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REPORT

CORONA J FLIGHT REPORT

FTV 1163-[illegible]

Distribution

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SECRET [redacted]

21 October 1963

CONTENTS

[redacted] [redacted]

21 October 1963

FIGURES

TABLES

[redacted]

[redacted] [redacted] [redacted] 21 October 1963

SECRET

SUMMARY

Flight Test Vehicle 1163 was an S-01A orbital stage employing an SLV-2A booster. The primary payload system aboard was J2, a dual recovery reconnaissance camera system, consisting of panoramic cameras 116 and 117 and stellar index cameras D18/17/18 and D13/14/13.

A two-phase seven-day camera operational mission with an on-orbit inactive or storage period between phases was programmed.

Launch occurred at 4:00 p.m. PDT on 23 September 1963. Ascent and injection into orbit were normal. A comparison between the actual and predicted orbital parameters is included as Table 1.

Table 1

ORBITAL PARAMETERS

Parameter	Predicted	Actual
Period (minutes)	90.67	90.57
Apogee (N.M.)	235.50	234.66
Perigee (N.M.)	99.61	100.17
Eccentricity	0.0189	0.0186
Inclination (degrees)	75.00	74.96
Perigee Latitude (degrees)	23.20	38.21

The slave panoramic camera operated satisfactorily throughout the first phase of the mission. A failure in the master panoramic camera system occurred during orbit 42. However, operation prior to orbit 42 was

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SECRET

satisfactory. The stellar index camera failed prior to orbit 25.

On 26 September 1963 the first phase of the mission was completed on orbit 49 and a successful air-catch recovery of the first recovery system was made. The camera system was operated after recovery No. 1 in a monoscopic mode using the slave instrument. A total of 268 cycles were completed between recovery No. 1 and deactivation.

The vehicle was deactivated on orbit 54 for the on-orbit storage period. Reactivation was first commanded on orbit 165 and was unsuccessful. Subsequent commanding was also unsuccessful and the vehicle re-entered the atmosphere on orbit 293 on 11 October 1963 without being reactivated.

An evaluation of the payload system operation as derived from telemetry records is included in the following sections of this report.

INSTRUMENTATION SYSTEM PERFORMANCE

Generally, the instrumentation system performance was satisfactory. However, certain anomalies were evident and are described herein.

At launch plus 24 seconds the fairing separation monitor changed state, indicating separation of the fairing. Two switches in series are used to monitor fairing separation and an indication of separation occurs if either switch is opened. The separation indication was probably due to the adjustment or alignment of the switches aggravated by the ascent vibration. This monitor again changed state to a "fairing on" condition during the recovery sequence on orbit 49.

An abnormality occurred in the vehicle telemetry system on orbit 29. This condition precluded operation of the telemetry system from the orbital programmer stored commands and necessitated turn-on of telemetry by real-time command. The turn-on of telemetry by real-time command was designed to be used under such abnormal conditions in conjunction with the lifeboat recovery system. When used under these conditions the telemetry channel for the slave instrument dynamic functions is switched to a lifeboat status monitor. Therefore, the operation of the slave instrument was not observed on the [redacted] ([redacted] Tracking Station) engineering passes on orbits 41, 47 and 49.

COMMAND SYSTEM PERFORMANCE

The command system performed satisfactorily through orbit 46. On orbit 47 the recovery enable command was issued at both the [redacted] and [redacted] tracking stations but was not executed due to an apparent failure in the vehicle command decoder. Recovery was enabled on orbit 48 by utilizing the lifeboat "next orbit" mode.

Reactivation was commanded on orbit 165 and was unsuccessful. Reactivation commands were issued each day thereafter and were unsuccessful. This failure precluded stabilization of the vehicle and operation of the payload system for the second mission.

CAMERA PERFORMANCE

The discussion of camera performance includes both panoramic camera and stellar index camera operation. Refer to table 2 for pertinent camera setting and film type data.

Immediately after orbit injection an engineering operation of nine cycles was performed. The operation appeared normal, which verified the camera system had survived the ascent environment.

Table 2

CAMERA SETTINGS AND FILM TYPES

Panoramic Cameras:

	Master	Slave
Film Type	SO132	SO132
Slit Width	0.200 inch	0.200 inch
Filter Type	Wratten 21	Wratten 21

Horizon Optics:

	Master	Slave
Aperture	F6.8	F6.8
Exposure Time	1/100 second	1/100 second
Filter Type	Wratten 25	Wratten 25

Stellar Index Settings:

	Stellar Index A		Stellar Index B	
	Stellar	Index	Stellar	Index
Film Type	SO102	SO130	SO102	SO130
Aperture	F1.9	F4.5	F1.9	F4.5
Exposure Time	*2 to 5 sec	1/500 sec	*2 to 5 sec	1/500 sec

* = Dependent on cycle period of master camera.

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[redacted] [redacted] 21 October 1963

Panoramic Camera Operation

Engineering Passes

Panoramic camera operation was normal on the engineering passes for orbits 9, 25 and 41. However, both cameras were cycling approximately 3 percent fast on orbit 9. The v/h ramp level was changed on orbit 10. When observed on orbit 25, the cycle periods for the master and slave cameras, respectively, were 2.5 percent and 1 percent faster than programmed. On orbits 41 and 47 both cameras were cycling within 2 percent of the programmed speed.

A lens stow operation was conducted on orbit 11 prior to turning on the v/h programmer. A total of seven cycles were completed by each camera at a cycle period of 4.8 seconds. Both lenses stopped in the home or stowed position.

On the engineering pass during orbit 47 the telemetry data indicated the master instrument had failed; the camera was scanning correctly and the lens was rotating but no film was being metered. A total of 32 cycles was completed during this operation. The only other anomaly evident in the data was that the film footage pot monitor for the master camera was reading 0.2 volts indicating the film footage pot puck-arm had traveled to the cutoff spot on the pot winding. The takeup cassette torque motor pot also is controlled mechanically by the film footage pot puck-arm. Therefore, it was assumed that the cut off points of both pots were reached essentially at the same time. This condition caused the cassette to stop and produce a failure of the master instrument system.

A post-recovery inspection of the takeup cassette system was conducted and it was found that the master instrument cassette would not operate

[redacted]

when voltage was applied. The operation of the slave instrument cassette was normal but could be stopped by overtravel of the puck-arm. This indicated a dead or open spot on this cassette takeup pot.

A review of the preflight history of the cassette was made and it was disclosed that during installation of the stellar-index cassette it was necessary to rotate the puck-arm mounting bracket 180 degrees. A recalibration of the puck-arm and the film footage and torque motor pots was not made after this installation. This resulted in overtravel of the puck-arm pot causing the cassette takeup motor to stop.

Post recovery inspection revealed that the RFI filter package attached to the cassette motor housing had rotated approximately 90°. The motor housing is held into its supports by friction and apparently worked free while under load. This is a dangerous condition in that the power leads to the motor could be broken resulting in a catastrophic failure of the same type experienced on this flight.

The operation of the slave camera was not observed on telemetry on passes 41 and 47 as a result of having to turn the telemetry on by real-time command. However, there were no anomalies in the instrument status monitors. The free,e pulse output of the clock triggered by the center of format switch appeared normal, indicating the instrument was scanning correctly.

Cut-and-Wrap Sequence

During the cut-and-wrap sequence the dynamic telemetry monitors for both cameras were tape recorded. Analysis of these data indicate the cut-and-wrap sequence for the slave camera was successful and that film metering and all transfer functions were normal. The cut-and-wrap sequence for the master camera was approximately as predicted. The cut-and-wrap sequence data indicated that slack was present in the film and that the system attempted to take up this slack during the 7-second delay between cassette power on and instrument operate but the cassette bound up or was stopped after approximately two complete revolutions. The horizon idler telemetry data indicated the film was pulled out of the rails and was pulled back and forth by the scan arm with no metering occurring during scan.

Post-flight analysis of the processed film indicated the master camera failure occurred on the fifth frame of orbit 42. There were no evidences of incorrect or abnormal metering on frames prior to the failure. A total of 107 frames were programmed between the frame where the failure occurred and the time the cut-and-wrap sequence occurred. Thus, the possibility exists that this film was dumped somewhere in the camera system. On the basis of the telemetry indication of at least 32 frames of operation after the failure and without knowing what path the film had taken, it was decided to operate in the mono mode using the slave camera to preclude possible impairment of the total system.

After recovery on orbit 49, an engineering operation of 23 cycles using the slave system only was conducted to assure operation of the system after the cut-and-wrap sequence. The cassette rotation monitor, the

[redacted]

clock freeze pulse output, and status monitors indicated correct operation of the slave system at a cycle period of 2.3 seconds per cycle. No subsequent instrument operations were monitored on telemetry. However, the cycle counters indicated that a total of 245 of a programmed 250 cycled were completed before deactivation of the vehicle.

Stellar-Index Camera Operation

The stellar-index camera operation appeared normal on the engineering pass of orbit 9. On the engineering pass of orbits 25 and 41, metering did not occur on one of the two programmed cycles. On the engineering pass of orbit 47 (the only daytime pass), metering occurred only once out of a programmed four cycles; shutter opening occurred twice, neither time in the correct sequence.

THERMAL CONTROL SYSTEM PERFORMANCE

The thermal control objective for this flight was to obtain an average instrument temperature of 70 ($\pm$ 10)$^{\circ}$F. Flight data indicated an average instrument temperature, after thermal stabilization, of approximately 77°F was obtained. The average skin temperature of barrel No. 2 was indicated to be 66.1°F.

Thermal data were tape recorded throughout the flight until deactivation. The tape recorder is controlled by the on-board programmer; therefore, the tape recorder was never reactivated due to the command problem previously discussed. In general, the quality of the telemetry were excellent and no significant data processing problems were encountered due to poor signal quality. The volume of the data processed and analyzed is too bulky for presentation in this document; however, the appendix contains a condensation which is considered sufficient to describe the thermal environment experienced. Figure 1 lists temperature data as read during real-time [redacted] passes.

Since the publication of the J-1 flight report, laboratory experiments have effectively established the nature of a significant anomaly in the thermal instrumentation system, i.e., the phenomena of self heating of the BN2400 and TE3A temp sensors under flight electrical load conditions. This phenomena results in a false indication of higher temperatures than actually exist. The error for the BN2400 is a function of time under exitation voltage conditions, and the error for the TE3A is a linear function of the indicated temperature. J-1 instrument temp sensors were biased 10°F on the basis of observing an apparent bias in the data during ground tests without having an understanding of the cause of the anomaly. On the average, the self heating correction is between 5 and 10°F. All J-2 temp data presented in this report were corrected for the self heating phenomena according to the results of the previously mentioned lab tests; no other biases or corrections were applied.

Figure 2 contains plots of instrument number 1 temp sensor 4th power averages vs orbit number. These plots indicate the internal temperatures required until approximately orbit 12 to completely stabilize. Data recorded immediately following orbit injection indicated the maximum internal temperature experienced during the flight occurred approximately 35 minutes after launch, instrument temperatures reaching approximately 100°F. The average instrument temperature during orbit 24 was indicated to be approximately 77°F; the average station skin temp of barrel No. 2 was indicated to be 66.1°F.

The data processing technique used to arrive at $\overline{T}$, the average station temperature, requires some explanation. The technique is based upon expediency and approximation rather than thermal theory. The analysis problem centers on deriving a sine type curve of temperature vs angular skin location (θ) using only 4 points, the four operable number 2 barrel skin sensors. It was hypothesised that there existed an arc of a circle that would intersect the points of minimum and maximum skin temperatures and that normals to this arc would intersect points of equal skin temperature. This hypothesis, if accurate within required tolerances, would allow a simple linear curve fit of temperature vs α, the arc in radians. A computer program was written which accomplished a double iteration on R (the distance of the origin of the hypothetical circle from the vehicle center) and on ρ (defined as the angle of rotation of the line joining the hypothetical circle origin and the vehicle center from the reference axis of the vehicle) such that the minimum standard deviation of skin temp vs α could be obtained. The curve fit for the four J-2 barrel No. 2 sensors resulted in a standard deviation (σ) of 1.1°F, a ρ of 9.8 degrees, and the center of the hypothetical circle

[redacted]

4.75 barrel radii from the vehicle center. The value of σ was well within required tolerances. The curve of skin temp vs α is presented in figure 3. This linear equation was then transformed into the curve of skin temp vs θ which is presented in figure 4. The 4th power average of this curve is $\overline{T}$, a significant figure for evaluation of the thermal control system performance. A plot of the internal temp sensors vs α is presented in figure 5, the average temperature being approximately 77°F, which is within the flight objective tolerances.

A plot of internal temperature vs skin temperature parametric to α is presented in figure 6. The slope of this curve is 0.34 degrees internal temperature per degree of skin temperature. It is significant that essentially the same curve was obtained for J-1 as shown by figure 6. The repeatability of these two curves for two vehicles experiencing wide variance in temperature adds credence to this empirical relationship. However, additional flights are required for confirmation.

CLOCK PERFORMANCE

The operation of the clock appeared normal throughout the flight with the accuracy within the reading tolerance of the data which is considered to be $\pm$.02 seconds.

RECOVERY SYSTEM PERFORMANCE

A successful air-catch recovery of the first recovery system was made on 26 September 1963, orbit 49. All retro events appeared normal and within tolerance. Parachute events were derived from accelerometer data and are subject to interpretation errors. The condition of the recovery capsule was satisfactory, with damage limited to normal paint blistering. Figure 7 diagrams the location and temperatures encountered by the templates attached to the recovery system cover. A re-entry sequence of events is included in table 3.

Table 3

RE-ENTRY SEQUENCE OF EVENTS

Event	System Time	Delta Time	
		Actual	Nominal
Transfer	3502.29		
Electrical Disconnect	3503.10		
Separation	3504.27	1.98*	2.0 ± 0.25
Spin	3506.42	3.32**	3.4 ± 0.30
Retro	3513.99	7.57	7.55 ± 0.45
De-spin	3524.49	10.50	10.75 ± 0.54
Thrust Cone Separation	3525.94	1.45	1.5 ± 0.15
Voltage Monitor Closed			
Voltage Monitor Open			
"G" Switch Open	4008.77	482.83	
Parachute Cover Off	4042.22	33.45	34.0 ± 1.5
Drogue Parachute Deployed	4042.83	0.61	0.75 ± 0.08
Drogue Parachute Released	4052.67	9.84	10.05 ± 1.0
Main Parachute Deployed	4053.39	0.72	1.20 ± 0.15
Main Parachute Dereefed	4058.03	4.64	4.0 ± 1.7

* = Transfer to Separation.

** = Electrical Disconnect to Spin.

[redacted]

1163 J2 TEMPERATURE SUMMARY

Temp Sensor	Orbit								
Master Inst.	1	9	16	25	31	41	47	49	54
3	68	65	59	60	55	59	52	52	52
4	73	65	60	61	57	60	55	55	55
5	71	79	73	77	69	75	69	69	69
6	68	92	86	89	81	87	80	81	80
7	67	82	78	79	74	77	73	72	71
8	71	75	70	74	67	72	64	67	67
9	71	83	77	80	71	77	71	73	83
10	68	78	77	75	72	73	71	73	67
11	—	—	—	—	—	—	—	—	—
12	75	64	57	60	55	59	52	52	52
13	64	73	68	70	64	70	62	62	59
Slave Inst.									
3	67	90	87	87	83	86	83	80	84
4	70	87	80	85	77	83	83	78	78
5	67	80	72	78	70	76	69	70	71
6	64	71	66	70	64	69	64	64	62
7	68	87	83	84	81	83	79	79	83
8	68	78	71	75	69	75	69	69	69
9	70	66	71	75	69	65	59	57	57
10	67	80	78	78	75	75	73	74	69
11	64	75	76	75	74	75	71	73	69
12	73	85	81	85	78	82	83	80	78
13	74	80	86	80	83	80	78	78	83
No. 1 Cassette	92	58	48	52	49	53	48		
Fairing								Barrel No. 1	
1	—	8	43	8	37	68	27	—	—
2	—	-5	-7.5	-1	-11	-5	-11	32	24
3	—	38	44	38	41	34	38	171	93
4	220	47	50	47	47	40	40	160	50
5	223	75	92	66	85	57	76	123	59
6	235	67	121	64	116	55	102	—	—

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21 October 1963
Figure 1
Sheet 2 of 2

[redacted]

1163 J2 TEMPERATURE SUMMARY

	Orbit L	9	16	25	31	41	47	49	54
Barrel No. 2									
1	154	101	130	89	118	82	111	111	61
2	Fixed Resistor								
3	169	16	73	19	70	12	61	78	16
4	214	-5	-2	-2	-3	-3	-9	-4	-5
5	157	16	26.	19	26	16	23	20	-5
Thermal Shield at Agena Interface									
	157	77	121	77	117	71	108	117	61
Supply Spool									
*1	71	69	68	72	69	65	67	67	66
*2	69	71	71	74	70	67	67	67	68
Clock									
1	90	88	84	89	87	89	85	86	80
2	104	94*	90	91	91	93	87	90	80
Thrust Cone									
*1	—	94	41	43	39	40	37	54	53
*2	85	69	63	63	60	61	57	76	74
Stellar Index									
	84	48	45	43	45	47	42	48	53
Recovery System No. 2 Battery									
*	75	65	61	59	56	58	54	55	77

* = Temp sensors not biased for self heating

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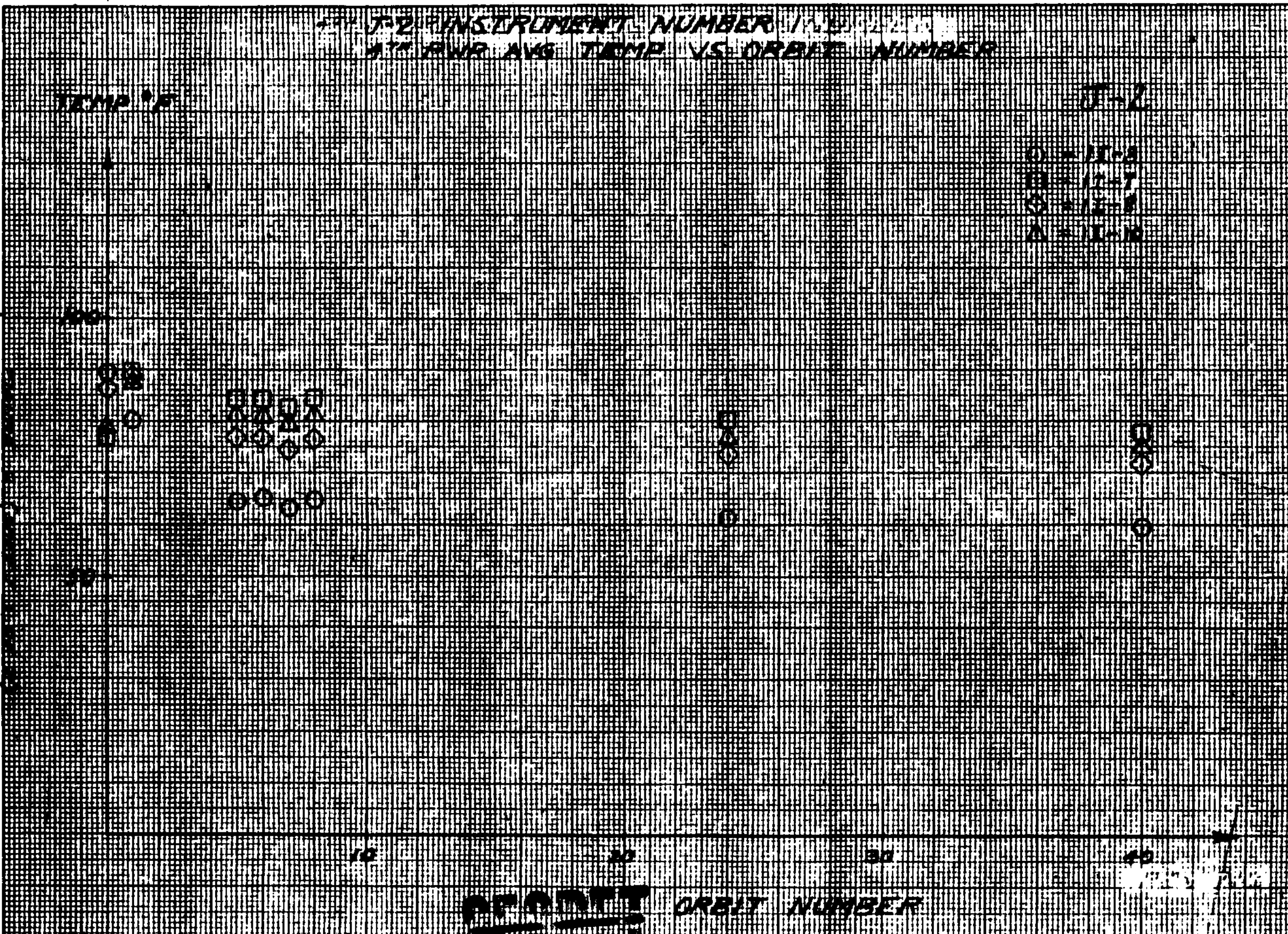

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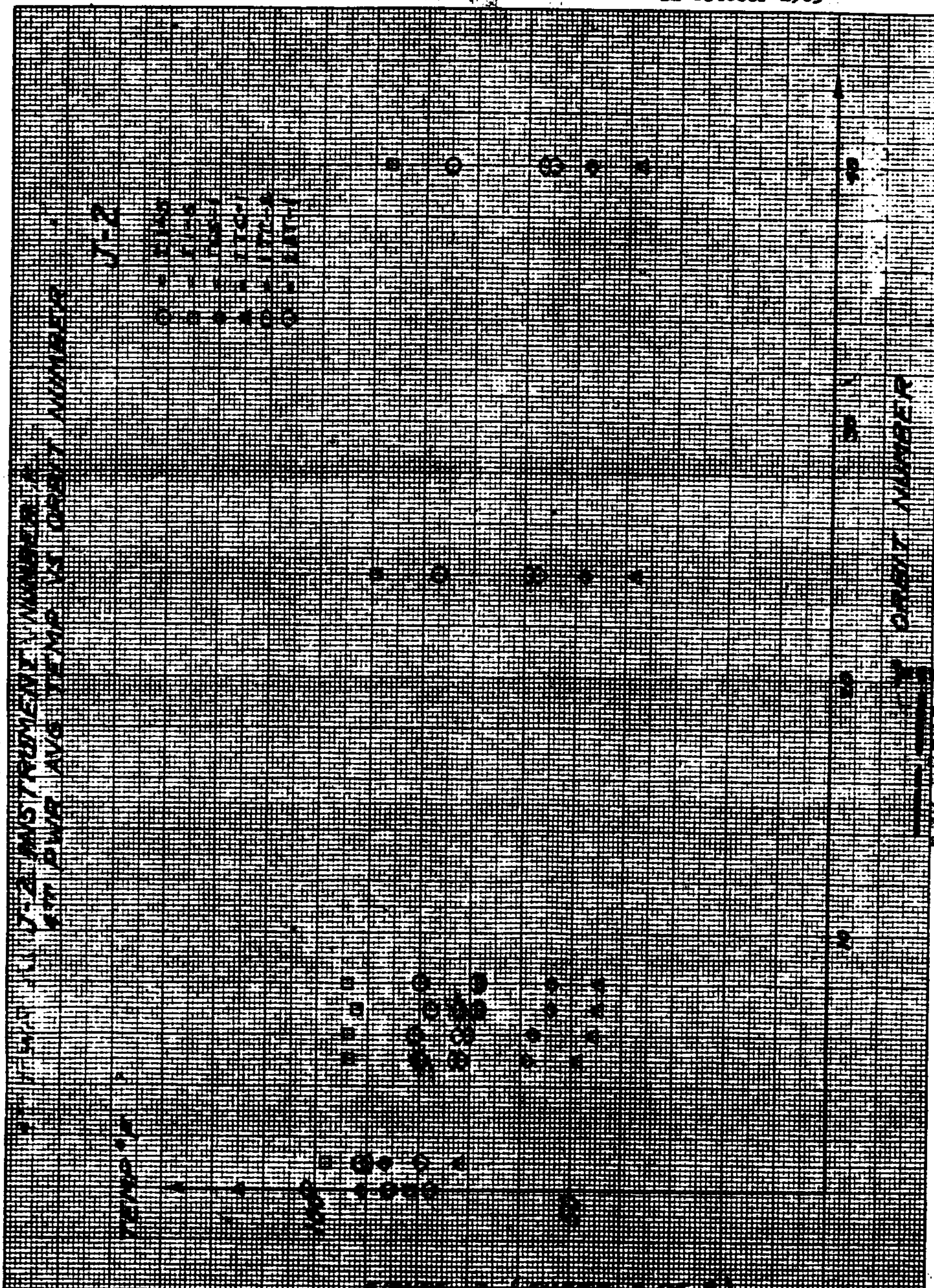
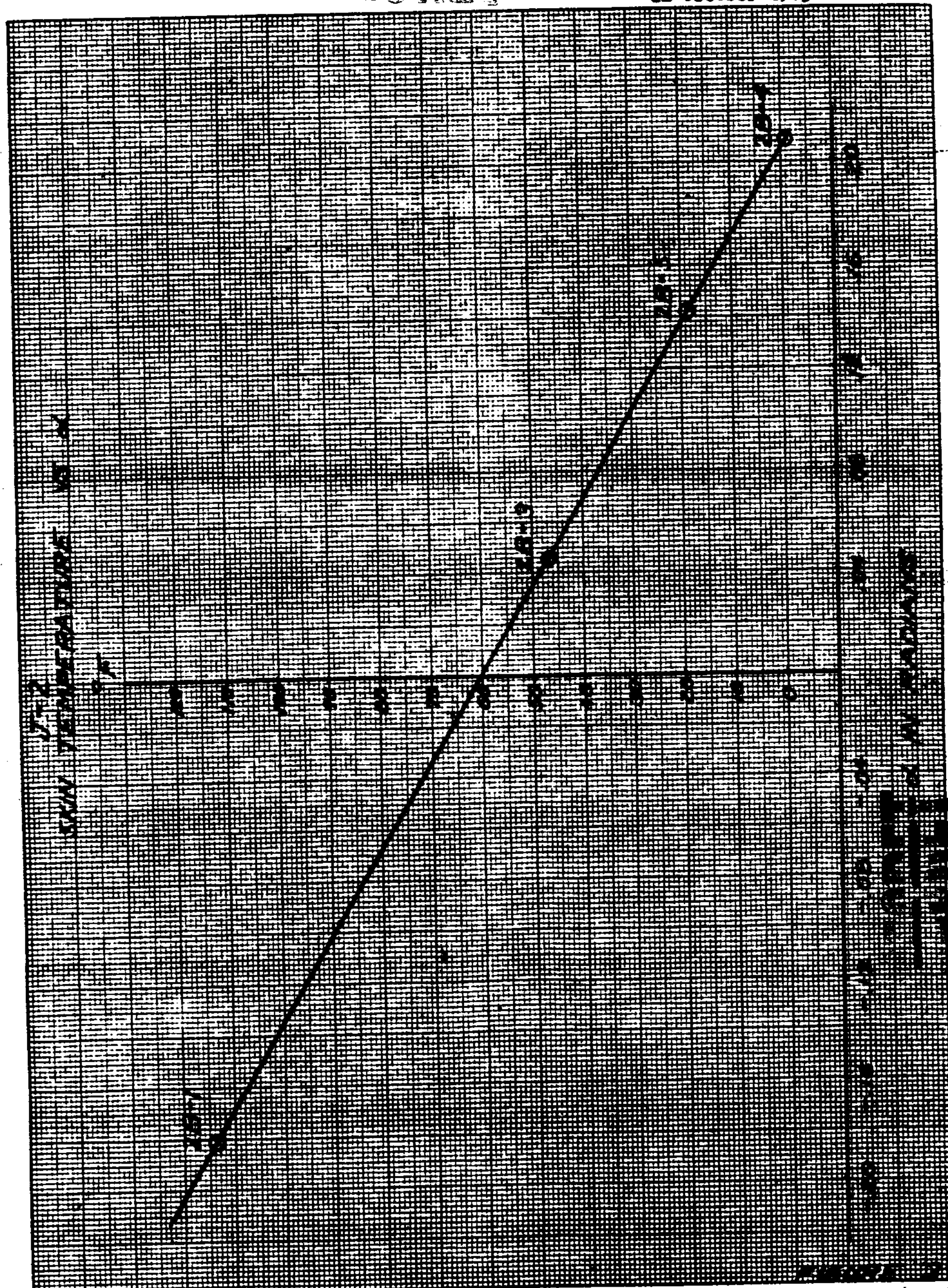
21 October 1963




T-2
SKIN TEMPERATURE VS α
°F
α IN RADIANS
LS-1
LS-2
LS-3
LS-4