CORONA TECHNICAL INFORMATION

VOLUME 2

J-3 PANORAMIC CAMERA

J-3 CAMERA SUBSYSTEM

PURPOSE

The purpose of the J-3 camera subsystem is to provide, from a reconnaissance satellite, high resolution stereoscopic photography having reconnaissance, cartographic, and geodetic evaluation capabilities.

PHYSICAL FEATURES

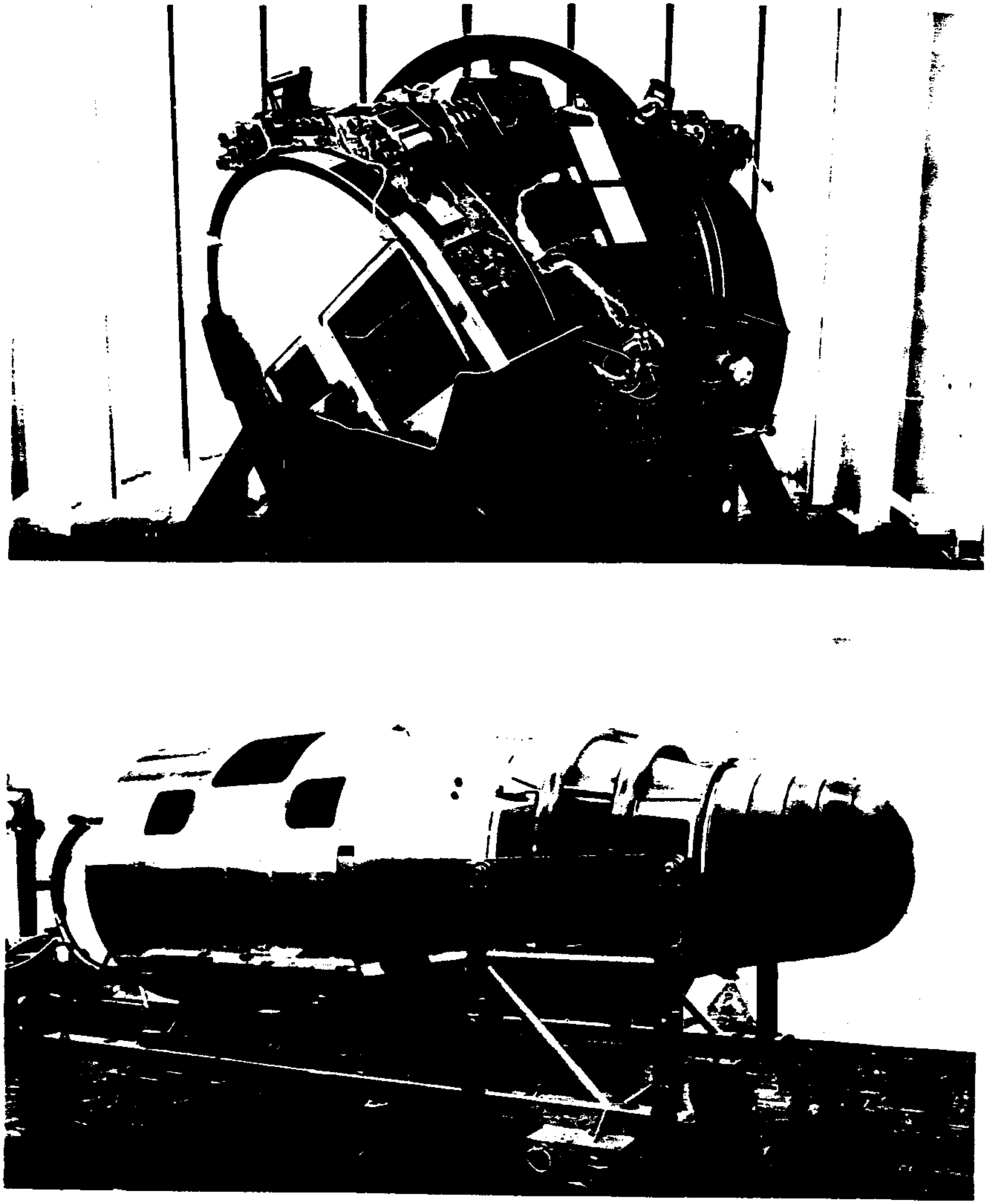
Configuration	30-degree convergent stereo panoramic cameras
Lenses	24-inch focal length, Petzval design
Films available	3404, SO-380, SO-230, SO-205, SO-121, SO-180, SO-242
Film capacity	16,000 feet of 70-mm, 3.0-mil, polyester-base film per camera
	24,000 feet of 70-mm, 2.0-mil, UTB, polyester-base film per camera
Film size (one frame)	31.632 × 2.754 inches
Usable format	29.323 × 2.147 inches

POWER

	Watt Hours 3.75 rad/sec	Watt Hours 2.5 rad/sec	Watt Hours 1.4 rad/sec
24 vdc (unregulated)	1,080	1,620	2,890
115 vac	180	270	480
Combined	1,260	1,890	3,370

OPERATIONAL FEATURES

Altitude	80 to 200 nm
Swath width	116 to 290 nm
Total forward cover	7.73 to 19.33 nm (7.6 percent overlap)



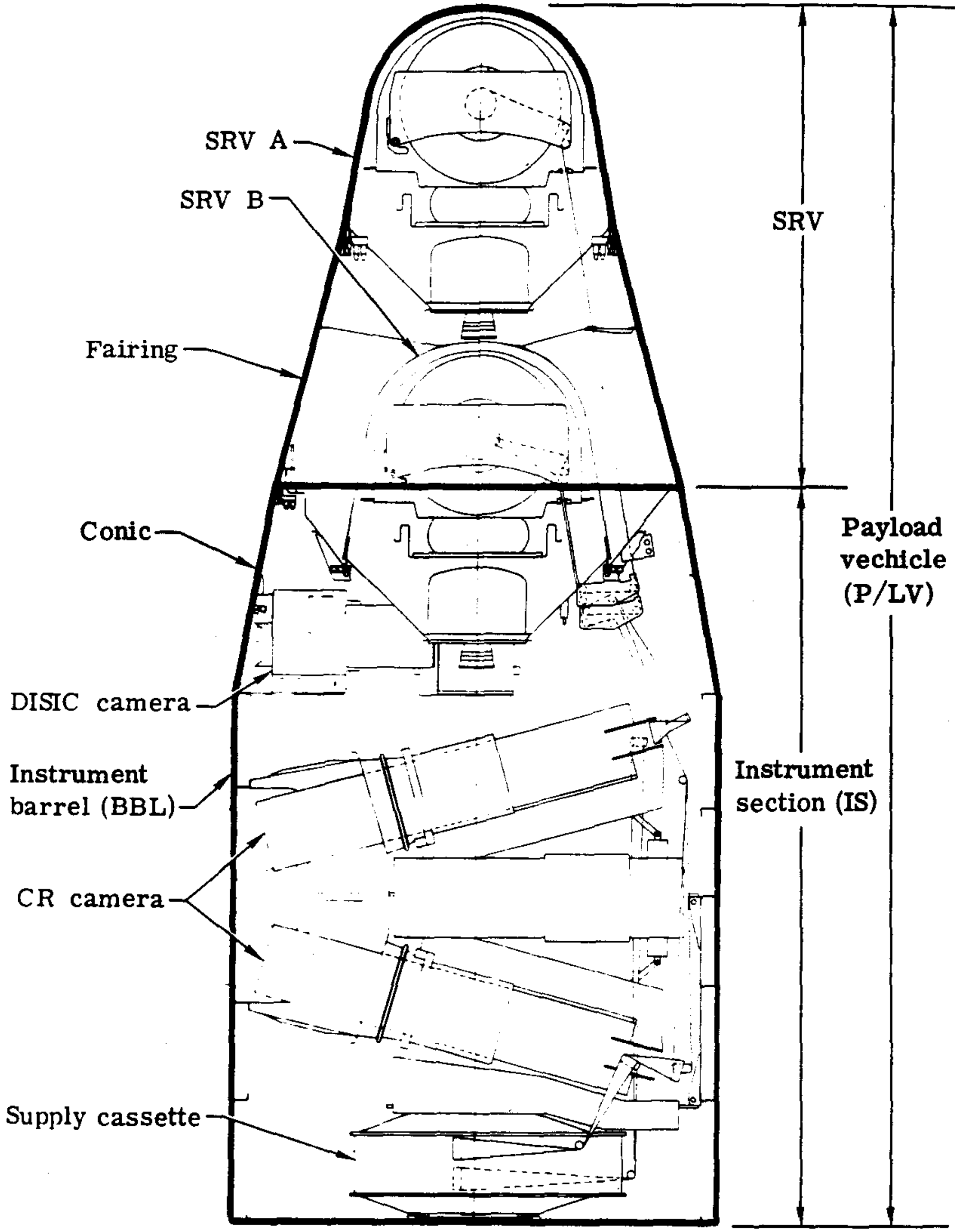
J-3 Payload

The complete J-3 system payload consists of the following:

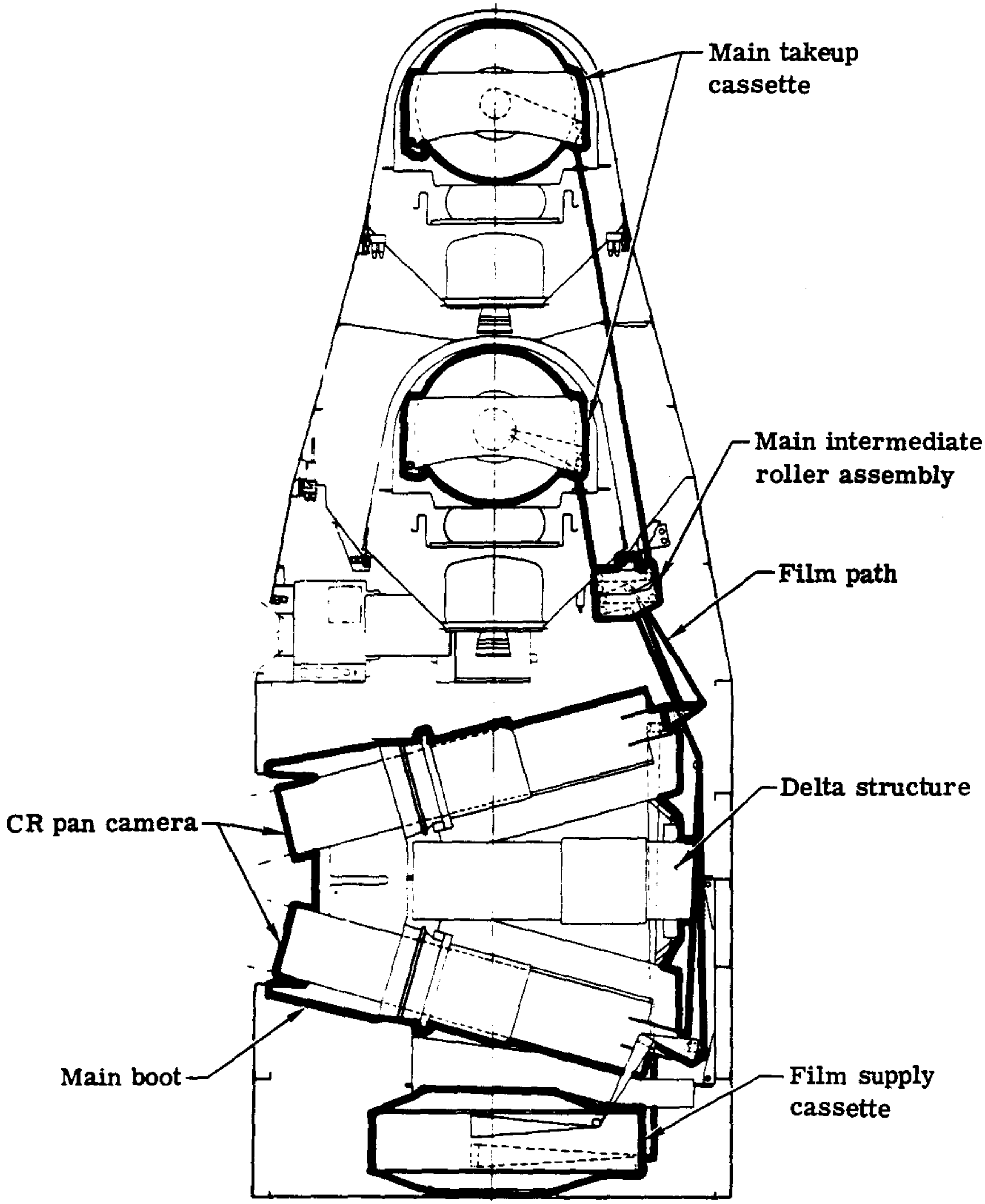
1. Two, 24-inch focal-length, f/3.5 panoramic cameras, each having two integrated 55-millimeter focal length, f/6.3 horizon optics
2. One auxiliary structure (supports both panoramic cameras and the electronics packages to form the so-called camera module)
3. One supply cassette
4. Main supply structure
5. Two takeup cassettes
6. One intermediate roller assembly.

The panoramic cameras are positioned on the auxiliary structure in a V-configuration to provide a 30-degree stereo angle. The auxiliary structure is three-point mounted to the vehicle so that the even serial-numbered camera is located forward and views toward the rear (AFT-looking), and the odd serial-numbered camera is located aft and views forward (FWD-looking). The auxiliary structure also provides the mounting surface for the system electronic packages. The supply cassette, which contains the total film supply for both cameras, is located aft of the camera module. The supply cassette is fastened to a support structure, which is, in turn, three-point mounted to the vehicle. Takeup A, located in recovery vehicle RV-1, and takeup B, located in RV-2, each take up half of the film of each camera. The intermediate roller assembly is attached to the vehicle between takeup B and the camera module.

NOMENCLATURE OF THE MAJOR SEPARABLE COMPONENTS OF THE PAYLOAD VEHICLE



MAJOR COMPONENTS OF J-3 SUBSYSTEM



EXPOSURE CONTROL SUBSYSTEM

PURPOSE

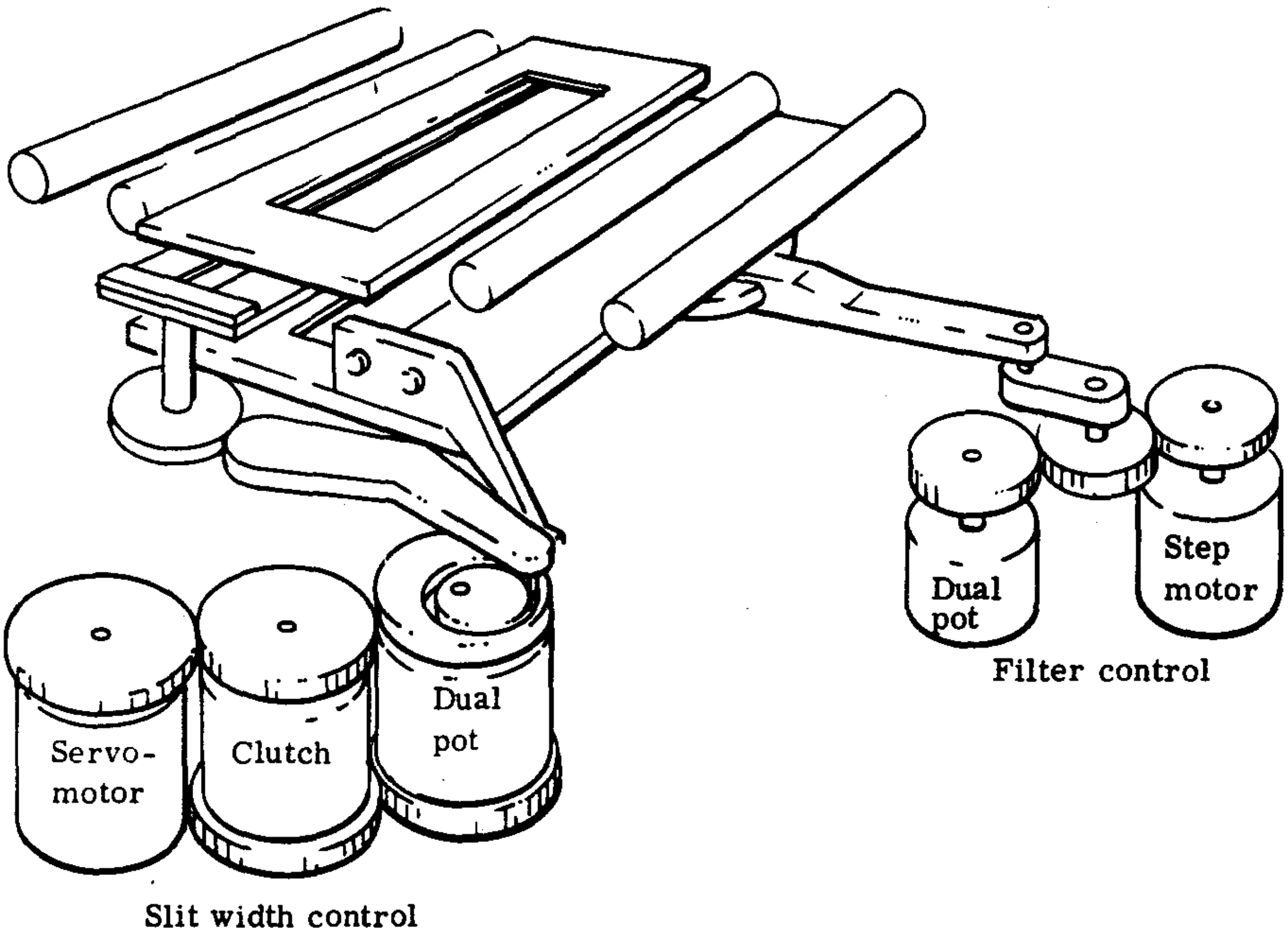
The purpose of the exposure control subsystem is to provide a controllable means of adjusting the exposure in the J-3 and DISIC cameras to be compatible with in-flight changes in film type (filter change), and with changes in target illumination as the satellite passes from night to day or day to night.

CHARACTERISTICS

The exposure control subsystem consists of the following:

1. The switch programmer
2. The four slit width positions in each J-3 instrument
3. The two filter positions in each J-3 instrument
4. The two expcsure control mechanisms in the DISIC.

SLIT WIDTH CONTROL ASSEMBLY IN SCAN HEAD



J-3 FORWARD MOTION COMPENSATION SYSTEM

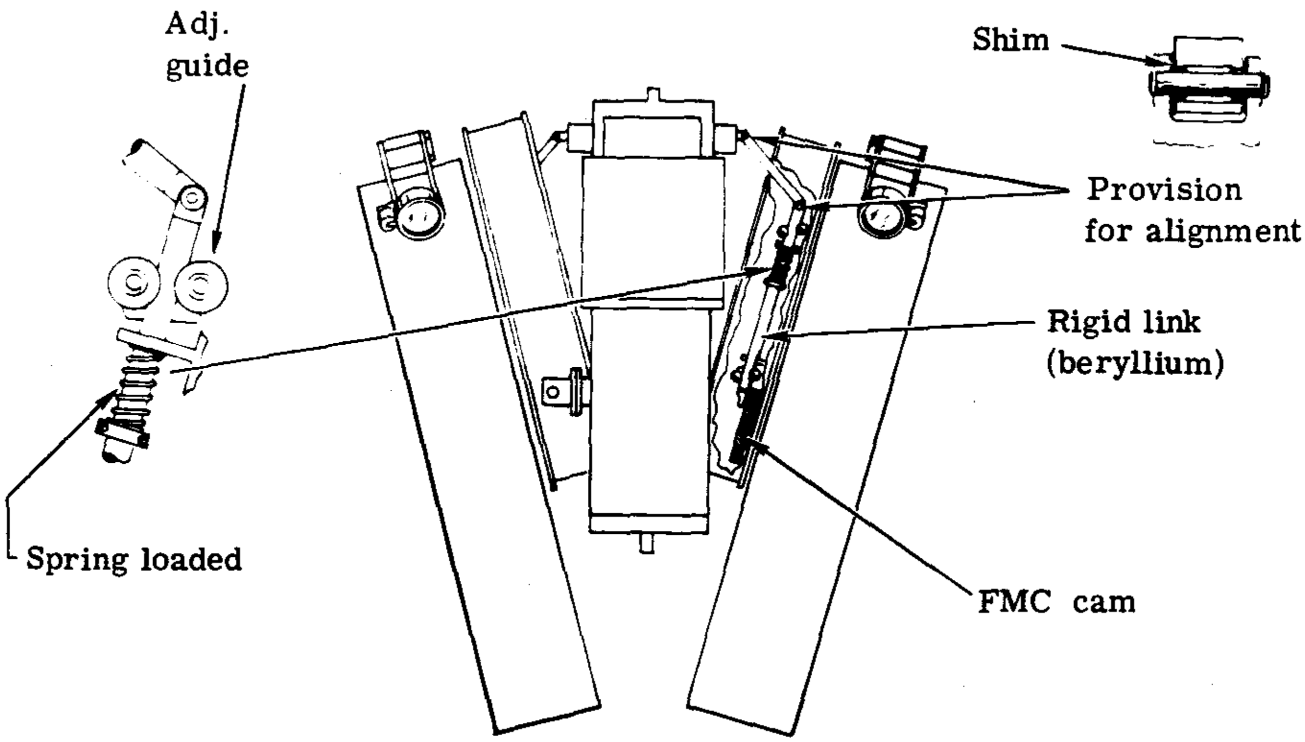
Each camera is independently nodded about an axis parallel to the pitch axis of the vehicle to accomplish forward motion compensation (FMC). The compensation for any given combination of altitude and ground speed (V/h) requires a constant angular rotation during the photographic scan. Since the cycle rate required to maintain constant overlap is also a function of V/h, the nod rate has a fixed relation to the scan rate. The overlap of this system is 7.6 percent at center of format. The required nod is accomplished by a cam-driven linkage, with the pivot point of the camera being located as close to the center of gravity as practical, to keep the inertia forces to a minimum.

The FMC cam and linkage form the equivalent of a planar 4-bar linkage, with the extensive link (cam pushrod) restrained at a constant angle with the driven link (scan shaft), one link fixed (delta), and one member (upper rod) rotatable at each end. The nod axis bearings are offset from each side of the central plane, while all other links are restrained in the center plane by clevis attachments and grooved rollers. The FMC cam and linkage are designed to give a specified ratio of nod angle rate to scan angle rate, and a specified stereo half angle at midscan (15.23 degrees).

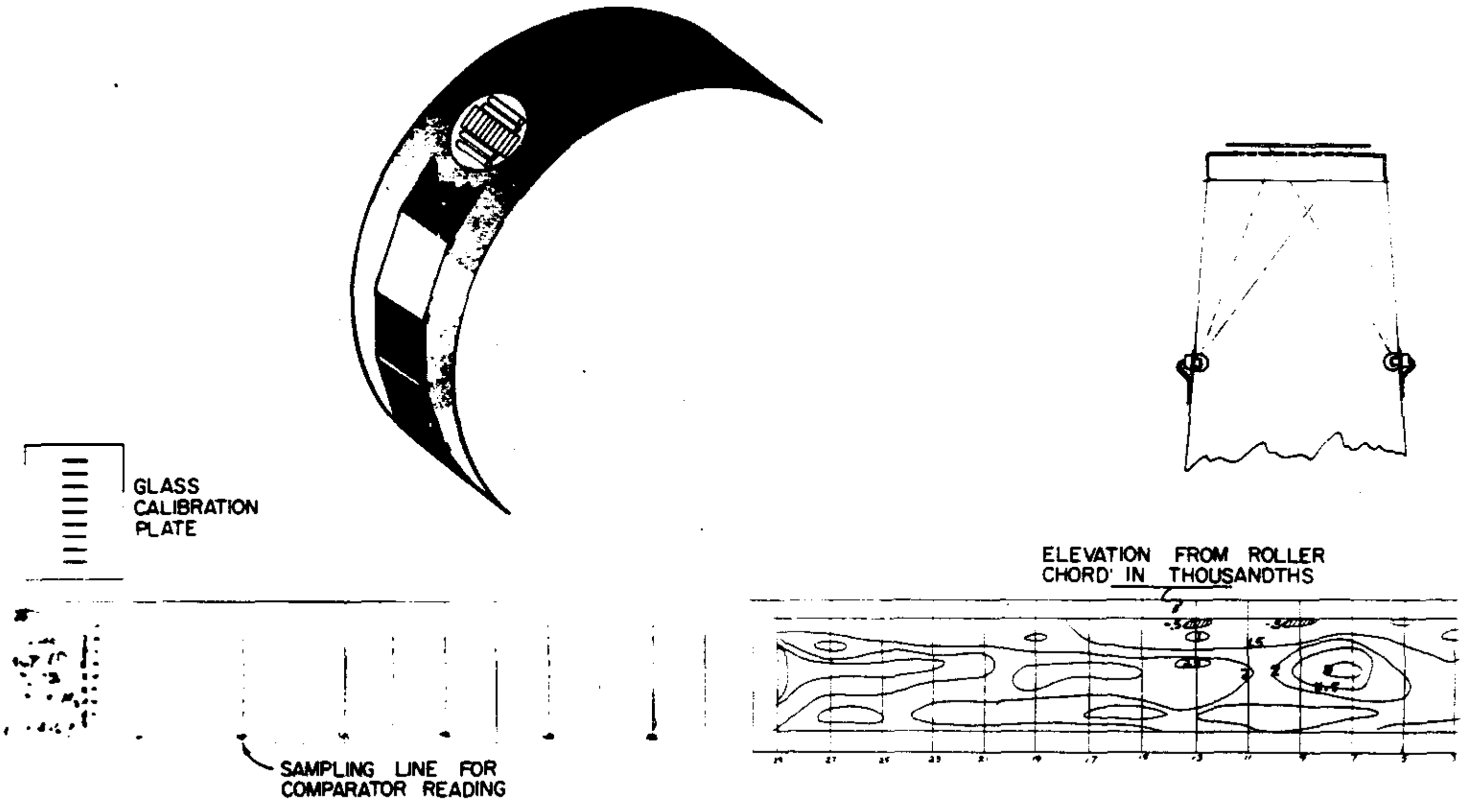
Photographic mission requirements determine the angular rate ratio between nod (FMC) rate and scan rate during the active scan section of the cycle. This ratio is constant and positive for the AFT-looking camera and constant and negative for the FWD-looking camera.

Even though the FMC cam is nearly symmetrical, there is a 180-degree phase difference of nod angle to scan position for the two cameras, making it impossible to interchange the cameras within a system. Once the cameras are assembled, they must remain as such in order to get proper FMC. The cam pushrod assembly is preset and pinned at assembly for proper spring preloading. This assembly is shimmed, aligned, and pinned to a given camera structure and must remain with that structure. The upper rocking link is carefully shimmed to ensure that it (the pushrod) and the scan shaft are coplanar.

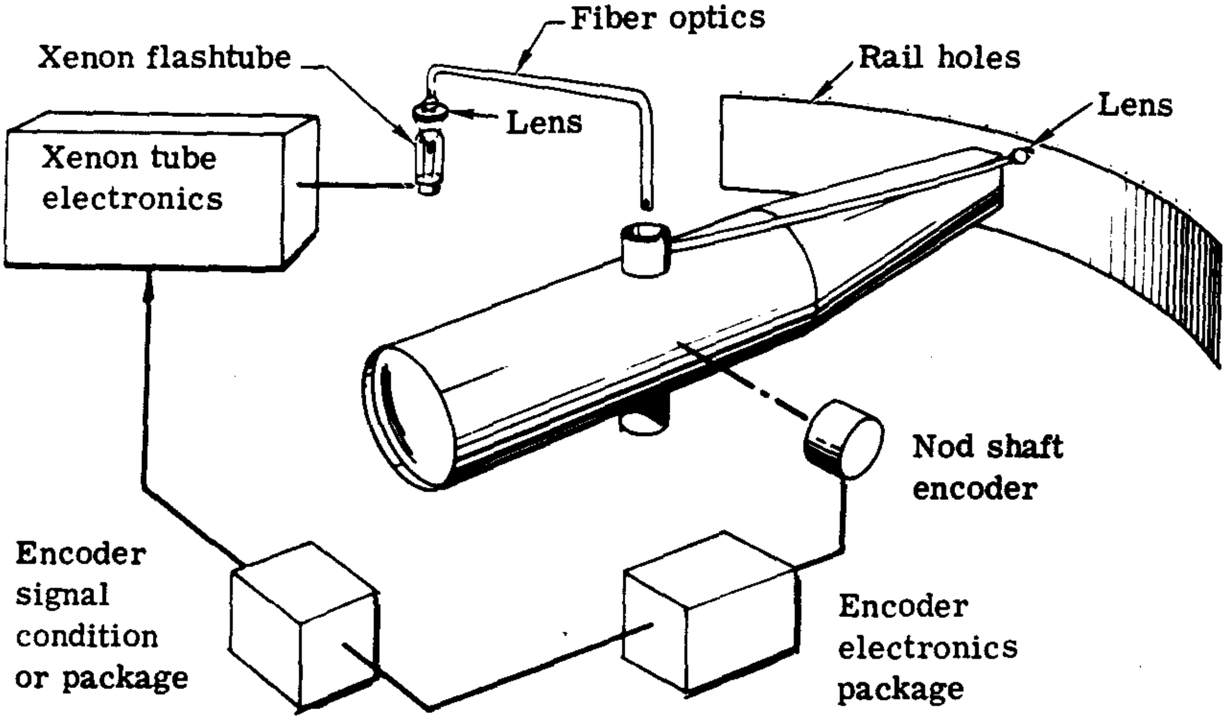
FORWARD MOTION COMPENSATION MECHANISM



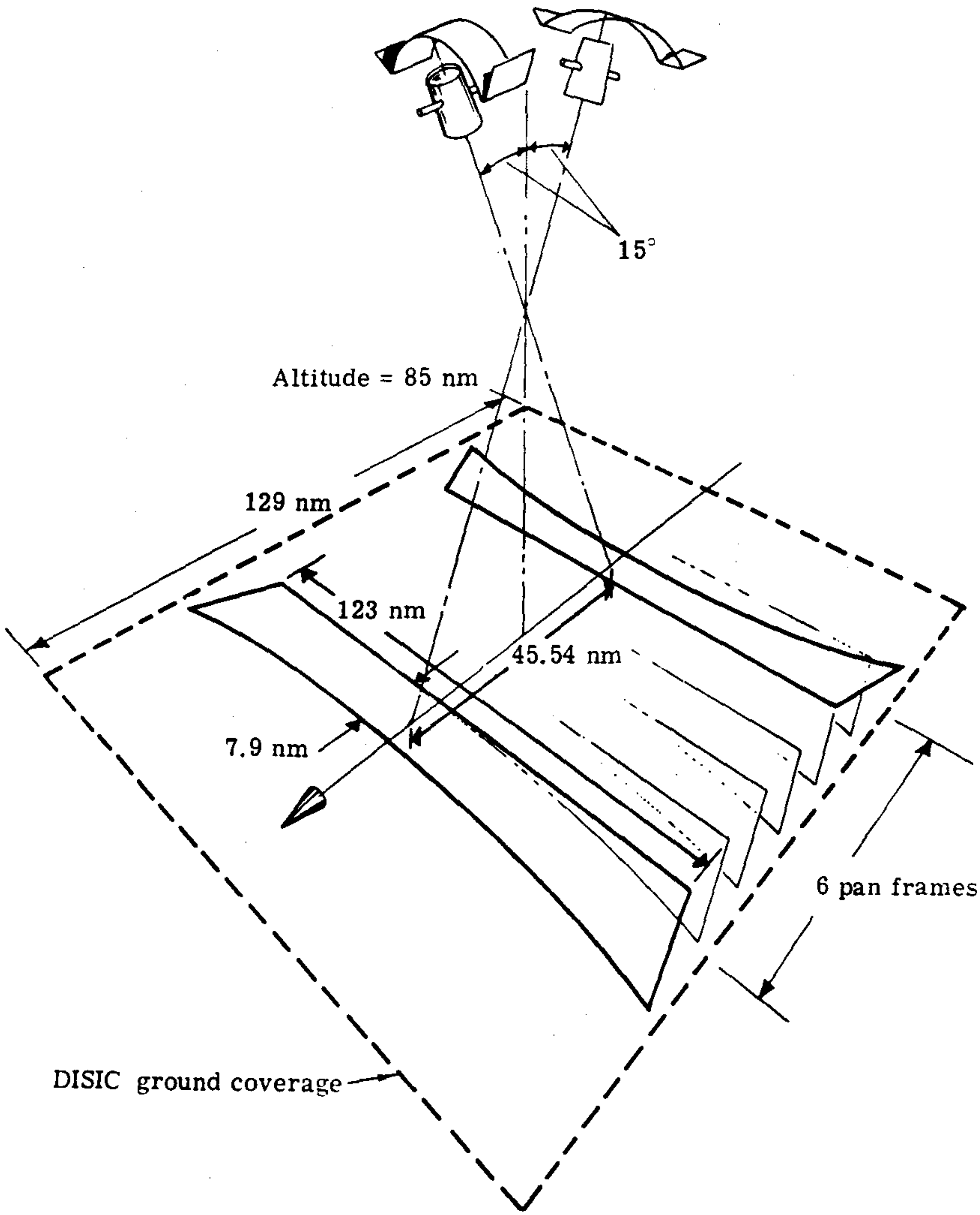
ASCHENBRENNER TEST FOR FILM POSITION



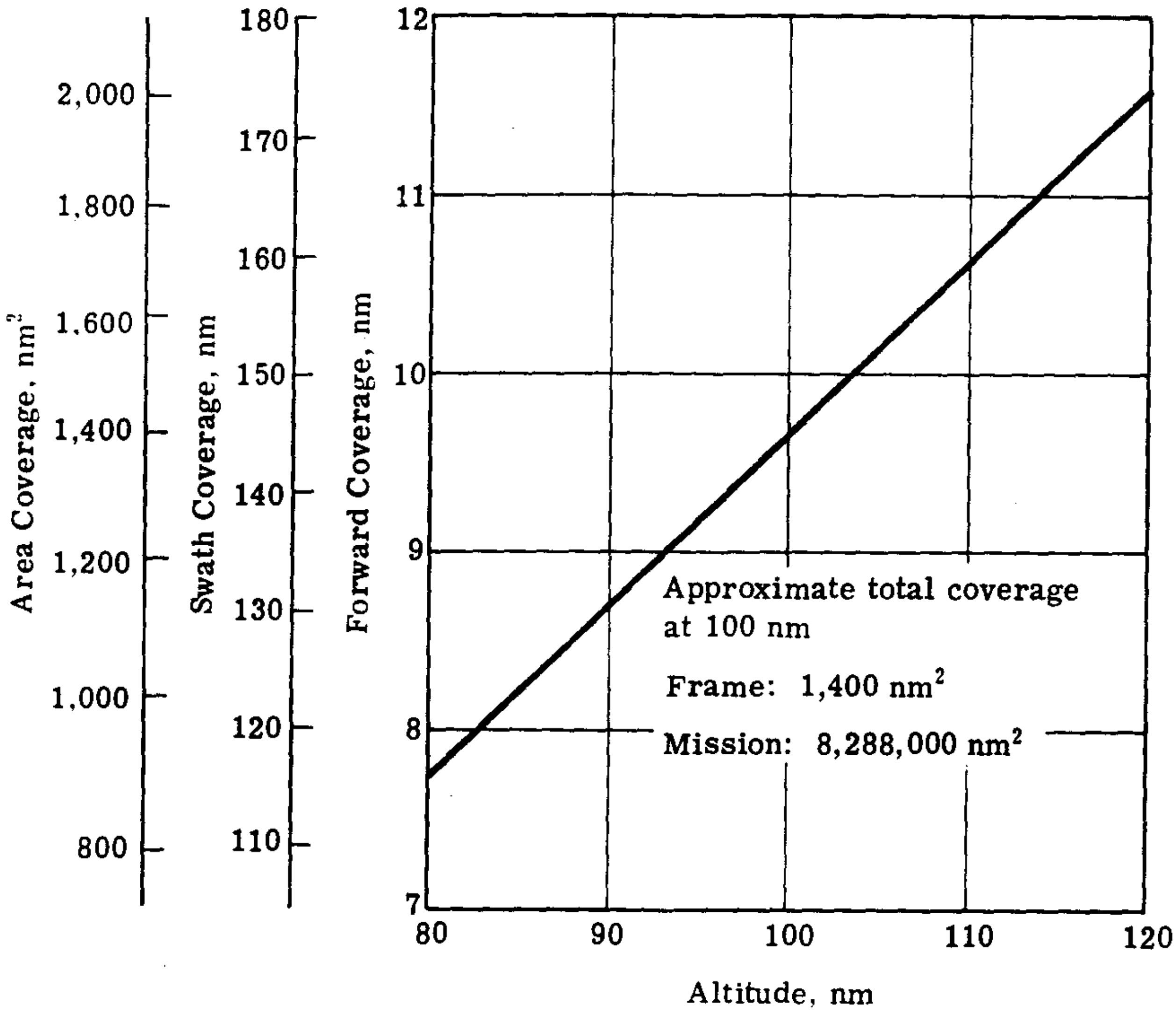
NOD TO SCAN SYSTEM



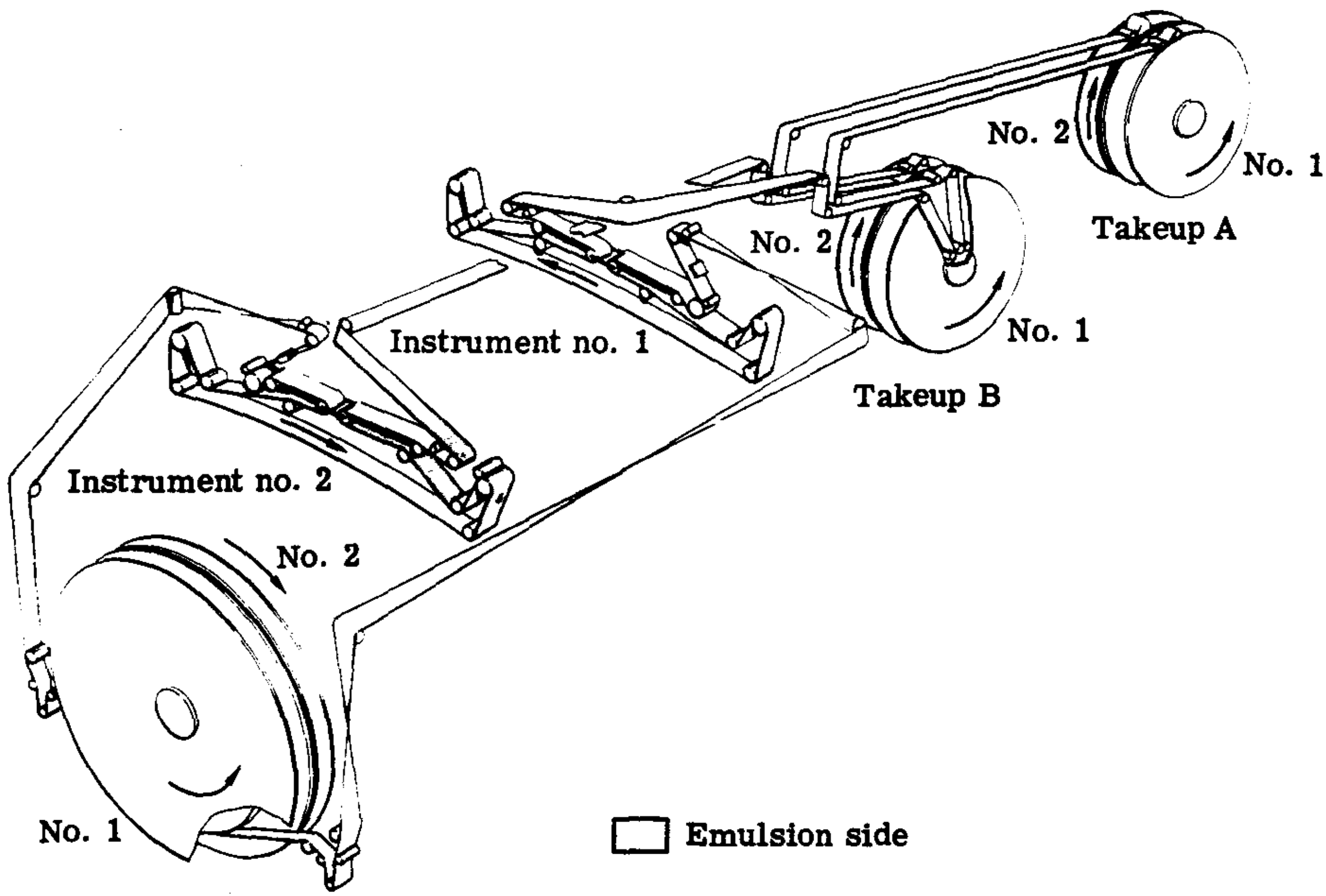
COMPARATIVE GROUND COVERAGES



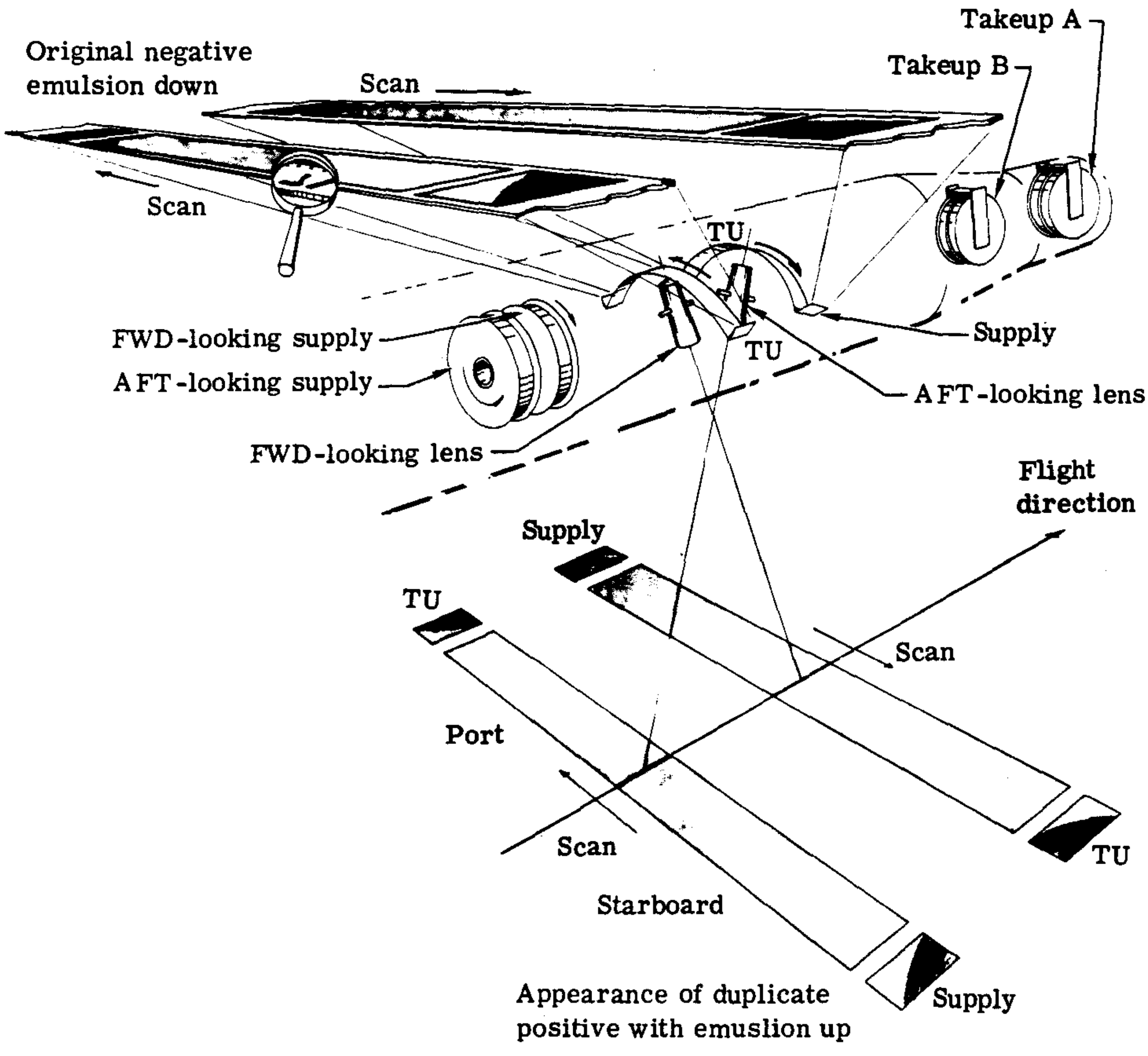
CORONA COVERAGE AS A FUNCTION OF ALTITUDE

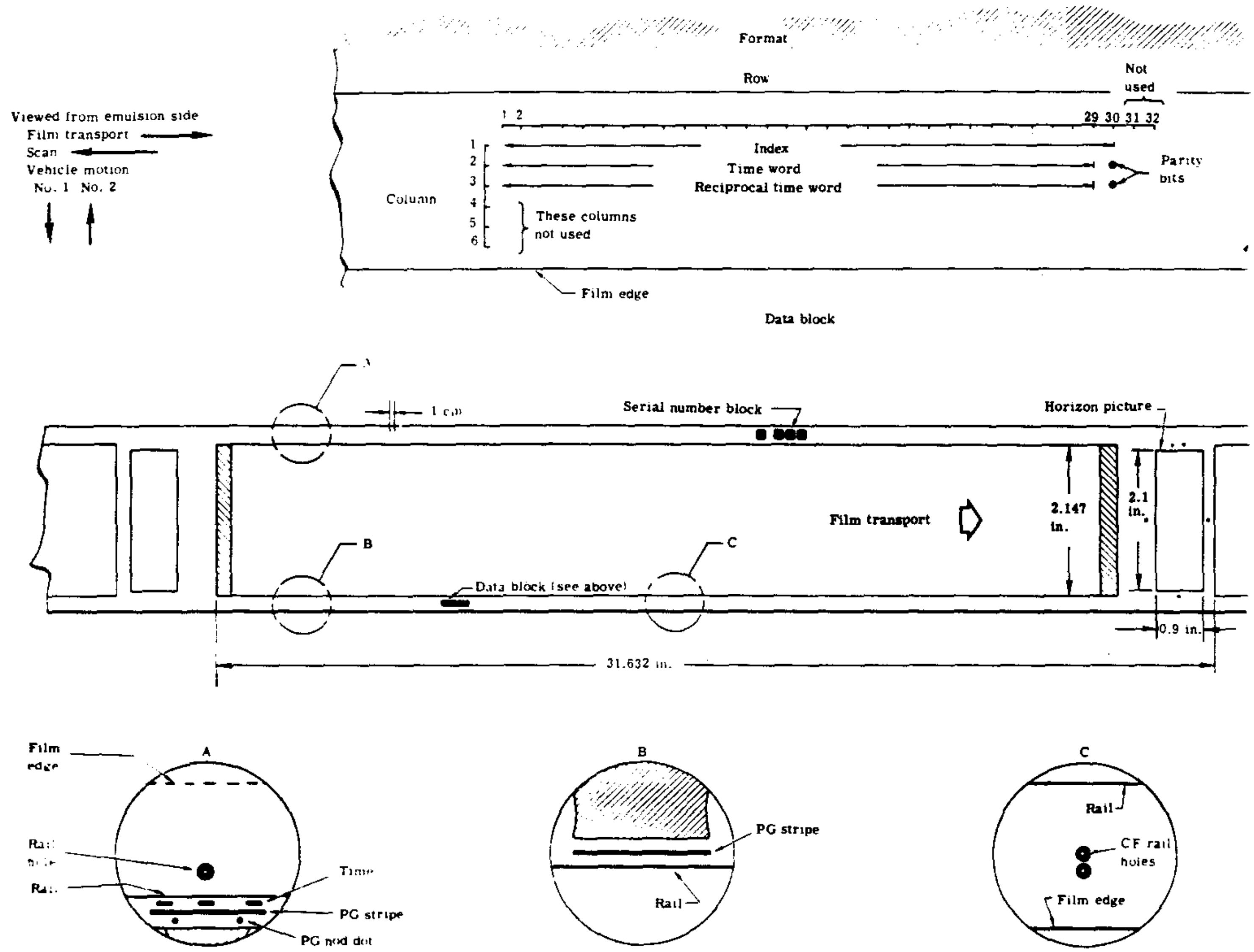


FILM TRANSPORT PATH



CONFIGURATION AND ORIENTATION




Format
Row
Not used
Viewed from emulsion side
Film transport
Scan
Vehicle motion
No. 1 No. 2
1 2
29 30 31 32
Column
1
2
3
4
5
6
Index
Time word
Reciprocal time word
Parity bits
These columns not used
Film edge
Data block
A
1 cm
Serial number block
Horizon picture
Film transport
2.147 in.
2.1 in.
B
C
Data block (see above)
0.9 in.
31.632 in.
Film edge
Rail
Time
PG stripe
PG nod dot
PG stripe
Rail
Rail
CF rail holes
Film edge

DISIC

DUAL IMPROVED STELLAR INDEX CAMERA SUBSYSTEM

PURPOSE

The purpose of the dual improved stellar index (DISIC) camera subsystem is to provide exposed film for use in precision geodetics and cartography, and also for use in conjunction with the main J-3 cameras to aid in establishing vehicle attitude and precise location of reconnaissance points of interest.

PHYSICAL SYSTEM CHARACTERISTICS

Parameter	Terrain Camera	Stellar Camera
Lens	3-inch Ikogon	3-inch Ikotar
Aperture	f/4.5	f/2.8
Film format	4.5 by 4.5 inches	1.25 diameter with flats
Angular coverage	74 by 74 degrees	23 ½ degrees
Lens distortion	30 microns (R) 5 microns (T)	15 microns (R) 5 microns (T)
Film flattening	By glass plate	By glass plate
Reseau	2.5-mm spacing 10 microns maximum width	2.5-mm spacing 10 microns maximum width
Reseau illumination	Natural	Artificial
Natural fiducials	1 set of four	1 set of four
Shutter type	Rotary	Rotary
Selective exposure time	1/250 second 1/500 second	1.5 seconds

Parameter	Terrain Camera	Stellar Camera
Cycle period	9.375, 12.50, 15.675 and 18.75 seconds (last two not on CR-1 through CR-6)	3.125 seconds (mode I) same as terrain (mode II)
Dual stellar operation	—	Simultaneous, or by selection
Knee angle	100 degrees	100 degrees
Data recording	Time and serial no.	Time and serial no.
Film type (normal)	3400	3401
Width	5 inch	35 mm
Total capacity	2,000 feet	2,000 feet
Metered length	5 inches	3 inches

DISIC SUBSYSTEM WEIGHT

1. DISIC instrument (including film chutes and baffles)	50 pounds
2. Supply cassette	12 pounds
3. Takeup cassettes (2)	13 pounds
4. Film (maximum)	25 pounds
5. Film exit housing	4 pounds
Total	104 pounds

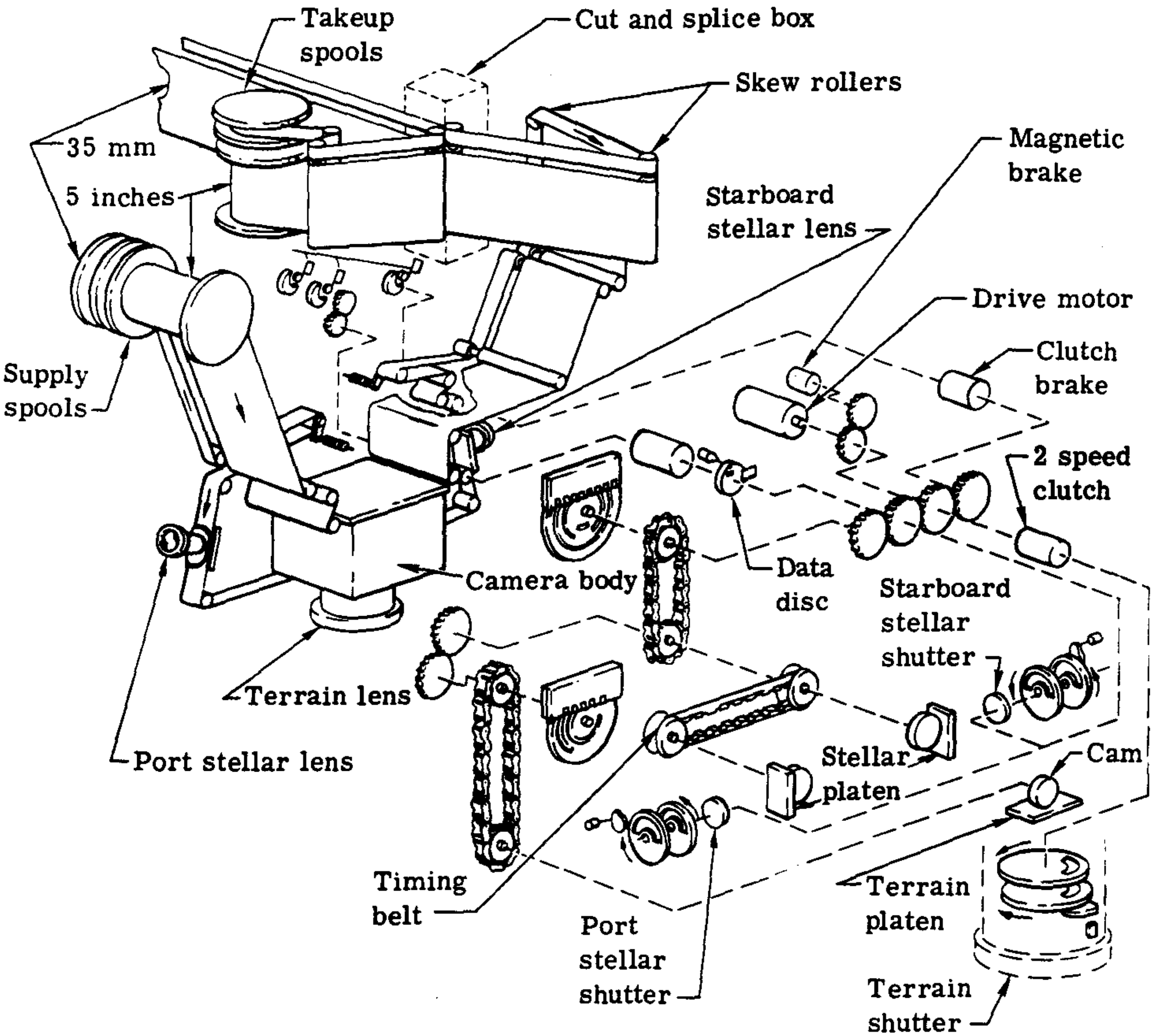
POWER

Index Cycling Rate	Approximate Total Power, watts	Current Total Average Amps
9.375 -second slave	72	3.00 (24 vdc)
9.375-second independent	66	2.75 (24 vdc)

NOTE: (1) The above tabulation gives the predicted average power consumption for the camera subsystem components along with the total current and power. One of two terrain cycling periods (9.375 seconds or 12.500 seconds/cycle) can be selected prior to flight. The numbers in the table above are based on cycling period of 9.375 seconds. This period is expected to be used for most flights, and power consumption at the 12.500-second period will be within 10 percent of those shown for 9.375 seconds.

(2) Power of approximately 850 watt-hours is required for the DISIC subsystem during flight, based on 14 days of active mission life with 2,000 feet of index and stellar film. Mission programming of the DISIC for the independent and slave modes may require less than 2,000 feet of film with a corresponding reduction in the power requirements.

FUNCTONAL SCHEMATIC AND FILM THREADING DIAGRAM



SATELLITE RECOVERY VEHICLE

SATELLITE RECOVERY VEHICLE (SRV)

PURPOSE

The purpose of the satellite recovery vehicle (SRV) is to provide a structural, heat-resistant nose cone section for the launch vehicle, to provide thermal protection for the inner capsule during orbital operations and re-entry, and to provide a separable re-entry vehicle with appropriate subsystems to de-orbit selected physical data.

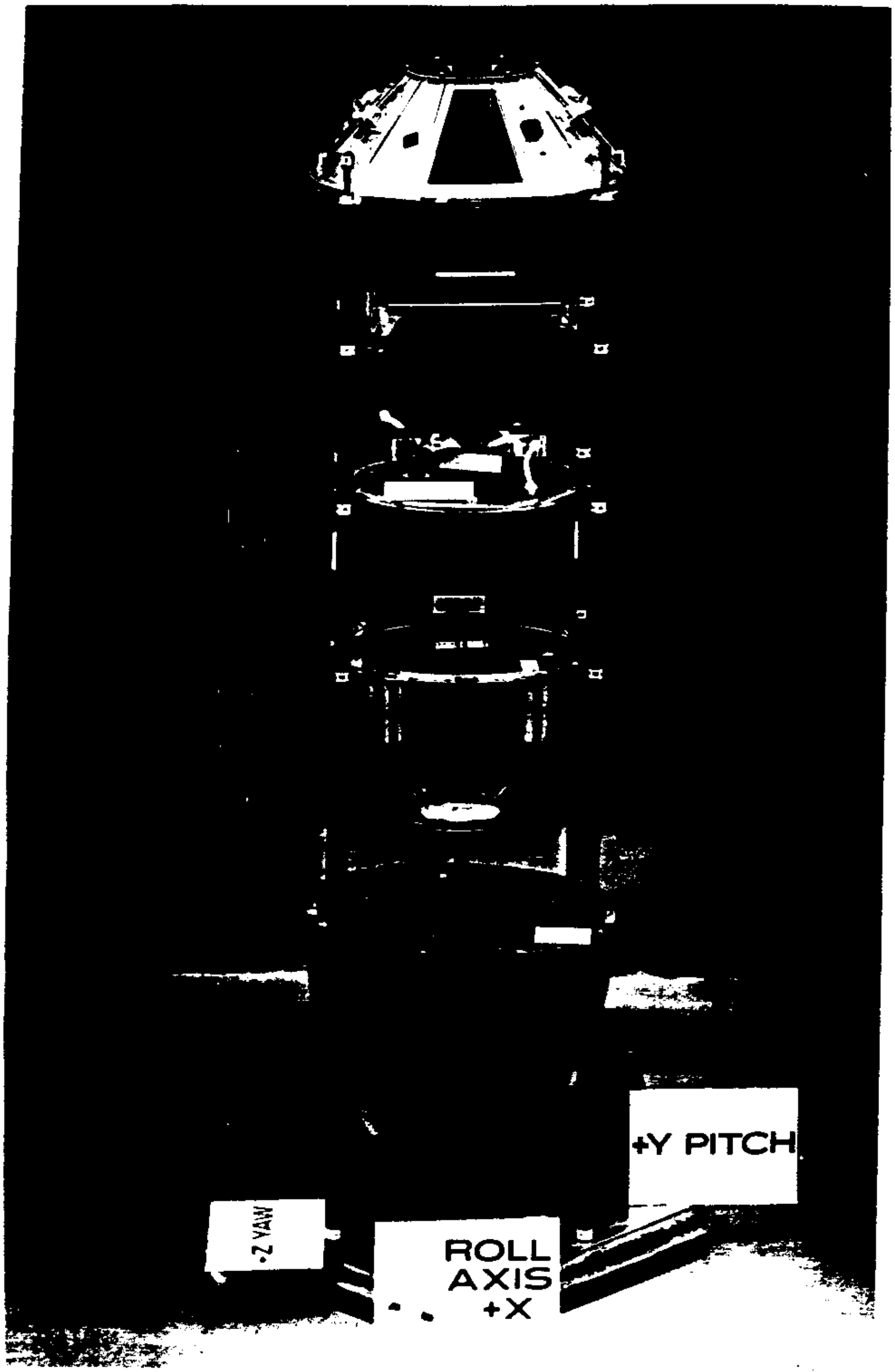
CHARACTERISTICS

Separation weight	414 pounds maximum
Re-entry vehicle	323 pounds maximum
Suspended weight	120 to 217 pounds (nominally 215)
Hypersonic ballistic coefficient	68 pounds/ft^2 maximum
Total impulse (retrorocket)	10,500 pound-seconds ± 3 percent
Rate of descent (at 10,000 feet)	28.5 feet/second maximum
Aerial recovery (JC-130)	15,000-foot altitude maximum 135 knots air speed maximum
Water recovery flotation period	55 to 95 hours
Reliability	0.984 (each SRV)
J-3 panoramic film recovered	80 pounds
DISIC film recovered	11.3 lbs

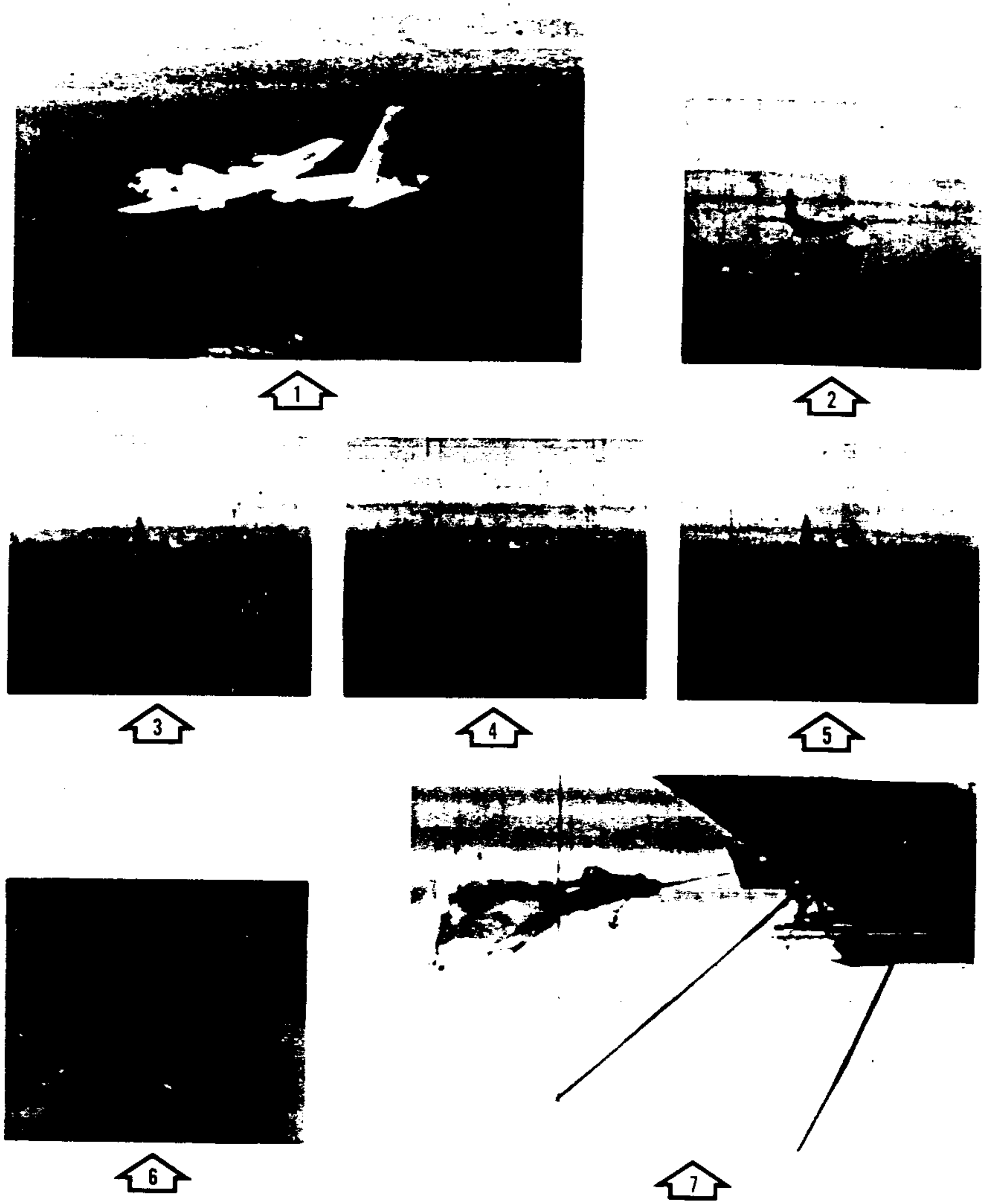
The design system duplicates the spin system, except that the nozzles are pointed in the opposite direction to effect a clockwise spin and are located 90 degrees from each spin nozzle. The despin tank has a working gas pressure of 2,400 psi.

The retro-rocket is a solid-propellant rocket which imparts a thrust of 1,000 pounds for approximately 10-second duration. The purpose is to decelerate the RV. The physical characteristics are listed as follows.

1. Total packaged weight is 63 pounds.
2. Burn time is approximately 8 seconds.
3. Propellant weight is 40 pounds.
4. Specific impulse = $260 \frac{\text{lb-secs}}{\text{lbs}}$
5. Total impulse = $260 \frac{\text{lb-secs}}{\text{lbs}} \times 40 \text{ lbs} = 10{,}400 \text{ lb-secs}$
6. Average thrust = 1,136 lbs
7. Maximum thrust = 1,609 lbs



J-3 Payload



10× Enlargements of Air Recovery

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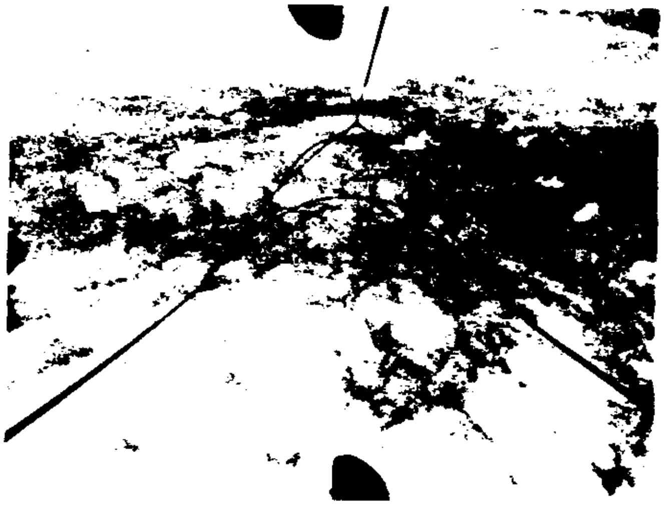
10× Enlargements of Air Recovery



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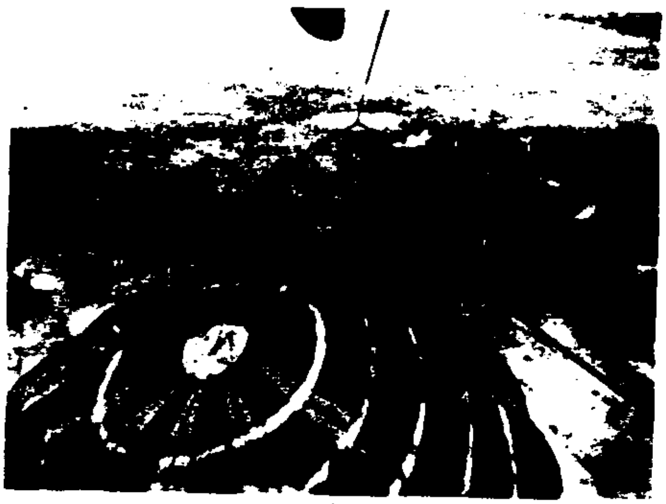

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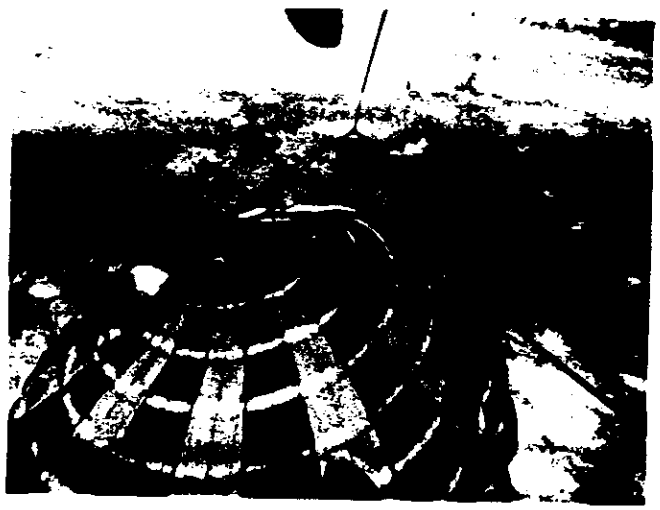

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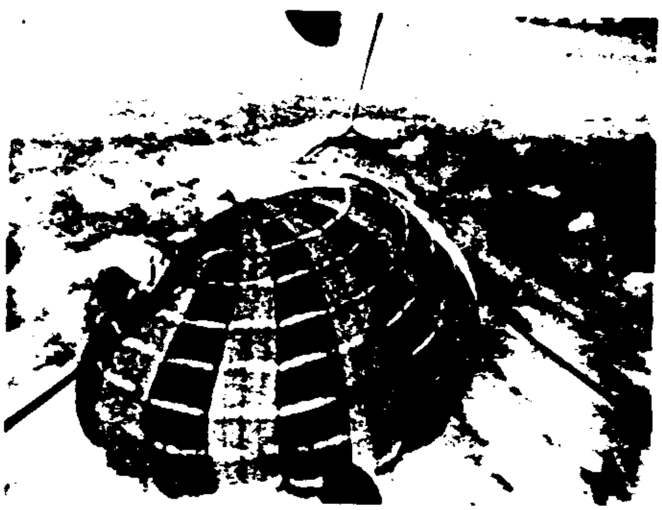

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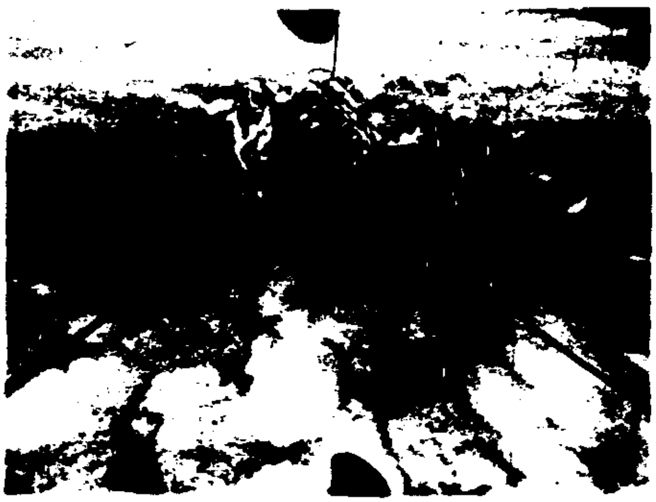

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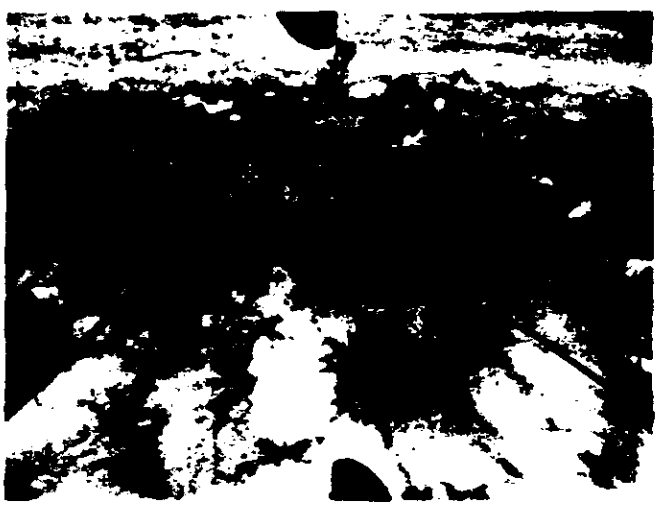

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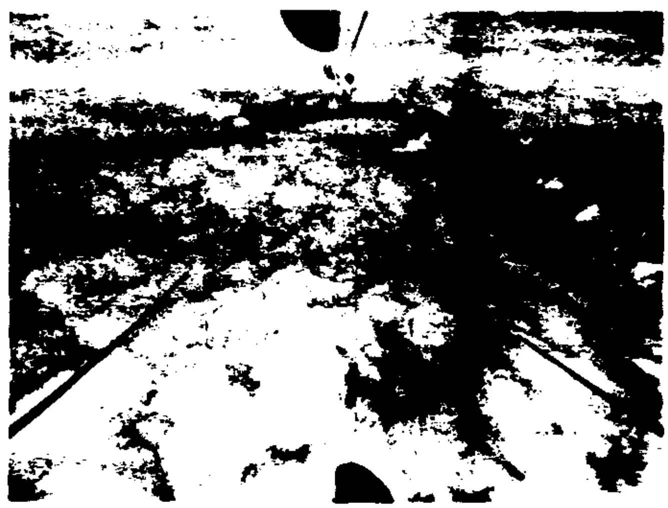

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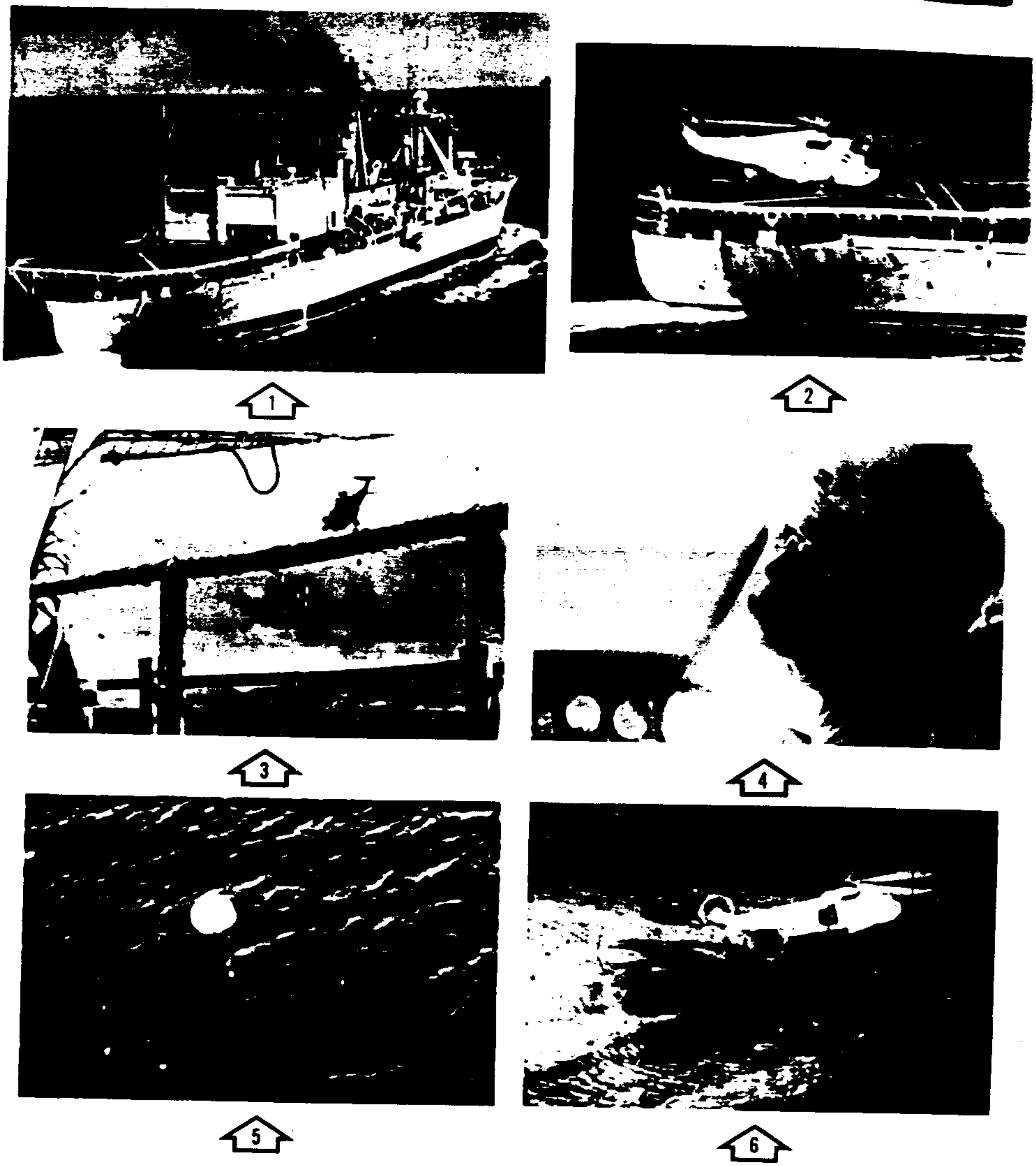
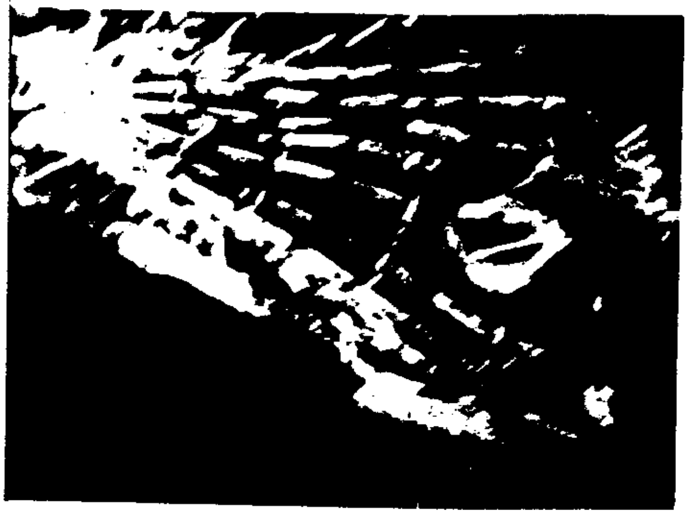


10× Enlargements of Sea Recovery



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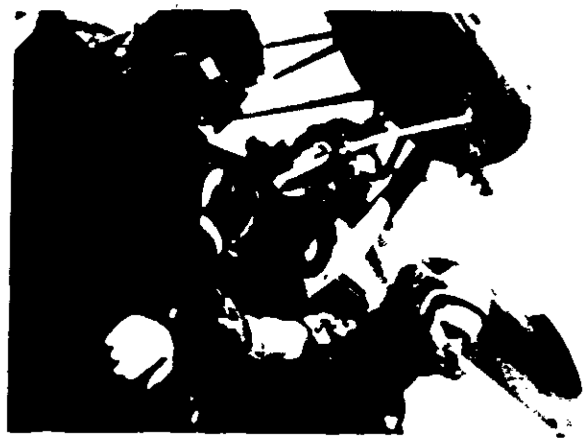

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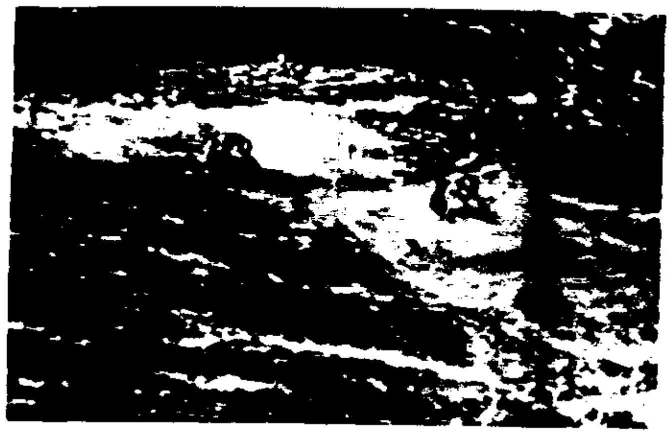

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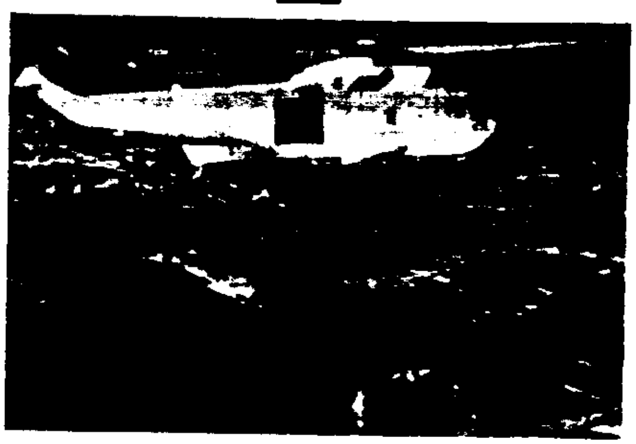

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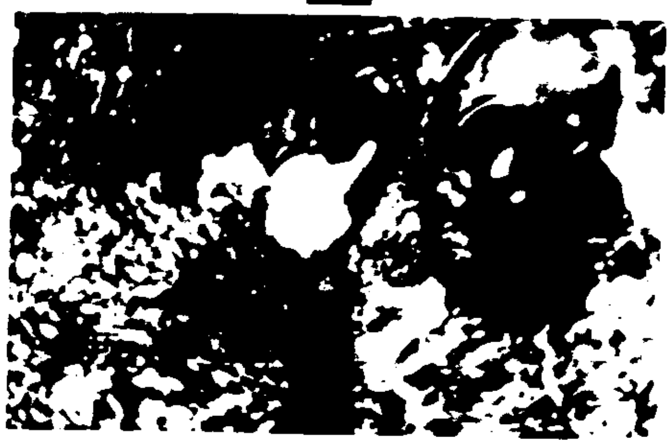

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10× Enlargements of Sea Recovery

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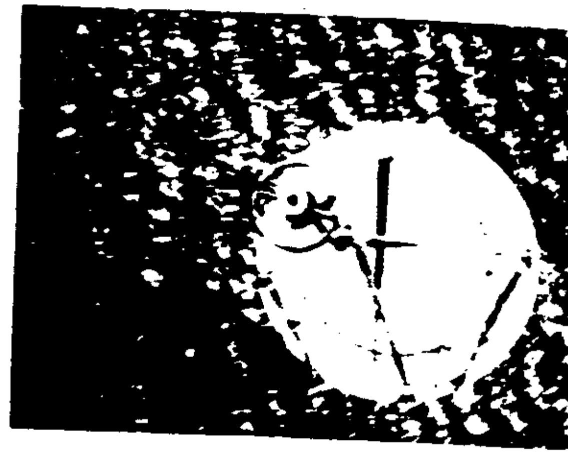

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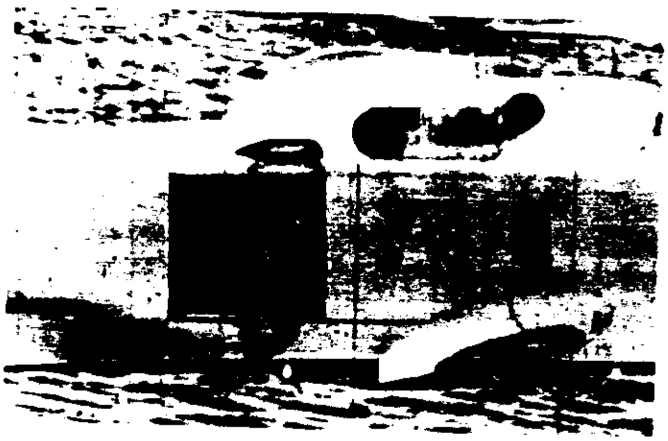

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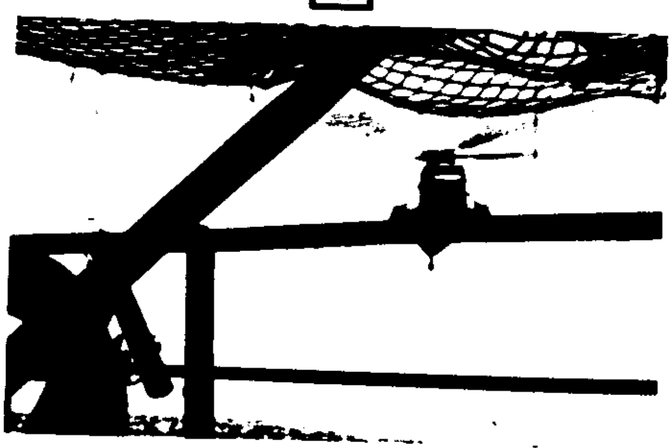

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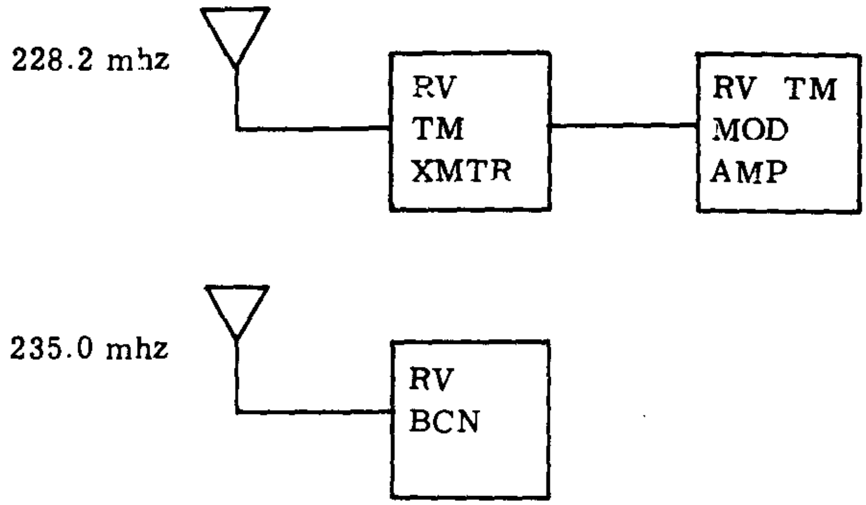
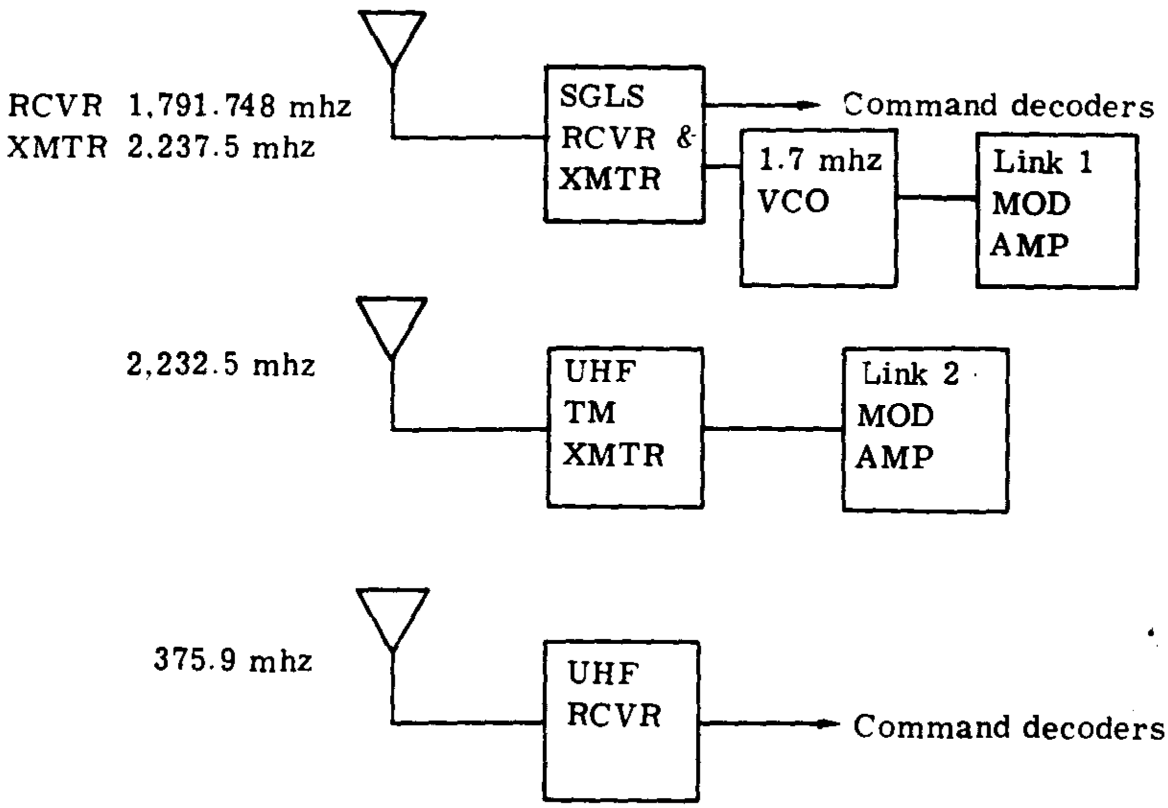
10× Enlargements of Sea Recovery

TELEMETRY

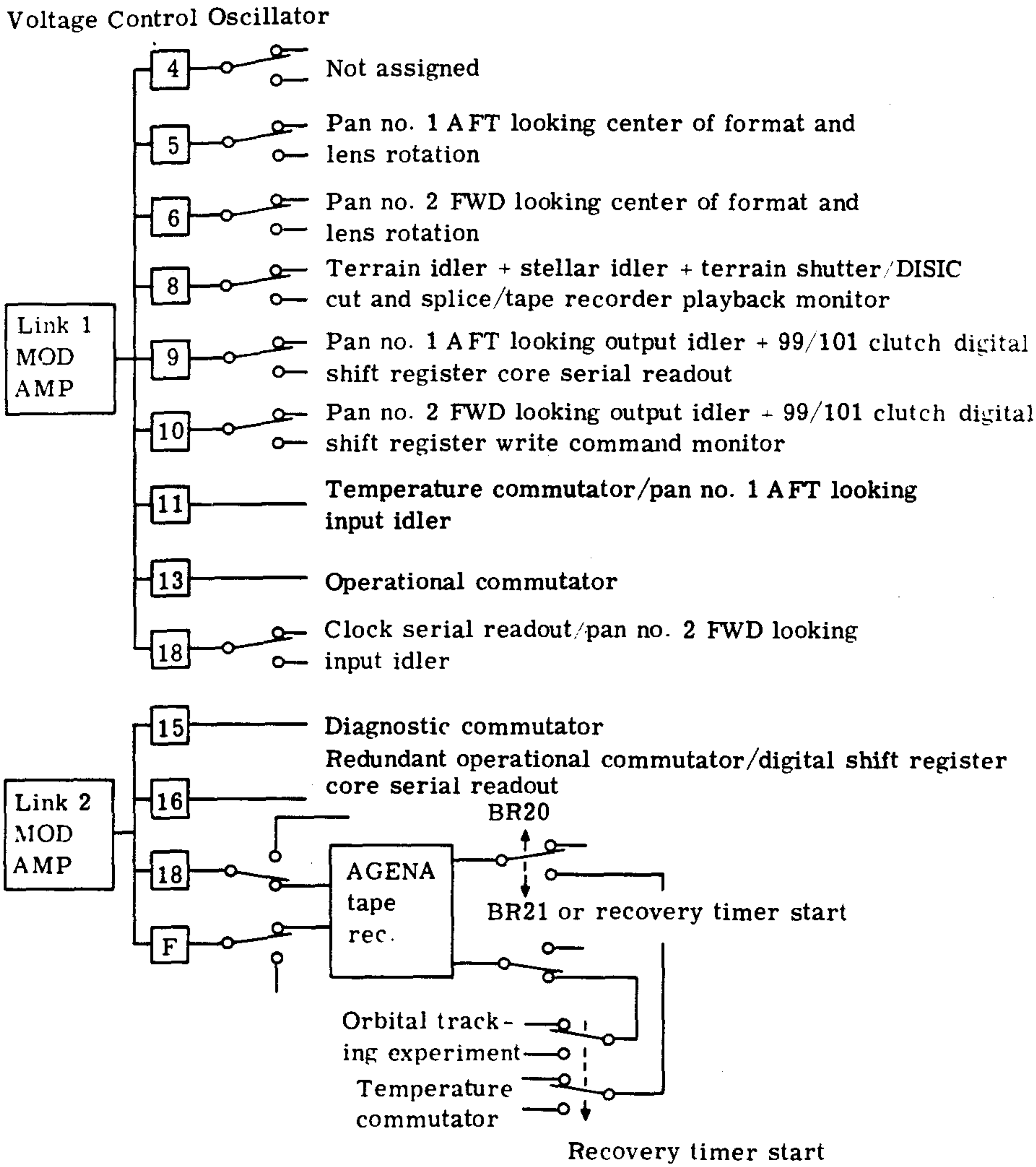
VEHICLE RADIO FREQUENCY EQUIPMENT
SGLS CONFIGURATION



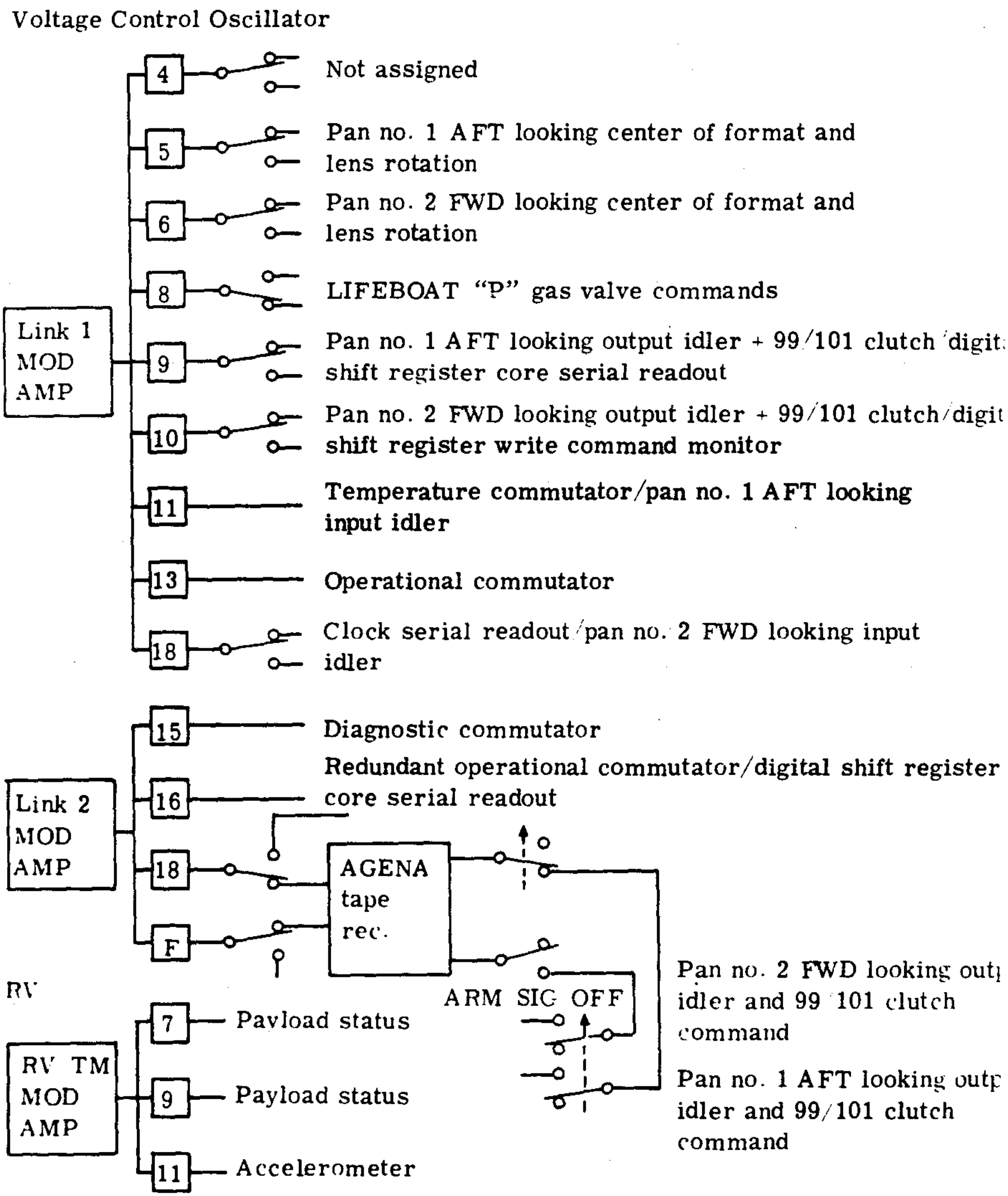
Re-entry vehicle transmitters



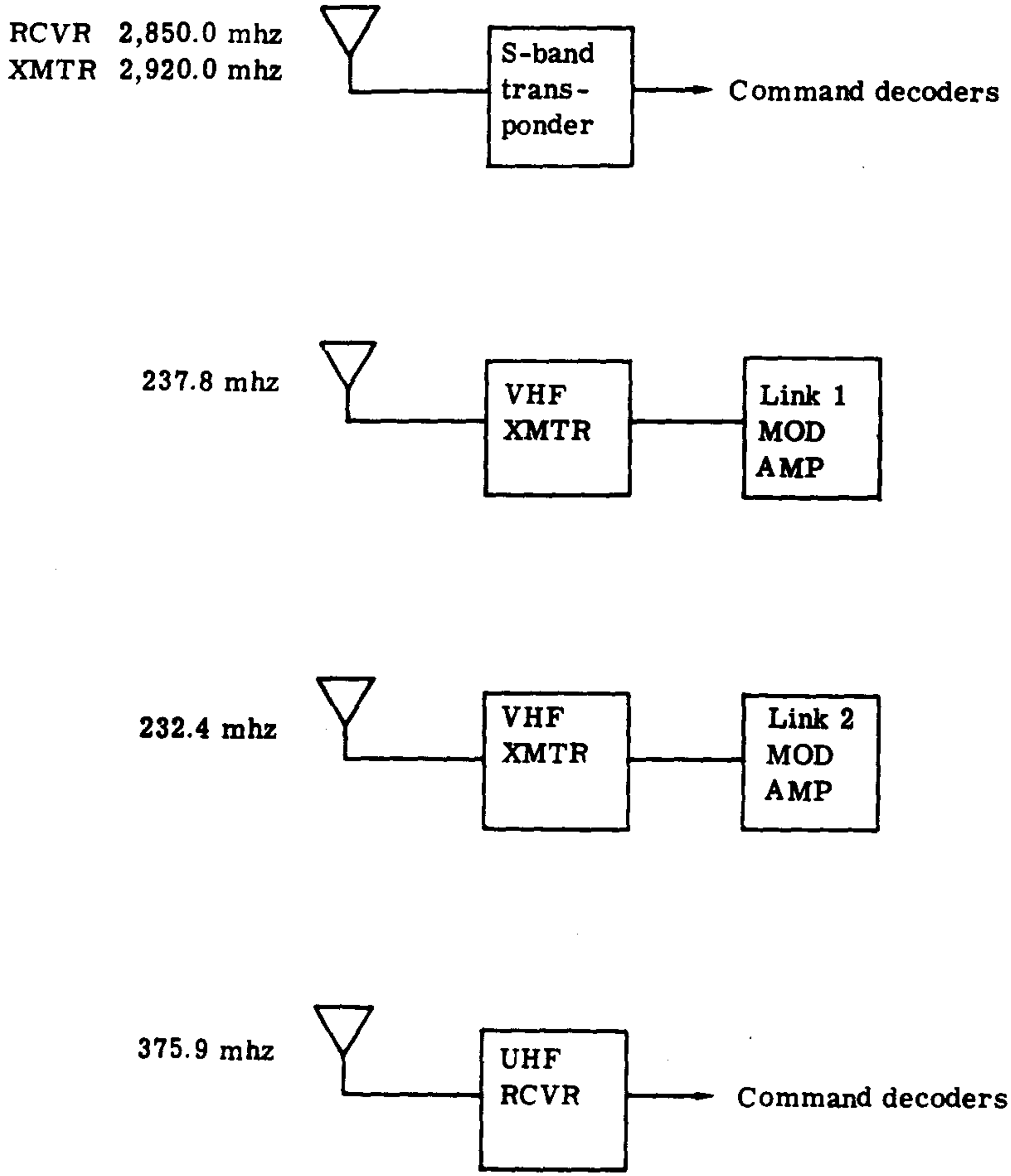
J-3 BLOCK DIAGRAM OF INSTRUMENTATION TELEMETER SYSTEM ORBIT CONFIGURATION



J-3 BLOCK DIAGRAM OF INSTRUMENTATION TELEMETER SYSTEM RECOVERY CONFIGURATION

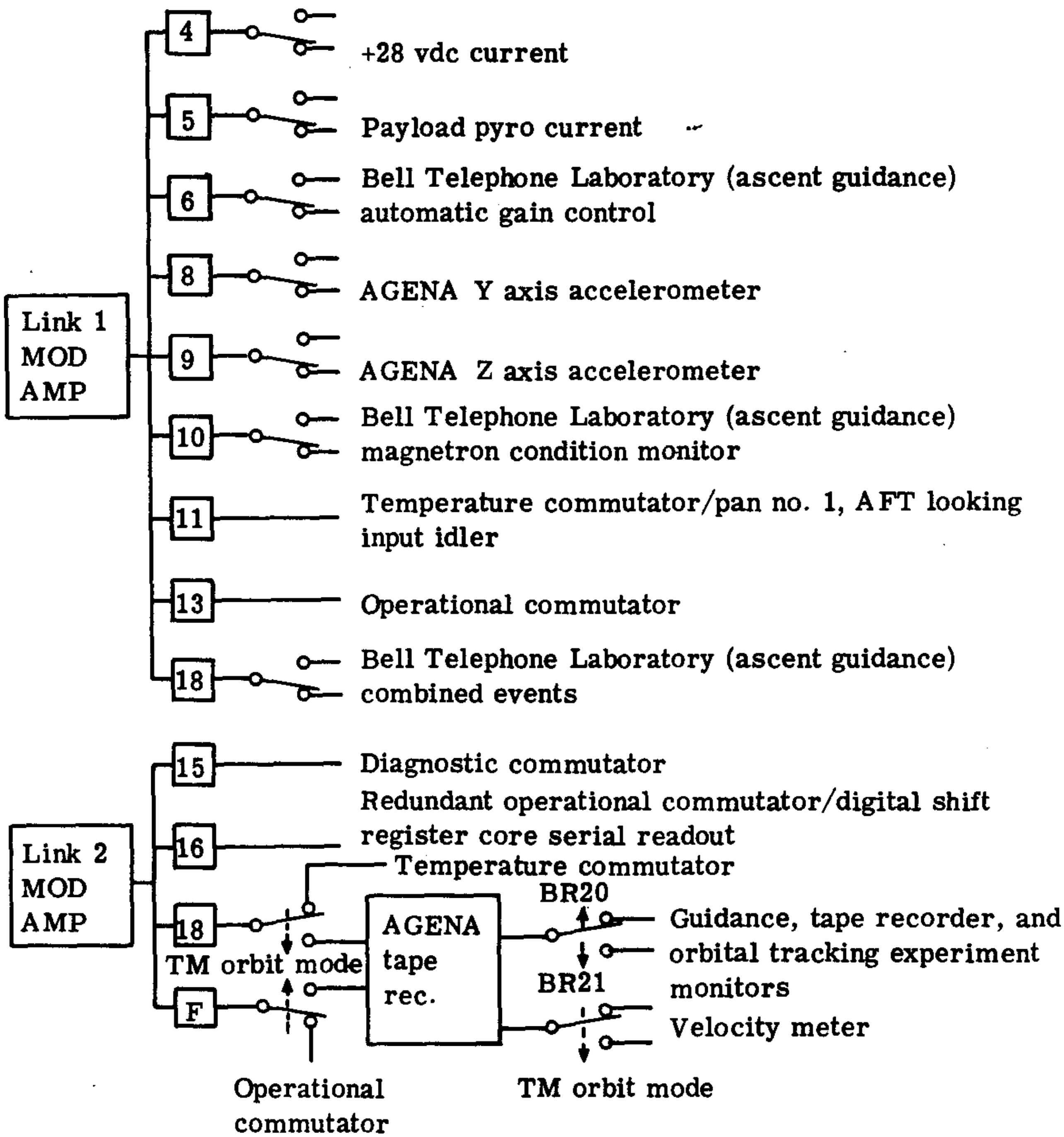


VEHICLE RADIO FREQUENCY EQUIPMENT
PRE-SGLS CONFIGURATION
(J-1; CR-1 THROUGH CR-7)



J-3 BLOCK DIAGRAM OF INSTRUMENTATION TELEMETER SYSTEM ASCENT CONFIGURATION

Voltage Control Oscillator



TELEMETRY CHANNELS ASSIGNED TO A/P

Link 1 Channel 4 - continuous:
Ascent - vehicle + 28 vdc current
Orbit and recovery - not used

Link 1 Channel 5 - continuous:
Ascent - payload pyro current
Orbit and recovery - pan no. 1 AFT looking lens angular position and center of format

Link 1 Channel 6 - continuous:
Ascent - ascent guidance gain control
Orbit and recovery - pan no. 2 FWD looking lens angular position and center of format

Link 1 Channel 8 - continuous:
Ascent - AGENA Y axis accelerometer
Orbit - time shared -
Terrain idler, stellar idler and terrain shutter of DISIC cut and splice, or tape recoder playback monitor
Recovery - LIFEBOAT "P" gas valve commands

Link 1 Channel 9 - continuous:
Ascent - AGENA Z axis accelerometer
Orbit and recovery - time shared -
Digital shift register core serial readout, or pan no. 1 AFT looking output idler and 99/101% clutch

Link 1 Channel 10 - continuous:
Ascent - ascent guidance magnetron condition
Orbit and recovery - time shared -
Digital shift register write command monitor, or pan no. 2 FWD looking output idler and 99/101% clutch

Link 1 Channel 11 -
Ascent, orbit and recovery - time shared
Commutated - temperature data
Pan 1 AFT looking temperatures
Pan 2 FWD looking temperatures
Fairing temperatures

TELEMETRY CHANNELS ASSIGNED TO A/P (Cont.)

DISIC temperatures
DISIC CONIC temperatures
Pressure makeup temperatures
Instrument barrel temperatures
AFT power box cover temperature
V/h programmer temperature
Switch programmer cover temperature
SRV internal temperatures
SRV retro temperatures
Blast shield temperatures

or continuous - pan no. 1 AFT looking input idler

Link 1 Channel 13 - ascent, orbit and recovery:
Commutated - operational command and control monitors
Storage register output
Selector position monitors
Pan operate
Door separation monitors
Pressure makeup bottle pressure
Pan, stellar and terrain takeup diameter monitors
Pan, stellar and terrain cycle monitors
Exposure programmer monitors
Pan slit monitors
Eccentricity program operate relay
FMC function output
Yaw and oblateness operate
Yaw oblateness general position
Pans exposure command

Link 1 Channel 18 - continuous:
Ascent - ascent guidance combined events
Orbit and recovery - time shared -
Clock serial readout or pan no. 2 FWD looking input idler

TELEMETRY CHANNELS ASSIGNED TO A/P (Cont.)

Link 2 Channel 15 - ascent, orbit and recovery
- Commutated - diagnostic data
  - SRV water seals
  - Pan input, intermediate roller and frame meter rotation monitors
  - Pan takeup, supply spool and drive motor voltages
  - Total payload and pyro current monitors
  - Pan horizon optic platen positions
  - Recovery mode and fairing and SRV separate monitors
  - Pan tachometer feedback monitors
  - Unregulated clock and pan operate voltages
  - SRV recovery battery monitors
  - Yaw resolver output
  - DISIC mode and terrain exposure monitor
  - Eccentricity function position monitor
  - 115 v 400 cycle voltage monitor
  - Pan horizon optics platen and shutter commands
  - Pan film door and DISIC cut and splice
  - Terrain and stellar capping and clutch commands
  - Pressure makeup outlet pressure switch
  - Film change detector
  - Terrain and stellar platen positions
  - DISIC motor voltage
  - DISIC operate command and 1 rev per cycle cam position monitor

Link 2 Channel 16 - ascent, orbit and recovery:
- Commutated - operational command and control monitors
  - Same as Link 1 Channel 13 (when switched by real time command)
    - continuous - digital shift register core serial readout

Link 2 Channel 18 - commutated:
- Ascent - temperature commutator (see Link 1 Channel 11)
- Orbit - tape recorder output of temperature commutator, guidance, tape recorder, and orbital tracking experiment monitors
- Recovery - tape recorder output of pan no. 1 output idler and 99/101% clutch

TELEMETRY CHANNELS ASSIGNED TO A/P (Concl.)

Link 2 Channel F

Ascent - operational commutator (see Link 1 Channel 13)
Orbit - tape recorder output of orbital tracking experiment data
Recovery - tape recorder output of pan no. 1 output idler and 99/101% clutch

SRV Telemetry

Channel 7 - continuous - payload status and recovery events
Channel 9 - continuous - payload status and recovery events
Channel 11 - continuous - accelerometer

FILMS AND FILTERS

AERIAL FILMS

Aerial films designed for reconnaissance and space application require characteristics which differ from conventional films. Aerial films must withstand the influence of environment, the requirements of system designs, and the handling from film manufacture through the duplication stages. Advances in emulsion making technology have made possible aerial films having a broad range of sensitivity, speed, and definition. Aerial color films are subjected to the same environment and design requirements as are black and white films. However, aerial color films have more critical exposure and color balance requirements. These special photographic characteristics are combined with a dimensionally stable Estar base to provide added dimensional stability. In the CORONA system, three primary black and white film types are used: 3404 (3414), 3400, and 3401. Three color film types have been experimentally used: SO-121, SO-180, and SO-242. All these emulsions have special characteristics and applications. Each is individually described in the following text.

PANORAMIC CAMERA FILMS

High Definition Aerial 3404 film has high contrast, high definition, extremely fine grain, and extended red sensitivity. The 3404 emulsion is coated on a 2.5-mil Estar base for use in cameras specifically designed for extremely high altitude stable platform photography. In the earliest missions, [redacted] used variable spray processing conditions for 3404 film. This three-level (primary, intermediate, and full) processing provided sensitometric responses separated by 1/2 f/stop. Beginning with mission 1104, however, a single level viscous process has been used. This "dual-gamma" sensitometric response effectively produces as wide an exposure latitude as the former three-level process as well as a lower D_{max} for more advantageous duplicating. On July 1970 Eastman Kodak replaced 3404 with 3414 film. The 3414 emulsion characteristics are similar to the 3404 emulsion with the exception of spectral response and film speed.

		3404	3414
Resolving power:	100:1 T.O.C.	671	704
	1.7:1 T.O.C.	221	272
AEI speed		3.4	5.0

SO-242 AERIAL COLOR FILM

SO-242 Aerial Color Film is an Ektachrome type reversal emulsion with a filter coating which is equivalent to a Wratten no. 2B filter. The very high definition feature of SO-242 makes it ideal for high acuity/high altitude photographic systems. The emulsion orientation is stacked such that the green sensitive layer is on top followed by the red and the bottom blue sensitive layer. Overcoating the emulsion layers is the filter layer for modifying the incident illumination. These filter and emulsion layers, together with an anti-curl backing layer, are coated on a 2.5-mil Estar base. The film speed has been designed to be compatible with the black and white 3404 and 3414 films as normally used, i.e., slit widths set for the black and white primary films for given mission parameters are also correct for the SO-242 film.

SO-242 mission 1108, December 1969, Williams Air Force Base

SO-121 AERO EKTACHROME FILM

SO-121 Aero Ektachrome film is a reversal material having fine grain characteristics capable of high definition suitable for high altitude photography. The SO-121 emulsion orientation is such that the green sensitive layer is on top, the blue sensitive layer in the middle, and the red sensitive layer on the bottom. One unique characteristic of this film is the absence of the yellow filter layer that is found in other color films. There is some overlap in sensitivity in the blue-green region. The green sensitive layer has mor than the normal amount of blue sensitivity. As a result this material generall does not reproduce blues well in that they tend to be blue-green in color. The three emulsions are coated on standard 2.5-mil Estar base material with a cle gel anticurl backing. The speed of this film had previously been in the neighborhood of 10-12. However, recent adjustments to the film by Eastman Kodak have lowered the speed in an effort to improve the film image quality.

Resolving power: T.O.C. 1,000:1 = 172 cycles per millimeter
1.7:1 = 63 cycles per millimeter

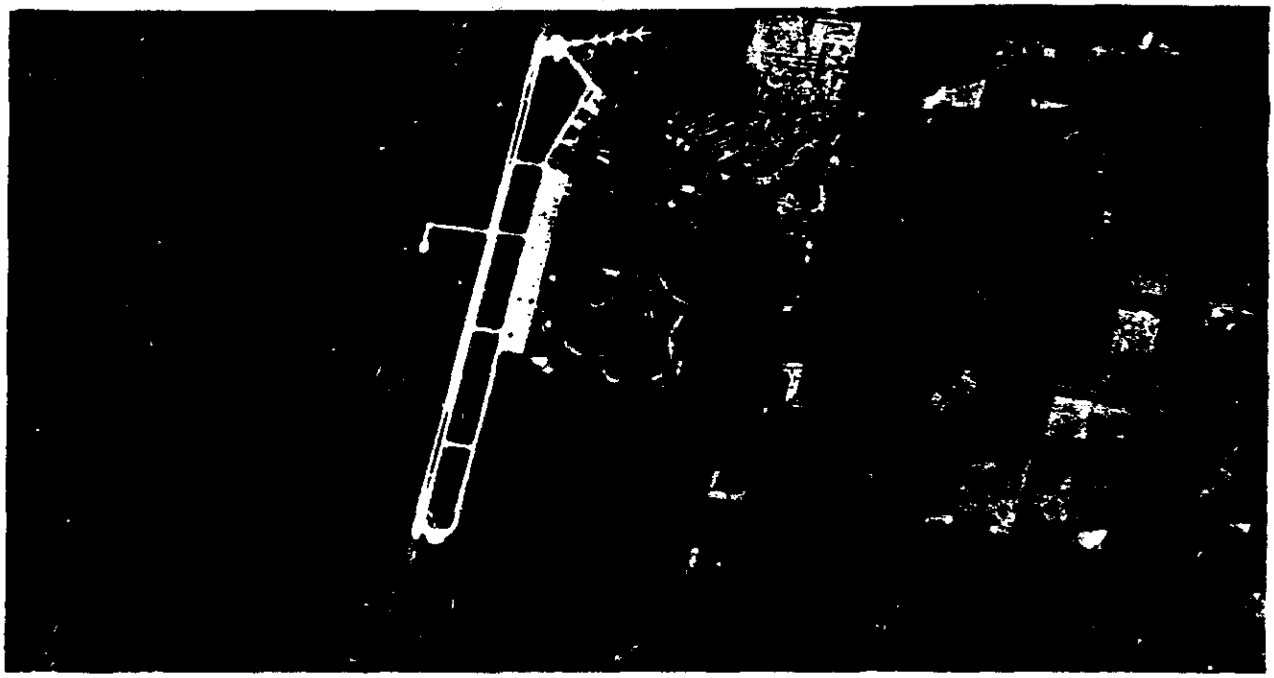
AEI: 5.0 to 8.0

SO-180 EKTACHROME INFRARED AERIAL FILM

SO-180 Ektachrome Infrared Aerial film is a color reversal film. The tripak emulsion consists of a green sensitive layer, a red sensitive layer, and a near infrared layer. The emulsion is coated on the 2.5-mil Estar base with a clear gel anticurl backing. The spectral sensitivity of SO-180, enables the recording of objects that have reflectances in the near infrared. The film construction is such that the infrared sensitive layer records as red, the red sensitive layer as green, and the green sensitive layer as blue. To compensat for this inherent blue sensitivity of all three layers, the SO-180 must be supplemented with a minus-blue (Wratten 12 or 15) filter with short wavelength cutoff in the 500-nanometer region. The cyan layer is designed to be slower than the other two layers because targets of interest for this material reflect comparatively more energy in the near infrared region than the green and red Therefore, its prime value is in the detection of changes in the 700-900 nanometer region that are not visually discernible.

Resolving power: T.O.C. 1,000:1 = 65 cycles per millimeter
1.7:1 = 35 cycles per millimeter

AEI: 18.0



SO-121 mission 1105, November 1969, Clinton Sherman AFB

SO-180 mission 1104, August 1968, Lompoc, California

DISIC —INDEX CAMERA FILM

Panotomic-X Aerial, 3400 is a moderate speed panchromatic sensitive emulsion having high contrast and extended red sensitivity. For added dimensional stability the 3400 emulsion is coated on the 2.5-mil Estar base material. [redacted] has a three-level process for 3400, providing 2/3-stop increments between each process. The film from DISIC, though, is processed in the single level processor using the Drape processor.

Resolving power: 1,000:1 = 184 cycles per millimeter
1.7:1 = 73 cycles per millimeter

AEI: 23.9

DISIC —STELLAR CAMERA FILM

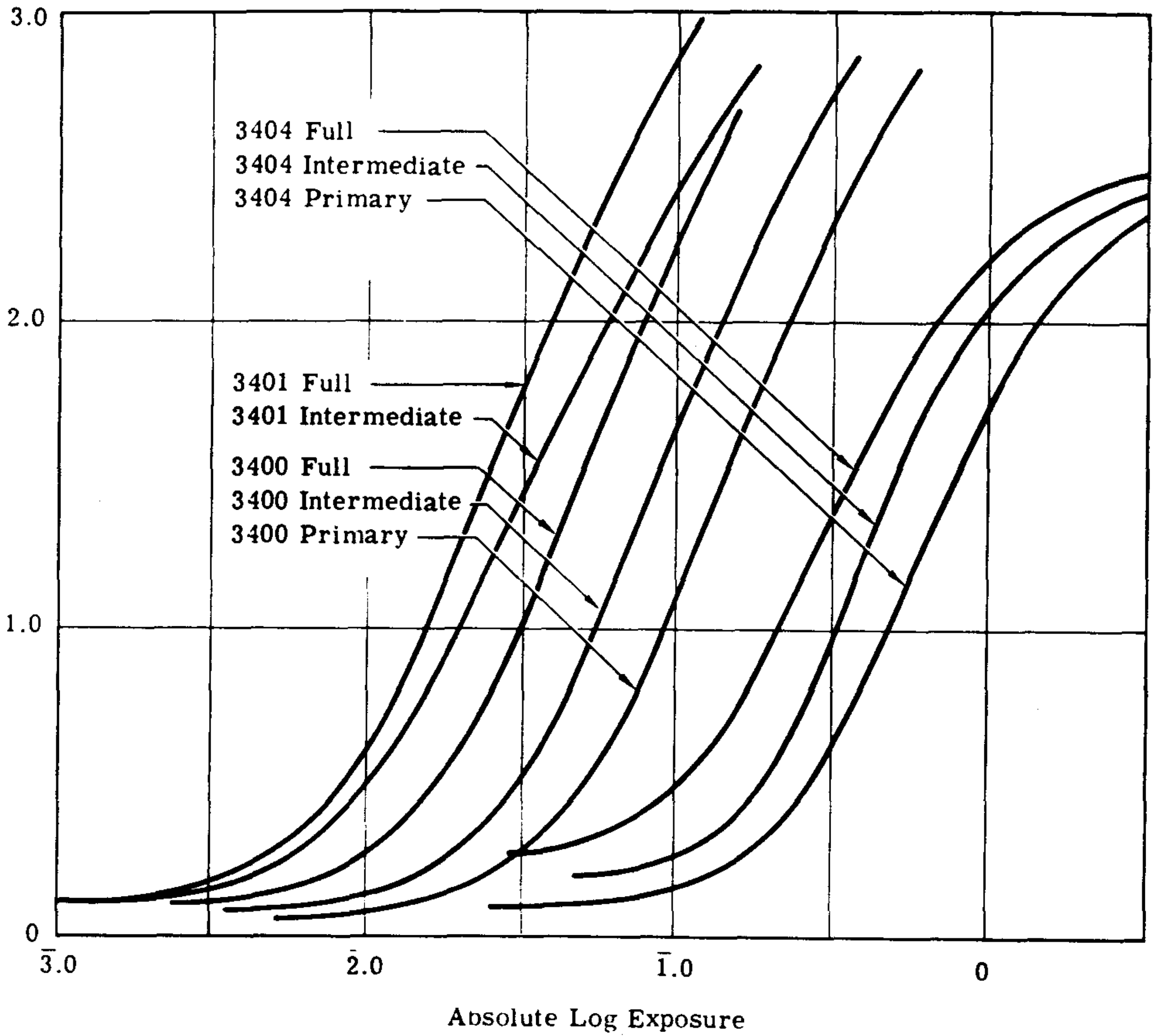
Plus-X Aerial, 3401 is a fast, high contrast, relatively coarse grain film emulsion and with records stellar images with a $1\frac{1}{2}$-second exposure at f/2.8 This film is panchromatic with extended red sensitivity. This film is coated on a 2.5-mil Estar base which has a green antihalation pelloid backing. The films reciprocity characteristics are such that it operates at peak efficiency with expose times on the order of that used in the stellar cameras. This material is processed in the Trenton processor at a single level development.

Resolving power: 1,000:1 = 109 cycles per millimeter
1.7:1 = 43 cycles per millimeter

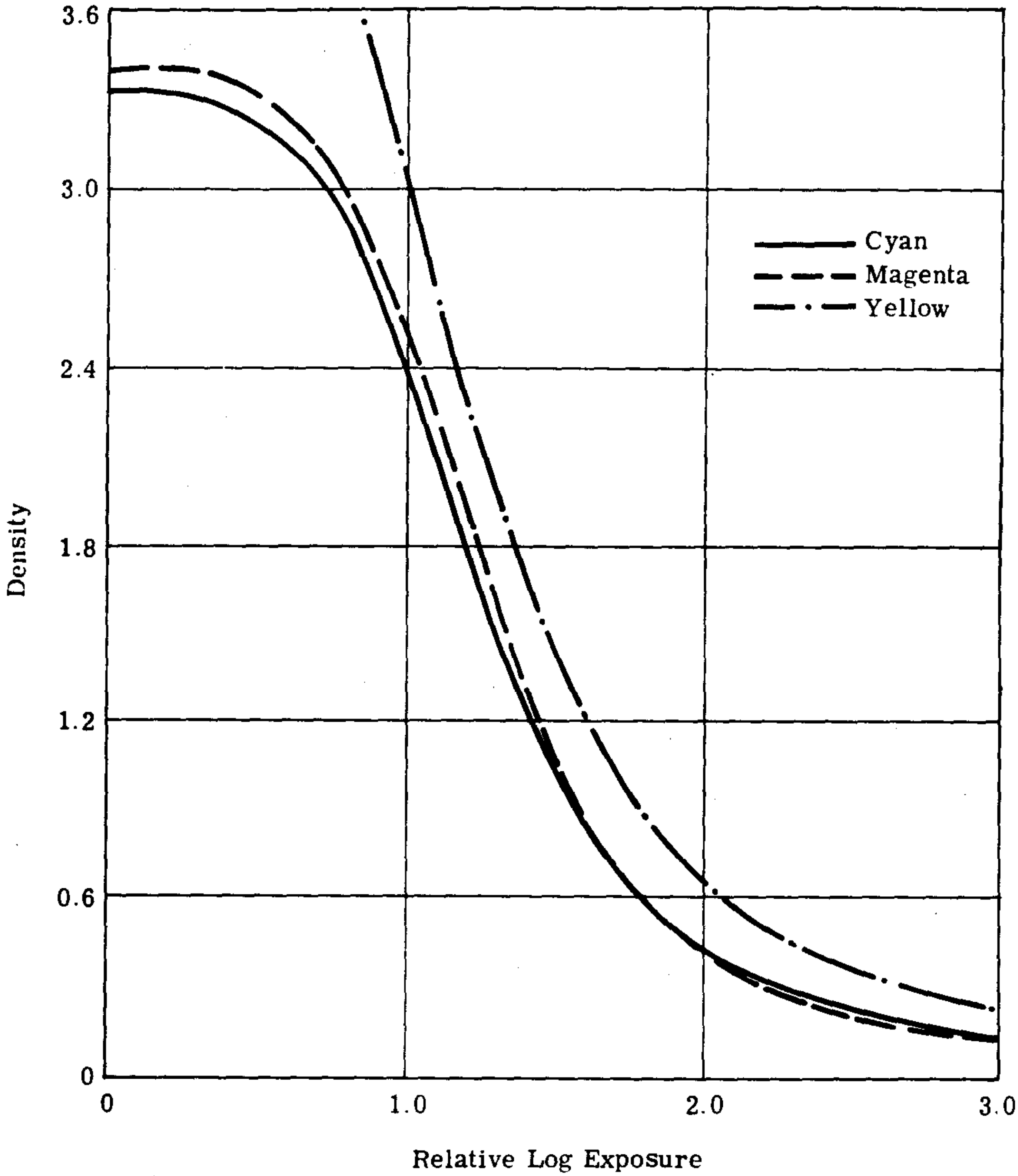
AEI: 60.0

SENSITOMETRIC CURVES FOR TRENTON SPRAY PROCESSING

3404 Index Camera Film
3401 Stellar Camera Film
3404 Panoramic Camera Film



SENSITOMETRIC CURVE FROM MAIN CAMERA MATERIAL
SO-121



SENSITOMETRIC CURVES FOR SO-242