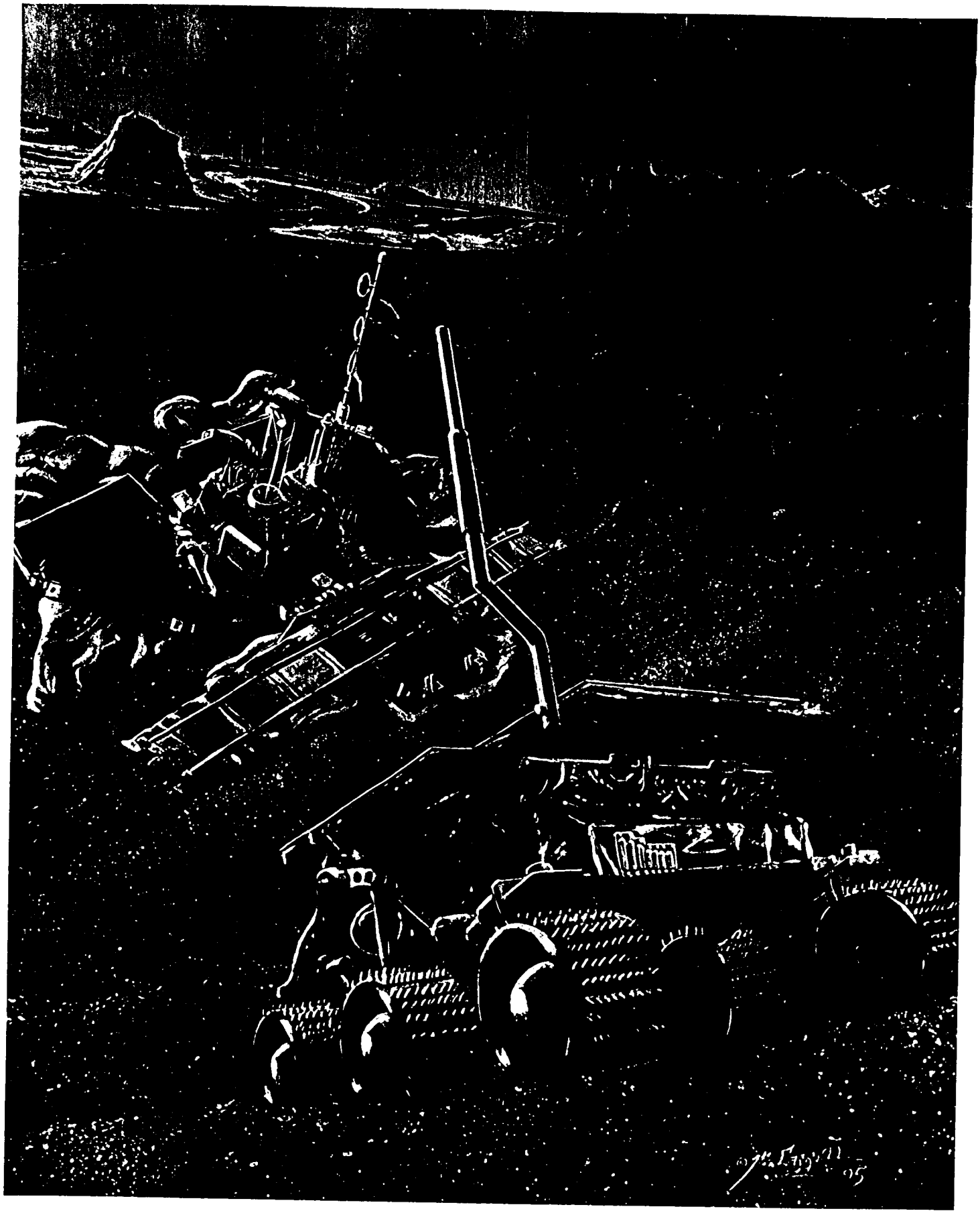
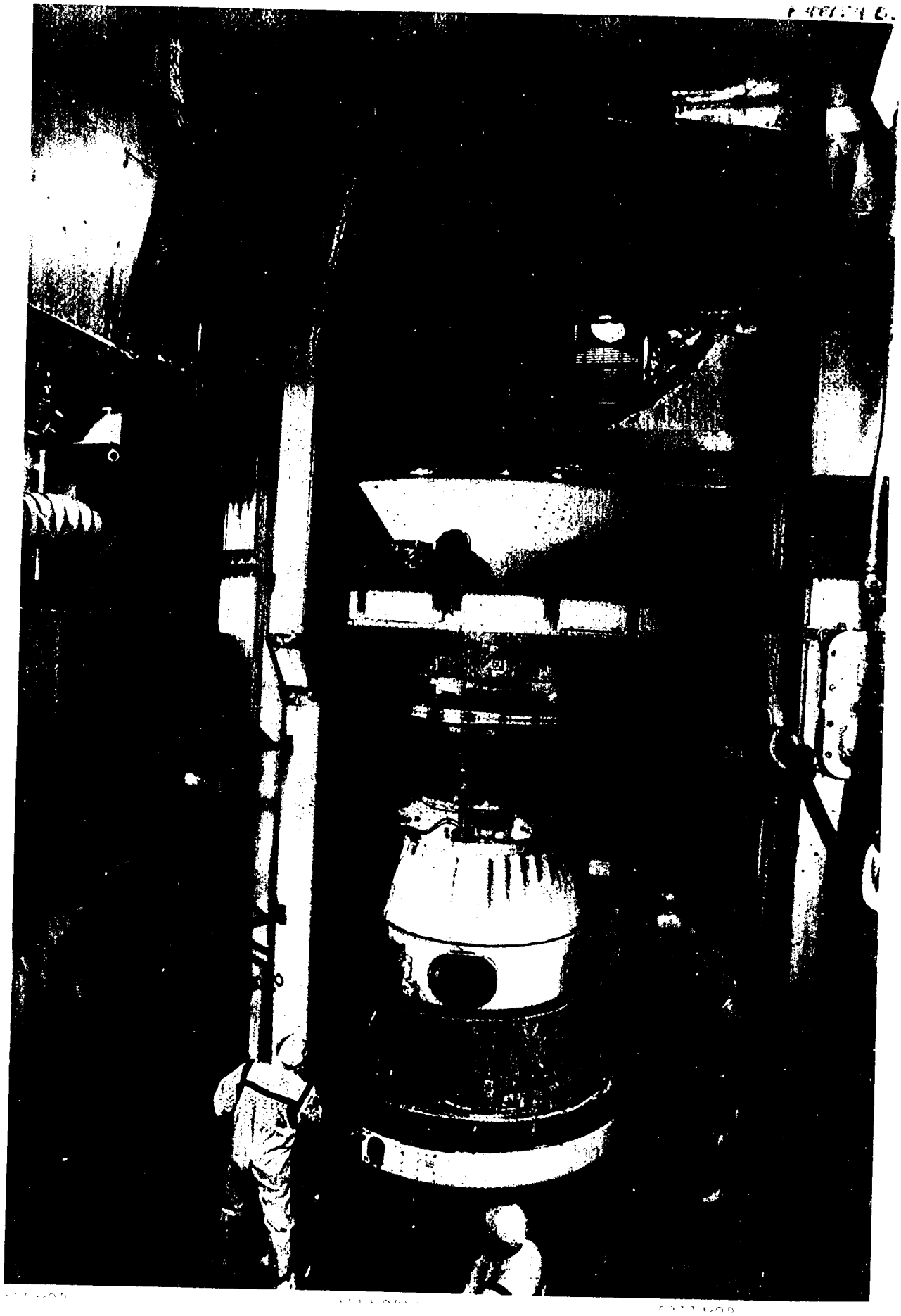
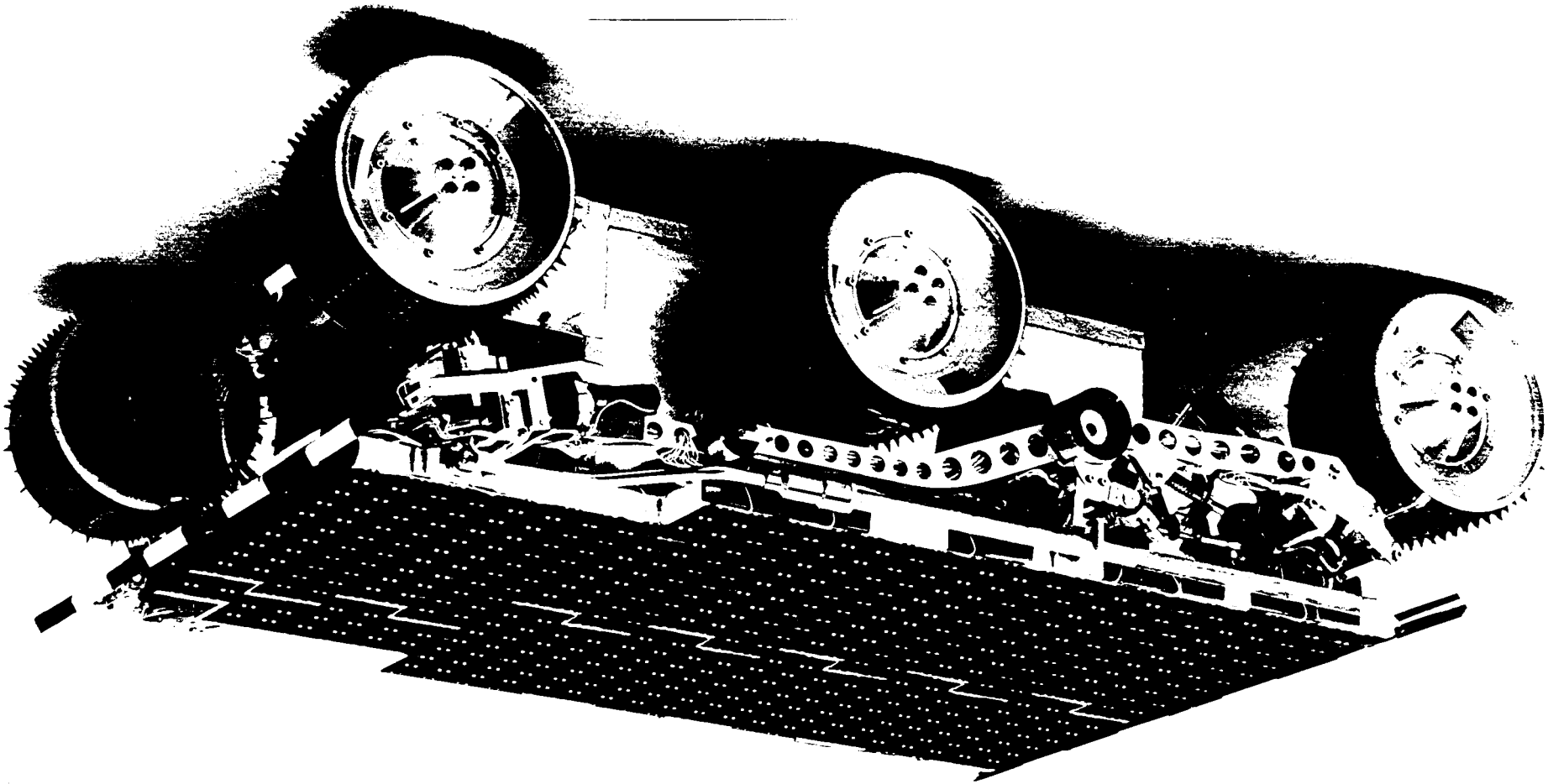
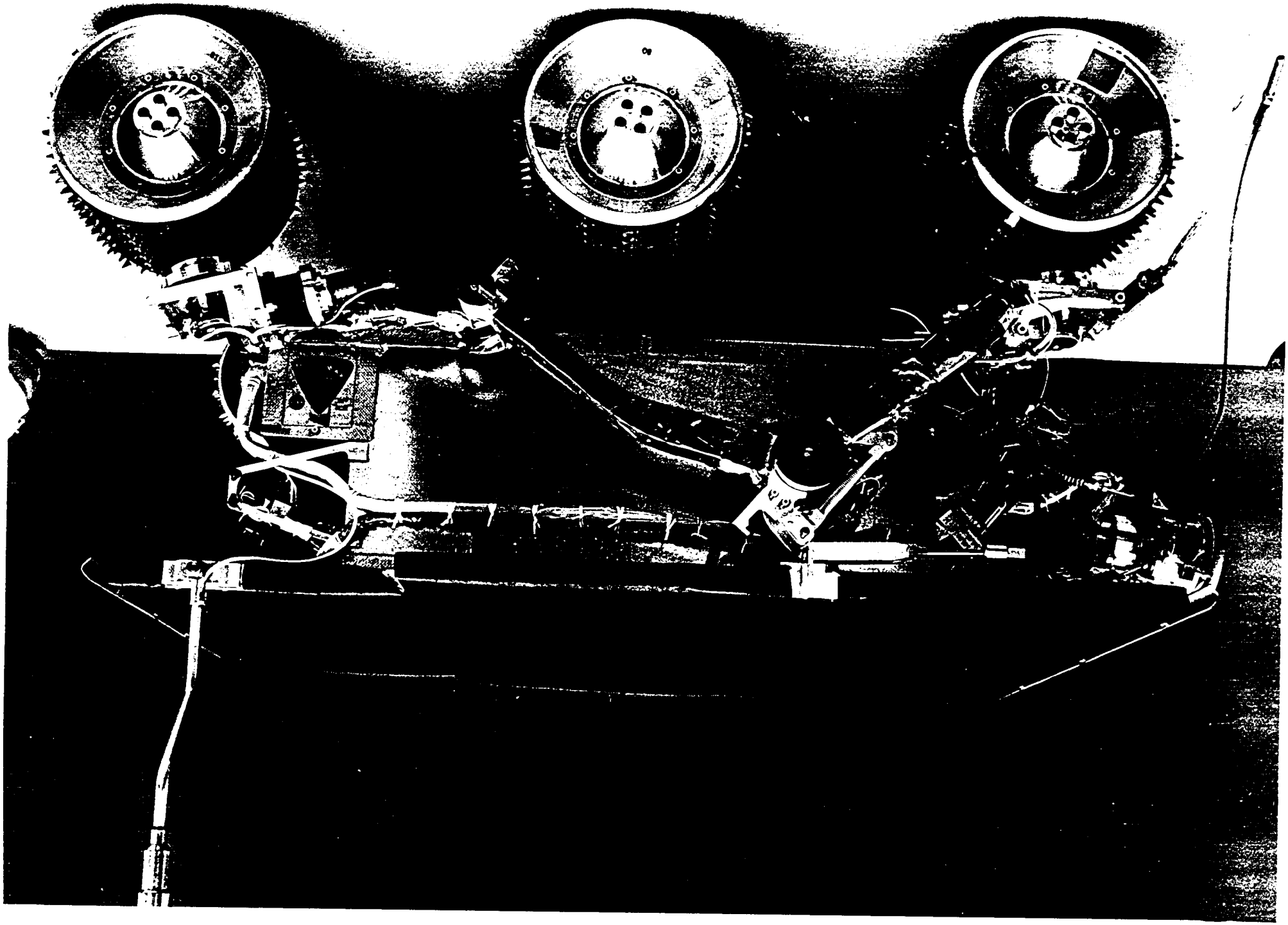
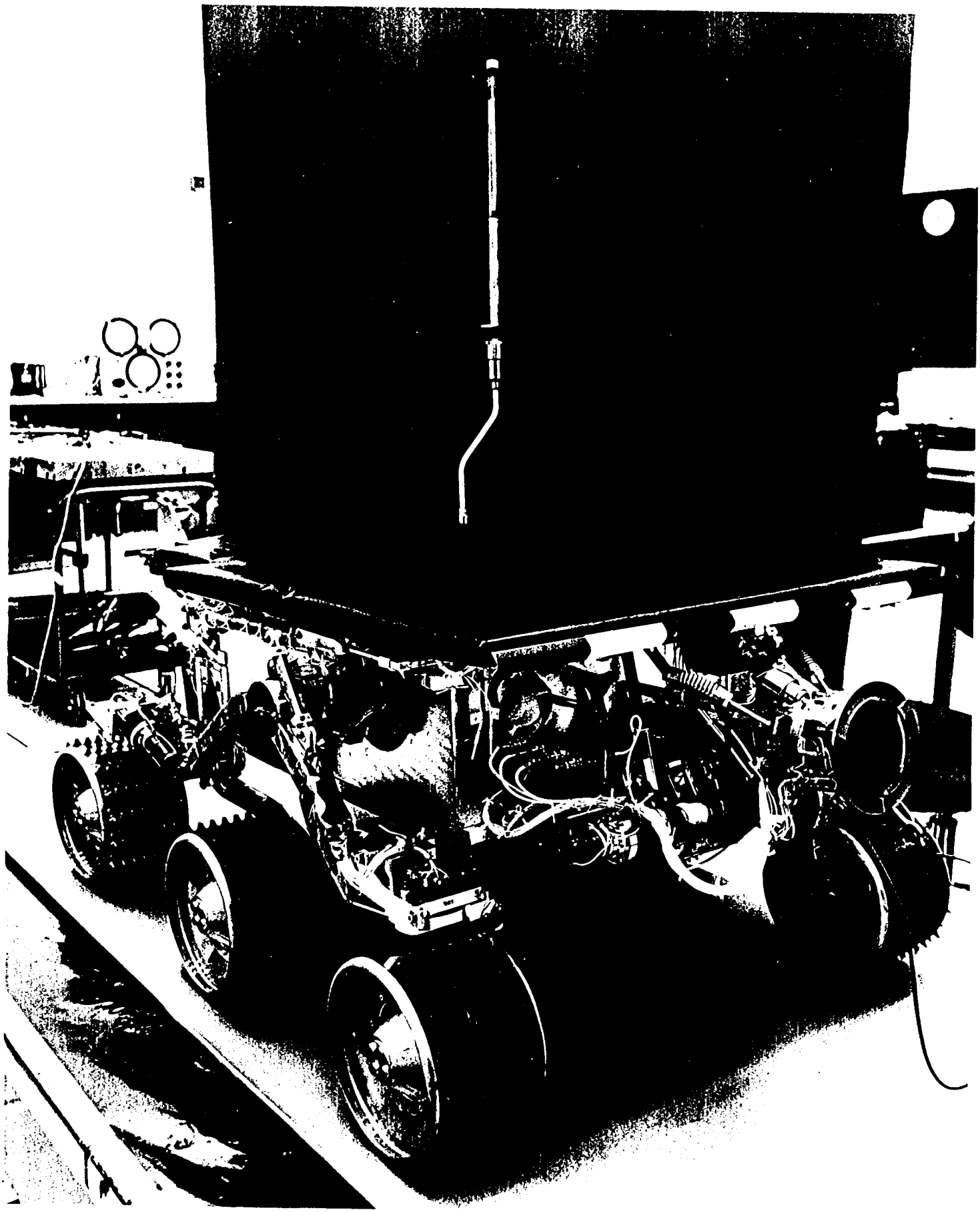


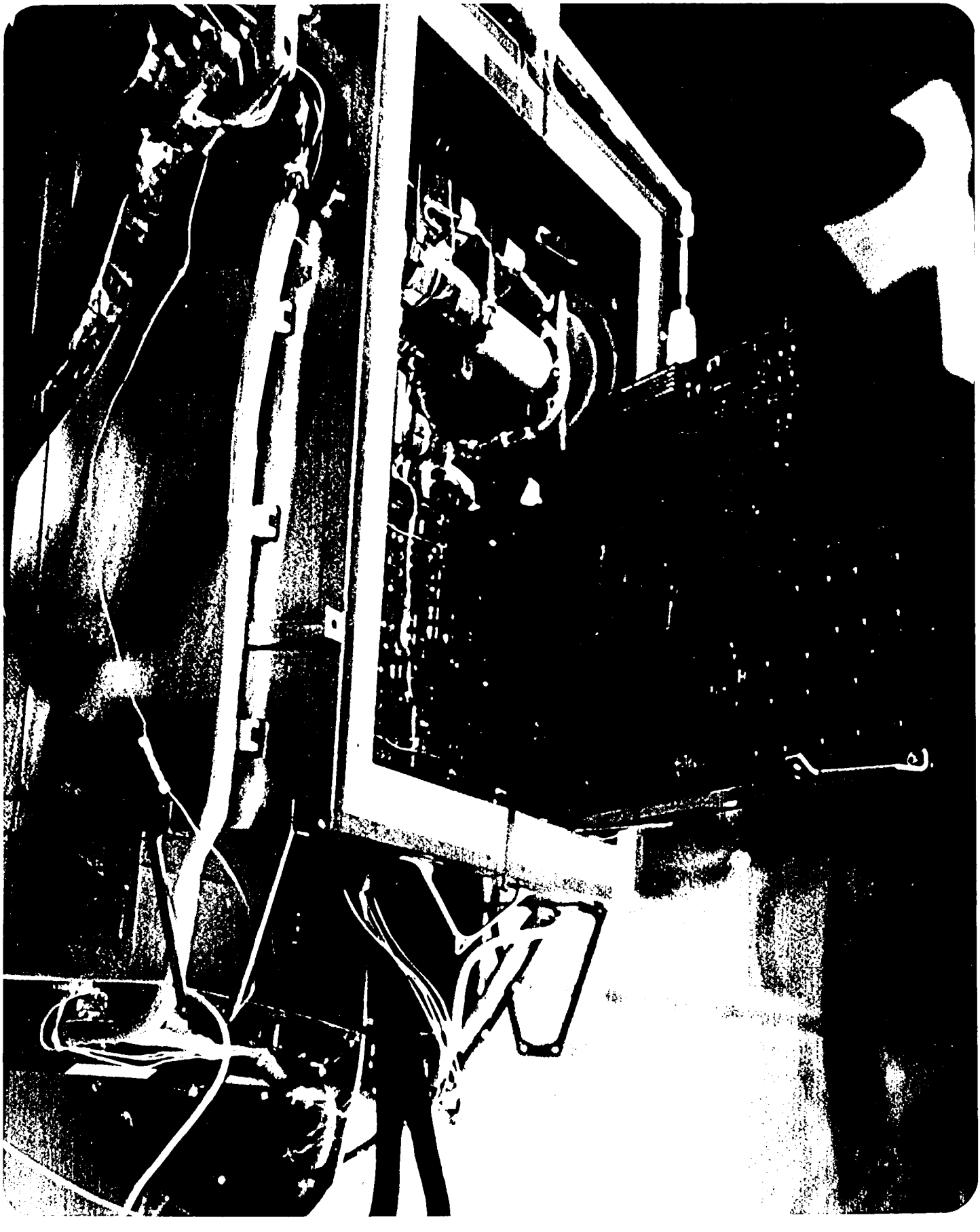
JPL

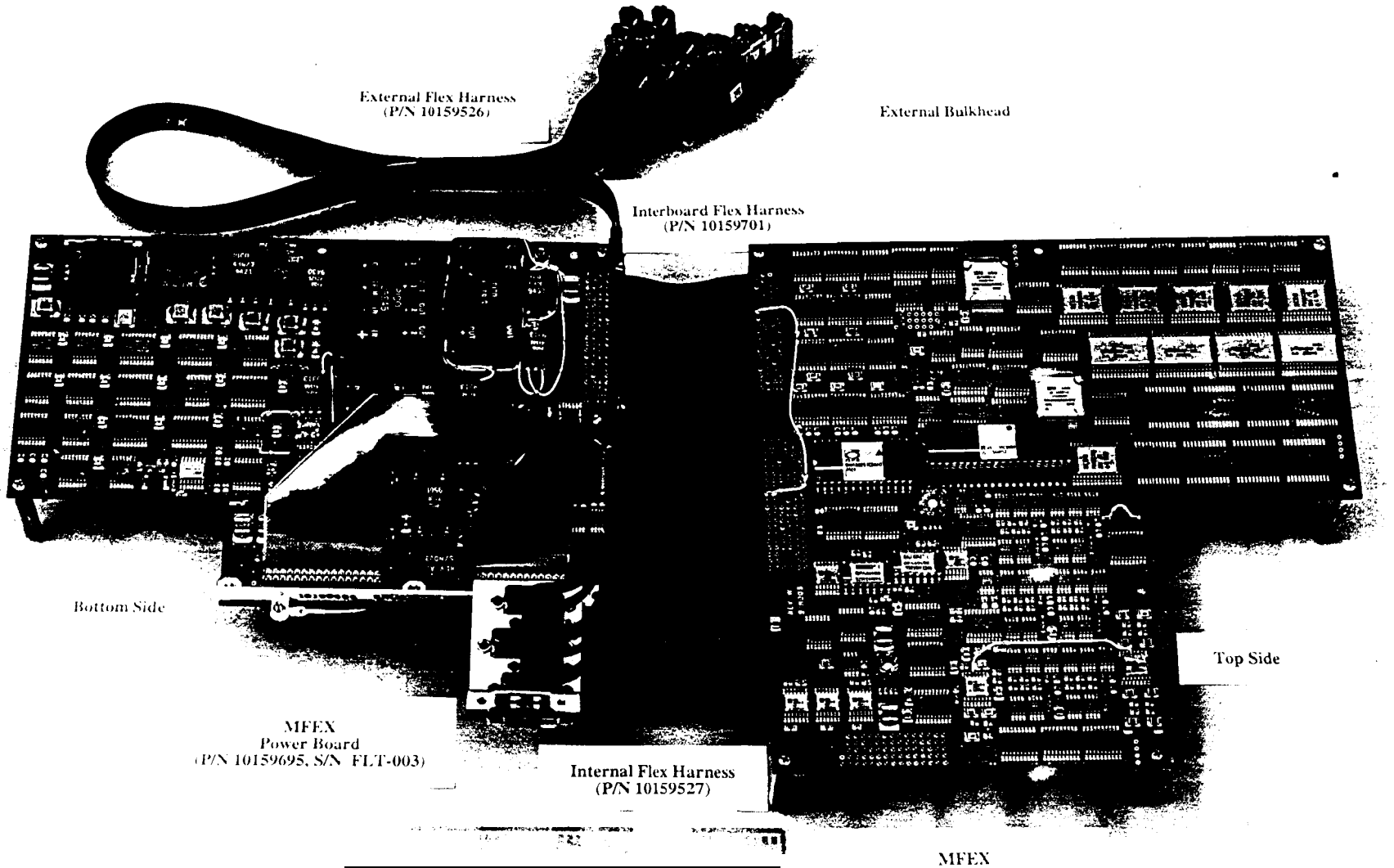








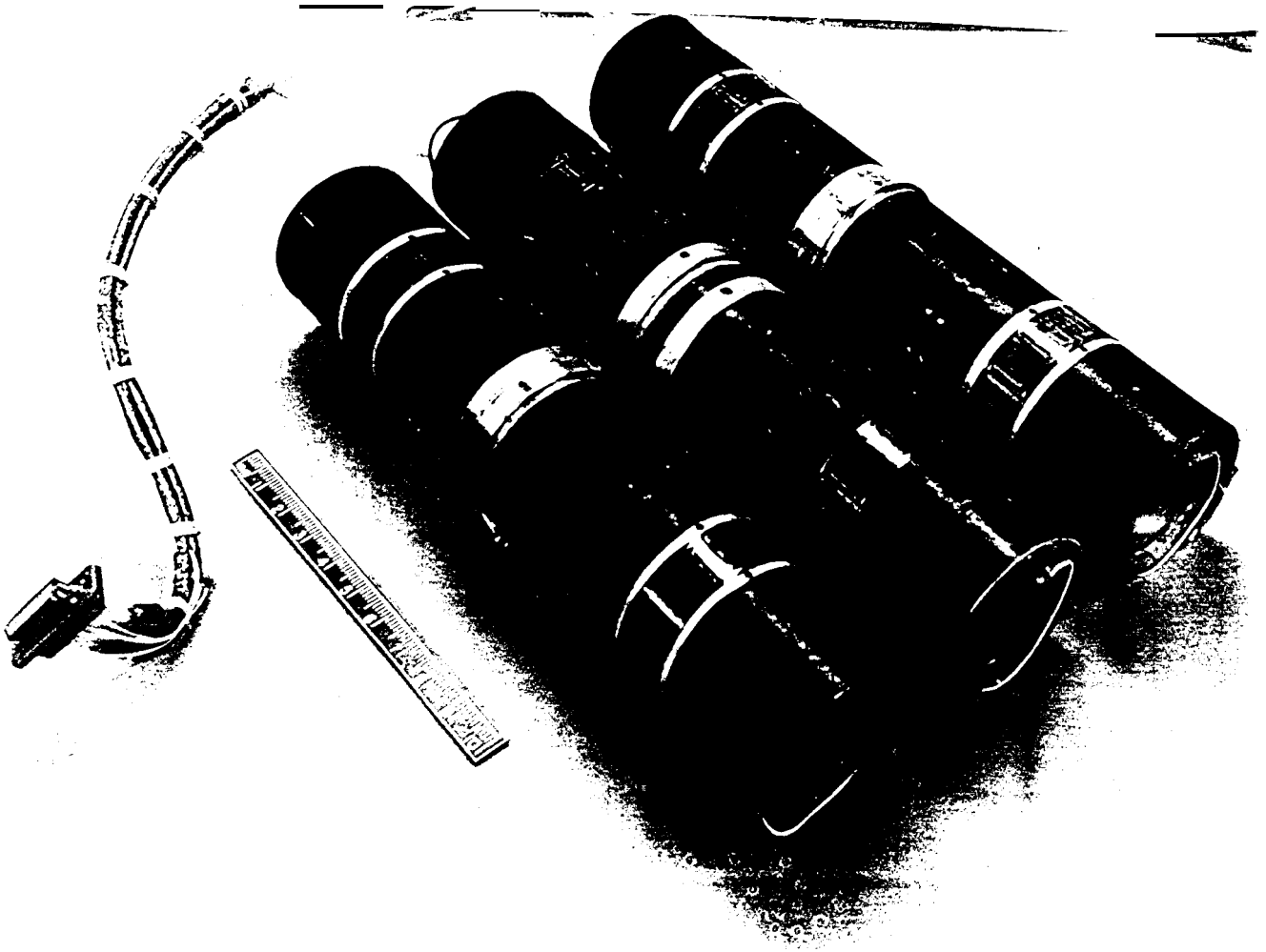




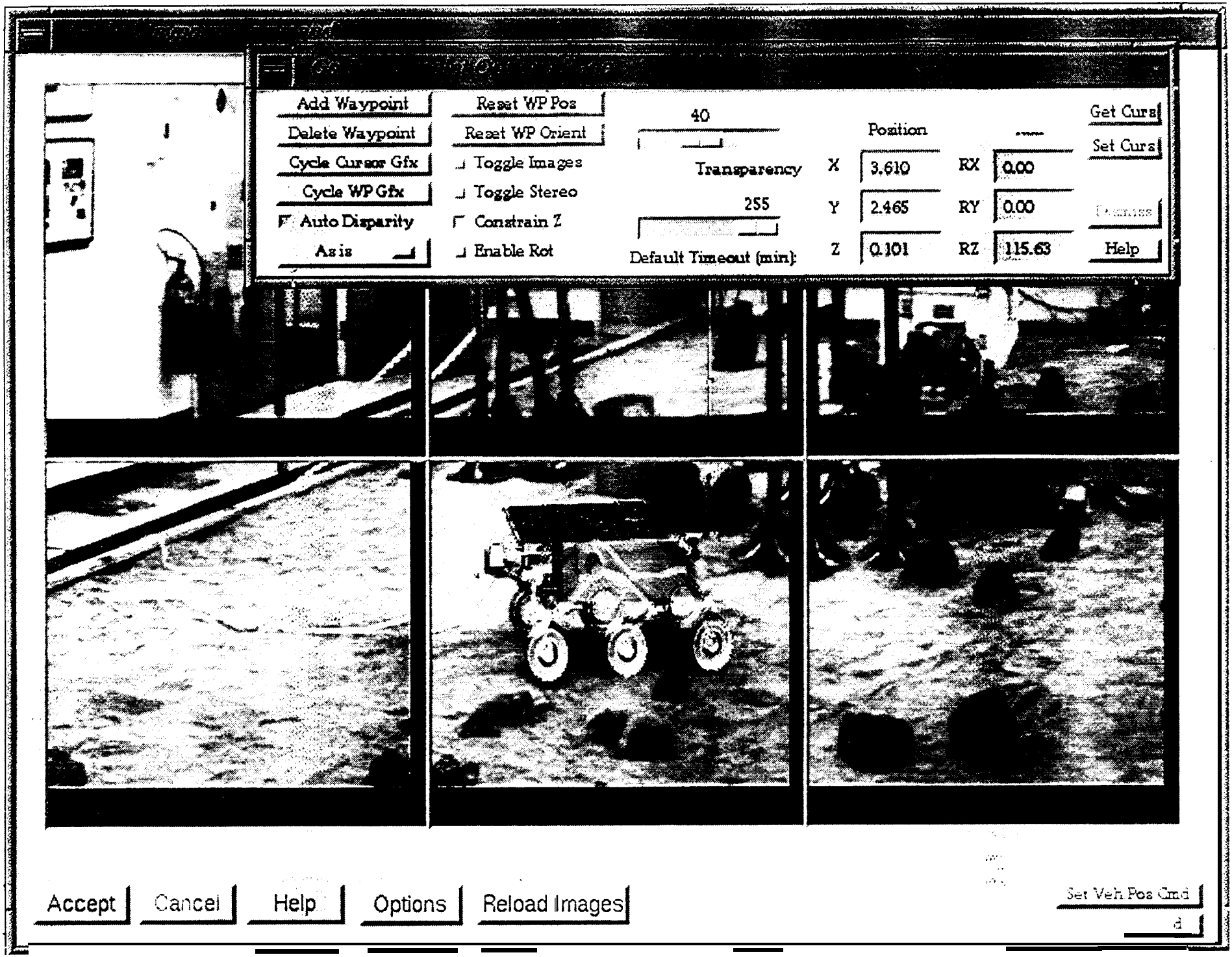
MFEX
Electronics Board Set
10159704, S/N FLT-003)

MARS PATHFINDER MICROROVER BATTERY

THREE 3-CELL
SYSTEM INTEGRATION MODEL (SIM) BATTERIES
TOTAL WEIGHT: 1237.5g
TOTAL CAPACITY(@25° C, 0.75 A): 39 Ah
Li-SOCl$_2$ 'D' SIZE CELLS MANUFACTURED BY SAFT AMERICA



Accept
Cancel
Help
Options
Reload Images
Set Veh Pos Cmd
Find Rock Cmd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Delete Waypoint
Cycle Cursor Gfx
Cycle WP Gfx
Auto Disparity
As is
Reset WP Pos
Reset WP Orient
Toggle Images
Toggle Stereo
Constrain Z
Enable Rot
40
Transparency
255
Default Timeout (min):
Position
X 3.610
Y 2.465
Z 0.101
RX 0.00
RY 0.00
RZ 115.63
Get Curs
Set Curs
Help
Accept
Cancel
Help
Options
Reload Images
Set Veh Pos Cmd

1996 JPL Rocky IV MICROROVER

MANUFACTURER

Jet Propulsion Laboratory
California Institute of Technology
4800 Oak Grove Dr.
Pasadena, Calif. 91109-8099

PRICE

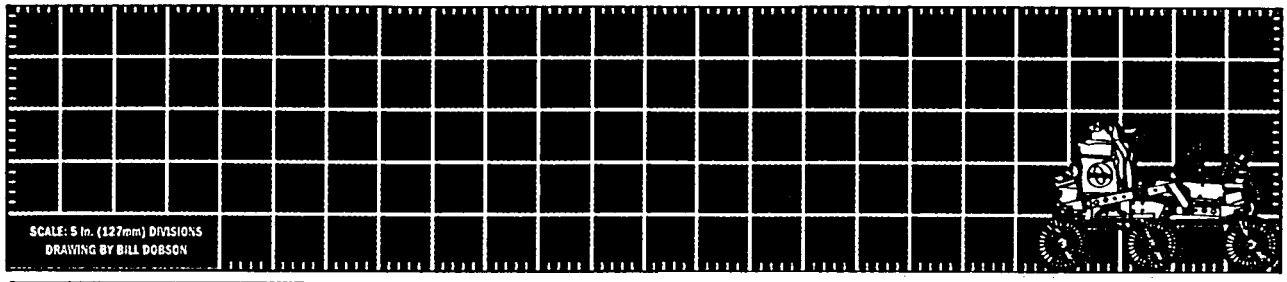
List price, MHWC[1] $2,500,000
Price as tested $2,500,000

Price as tested includes std equip. '(navigation, control, command, data handling and imaging subsysterns, warm electronics compartment, *Viking*-like aeroshell, parachute, dual dual airbags[3], neat little tetrahedral carrying case with solar-array petal deployment).

0–0.037 mph . . . . . like right now
0–¼ mi . . . . . 24,139.0 sec
Top speed . . . 0.037 mph/14,000 mph

TEST CONDITIONS

Temperature . . . . . 59° to -190° F
Wind . . . . . light, 15 mph; possible gusts to 180 mph
Atmosphere . . . . . very sparse[4]
surface grainy . . . . . 0.8g[5]
surface condition . . . . . desertlike and red[6]
Day condition . . . . . 24 hr 37 min 23 sec[7]
Month condition . . . . . variable[8]
Year condition . . . . . 687 Earth days



MOBILITY ASSEMBLY

Motors DC permanent magnet, electric
Number . . . . . 6. one per wheel
Size . . . . . 0.87-in. dia x 1.2 in.
Weight . . . . . 1.902.
Power . . . . . 2 W/motor
Torque . . . . . adequate[9]
Redline . . . . . 8000 r-pm
Gear reduction
Type . . . . . 5-stage planetary
Ratio 2000.1
Battery pack Lithiumlodide D-cells
Number 12
Output . . . . . 150 W hr
Solar-power array . . . . . Silicon cells
Size . . . . . 21 2 sq ft/2000 sq cm
Output, on a dear day: 100 W hr/day
Output, in a dust storm: 50 W hr/day

CHASSIS & BODY

Layout . . . . . hub-mounted motors/ 6-wheel drive
Body/frame . . . . . multi-unit aluminum
Brakes
front . . . . . electric-motor-drag
Middle . . . . . same as front
Rear . . . . . same as middle
Total swept area . . . . . na[10]
Wheels . . . . . machined alloy, 3.8 x 1.8
Tires . . . . . 17-7PH stainless steel radial, 5.1 x 2.4R-3.8
Steering . . . . . 4-wheel independent
Overall ratio . . . . . na[11]
Turns, lock to lock . . . . . na[12]
Turning circle . . . . . 1.97 ft[13]
suspension
Front . . . . . steerable kingpin on leading arm, dual-wheel bogie shared with middle
Middle. non-steerable spindle at bogie pivot, dual-wheel bogie shared with front
Rear . . . steerable kingpin on trailing arm, forward extension forming rocker arm wfth bogie

GENERAL DATA

Earth weight . . . . . 16.5 lb
Test weight . . . . . 6.3 lb"
Ground pressure, on Mars less than 0.5 psi[15]
Weight dist, f/m/r, %: variable/variable/variable[16]
Wheelbase, f/m, m/r, f/r. 10.0 in., 9.0 in., 19.0 in.[17]
Track, f/m/r: 15.0 in./15.0 in./15.0 in.
Length . . . . . 23.6 in.
Width . . . . . 18.1 in.
Height . . . . . 11.0 in.
stowed . . . . . 7.1 in.
Ground clearanc e.... 34.8 million mi[19]

MAINTENANCE

Path and task designation update: daily[20]
Mission duration, minimum . . . 7 days
Basic warranty: 30 days/34.8 million mi[21]

ACCELERATION

Time to speed	Seconds
0–0.037 mph	like right now
Time to distance	
0–100 ft	1828.7
0–500 ft	9143.6
0-1320 ft (¼ mi):	24,139.0 @ 0.037 mph
Top speed	0.037 mph[22]

HANDLING

Landing accel (with airbags) 50g
Vertical step, both whee . . . . . 5.9 in.
Steering agility . . . . . extreme[23]
Other neat tricks . . . . . soil testing[24]

FUEL ECONOMY

Normal[25] use . . . . . 14.7 W hr/day
Night use . . . . . 8.0 W hr
Cruise range: lots of days; one night only[26]

ACCOMMODATIONS

Computer . . . . . 80C85 dual-speed CPU
Work mode . . . . . 200 Kips w/ 512 KBytes of RAM
Idle mode[27]: 2 Kips w/32 KBytes of RAM
Camera . . . . Kodak KAI-0370 CCD Array
Transmission rate . . . . . 8 Kbits/sec[28]
Communications link: Motorola RF Modem
Range . . . . . 1.2 mi at 9600 baud
Antennas . . . . . 39.4-in. whips[29]
Material analysis technique: alpha-proton-x-ray spectrometry[30]
Warm compartment
Material . . . . . vacuum-wall insulation
Supplier . . . . . Owens-Corning
Heater source, day . . . . . solar panels
Minimal temperature, night . . . . -40° [31]
Equipment enclosed . . . computer, RF modem, power regulator, battery pack, CCD and APXS electronics

DELIVERY SYSTEM

Entry velocity, trans-Mars trajectory: 14,000 mph
Aeroshell braking
Entry angle . . . . . 20 deg
Altitude . . . . . 78 mi
velocity reduction . . . . . from 14,000 to 560 mph
Parachute braking
Deployment . . . . . 94 sec after entry
Altitude . . . . . 6.6 mi
Velocity reduction: from 560 to 78 mph
Airbag braking
Deployment . . at an altitude of 1.2 mi
Velocity reduction . . . . . from 78 mph to touchdown
Touchdown time . . 300 sec after entry

INSTRUMENTATION

Bogie angfe encoders[32], motor speed, motor voltage, motor current, motor temperature, motor position, wheel Strut strain gauges[33], pitch sensor, roll sensor[34], accelerometers, thermocouples and other gizmos[35]

FootNotes...

[1] Mars, Here We Come!
[2] Entertaining though Rocky IV may be in a Pasadena arroyo, she comes into her own only with the MESUR (Mars Environmental Survey) *Pathfinder Mission* rocketship and other related stuff. On the other hand, we consider this additional $150,000,000 # destination charge, and as you know, we factor these oert of our price data.
[3] Fixially, something familiar to us car guys.
[4] About 0.01 as dense as Earth's atmosphere, It's mostly CO_2. There are traces of nitrogen, oxygen, carbon, water vapor, even argon. But fat lot of good they do it.
[5] Thus, Shylock's "pound of flesh" would weigh only 6.1 oz. here.
[6] Color comes from oxidized iron.
[7] This gives rise to the local quip, "Time sure drags around here." A little Martian humor.
[8] Mars has two moons. Deimos rises once every 5½ days. Phobos travels so quickly that it rises in the west and sets in the east.
[9] Not unlike the Rolls-Royce Actually, though, Rocky IV can spin all six wheels.
[10] Not applicable. But you might like to know that Mars has an area of 55,681,855 sq mi, about 28 percent that of Earth. Like many parts of Earth, it, too, is unswept.
[11] Not applicable. This is as good a place as any, though, to remind you that Mars is never any closer to Earth than 34.8 million miles, and this only at 17-year intervals.
[12] Not applicable either. But did we tell you that a two-way Earth/Mars communication can take as long as 40 minutes? Thus, Rocky IV's commendable degree of control autonomy.
[13] See Handling.
[14] Empty Martian weight; increases with rock and soil sample payload.
[15] Good in soft sand.
[16] See Footnote 14.
[17] f/m wheelbase is fixed, but m/r and hence f/r vary with suspension attitude. Thus, those of an analytical bent (you nits know who you are) only wasted their time in verifying that these figures are additive.
[18] In that neat little tetrahedral carrying case.
[19] Defining ground clearance as the minimal distance to Earth. Some more Martian humor here.
[20] Once updated, Rocky IV has autonomy for task execution and hazard avoidance, thus exhibiting more responsibility than the average teenager.
[21] The time period is short, but the mileage allowance sets a new R&T record.
[22] Equivalent to 3.3 ft/min, impatient sorts are referred to the fable of the Tortoise and Hare.
[23] What with 4-wheel independent steering and all, Rocky IV can turn around in her own length.
[24] By locking five wheels and driving the sixth, Rocky IV can measure soil shear resistance and cohesion. By measuring wheel track depth, she can derive information on sinkage and soil compressibility.
[25] Such as it is.
[26] Might this be called the first Martian One-Night Stand? Another little bit of Martian humor.
[27] There's a lot of this around our place too.
[28] Thus, each image takes about 6.2 min to transmit to Rocky IV's home base/lander module. By the way, Rocky IV's range-finding technology is the same as that of a point-and-shoot camera.
[29] Reynolds was especially keen when we told him whips were involved.
[30] APXS, for short, and we don't know quite where to begin. A tiny Gatling gun prepares the surface, but you're on your own with the spectrometry part.
[31] Did you know -40° C and -40° F are identical? You do now.
[32] These sense vehicle response, slope climbing ability and stability assessment.
[33] These sense rolling resistance, sideslip force, structural stress and vehicle response.
[34] This senses vehicle response, stability assessment and lateral slope traversability.
[35] We aren't competely sure of these.

Sojourner was named by Valerie Ambroise of the United States of America in an international student contest to name the rover after an historical women whose mission in life paralleled that of the rover on Mars. Sojourner Truth was an ex-slave who traveled the United States and became an inspiration for human freedom.

Jet Propulsion Laboratory
The Planetary Society

AVIATION WEEK
& SPACE TECHNOLOGY
A PUBLICATION OF THE McGRAW-HILL COMPANIES
APRIL 22, 1996

PATHFINDER PREPARING FOR MARS

PAGE 56