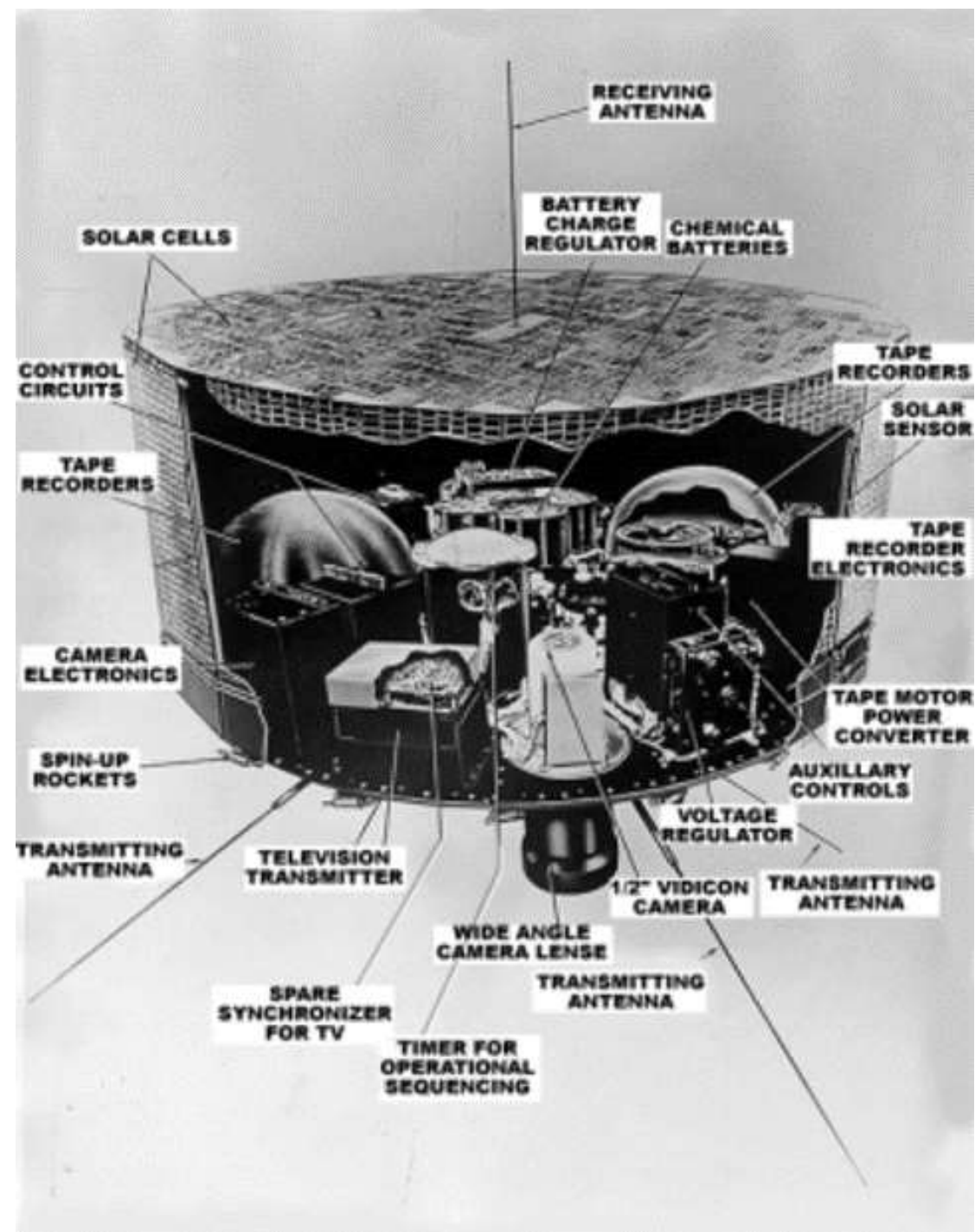


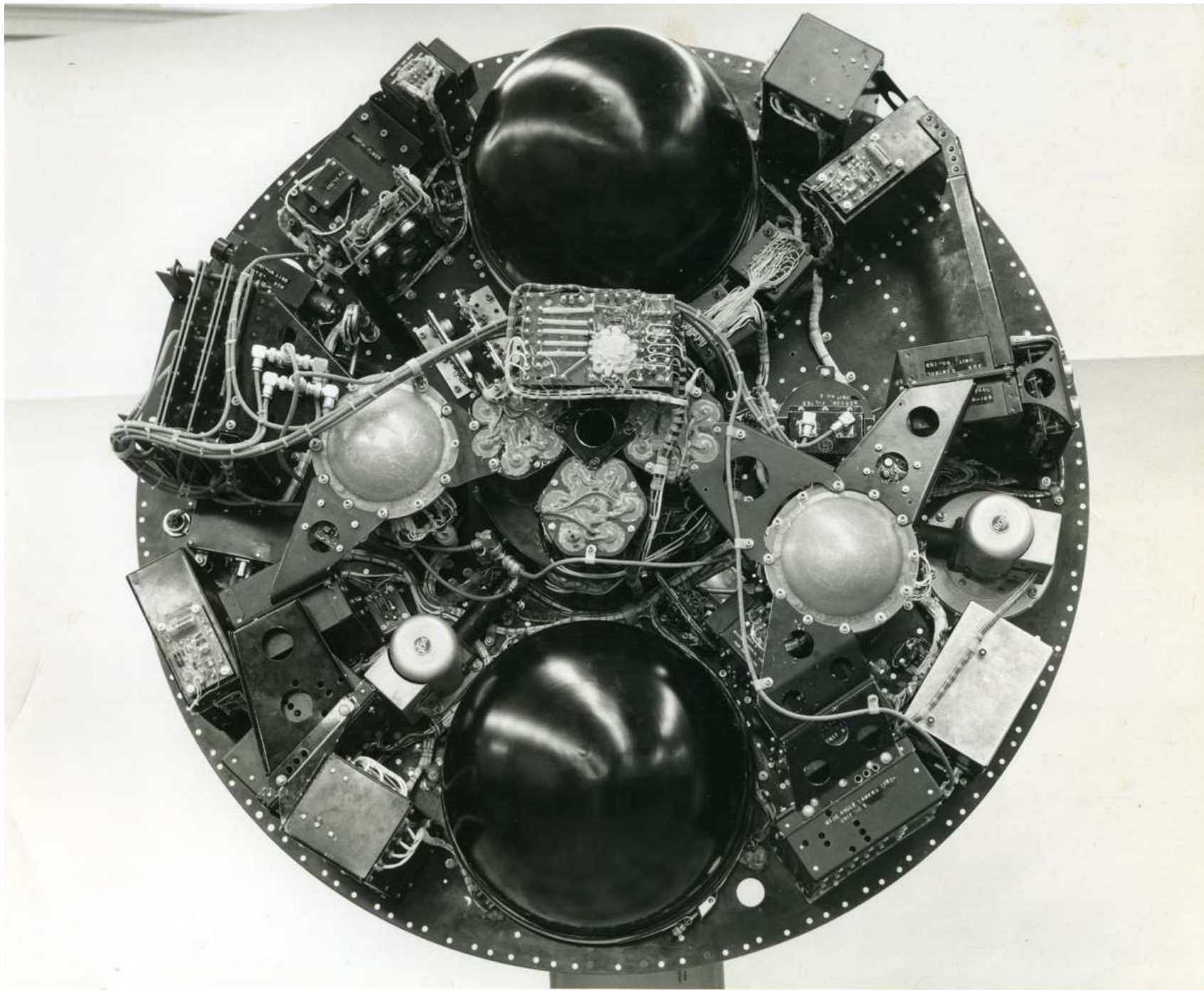
Tiro Operational Satellite

Weather
Satellite

Observing the
World's Weather



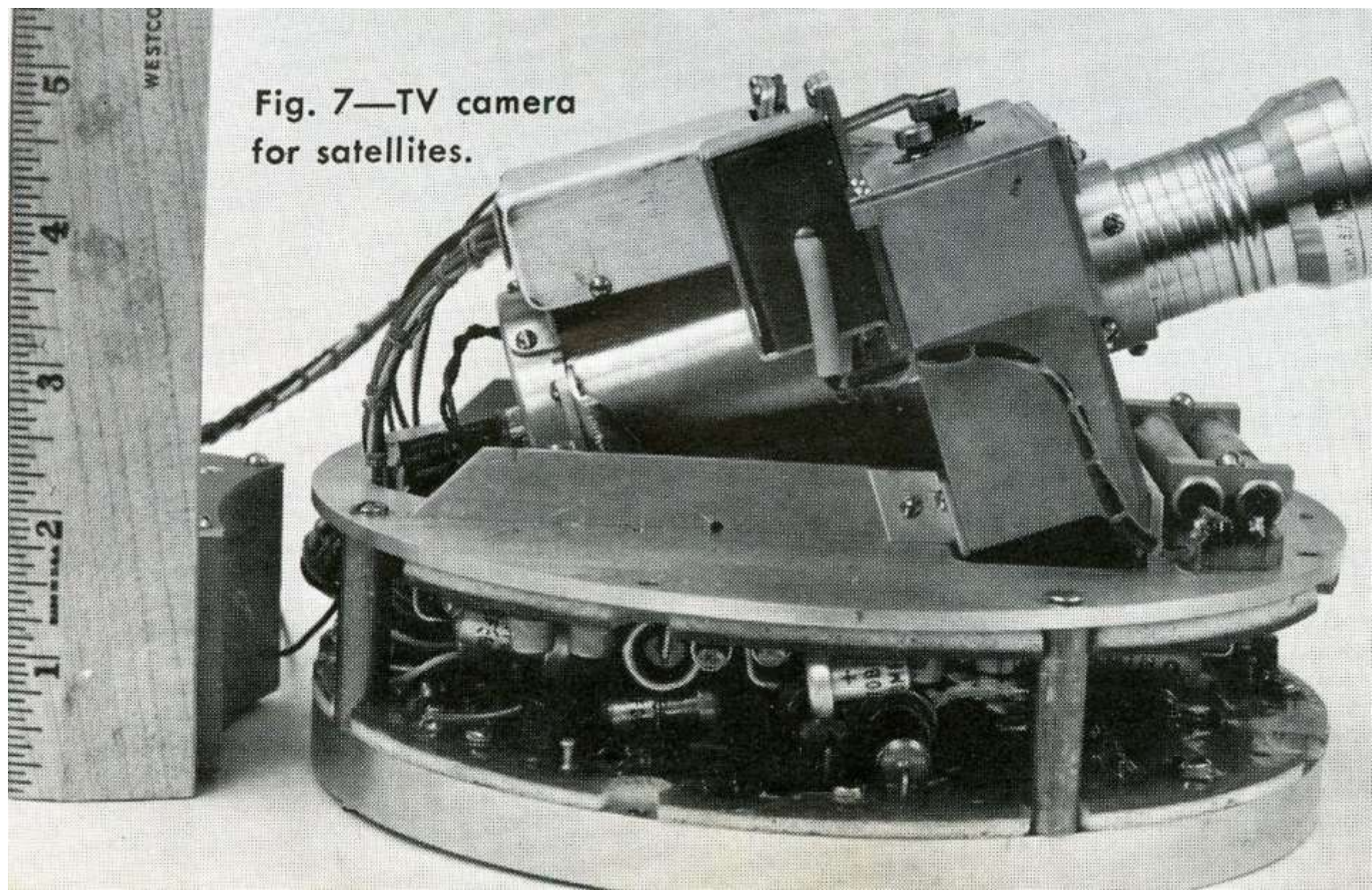




TIROS Primary Components

- Two television cameras were housed in the craft, one low-resolution and one high-resolution
- A magnetic tape recorder for each camera was supplied for storing photographs while the satellite was out of range of the ground station network.
- Clock, Receiver, Transmitters, etc.
- Antennas consisted of four rod/sleeve assemblies from the base plate to serve as transmitters and one vertical rod from the center of the top plate to serve as a receiver.

Fig. 7—TV camera
for satellites.



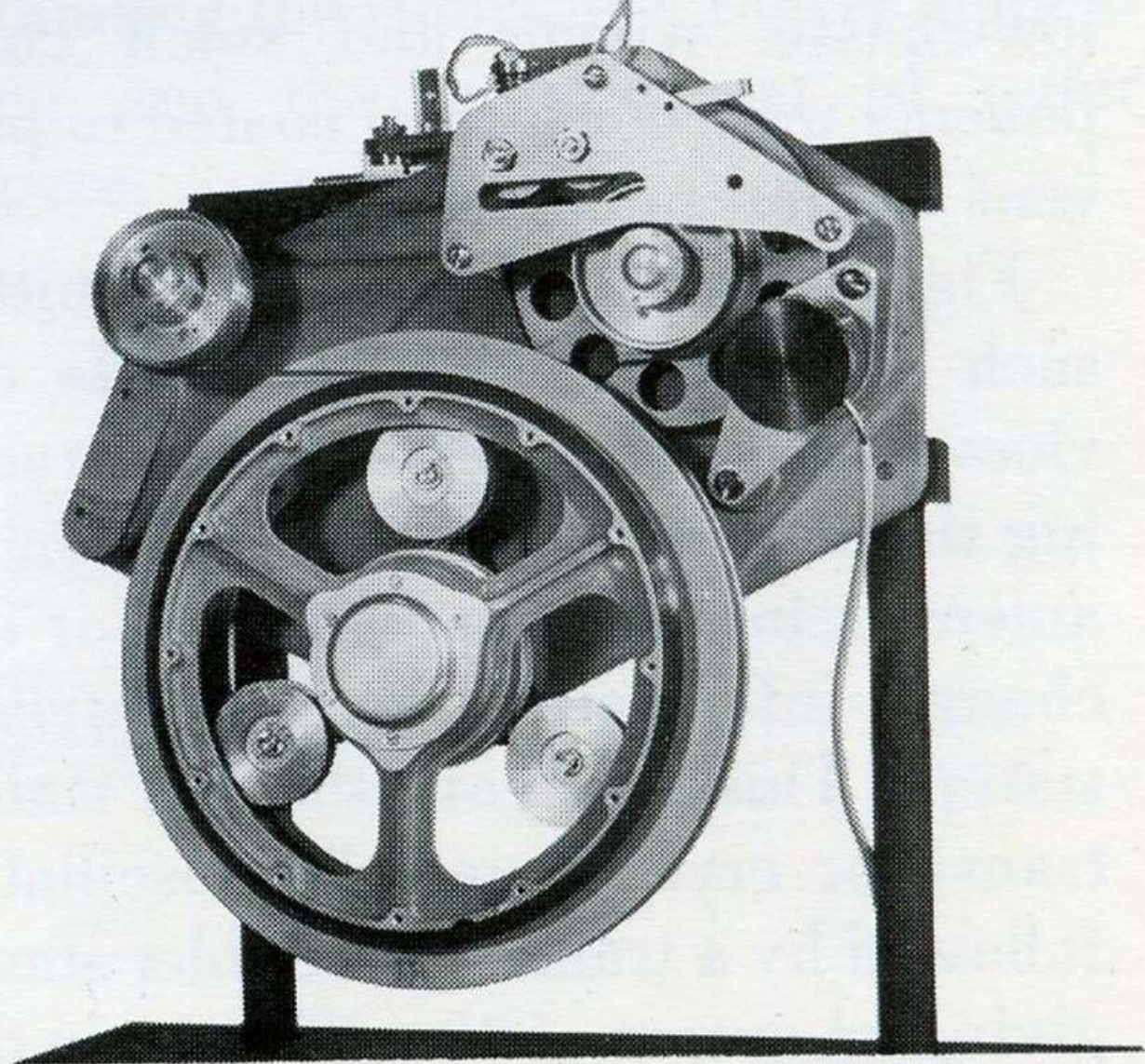


Fig. 4—Magnetic-tape transport for video storage on board a satellite. Tape speed is 50 ips, with a 1½-minute running time.

Magnetic Tape Data Recorder

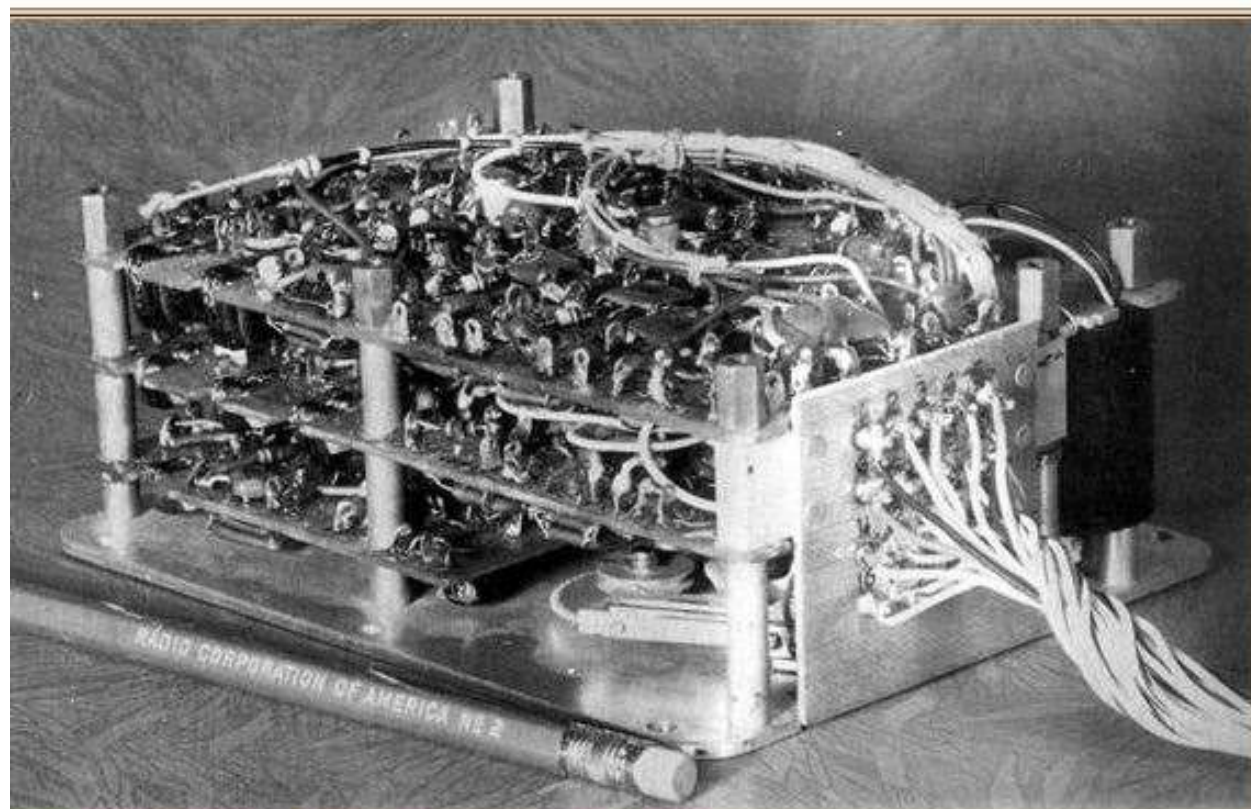
Tiros I Meteorological Satellite

This is an engineering prototype of the magnetic tape data recorder flown on Tiros I, the first weather satellite. The instrument was designed to record and then play back the first television images from space.

Gift of Lockheed Martin

A19980293000





TIROS 1 and 2 Clock Units. Redundant units were used on the satellite.
Ref. 13 pages 14 and 15.



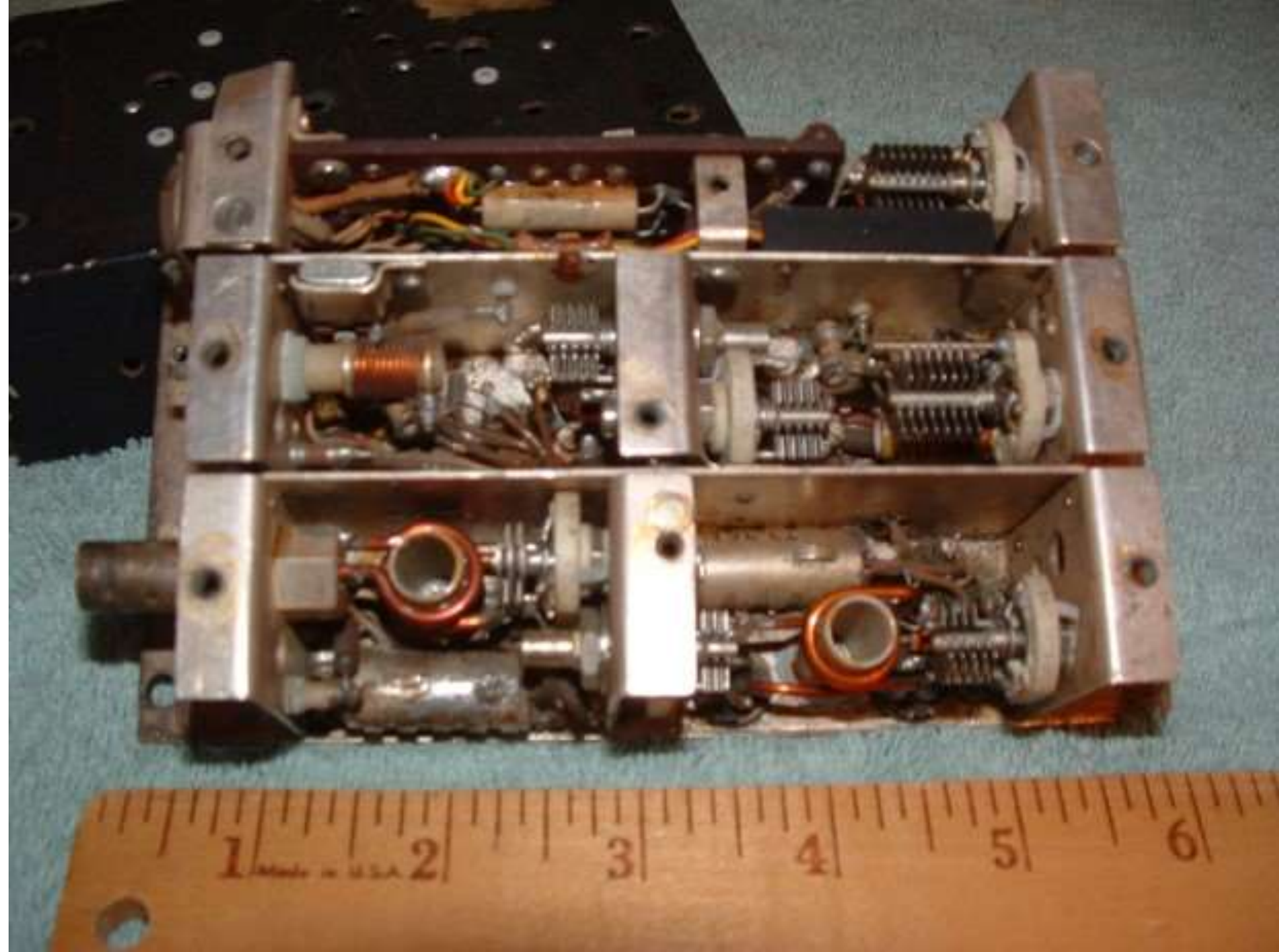


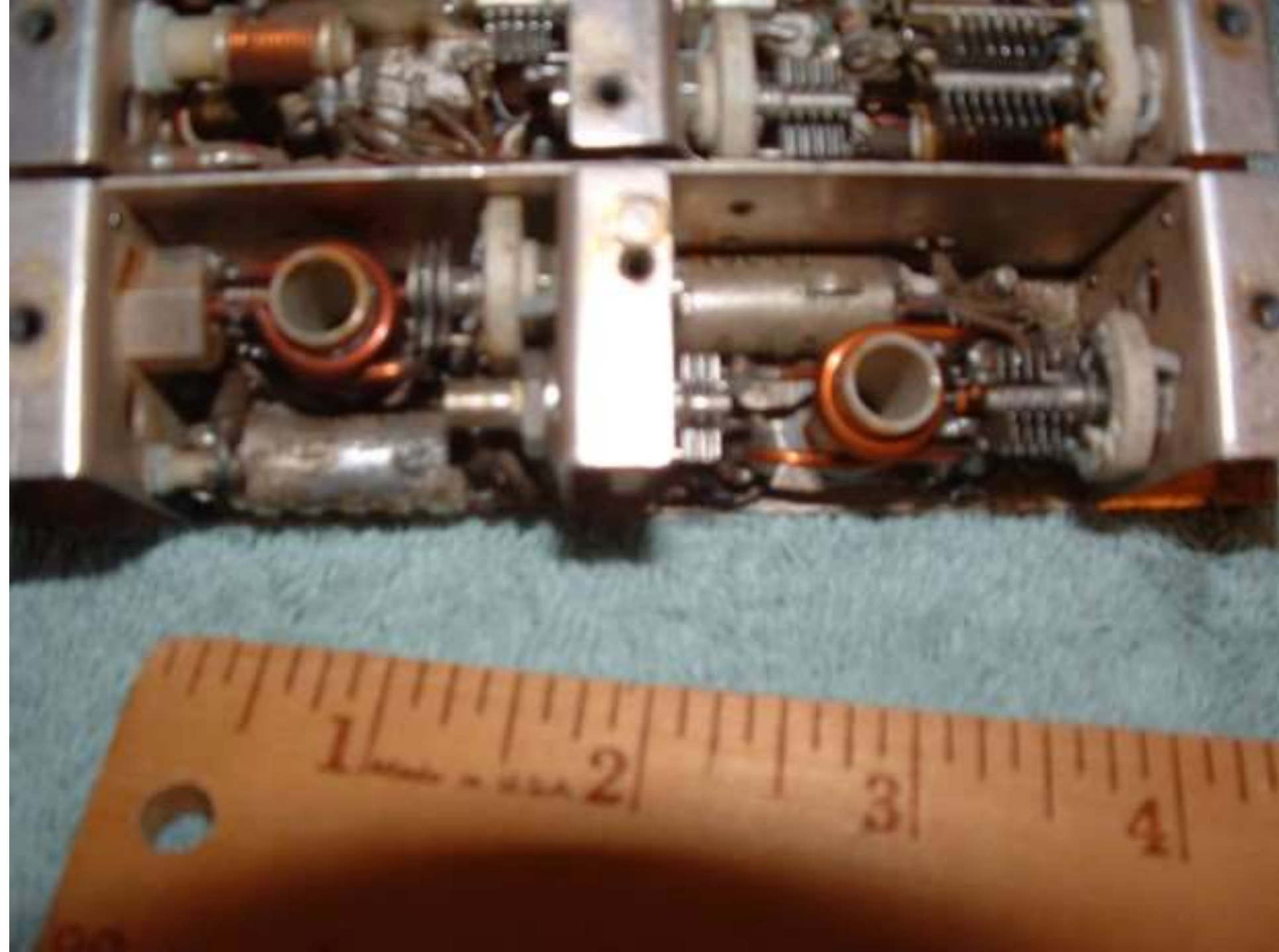
Television Transmitters

- 2 Television Transmitters in each TIROS
- Sub-Miniature Vacuum Tubes, no transistors!
- Transmitter one at 235 MHz
- Transmitter two at 237.5 MHz
- Crystal Controlled, with multipliers
- Phase Modulated
- 2 watts power out per transmitter
- Each transmitter consumed 5 watts (40% overall efficiency)









Beacon/Telemetry Transmitters

- TIROS carried 2 telemetry transmitters
- TIROS 1 - 3 assigned 108.0 MHz and 108.03 MHz
- TIROS 4 - 8 assigned 136.23 MHz and 136.92 MHz
- 30 Milliwatts out from each transmitter
- All Solid-State design, using transistors









TIROS I Telemetry Overview

- 40 discreet signals are monitored and reported to ground stations
- Seven of these signals are derived from Zener references
- Audio generator frequency modulated by monitored signals
- Beacon/Telemetry transmitter amplitude modulated with tones
- Ground station records the series of tones on magnetic tape
- Tape playback through frequency-to-voltage converter
- Varying voltage coupled to Brush chart/pen recorder
- Interpretation is totally manual

TIROS Telemetry System of Voltage and Temperature

The telemetry system in TIROS is a conventional somewhat archaic pulse-amplitude modulation frequency modulation amplitude modulation system. There are two complete systems functionally redundant and carrying identical information. The only differences between the systems are the carrier frequencies of the two transmitters and the order in which various signals are commutated. Certain of the telemetry voltages are generated by relatively high-impedance sources, and are connected in different parts of the sequence of the two telemetry switches in order that they not be subjected to simultaneous loading by both subcarrier modulator circuits - since the switches are stepped by separate free-running oscillators, there is no synchronism, no certainty of the loading, and hence no certainty of the calibration if a high-impedance quantity is susceptible to simultaneous dual sampling.

The switches are mechanical, solenoid-operated, and have forty non-shorting contacts. They are cycled once on each pass where an ground CDA interrogation occurs rather than continuously; in order to save power.

The subcarrier oscillator is transistorized operates at 1300 cps for zero volts input and deflects plus or minus 100 cps for plus or minus 5 volts on its input. Six of the forty channels on each switch are used for a set of calibration signals derived from zener reference diodes, so that linearity and long stability of the subcarrier oscillator are not significant sources of error in the overall system.

The telemetry transmitter is a 30-milliwatt transistorized amplitude modulation transmitter operated at 108 mega cycles. Its presence in the satellite is primarily for tracking by the Mini track network.

The telemetry radiator is combined with the television antennas. Each of the 235 Mc/s monopoles acts as a mechanical support and electrical feed to an extension operating at 108 Mc/s.

Separate horizontal and vertical feeds and polarization diversity reception are employed at 108 Mc/s as well as at 235. The same dish is used for both frequencies.

Telemetry reception is by means of fixed-tuned converters down to about 14Mc/s, followed by use of military hf communications receivers. The telemetry output is frequency-demodulated and pen-recorded in a commercial unit. Interpretation is manual.

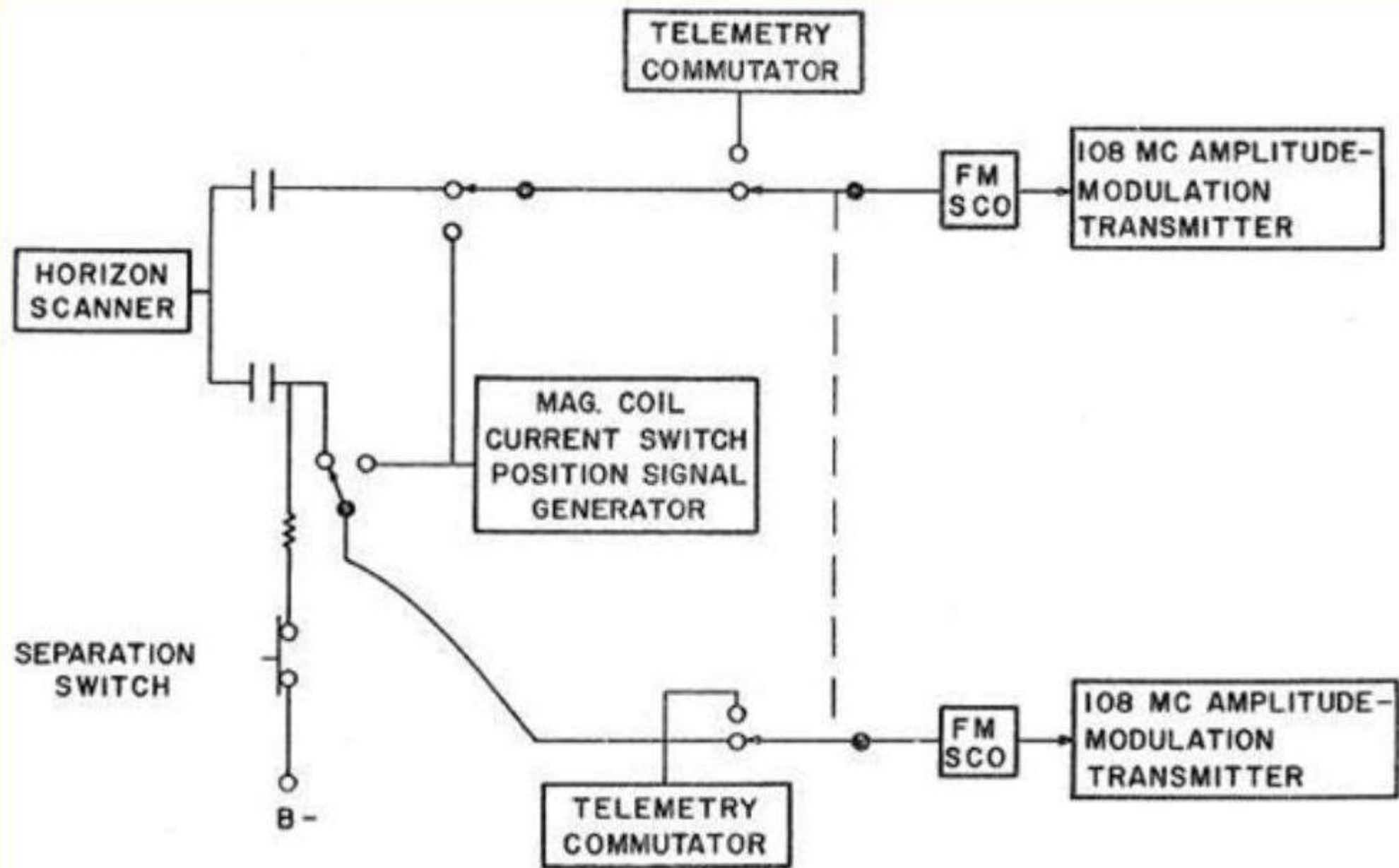


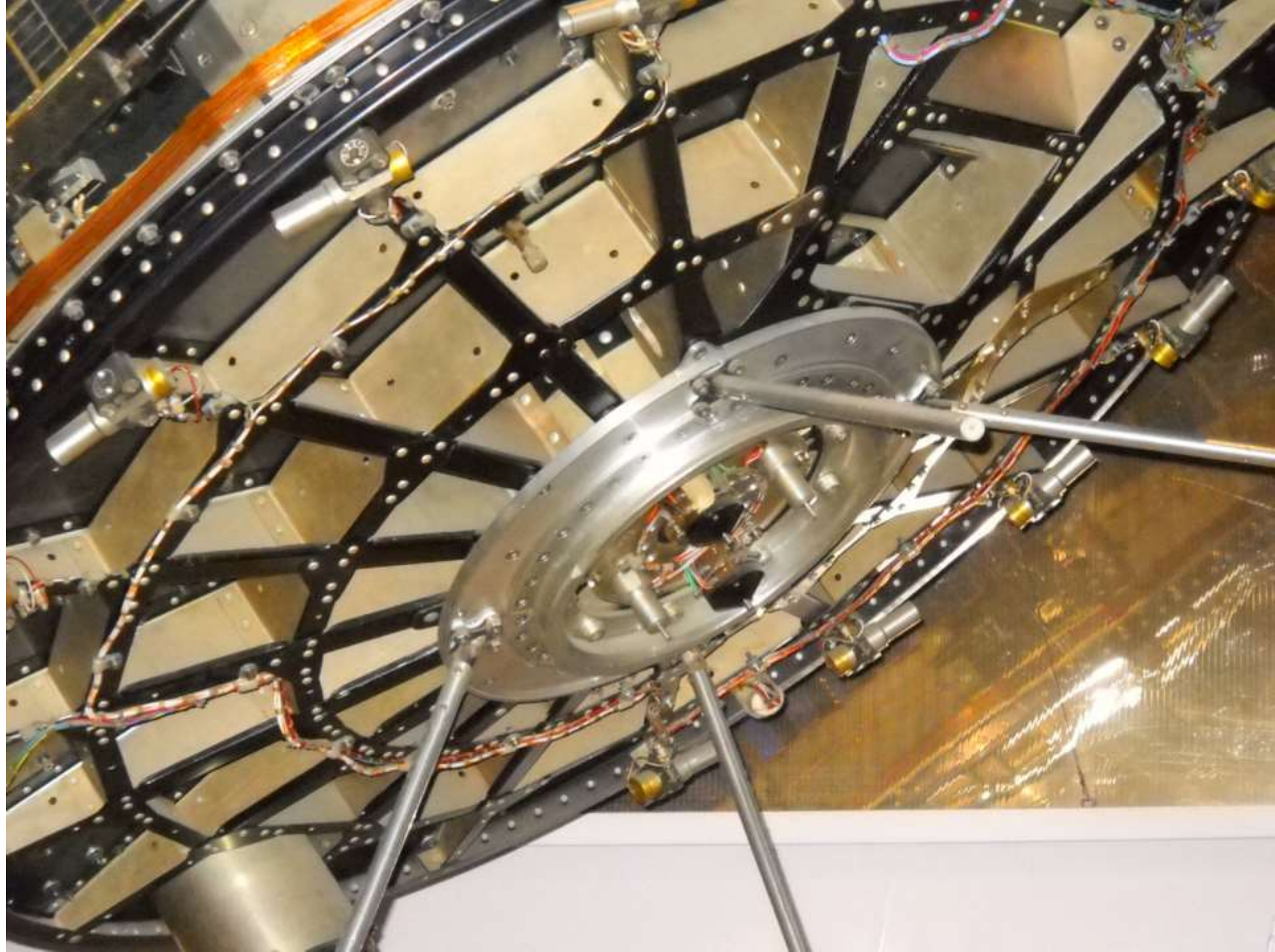
Figure 4. Combination Circuit, Beacon Subcarrier Input Signals

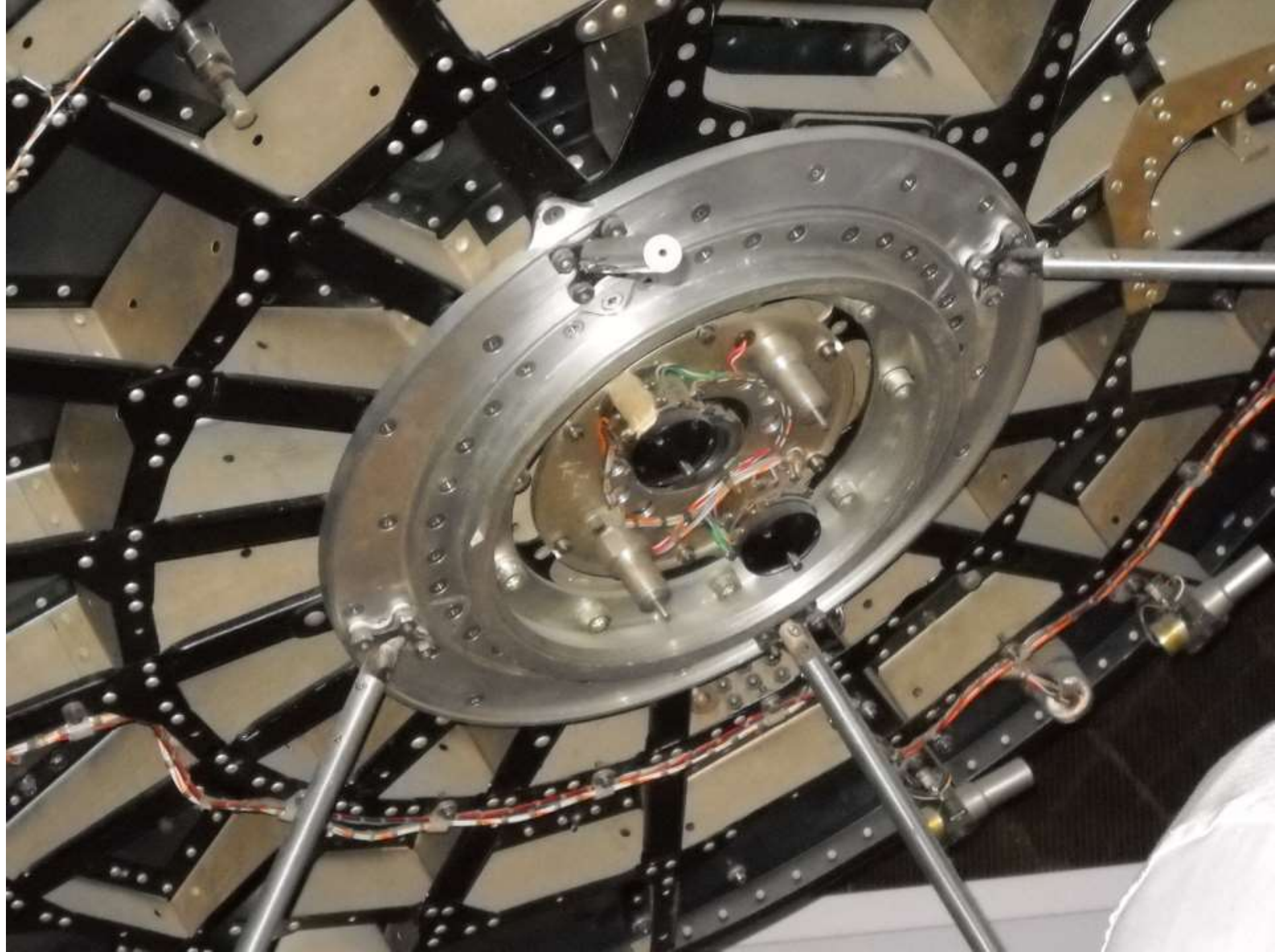
TIROS Antenna Systems

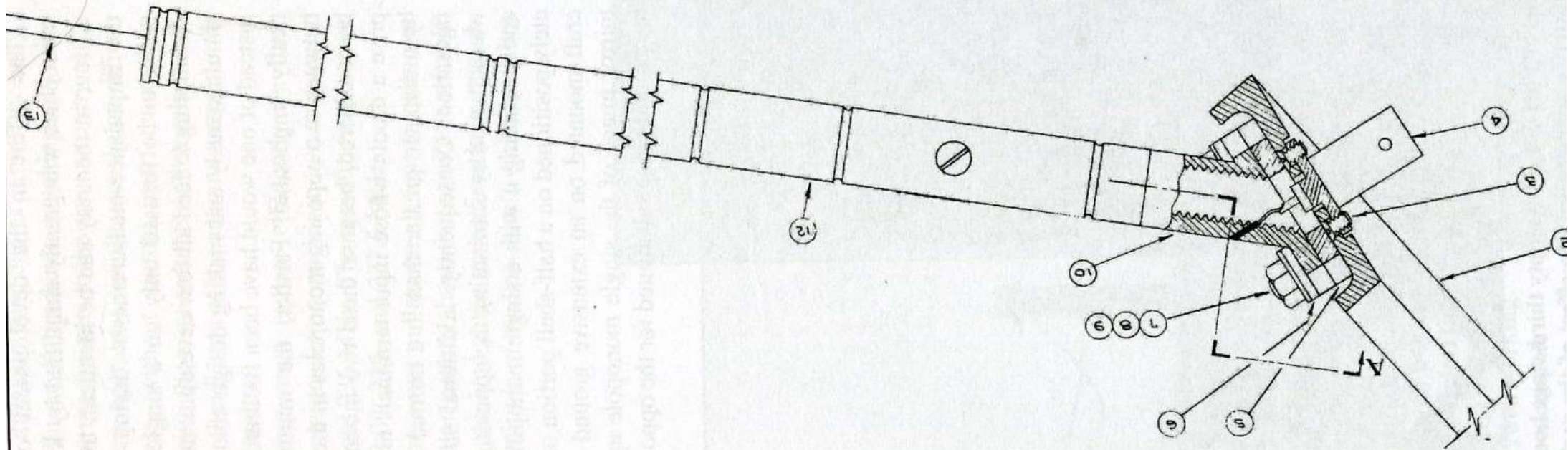
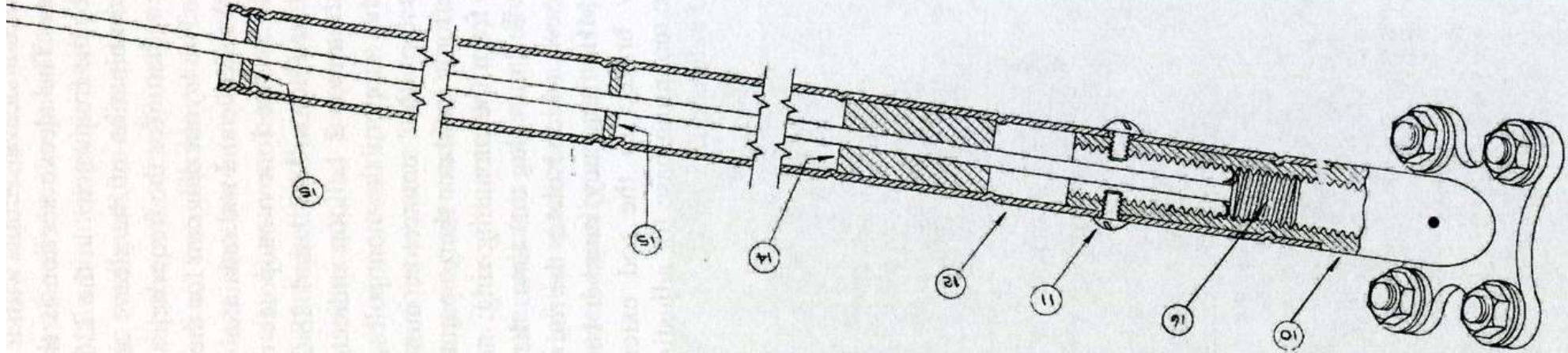
- One monopole receiving antenna (top)
- Transmit uses 4 rod/sleeve monopoles
- RHCP for one TV and Beacon/Telemetry transmitter
- LHCP for the other TV and Beacon/Telemetry transmitter
- Coupling system on pc board stripline employing ring diplexers, baluns, selective filters, open and shorted stubs, and phasing lines



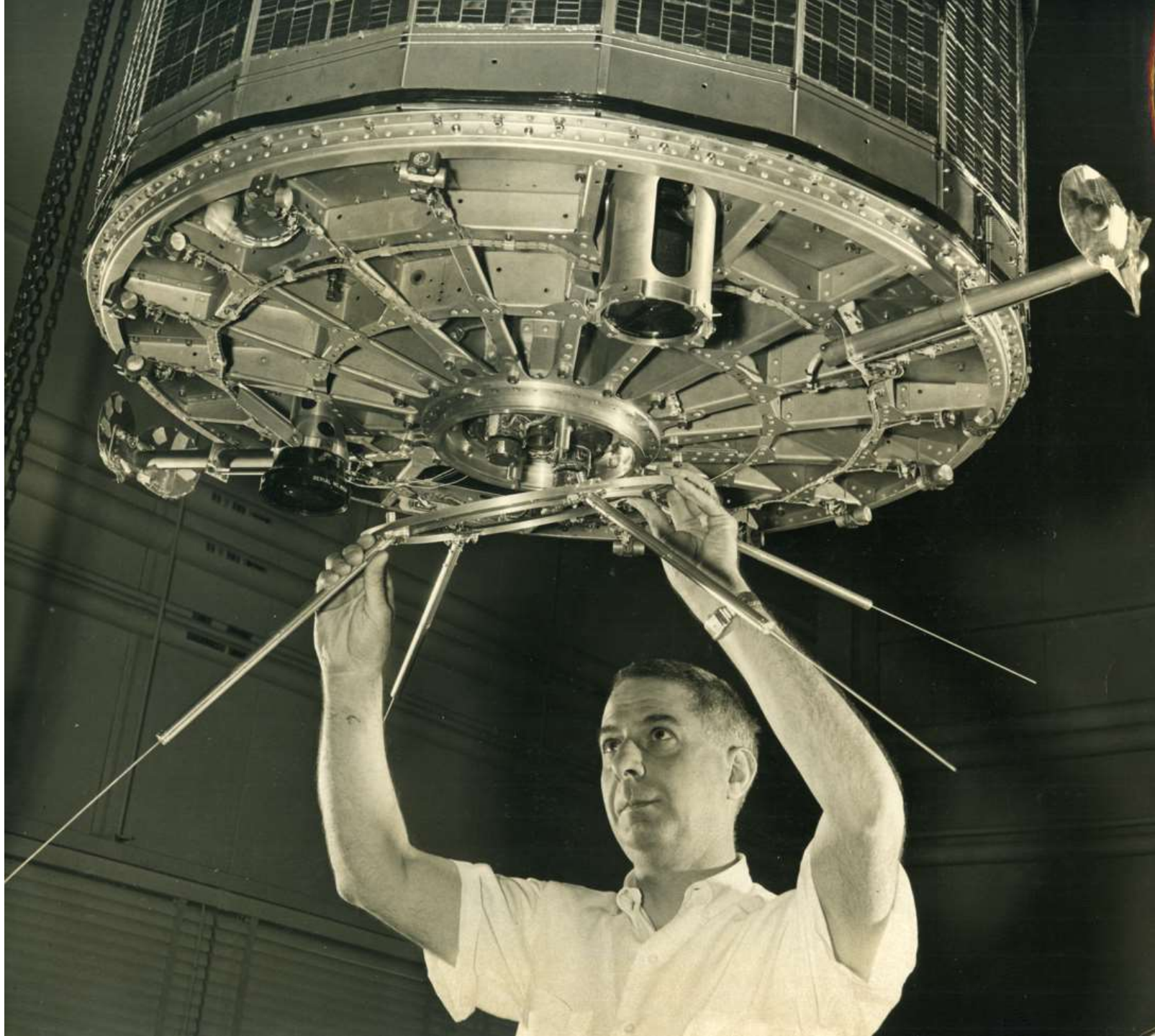












Antenna Modeling

- Early design and validation at $\frac{1}{4}$ scale
- Frequencies multiplied by four
- Test of individual monopoles via half-shell on ground plane
- Full system test of four monopoles (crossed dipole CP array)







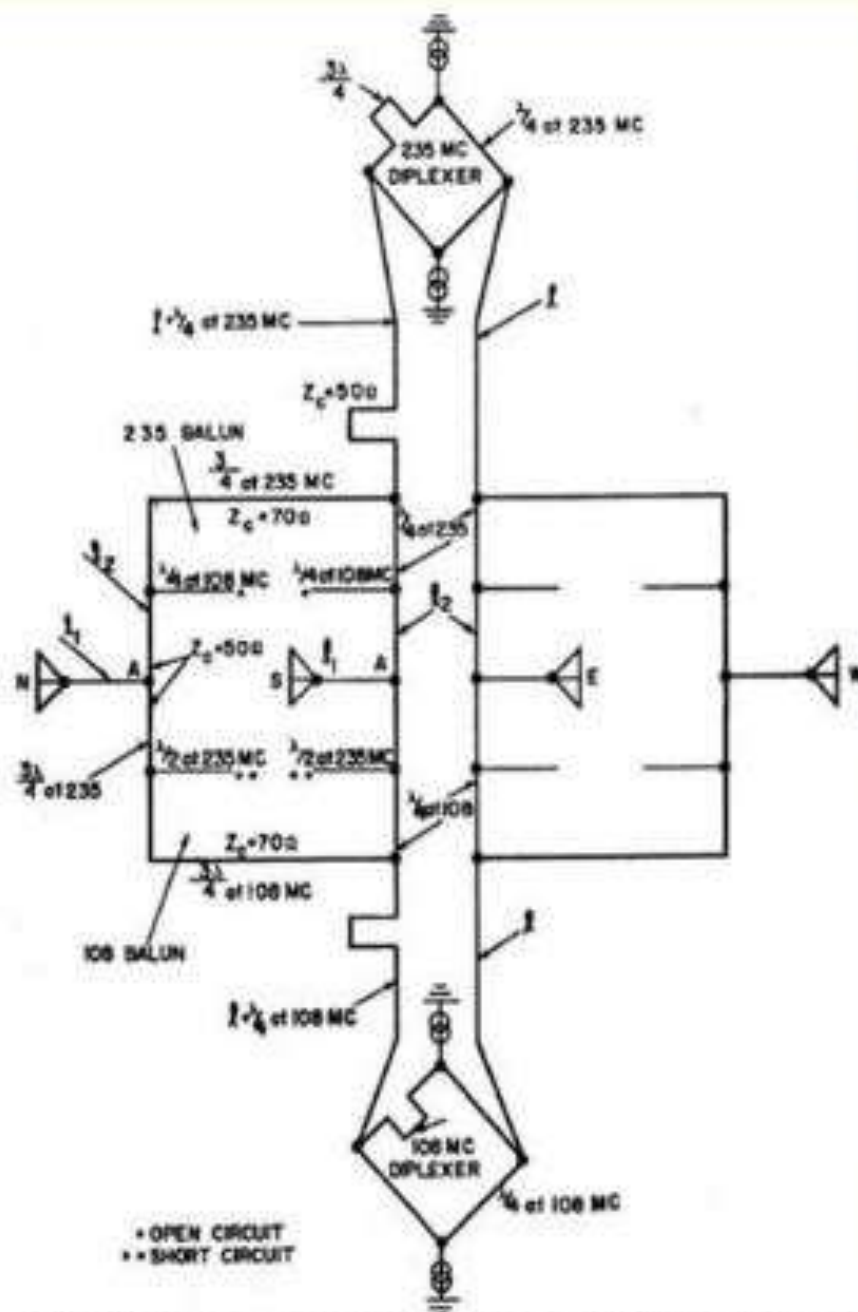
TIROS 1

Transmit Antenna Coupler

Design by Walt Maxwell

Two Video and two Beacon Telemetry transmitters were coupled to the four elements of the Transmit Antenna, the four thin rods that extended below the spacecraft baseplate.

The diagram on the right illustrates the RF matching network to provide this coupling so that all transmit units could be on simultaneously.



Circuit Diagram of TIROS 1 Coupling and Matching Network

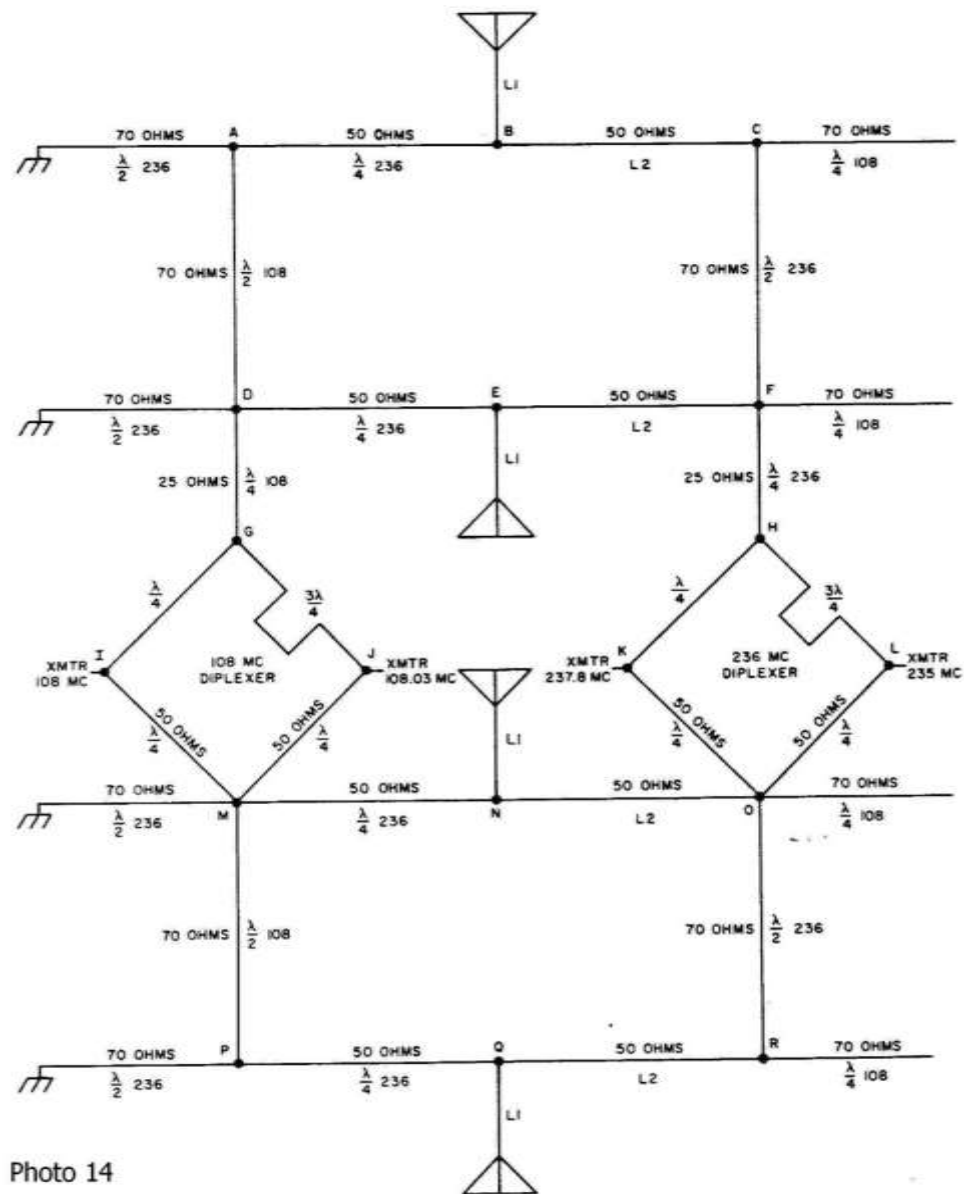
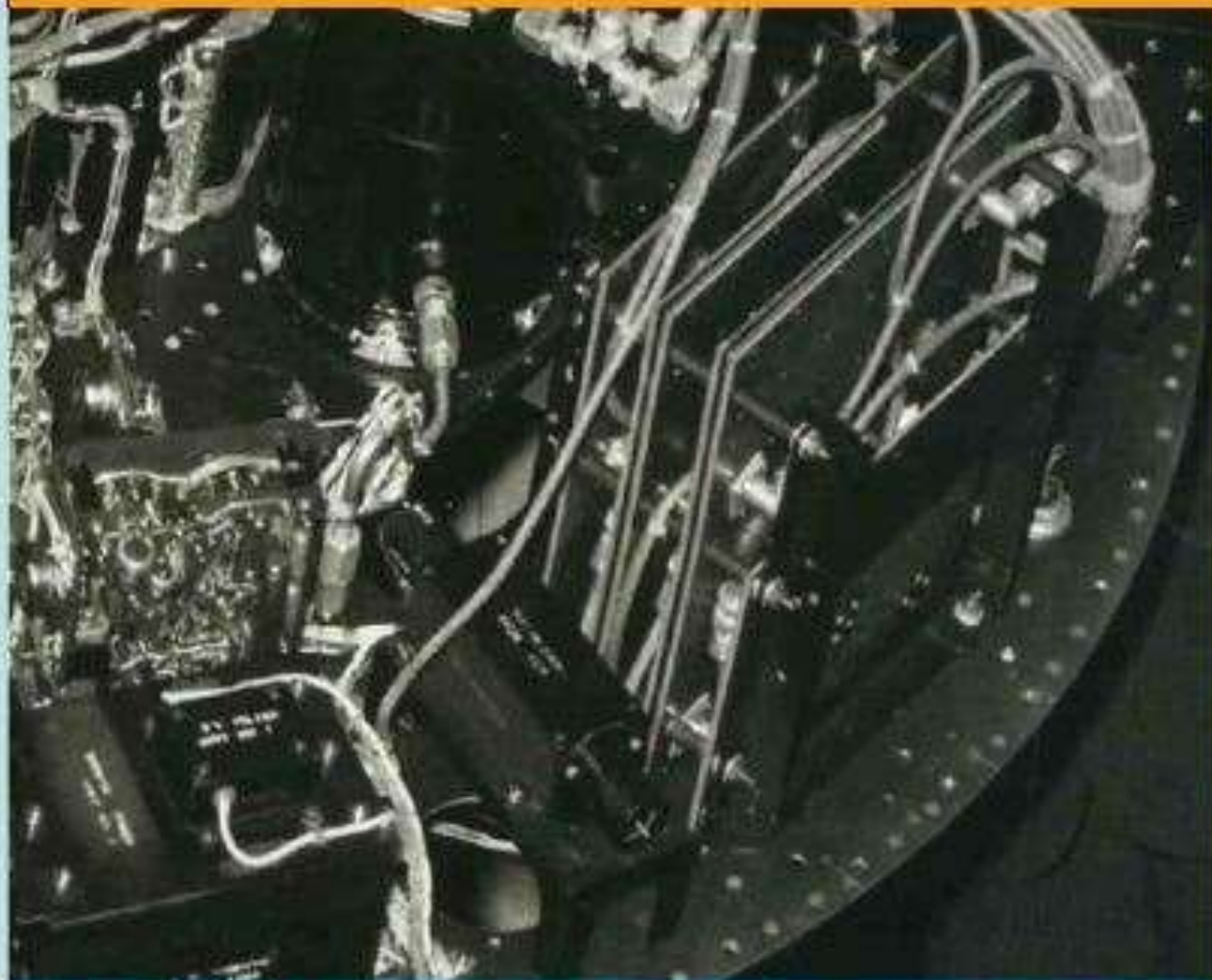


Photo 14

Circuit Diagram of TIROS 1 thru 3 Antenna Coupling and Matching Network

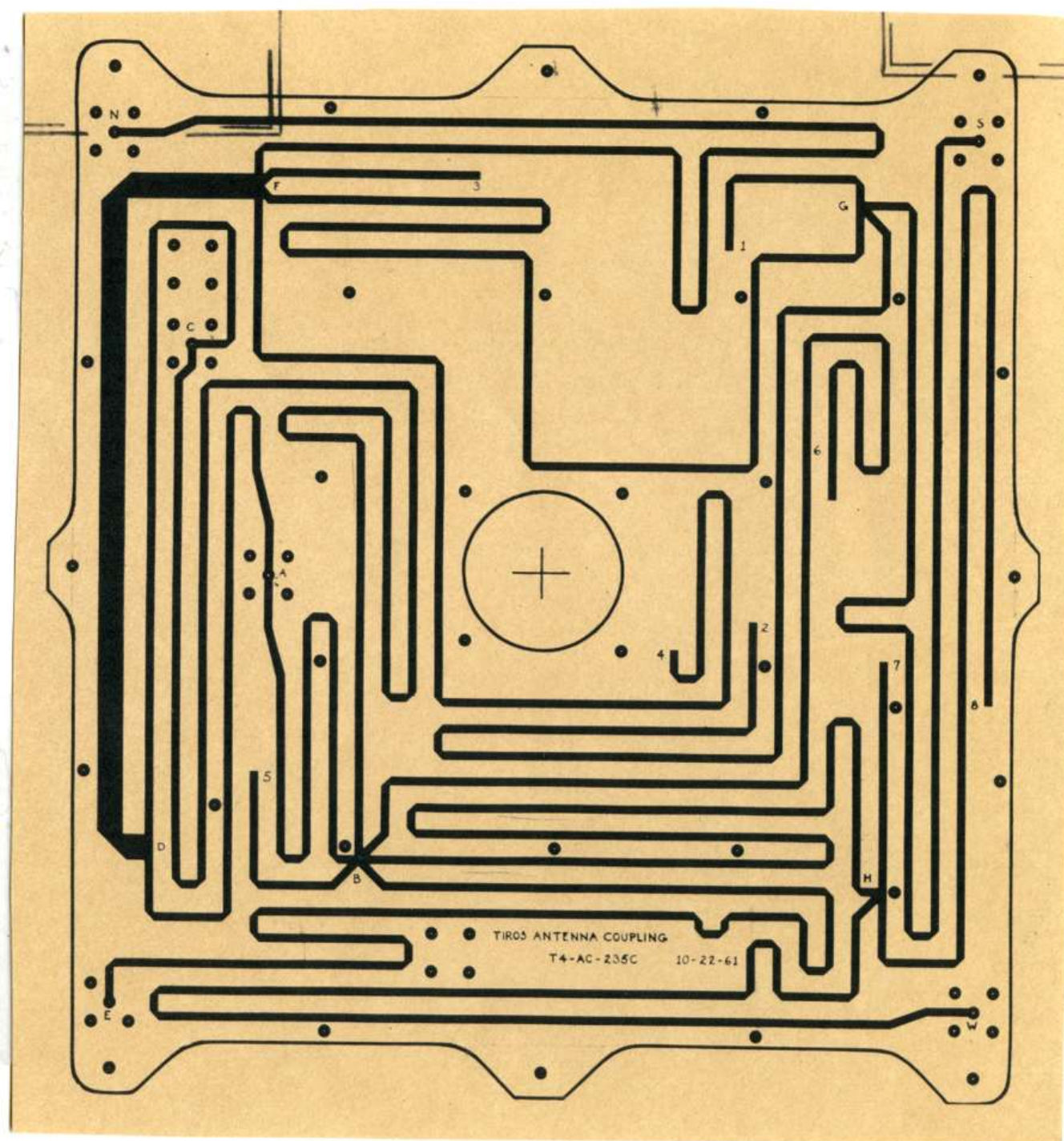
TIROS 1 Transmitters Coupler Diplexer

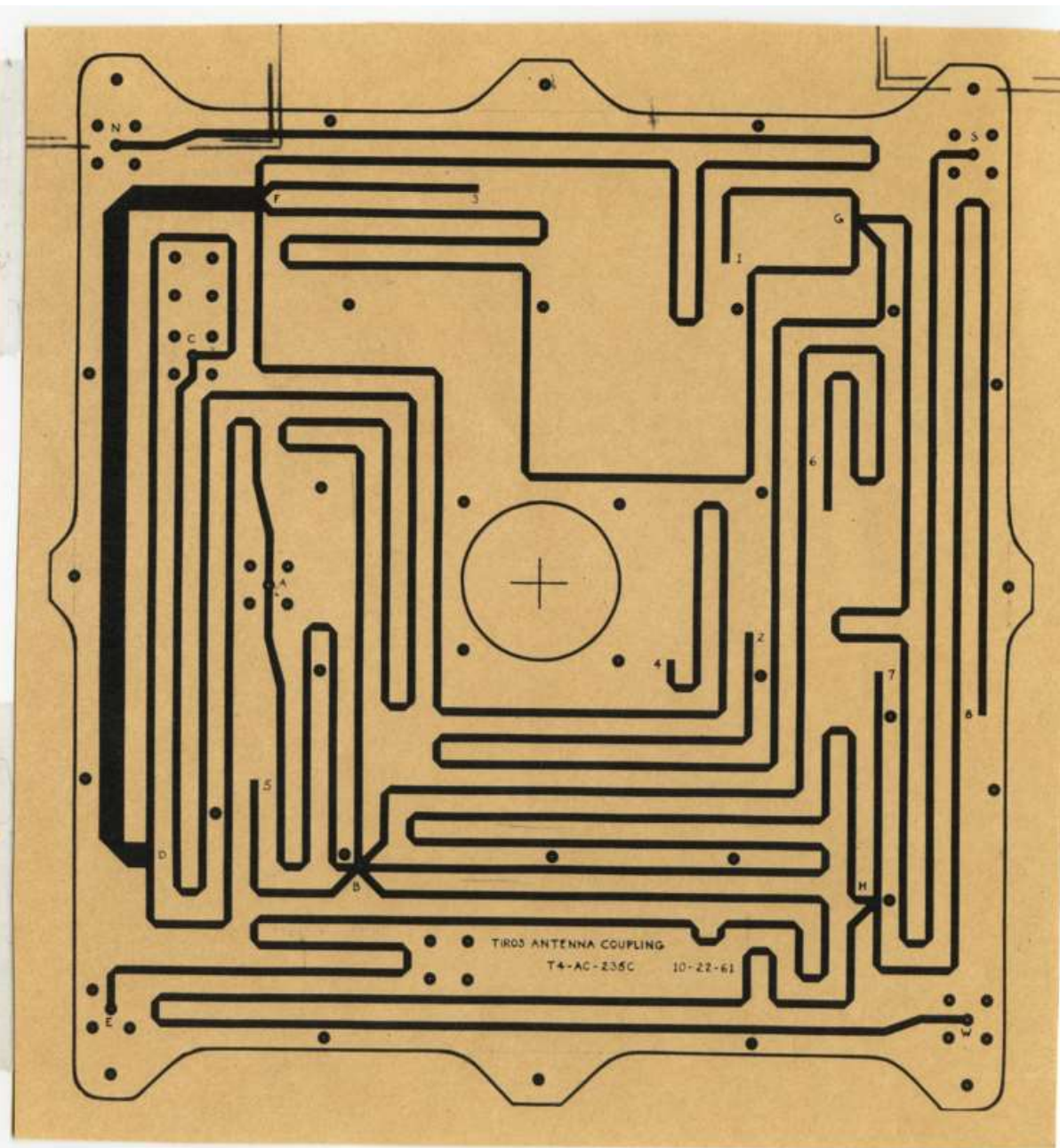
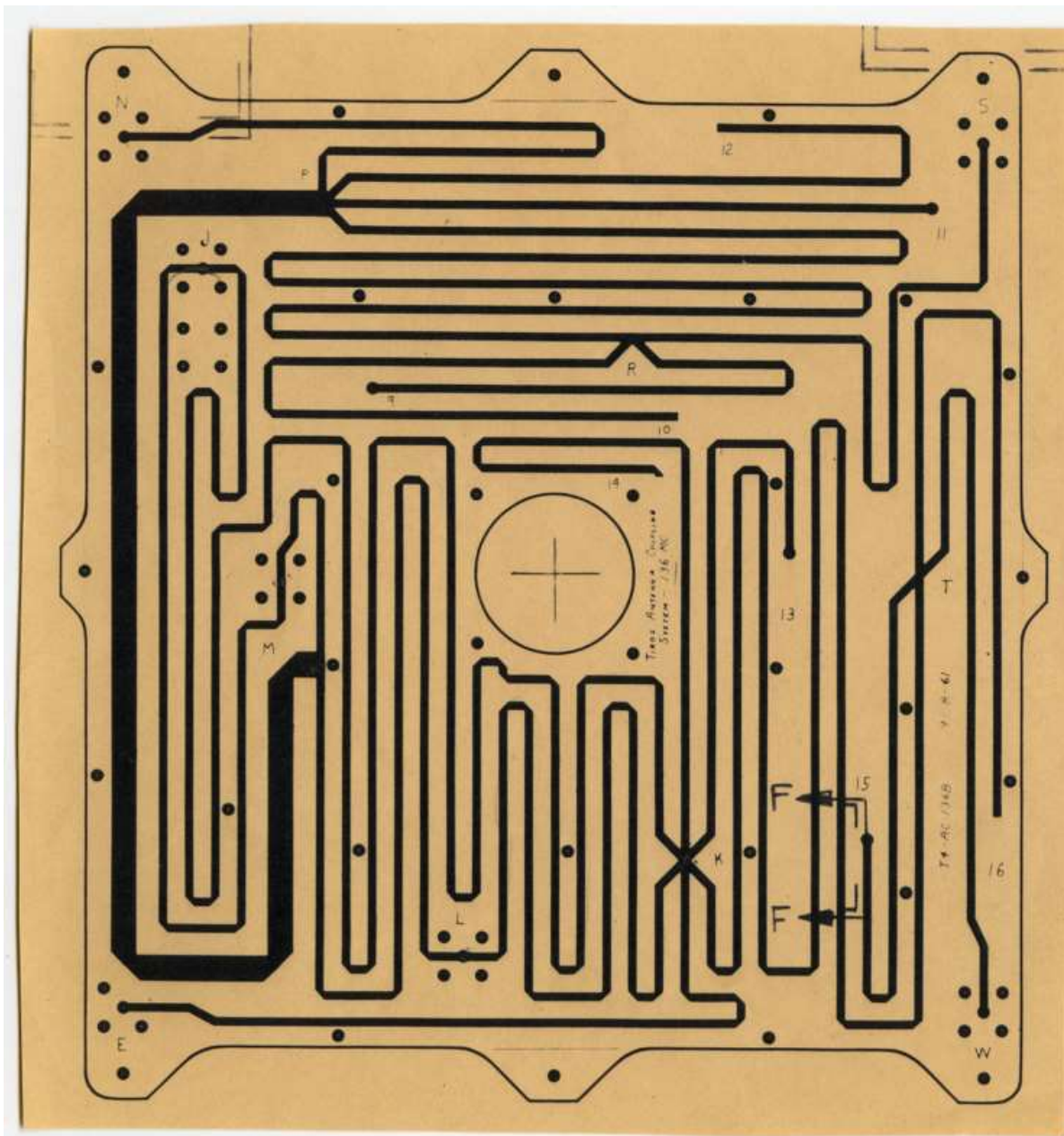


TIROS I's RF coupler diplexer unit, is seen as four vertical boards of components with cables.

The design used discrete components to achieve the required impedance values.

Each of the four Video 235 Mhz antenna radiators supported and electrical feed the Beacon-Telemetry 108 Mhz radiators.



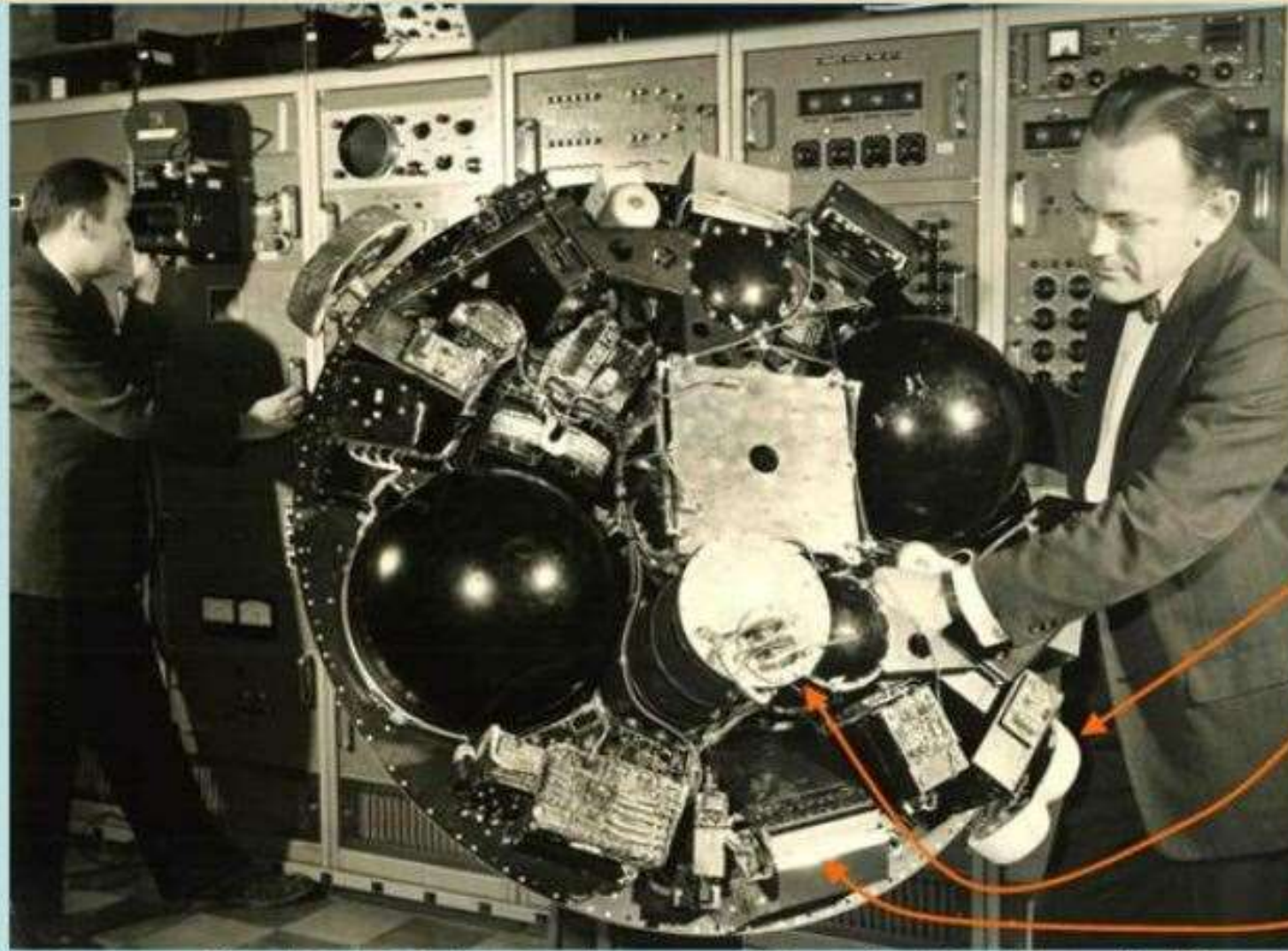






TIROS 2 Spacecraft with Solar Array Removed

Photo from Walt Maxwell Collection

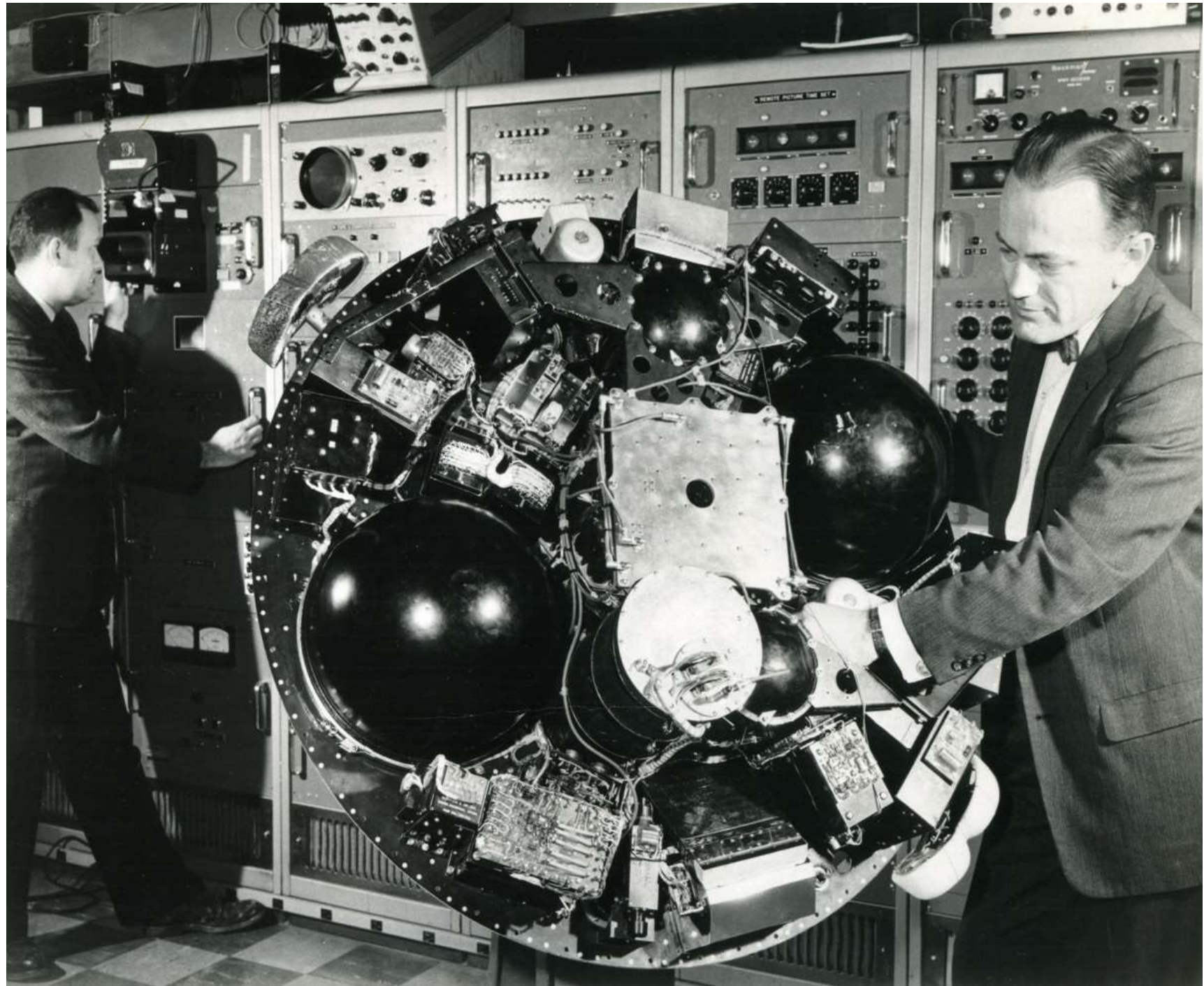


LRIR
Black Cone
White Cone
Wide FoV

MRIR
Electronics
Tape Recorder
Transmitter

MRIR Sensor
5 Channels
Optics, Filters
Detectors

TIROS spacecraft with RCA Engineers Marvin Harper (left) and Glenn Corrington performing tests with the Command and Data Acquisition Ground Station at East Windsor, NJ.



End of Part 1