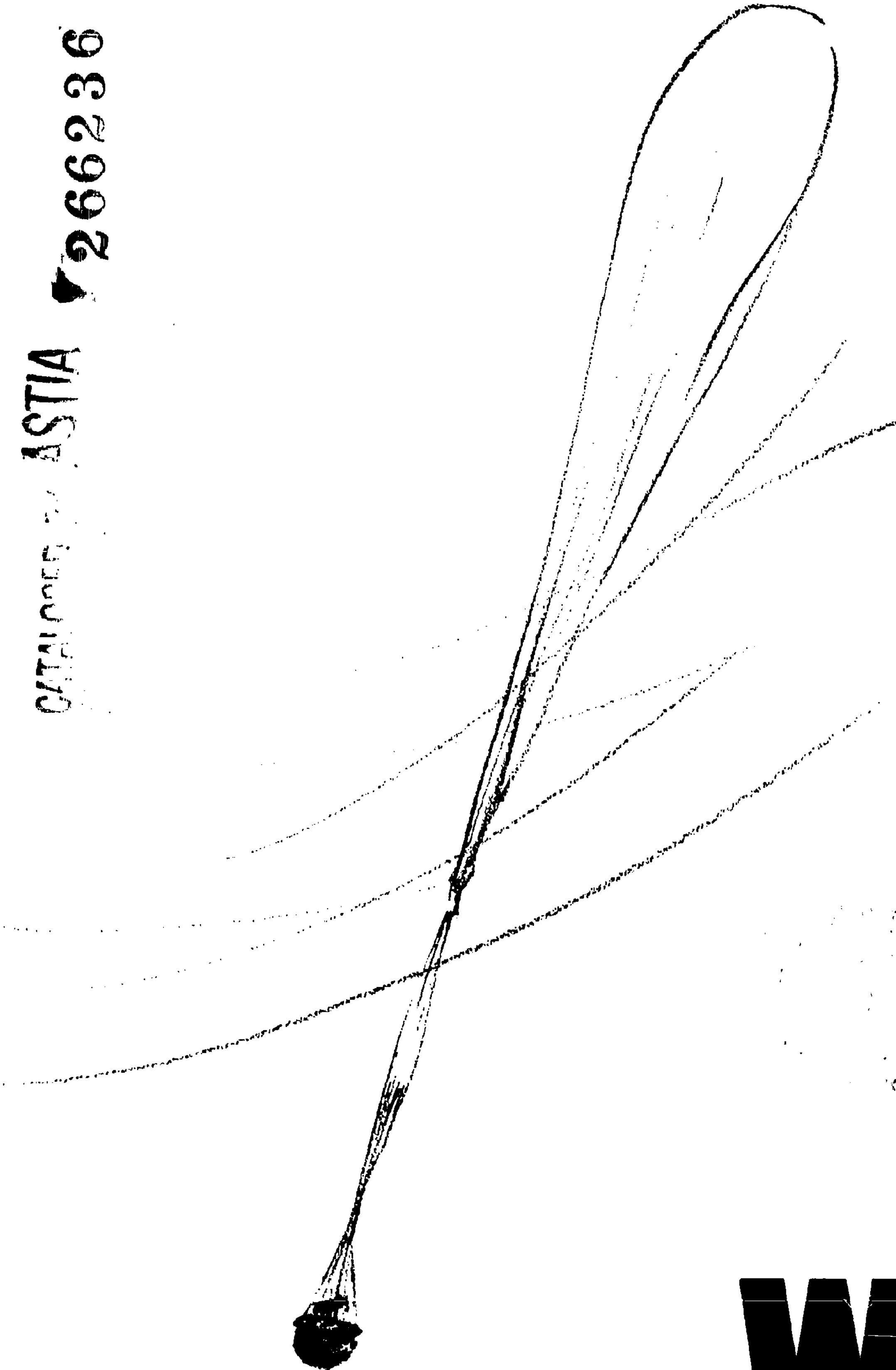
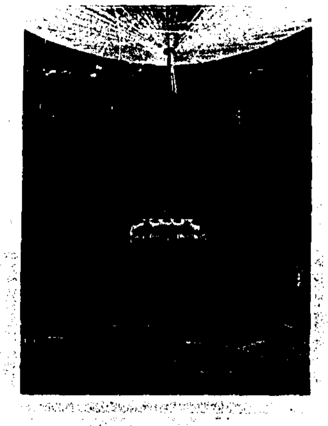
62-1-3
XON



WINZEN RESEARCH INC., MINNEAPOLIS 20, MINNESOTA

WRI



WINZEN
RESEARCH INC.

8401 LYNDALE AVENUE SOUTH
MINNEAPOLIS 20, MINNESOTA
TELEPHONE TUXEDO 1-5871

FINAL REPORT

STRATO-LAB OPEN GONDOLA - HIGH ALTITUDE OBSERVATORY BALLOON FLIGHT NO. 1

Report No. 1268-R

Submitted to: Office of Naval Research
Air Branch, Code 461
Department of the Navy
Washington, D. C.

Contract NONR 1460(12)

Prepared by: WRI Technical Staff

Approved by: O. C. Winzen

Date: 15 September 1961

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LIST OF ENCLOSURES

I. PREFACE

The plastic balloon has served for more than a decade as a vehicle enabling man to extend basic research related to the earth's atmosphere, to obtain near space conditions with manned sealed gondolas and to make astronomical observations unhindered by the earth's atmosphere.

The Office of Naval Research has supported, as one of its research programs, the role of the plastic balloon, in research. Its programs, designated Skyhook and Strato Lab, relate to the use of plastic balloons in research, the first to unmanned instrumented flights and the latter to manned flights. This flight was the eighth in the Strato Lab Series that reached the stratosphere, three of the previous being conducted in the two man sealed gondola (8 November 1956, 18 October 1957 and 26-27 July 1958). It was the second flight in an open gondola in which a scientist entered the stratosphere to make precise physical measurements.

The primary scientific objective of the flight was under the cognizance of the High Altitude Observatory, University of Colorado at Boulder, Colorado. The project scientist was Dr. Gordon Newkirk, under whose direction a special flying Coronagraph had been developed for use on the flight.

Winzen Research Inc. of Minneapolis, Minnesota, a pioneer in the fabrication of and conduct of flight operations utilizing plastic balloons, under contract to the Office of Naval Research, was responsible for the balloon system, launch and related operational aspects.

This report documents the flight, designated Strato Lab Open Gondola-High Altitude Observatory Flight #1.

II. ABSTRACT

The Strato Lab Open Gondola - High Altitude Observatory Balloon Flight #1 was launched at 0540 MST on 7 August 1959, from the Strato Bowl located near Rapid City, South Dakota. Commander Malcolm D. Ross, USNR was the pilot and Robert H. Cooper of the High Altitude Observatory, Boulder, Colorado was the scientific observer.

The primary objective of the flight was to measure the variation in sky brightness near the sun as a function of altitude to a maximum altitude of approximately 40,000 feet. Secondary objectives were (1) to obtain physiological data regarding the respiration, ekg and temperature of the flight crew during the flight, (2) to conduct performance evaluation tests of special exposure clothing provided by the U.S. Naval Supply Research and Development Facility, Clothing and Textile Division, and (3) to obtain data regarding the system stability and orientation control with respect to its suitability for use as an astronomical observation platform.

The flight trajectory was generally eastward throughout the entire duration. A floating altitude of approximately 38,000 MSL was maintained for three and one half hours. The landing was made near Milford, Iowa at 1425 MST. Total flight duration was eight hours and forty six minutes.

The operation of the Aerostat System was in general successful. Communication difficulties were encountered but they did not directly effect the astronomical observations. A change in the flight plan,

necessitated by weather conditions and difficulties with the scientific instrument, did limit the observing altitude to the ceiling floating altitude only.

This report is primarily limited to the Aerostat System and its performance with no attempt made in evaluating the scientific experiments.

III. SCIENTIFIC OBJECTIVES

The flight entailed the efforts of several personnel and organizations in combining in the one flight the various scientific objectives. The primary responsibility for the objectives and brief description follows. Detailed descriptions of the scientific objectives, procedures, and results will be covered under specific reports by the cognizant investigators.

A. SKY BRIGHTNESS

The primary scientific experiment and flight objective was that of measuring the variation in sky brightness near the sun as a function of altitude. This experiment was under the cognizance of the High Altitude Observatory of the University of Colorado at Boulder, Colorado. Dr. Gordon Newkirk of the Observatory Staff was the principal scientific investigator and Robert H. Cooper was the scientific observer.

The following information and description is as presented by the High Altitude Observatory in a fact sheet relating to the experiment.

Purpose of the Experiment

To measure the brightness of the sky radiance at small angles (from less than a half-degree to about three degrees) at various heights above the earth.

The sky radiance comes from (1) the atmospheric halo around the sun produced by dust, ice and other light-scattering material in the earth's atmosphere, and (2) from the solar corona.

The radiance measurements will give information about the number of scattering particles and their sizes for various heights above the earth. The solar corona can be expected to remain essentially constant during a given balloon flight.

The first flight will determine the feasibility of the method and the suitability of the equipment. If successful, it will also yield information at greater heights (up to 40,000 feet) than have been available for previous studies with such equipment (5,000 feet to 23,000 feet).

Later flights will determine whether atmospheric dust or other scattering particles exist at very high altitudes. This will indicate, for example, whether or not there is significant seeding of the atmosphere by meteoric dust from outer space. Further flights may also indicate whether there are increases in light-scattering particles at high altitudes on days following strong auroral displays or geomagnetic disturbances, and may thus assist in discovering if weather is influenced by cosmic phenomena, as some other researches at the High Altitude Observatory and elsewhere suggest.

Description of the Instrument

The instrument is a small solar telescope that makes an artificial eclipse of the sun, and then allows the halo around the sun to be photographed. The instrument is a modified coronagraph, and closely resembles a "vest pocket" version of the large solar telescopes of the High Altitude Observatory at Climax, Colorado, and of the Sacramento Peak Observatory at Sunspot, New Mexico.

The coronagraph is fitted to be carried to high altitudes in an open gondola balloon, and is suited for manual operation under extreme conditions of cold and altitude.

The original version of the instrument was designed at the High Altitude Observatory in 1946, by Dr. John W. Evans. The present instrument was perfected by Dr. Gordon A. Newkirk, Jr., who has planned the observing program and carried out previous ground-based researches with the instrument. It will be operated on the balloon flight by Mr. Robert H. Cooper, who has also assisted in preparation of the instrument for the flight.

The overall length of the telescope is 70 inches. The main lens is less than a tenth of an inch in diameter. The instrument is equipped with a shutter controlled by photocells to bar blinding light from the sun's face from the film if oscillations of the balloon cause the telescope to err in its aiming, and thus to fail in producing its artificial eclipse.

The artificial eclipse is recorded on 35 mm film in an automatic camera whose exposures are photoelectrically controlled.

The artificial eclipse photographs are to be made in red and blue light, and through polaroid filters.

The brightness of the sky halo to be photographed, after the balloon reaches stratospheric altitudes, will be comparable with the brightness of the full moon, and thus very much fainter than the brightness of the sun's face. The atmospheric halo can be expected to be, under average cloud-free stratospheric conditions, but a few millionths of the brightness of the sun's face.

B. EXPOSURE CLOTHING

The special exposure clothing was of particular importance with respect to allowing the flight personnel to perform their tasks under the adverse low temperatures encountered. The clothing was provided by the U.S. Naval Supply Research and Development Facility, Clothing and Textile Division, Brooklyn, New York. Lt. Commander John Anderson, Dr. Sydney Schwartz, and Mr. George Higginbottom were primarily responsible for the design and fabrication of this equipment.

The unique design of the clothing featured two layers of rubberized fabric, so arranged that a spring-like plastic spacer held the two layers apart. Both surfaces of the rubberized fabric had been coated with a thin aluminum film. At altitude the assembly worked in a manner somewhat similar to a thermos bottle. The aluminum film served to reflect the sun's heat in the daytime and at night it would serve to reduce the loss of radiant heat from the man.

Laboratory analysis had shown that the material had approximately the same insulation value as conventional woven or fur like material but with about one-half the weight.

C. PHYSIOLOGICAL DATA

Responsibility for obtaining the physiological data was under the command of Captain Norman L. Barr, USN and Project RAM Personnel of the Naval Medical Research Institute, U.S. Naval Hospital, Bethesda, Maryland. Instrumentation included means of sensing certain physiological data and automatically transmitting it to the tracking Navy R5D aircraft for monitoring and evaluation.

D. AEROSTAT SYSTEM STABILITY

The system stability study was under the cognizance of Dr. Sidney Reid, Office of Naval Research, Physics Branch and Jarus Quinn, Catholic University, consultant to Winzen Research Inc.

Photographic means were employed to record the rotational motion of the gondola and the normal differential motion between the gondola and balloon and the change, if any, when the orienter was used.

IV. BALLOON SYSTEM DESCRIPTION

The basic requirement of the balloon system, a capability of carrying two flight personnel and their associated scientific equipment to an altitude of approximately 40,000 feet, were established by the primary scientific objective. To meet the requirements, an open gondola balloon system was utilized, a basic system used in several previous occasions to conduct scientific experiments and balloon pilot training. Simply, the system consists of a gondola suspended by means of a parachute from the balloon. The complexity of the integrated systems has varied according to requirements. The following is a description of the system used for this flight.

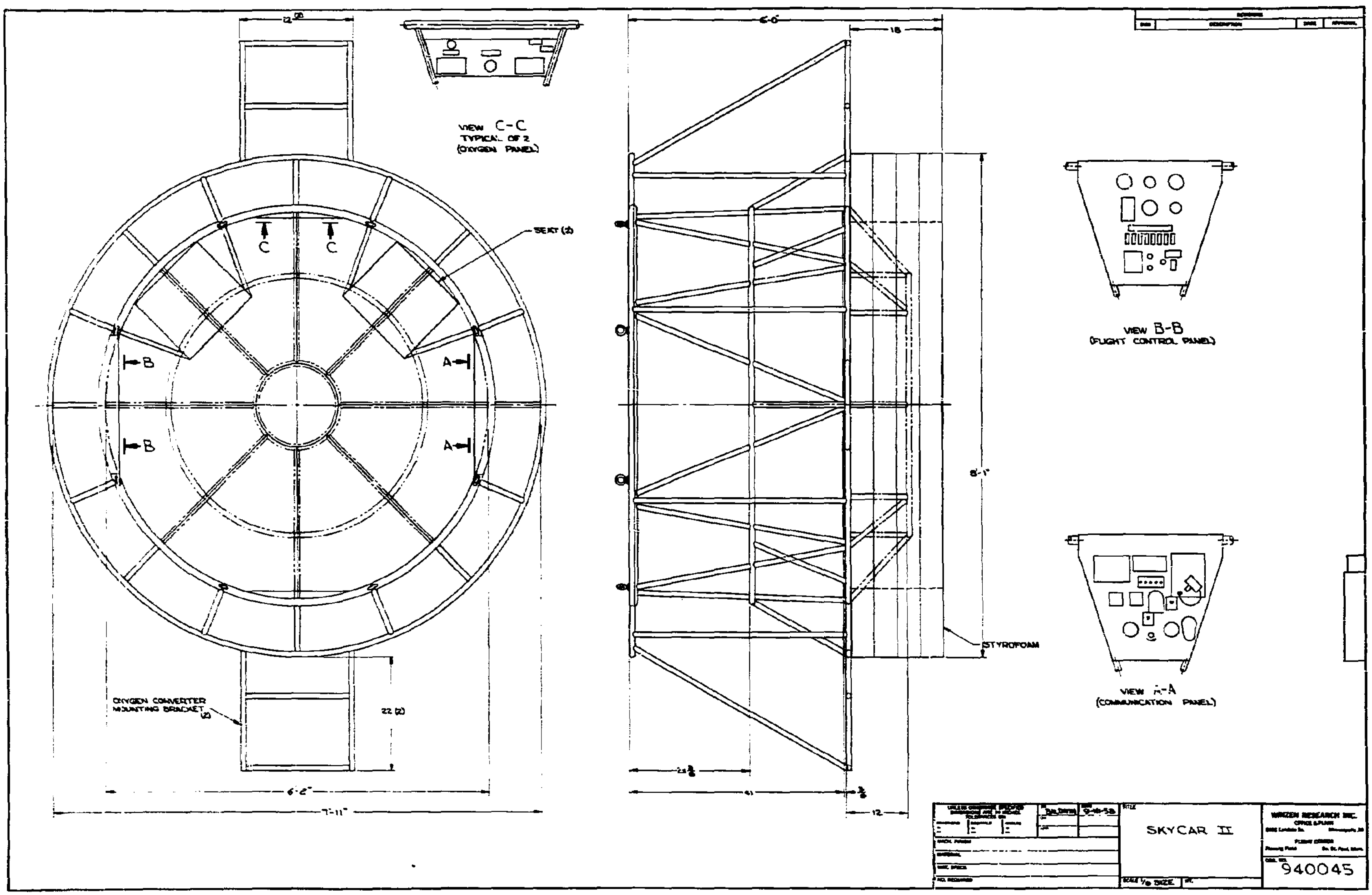
A. OPEN GONDOLA

A Winzen Research open gondola designated Sky Car II was used. The gondola is equipped and instrumented for conducting flights to approximately 40,000 feet with a crew of four.

The basic gondola structure is shown by Drawing No. 940045. The inner frame-work is of steel aircraft tubing, the outer frame forming the maximum eight foot diameter is aluminum. The under-carriage is in the form of a circular ring, constructed from styrafoam.

Instrumentation and equipment included as an integral part of the Sky Car for this flight is as follows:

1. Flight Instruments.
   a. Altimeter


VIEW C-C
TYPICAL OF 2
(OXYGEN PANEL)
SEAT (2)
VIEW B-B
(FLIGHT CONTROL PANEL)
VIEW A-A
(COMMUNICATION PANEL)
STYROFOAM
OXYGEN CONVERTER
MOUNTING BRACKET (2)
22 (2)
6'-2"
7'-11"
6'-0"
18
8'-1"
41
12
SKYCAR II
WINZEN RESEARCH INC.
940045

b. Rate of climb indicator.

c. Clock.

d. Compass.

e. Cosim Variometer.

f. Thermometer.

g. Recording Barograph.

2. Communications.

The gondola was equipped with VHF for primary communications, an intercom system for use while the crew was wearing oxygen masks and a tape recorder. The normal VHF frequency was 122.8 mc with an emergency frequency of 1710 KC provided for CW operation. Normal operation of the VHF at altitudes not requiring oxygen masks was by means of a hand mike and speaker. A push-button switch allowed for VHF transmission when wearing oxygen masks. The intercom system was for use with the oxygen equipment. It was designed so that all VHF transmissions overrode the intercom system.

The dictet tape recorder was arranged to record all transmissions when turned on, both VHF and intercom. It was controlled by a foot switch and push-button station.

3. Oxygen System.

The oxygen system consisted of a standard automatic pressure demand system with facilities for four personnel.

Oxygen for the system is normally supplied from two 20 liter liquid oxygen converters, for this flight one converter had been replaced by two 514 inch^3 high pressure gaseous oxygen bottles. The regulators and controls were located on two panels and so situated that a regulator was adjacent to each seat.

The main components comprising the system are as follows:

Component	Type
Oxygen, regulator, automatic pressure demand	A-2
Converter, Oxygen, aircraft liquid to gaseous	MA-1
Oxygen Masks	MS-22001
Electrical heater, oxygen mask	P-66A 3

4. Power System.

The primary power was furnished by four 12 volt packs. Each pack consisted of two Rebat R 33 lead acid batteries connected in parallel. An emergency power supply was provided with Yardney LR 100 batteries. The total system capacity was 300 ampere hours, 220 ampere hours from the primary supply and 80 ampere hours from the emergency supply.

In addition, one 12 volt supply and one 6 volt supply were provided from silver cells for use with the experiments.

The lead acid batteries were rigged with parachutes and mounted in the gondola under-carriage by means of explosive bolts for use as ballast.

All silver cell packs were mounted in the storage space of the gondola.

B. AEROSTAT

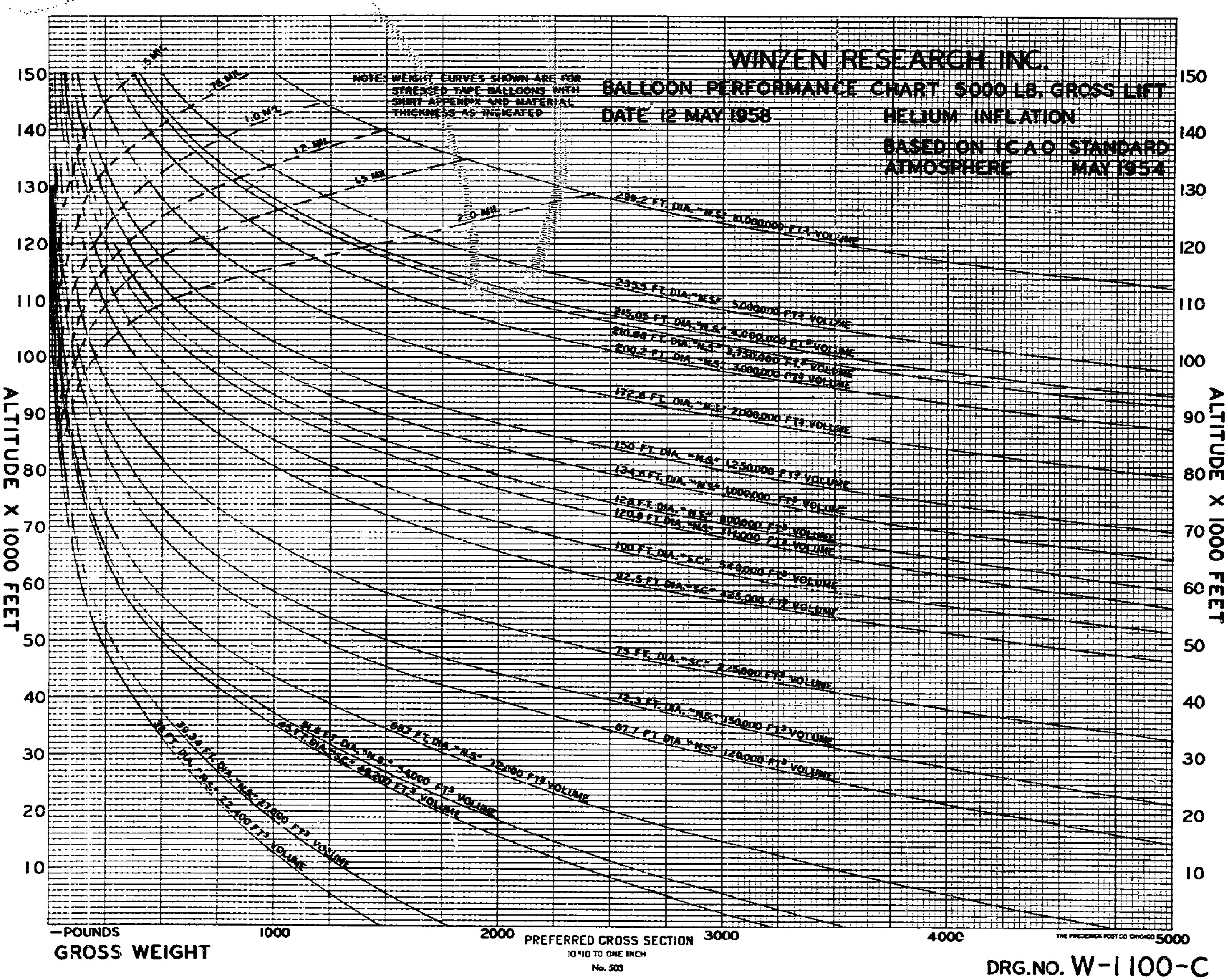
The size of the required balloon was dictated by the altitude and payload requirements. A maximum altitude of approximately 40,000 feet was required with an estimated gross load of 2,500 pounds. To meet these requirements, a standard WRI 72.3 foot diameter balloon with an inflated volume of 150,000 cubic feet was used.

The balloon and its performance curve are shown on Drawings No. W-1100C and 475340. From the performance curve it can be seen that the theoretical altitude with a gross airborne weight of 2,500 pounds is 39,600 feet MSL.

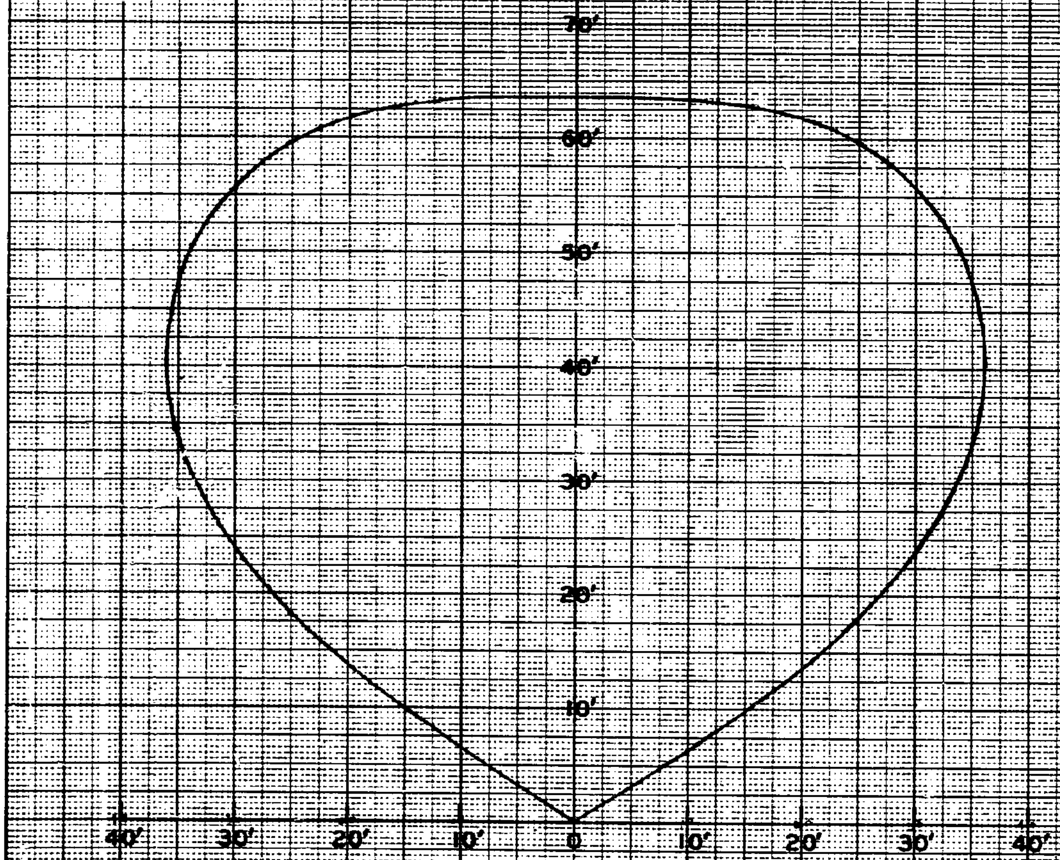
C. SUSPENSION SYSTEM

The standard technique of utilizing the main safety parachute in an extended condition as part of the suspension system was used in this flight. The complete system is illustrated by Drawing No 475537.

The parachute was a 70 foot diameter flat canopy with alternate orange and white gores of 1.1 ounce rip stop material with 96 shroud lines of 550 pound test nylon. The shroud lines terminated at eight risers



DRG.NO. W-1100-C



DESIGN SPECIFICATIONS

NATURAL SHAPE	
$\Sigma = 0.15$	$5\lambda = 104'$
DIAMETER	72.3 FEET
VOLUME	150,000 FEET^3
INFLATED HEIGHT	63.55 FEET
DEFLATED LENGTH	104 FEET
NO. OF GORES	25
MATERIAL	VISKING DE-2500 "A" FILM-.002"
LOAD TAPES	30 (2) 500 LB TEST INTEGRAL LOAD BANDS
DESIGN PAYLOAD	250 LBS.
CONSTRUCTION	WRI "FIST" DESIGN
VALVE	14" DIA. ELECTRIC
LOAD	RING BASE
SUSPENSION	MULTIPOINT SUSPENSION
APPENDIX	DUCT - SINGLE - 49'-6" LONG
NOMINAL WEIGHT	225 LBS.

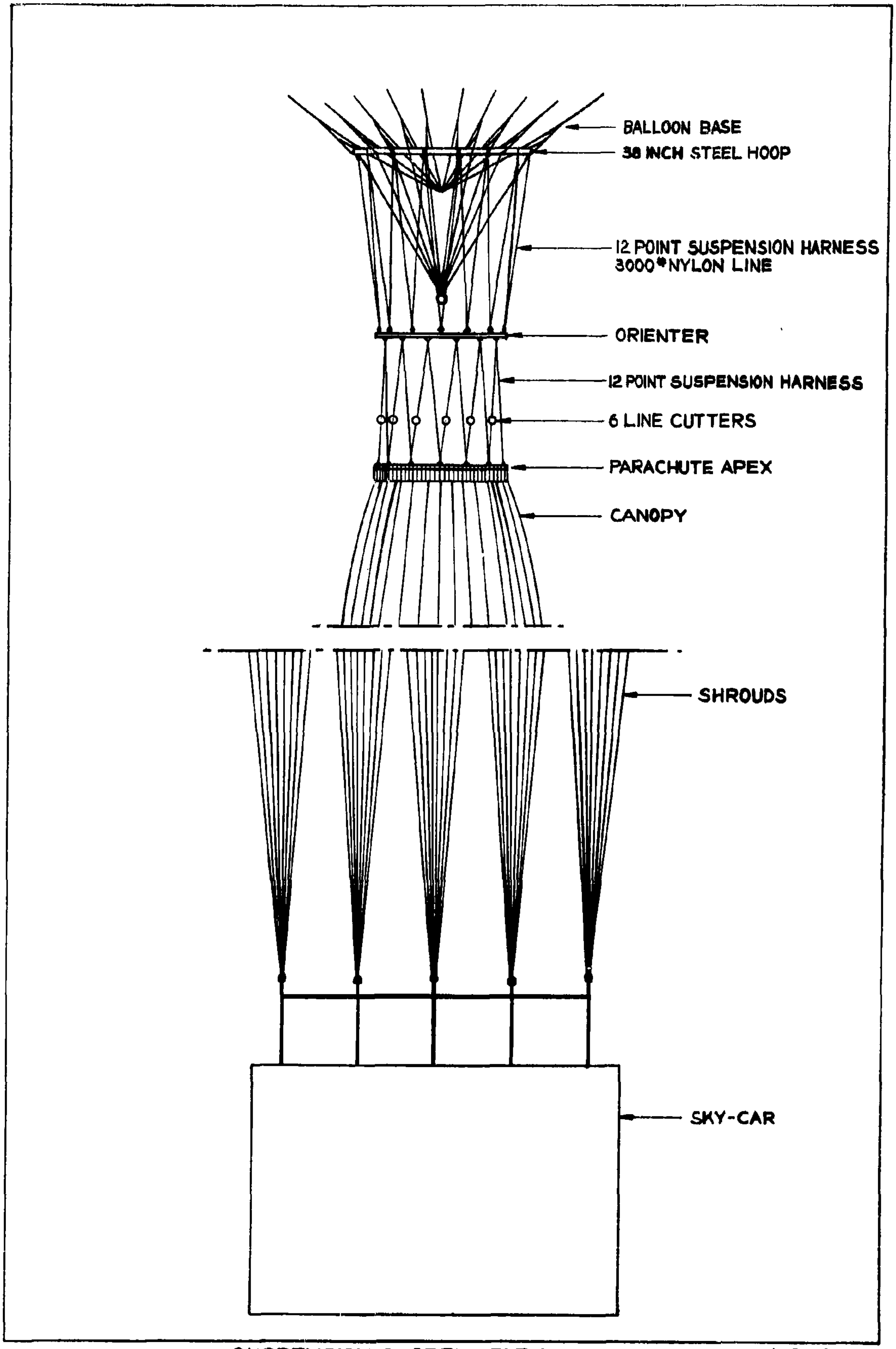
NOTE: NO BALLOON ACCESSORIES OR RELIEF VALVES SHOWN

WINZEN RESEARCH INC.

"SKYCAR" BALLOON

1 AUGUST 1959

DWG. NO. 475340



SUSPENSION SYSTEM FLT. 820

DWG. NO. 475 537

which in turn were attached to a harness of nylon webbing attached to the eight suspension points of the gondola. The parachute was modified to include a thirty inch diameter hoop at its apex to facilitate the formation and attachment of the multi-point suspension harness between the balloon and parachute.

Normally only one suspension harness is required; for this flight, to accommodate the orienter, two harnesses were required. Both were of 3,000 pound nylon line. The harness between the orienter and parachute included provision for severing the lines to separate the balloon at termination.

D. FLIGHT CONTROLS

Flight controls were provided for in the system which allowed the crew to control rates of rise and descent, altitude, azimuth orientation of the gondola, and flight termination. These controls were afforded by the following control measures.

1. Ballasting.

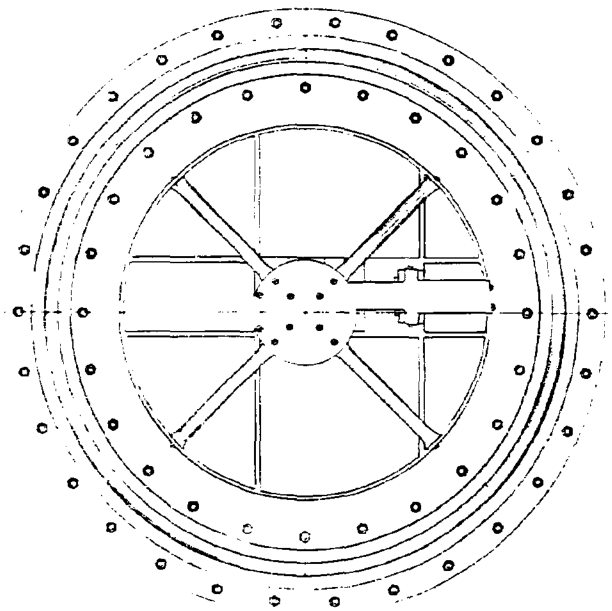
Ballast was available in the form of steel shot and the lead storage batteries of the power supply.

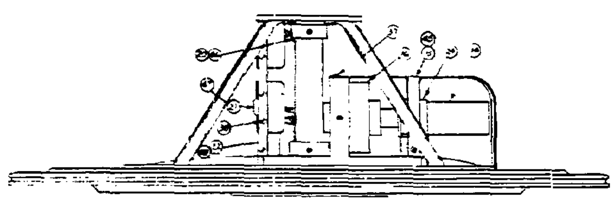
A total of two hundred pounds of steel shot was packaged in twenty five pound bags. The eight storage batteries gave an additional ballast capability of 240 pounds. Normally, only expended batteries would be released.

The lead batteries were packaged with individual chutes and mounted by means of explosive bolts on the underside of the gondola for remote control of their release. The release was affected by means of a selector switch to select the pack to be dropped, and a battery jettison switch to supply power to the explosive bolts retaining the battery.

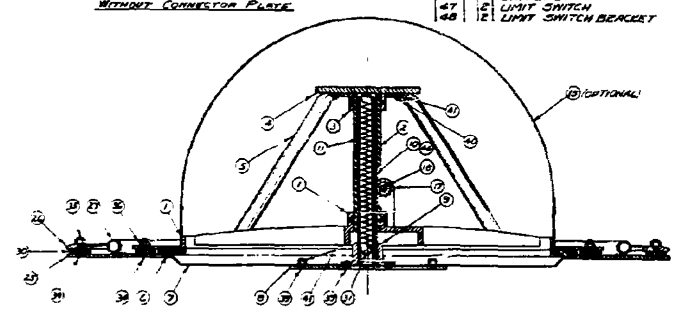
2. Apex Valve.

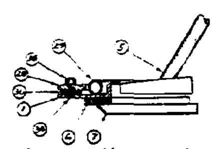
Valving of helium from the balloon was accomplished by means of the standard Winzen Research Inc. 14 inch diameter electrically operated valve located in the balloon apex (see Drawing No. 440401). The valve is operated by an electric motor and clutch arrangement in such a way that when power is supplied, the motor, driving through an electric clutch, opens the valve. At full open position a limit switch stops the motor and the valve is held open by the clutch until power is removed. Normal position of the valve is closed and it is held closed by spring action. In addition to the control switch on the pilots panel there are three indicator lights which show the valve position as closed, partially open or full open. The controls and power in the gondola were connected to the valve by means of an electric cable.





Notes:
* 1) Parts 25, 26, & 27 to Be Used Only With Connecting Plate Method of Attachment
† 2) Parts 28 & 29 To Be Used For Alternate Method Of Attachment Without Connecting Plate
3) Part 13 Rain Shield – Optional
4) Commercial Part – See Specification Control Dwrg. Before Ordering





Alternate Method of Attachment Without Connector Plate

Rev.	Description	Date	Approval
A	Redesigned & Redrawn	12-2-58	

PARTS LIST

Item	Quan. Standard Valve	Quan. Hermetically Sealed	Name	Drg. No.
1	1	1	Valve Frame Casting	440,501
2	1	1	Cylinder	383,563
3	1	1	Cylinder Flange	383,564
4	1	1	Cylinder Cap	383,565
5	4	4	Cylinder Cap Brace	383,566
6	1	1	Valve Gasket	383,556
7	1	1	Valve Diaphragm	383,557
8	1	1	Valve Diaphragm Backing	440,516
9	1	1	Valve Diaphragm Flange	383,559
10	1		Valve Spindle	383,560-1
11	1	1	Valve Spring	383,561
12	1	1	Valve Spring Anchor Pin	383,562
13	1		Hood	440,502
14	1	1	Motor	440,503
15	1		Motor Guard	383,571
16	1	1	Clutch	440,504
17	1	1	Pinion	440,505
18	1	1	Pinion Shaft	383,576
19	1	1	Pinion Shaft Bearing	440,506
20	1		Switch Cam	440,510
21	2		Limit Switch	440,511
22	2		Limit Switch Bracket	440,509
23	1	1	Terminal Strip	440,508
24	1	1	Motor Mount	383,572
* 25	1	1	Connecting Plate	443,503
* 26	1	1	Clamp Ring	443,505
* 27	1	1	Hoop	443,502
† 28	1	1	Clamp Ring	383,553
† 29	1	1	Hoop	383,552
30			Gasket, 1/16 x 1/2 Sponge Rubber	
31	1	1	Screw, 10-32 NF x 1 1/8 Round Hd. Mach	AN520-10-18
32				
33				-
34	56	56	Screw, 10-32 NF x 3/4 Flat Hd Mach	AN510-10-12
35	30	30	Stop Nut 10-32 NF	AN365-1032
36	26	26	Nut, Hex 10-32 NF	AN315-3
37	8	8	Screw, 6-32 NC x 1/4 Round Hd. Mach	AN520-6-4
38	4	4	Screw, 6-32 NC x 1" Round Hd. Mach	AN520-6-16
39	16	16	Screw, 6-32 NC x 3/8 Flat Hd. Mach	AN510-6-6
40	6	6	Screw, 6-32 NC x 7/16 Flat Hd. Mach	AN510-6-7
41	18	18	Stop Nut 6-32 NC	AN365-632
42				
43	1	1	Wiring Diagram	383,582
44		1	Valve Spindle	383560-2
45		1	Motor Guard	440515
46		1	Switch Cam	440513
47		2	Limit Switch	440514
48		2	Limit Switch Bracket	440512

Drawn	Boone 4-23-57
Checked	RMB 5-3-57
Approved	DLF 6-6-57
Mach. Finish	See Details
Material	"
Heat Spec.	"
No. Required	"
Title	ELECTRICAL APEX GAS VALVE ASSEMBLY
Scale	1/2
Dwg. No.	440,401

WINZEN RESEARCH INC.

440,401 A

3. Azimuth Orienter.

Azimuth control of the gondola was obtained by means of the orienter located in the suspension system as shown by Drawing No. 475537.

The orienter is shown by Drawing No.515401. It consists of two cast aluminum rings, one with a machined internal gear. Relative motion between the two rings is by means of an electric motor and spur gear mounted on one ring driving through the integral gear of the other ring. The load and rotation is transferred between the rings by means of cam followers.

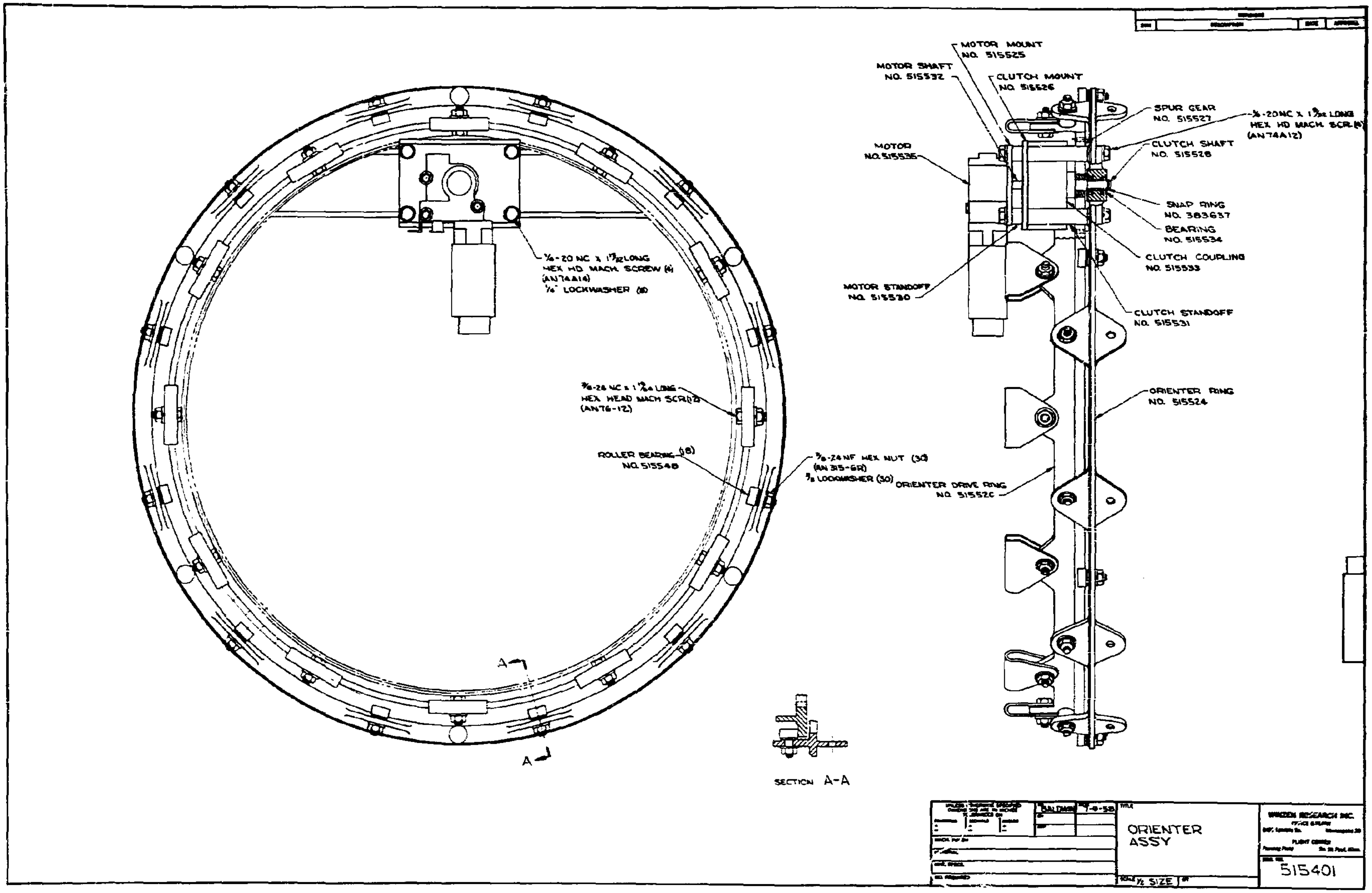
Direction of rotation was controlled by reversing the polarity of the applied voltage by means of relays. A pilot operated switch controlled the operation.

The orienter was designed so that the rotation of the lower ring and hence the gondola, was against the inertia supplied by the balloon to the upper ring,

4. Termination.

Separation of the parachute from the balloon is accomplished by severing the suspension harness line between the parachute and orienter. Six electrically fired squib operated line cutters are used to sever the line.

The operation of the cutters is controlled by two pilot operated switches, one a hooded toggle switch to arm the circuit and the


MOTOR MOUNT NO. 515525
MOTOR SHAFT NO. 515532
CLUTCH MOUNT NO. 515526
SPUR GEAR NO. 515527
1/4-20NC x 1 9/32 LONG HEX HD MACH. SCR.(4) (AN74A12)
MOTOR NO. 515535
CLUTCH SHAFT NO. 515528
SNAP RING NO. 383637
BEARING NO. 515534
CLUTCH COUPLING NO. 515533
MOTOR STANDOFF NO. 515530
CLUTCH STANDOFF NO. 515531
1/4-20 NC x 1 9/32 LONG HEX HD MACH. SCREW (4) (AN74A14) 1/4" LOCKWASHER (8)
3/8-24 NC x 1 7/64 LONG HEX HEAD MACH SCR.(12) (AN76-12)
ORIENTER RING NO. 515524
ROLLER BEARING (18) NO. 515548
3/8-24NF HEX NUT (30) (AN 315-6R) 3/8 LOCKWASHER (30)
ORIENTER DRIVE RING NO. 515520
A
A
SECTION A-A
ORIENTER ASSY
1/2 SIZE
WINZEN RESEARCH INC.
515401

second a push button switch in series to fire the cutters.

E. FLIGHT INSTRUMENTATION

A standard Winzen Research Inc. Altitude Beacon was included to provide telemetered altitude data. A bellows transducer moves a contact finger on a rotating drum to give altitude as a Morse coded CW signal. The transducer is calibrated against the standard ICAO atmosphere and has a resolution of plus-minus 500 feet at 90,000 feet.

A timer controlled switch is contained in the unit which periodically keys the transmitter to give a steady carrier for D.F. purposes. The unit was modified so that the flight crew could use the transmitter as an emergency channel for CW operation on a frequency of 1710 KC.

V. FLIGHT OPERATIONAL REPORT

A. OPERATIONAL PLAN

I. GENERAL INFORMATION

1. The primary objective of the operation is to safely conduct a manned balloon flight from the Stratobowl (near Rapid City, South Dakota) about 1 August 1959 carrying a Flying Coronagraph for the High Altitude Observatory, Boulder, Colorado. Winzen Research Inc. will conduct the flight under contract with the Office of Naval Research. Flight personnel will consist of Commander M.D. Ross as pilot and Mr. R.H. Cooper as operator of the Coronagraph. Secondary purposes of the flight include the collection of physiological data and test data on the motions during flight and general compatibility of the system for conducting the primary measurements.

2. Participating personnel and responsibilities are as follows:

   a. Cmdr. M.D. Ross - Pilot

   b. O.C. Winzen - Balloon, gondola, launch and recovery
      Donald L. Foster - WRI Project Engineer

   c. Mr. R.H. Cooper - Coronagraph operation

   d. Dr. N.L. Barr - Collection of physiological data and flight safety

e. Dr. Gordon Newkirk - Principal scientific investigator

f. Cmdr. R.M.J. Halman - Represent the ONR scientific officer

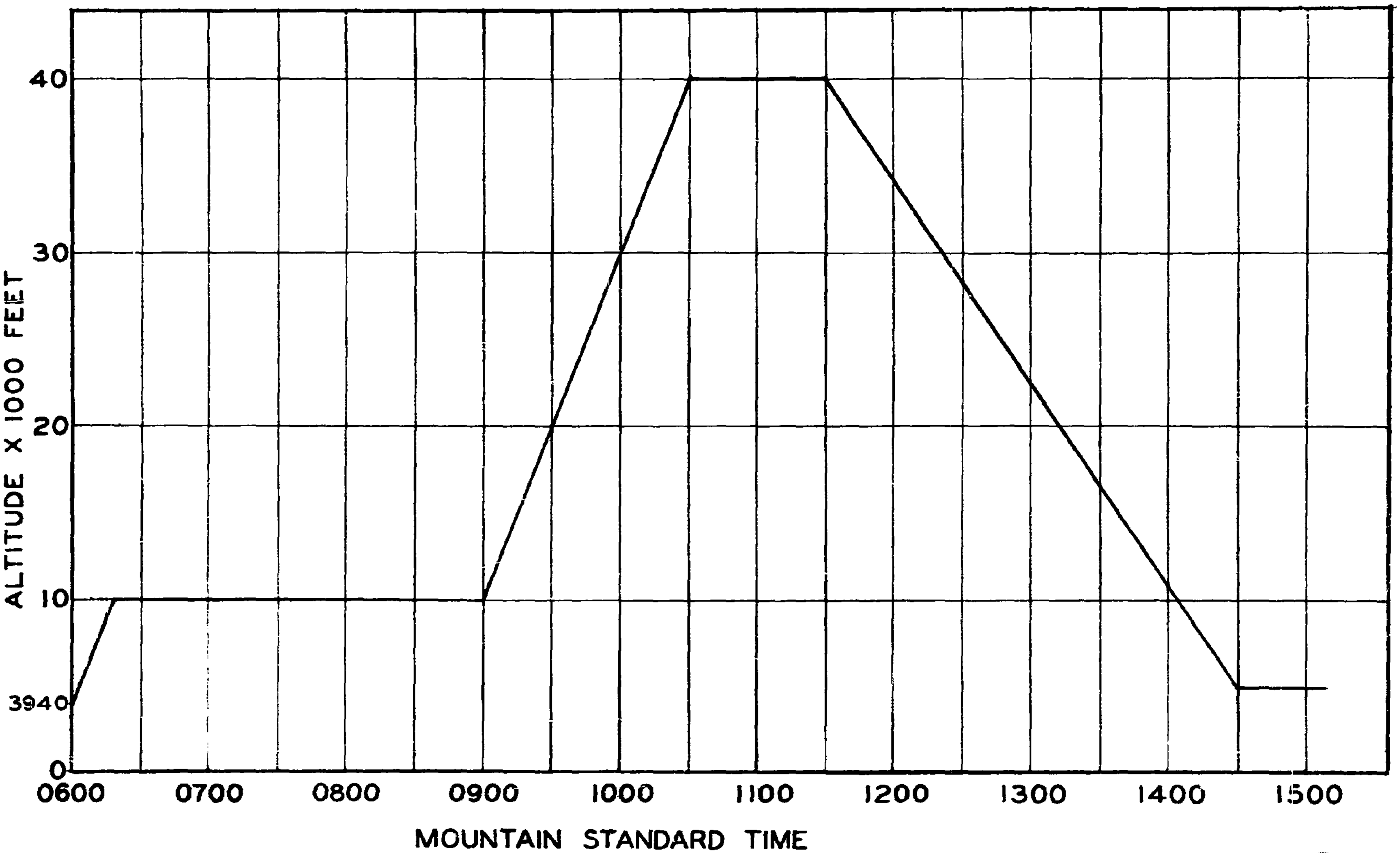
g. Cmdr. J.W. Sparkman - Flight coordination

h. Lcdr. R.J. Mumford - Technical information officer

3. It is anticipated that the flight profile as shown will result in a landing 300 - 350 miles ESE of Rapid City (see Drawing 475341).

4. A primary consideration governing the launch will be the anticipated landing area. The enclosed chart depicts the suitability of various areas for landing. An outline of these areas will be marked in the atlas for the R5D, gondola and Apache. (See Drawing 475342).

WINZEN RESEARCH INC.
FLIGHT PROFILE
SKYCAR FLIGHT
1 AUGUST 1959



ALL ALTITUDES AND
TIMES APPROXIMATE

DWG. NO. 475341

WINZEN RESEARCH INC.
LANDING AREA
SKYCAR FLIGHT
1 AUGUST 1959

SCALE: 1" = APPROX. 65 MILES

DWG. NO. 475342

II. TRANSPORTATION INVOLVED AND PERSONNEL ASSIGNED

1. R5D - Command Post (Radio call NCA-36)

Capt. N.L. Barr
Lcdr. G. Baker
Lcdr. D. Smith
Carlile, ET 1/c
Williams, HM 1/c
Gilbert, Mechanic
Savage, Radioman

O.C. Winzen
Dr. Gordon Newkirk
Cdr. R.M.J. Halman
Cdr. J.W. Sparkman
Capt. Newsom

2. Navy Ambulance (Radio call NCA-39)

Croucher, HM 1/c
Cdr. Sanborn

3. Navy Station Wagon (No communications)

Larkin, DM 1/c
Chief Kelly

Koukas
Simpson

4. ONR Truck (Radio Call NCA-35)

Evanick, AGC
D. Foster, WRI

Cmdr. Mumford
Miles, PRC

5. Apache Aircraft (Radio call NCA-34)

G. Hovland
S. Kela
Ed Lewis

6. WRI Stake Truck (Radio call NCA-32)

Paul Peterson
LeRoy Johnston

7. Gondola (Radio call NCA-38)

Cmdr. M.D. Ross
Mr. R.H. Cooper

III. FLIGHT OPERATION

1. Pre-Launch

It is anticipated that all equipment will arrive in Rapid City by 30 July. Installation and checking of equipment will be done on 30 and 31 July. At 1000 Friday, 31 July, a general operations conference will be held at the C of C building in Rapid City. All personnel involved should be present at this review of assigned duties. With favorable weather conditions the flight will be launched on Saturday, 1 August.

The flight trajectory will be determined daily by E.F. Lewis based on meteorological data available from Ellsworth Air Force Base and the U.S. Weather Bureau, Rapid City. At 2030 each evening beginning 31 July a meeting will be held at the motel, Room 27, with the following: Cdr. Ross, Mr. Cooper, Dr. Newkirk, Capt. Barr, Cdr. Halman, Cdr. Sparkman, Mr. Winzen, Mr. Foster and Mr. Lewis. At this time the local forecast and trajectory will be considered with respect to a launching the following morning.

Vehicle drivers should be available immediately after the meeting for the possibility of departure to down-wind positions or other final instructions. All vehicles not required at down-wind positions will be in the Stratobowl at launch.

At 2400 MST prior to launch at 0500, all ground operations personnel will be called out, and each shall eat and be ready to move to the Stratobowl at 0130. Arrival at the Stratobowl shall not be later than 0200. The following schedule is anticipated after arrival at the Stratobowl:

0200	Fill O_2 system
	Complete pre-flight check
0230	ONR truck pick up pilots
0300	Pilots arrive Stratobowl and begin pre-flight procedures
0300	Lay out balloon
0330	Begin inflation
0430	Inflation complete
0445	Crew in Sky-Car and pre-flight checks completed
0450	Communications check with Apache, ONR truck, and stake truck
0455	Free lift weigh off
0500	Launch

2. During launch and initial ascent, the Apache will be airborne in the vicinity of Stratobowl and be available to direct Navy ambulance and ONR truck to the scene in emergency.

Immediately after launch, personnel assigned to the R5D will depart via Navy station wagon and available commercial vehicles to the Municipal Airport or Ellsworth Air Force Base at Rapid City. After the R5D is airborne and communications established with the gondola and Apache, the coordination of all vehicle movements will be done under the direction of Cmdr. Sparkman from the R5D. At this time the Apache will land at Rapid City Municipal Airport, pick up E.F. Lewis and when airborne assume the duties of a secondary command post in case of the inability of the R5D to remain in radio contact with the gondola.

3. Under normal operations the following will be the assigned duties of each ground vehicle:

a. Navy Ambulance

Provide medical assistance at landing site.

b. Navy Station Wagon

As directed by Cmdr. Mumford

c. ONR Truck

Maintain listening watch on 122.8 mc and 6700.5 kc and assist at landing.

d. WRI Stake Truck

Recovery and return gondola to plant. Stake truck will keep WRI plant (phone TU 1-5871, Minneapolis) informed of the progress of the flight. These reports will be made hourly (15 minutes prior to the hour) by telephone.

Units having communication difficulties may obtain information by calling the WRI plant collect - Minneapolis, Tuxedo 1-5871, mentioning flight number 820.

IV. LANDING AND RECOVERY

1. During the latter portion of the flight, the latest wind data will be obtained by personnel aboard the R5D and the balloon pilot will be kept advised of the most practicable landing area. The Navy ambulance and the ONR truck will make every effort consistent with safety to be present at the landing site. After a normal landing, flight personnel will remain with the gondola until ground personnel have arrived.

2. As soon as ground personnel arrive at landing site, the gondola crew will be transported via Navy ambulance and/or ONR truck to the R5D for further transportation to Minneapolis.

V. COMMUNICATIONS

1. The gondola is equipped with intercom, VHF and provisions for keying on 1710 in emergency. Normally the flight personnel will be on intercom with the ability to transmit (VHF) by pushbutton. VHF transmissions from aircraft or vehicles will override the intercom in the gondola. Each half hour the pilot will report to the command post the:

a. Time

b. Altitude

c. Ambient air temperature

d. Oxygen content

e. Physical condition

f. Miscellaneous data if appropriate.

Under routine conditions, transmissions will be made only by the gondola and the command post, with other vehicles maintaining a listening watch on the gondola frequencies. When routine half-hourly reports are not received, the Command Post will initiate contact with the gondola. Information from the gondola should be recorded by all stations within range. Scientific data sheets are to be used for logging experimental information transmitted from the gondola.

2. Primary communications between the gondola and other units will be on 122.8 mc and emergency communications

will be on 121.5 mc voice and 1710 key. Normal communications between tracking vehicles will be on 6700.5 kc.

3. Available units cover the following frequencies:

Description	Call	Transmit and Receive	Receive Only	Transmit Only
WRI Plant	NCA 31	122.8 MC 121.5 MC 6700.5 KC	1710 KC	
WRI Stake Truck	NCA 32	122.8 MC 121.5 MC 6700.5 KC	1710 KC	
WRI Apache	NCA 34	122.8 MC 121.5 MC 6700.5 KC	1710 KC	
ONR Truck	NCA 35	122.8 MC 121.5 MC 6700.5 KC	1710 KC	
R5D Aircraft	NCA 36	122.8 MC 121.5 MC 6700.5 KC	1710 KC	
Gondola	NCA 38	122.8 MC 121.5 MC		1710 KC beacon and key
Navy Ambulance	NCA 39	122.8 MC 121.5 MC		

VI. SCIENTIFIC OBJECTIVES AND PROCEDURES

The flight has one primary scientific objective and two secondary objectives. The primary scientific objective is under the cognizance of personnel of the High Altitude Observatory of the University of Colorado, Boulder, Colorado. The aim will be to use a special Flying Coronagraph to make measurements of the variation in sky brightness near the sun as a function of altitude. Secondary obejctives will be to acquire system data and physiological information from the flight personnel.

1. Primary Experiment and Procedure

Project scientist for the High Altitude Observatory is Dr. Gordon Newkirk. Under his direction a special Flying Coronagraph has been developed for use on the flight. Robert H. Cooper, also of the High Altitude Observatory staff, will be the flight scientist and make the measurements aloft.

The instrument is essentially a sky photometer which subtends a solid angle of about 6 degrees. Coronagraph optics are utilized with an occulting disc which has a diameter of about 38 minutes of arc. Since the solar disc has an angular diameter of about 31 minutes of arc, it is then possible, with the disc in place and the photometer pointed at the sun to obtain brightness photographs of the solar aureole. At the same time each exposure is calibrated by means of a step wedge with full sunlight for film exposure.

It is planned to obtain photographs of the solar aureole in the lower stratosphere at the maximum flight altitude of about 40,000 feet, then to obtain as many additional exposures at lower altitudes as time, rate of descent, and rotational capability will permit. Exposure times will vary with altitude, and it is estimated that exposures from 2 to 8 minutes may be necessary at 40,000 feet with exposures in the order of seconds at the lowest altitudes.

The Flying Coronagraph is mounted with a yoke on a gimbal and has a simple manual drive mechanism so that the flight scientist has about a 60 degree azimuth orientation capability without orienting the gondola with respect to the sun. His procedure will be to aim the instrument at the sun and make acquisition by observing the solar image on a ground glass screen with cross hairs. When the image is in proper position the shutter is automatically opened by photoelectric means. An audible tone will be transmitted to the flight scientist and an external light will turn on. The latter can be seen by both flight personnel.

Time, altitude, exposure number and exposure duration are then logged and subsequently will be reported by radio. The flight observer will then maintain the proper instrument position by watching the image on the ground glass screen. When the exposure is completed, time, altitude, exposure number and exposure duration are again logged and reported by radio. The above procedure will be repeated for each exposure obtained.

2. System Test Experiment

Photographic means will be employed, under the direction of Winzen Research Inc. personnel, to acquire data descriptive of the system motions while airborne. One K-100 camera will be directed toward the ground with a plumb bob in the field of view so that rotational motion of the gondola will be recorded. A second K-100 camera will be mounted to look up and view the balloon and parachute suspension to record the differential motion between the balloon and gondola. The cameras described will be operated automatically in time-lapse fashion at a rate of 8 frames per minute.

A third K-100 camera, also looking up, will turn on automatically when the orientation control system is operative and will take time-lapse photographs at the rate of 20 frames per minute. Its field of view will be the same as camera #2, thus it will operate as a photographic clock to observe system changes which may occur when the orienter is in use. The latter is a simple ring gear, motor driven, mounted between the balloon and cargo parachute, ~~and will be operated by the pilot.~~

3. Physiological Experimentation

As in previous STRATO-LAB flights, all medical aspects are under the supervision of Captain Norman L. Barr, MC, USN, and his Project RAM personnel of the Naval Medical Research

Institute, Bethesda, Maryland. The flight personnel will be equipped with physiological sensing instrumentation and the information (heart action, respiration, etc.) will be transmitted automatically to the Navy R5D aircraft for continuous monitoring and evaluation by Dr. Barr and associates.

In addition to the value of the information as basic data collected during a stress situation, Dr. Barr will have appropriate information available for making recommendations related to safety of the personnel.

SYSTEM WEIGHT BREAKDOWN

Balloon with valve	227 pounds
Multipoint suspension harnesses	25
Orienter with power supply	100
Sky Car parachute and risers	100
Gondola	
Basic Sky-Car	653
Flying Coronagraph with controls	85
Lead acid batteries	
a. Ballastable	230
Silver Cells	
a. Dr. Barr (12 volt)	32
b. Dr. Barr (24 volt)	64
c. HAO Heaters and O_2 mask heater (24 volt)	64
d. Emergency (12 volt)	32
Oxygen (liquid)	50
Drag rope	43
Control ballast	200
Thermistor waver	7
Paravia (Barograph)	8
Dr. Barr transmitter	10
Miscellaneous experiments	70
Miscellaneous flight gear	20
Crew	
Basic	310
Exposure clothing	90
Personnel chutes and bail-out O_2	80
Miscellaneous equipment	20
GROSS LOAD	2,520 pounds

B. PRE-LAUNCH AND LAUNCH

The operation proceeded according to schedule and on 1 August installation and checking of all equipment was completed. Launch now depended upon waiting for acceptable weather conditions at the launch location as well as along the predicted trajectory.

During the period of 1-6 August a high pressure system persisted over the eastern half of the United States and an extensive low pressure area with a relatively flat pressure gradient dominated the United States and Canadian Central Plains and the Rocky Mountain States. Moderate to fresh southerly winds brought in moisture from the Gulf of Mexico resulting in cloudy skies and a daily occurence of afternoon and evening thunderstorms over the Dakotas and eastward.

On the 4th another low pressure system was located on the Saskatchewan-Manitoba border with a cold front extending south and westward along the United States-Canadian border.

On the 5th this low pressure area moved east-northeastward to the westerly Hudson Bay area while the cold front extended southward through the low pressure system in the western Dakotas, with a Pacific high cell moving in behind it. Cloudy skies, thunderstorms and gusty surface winds preceded the frontal system followed by clearing skies and strong northerly surface winds.

The weather systems moved eastward and by the night of the 6th the low pressure trough extended from Michigan through Arkansas. The

Central Plains were under influence of a weakened high pressure ridge and the northern Rocky Mountain States were again dominated by a flat low pressure system.

On the basis of the weather situation as it existed on the night of the 6th, the launch was scheduled for the 7th. The weather situation was continuously monitored and after launch proceedings had commenced weather information received from Ellsworth Air Force Base disclosed scattered thunderstorms north and east of the Air Base. The clouds were in a band approximately fifty miles wide, extending east from a point fifteen miles east of Ellsworth. Radar indicated the cloud tops at less than the ceiling altitude expected to be maintained by the balloon flight. Because of this and the fact the storms were isolated and not connected with a frontal system, the flight was not cancelled although it was anticipated the proposed flight profile would have to be modified.

The launch technique was that of a standard vertical inflation. The balloon was allowed to become vertically erected during inflation and the lift determined directly from a weight indicator to which the balloon was anchored through its single point suspension harness. After the inflation was completed the multipoint harness was connected to the balloon and the balloon slowly let-up by means of a pulley and anchor line arrangement. The balloons lift was then transferred to the anchored gondola. The following is the schedule followed in conducting the launch operation.

Balloon layout started	0310
Layout completed	0320
Inflation started	0329
Inflation completed	0423
Communication check completed	0430
Crew boarded Sky Car	0450
Commenced let-up	0525
Let- up complete	0535
Launch	0540

The balloon was launched with a gross inflation of 2829 pounds. This was accounted for in a total airborne weight of 2563 pounds, and a free lift of 266 pounds. A weight break-down is as follows:

Gondola and crew	1424
Beacon and antenna	23
Parachute	95
Orienter	100
Harness (4)	17
Batteries (storage)	240
Hard hats	6
Exposure clothing	44
Oxygen masks and tubing	5
Personnel chutes and seat packs	60
Cameras	32
Oxygen	50

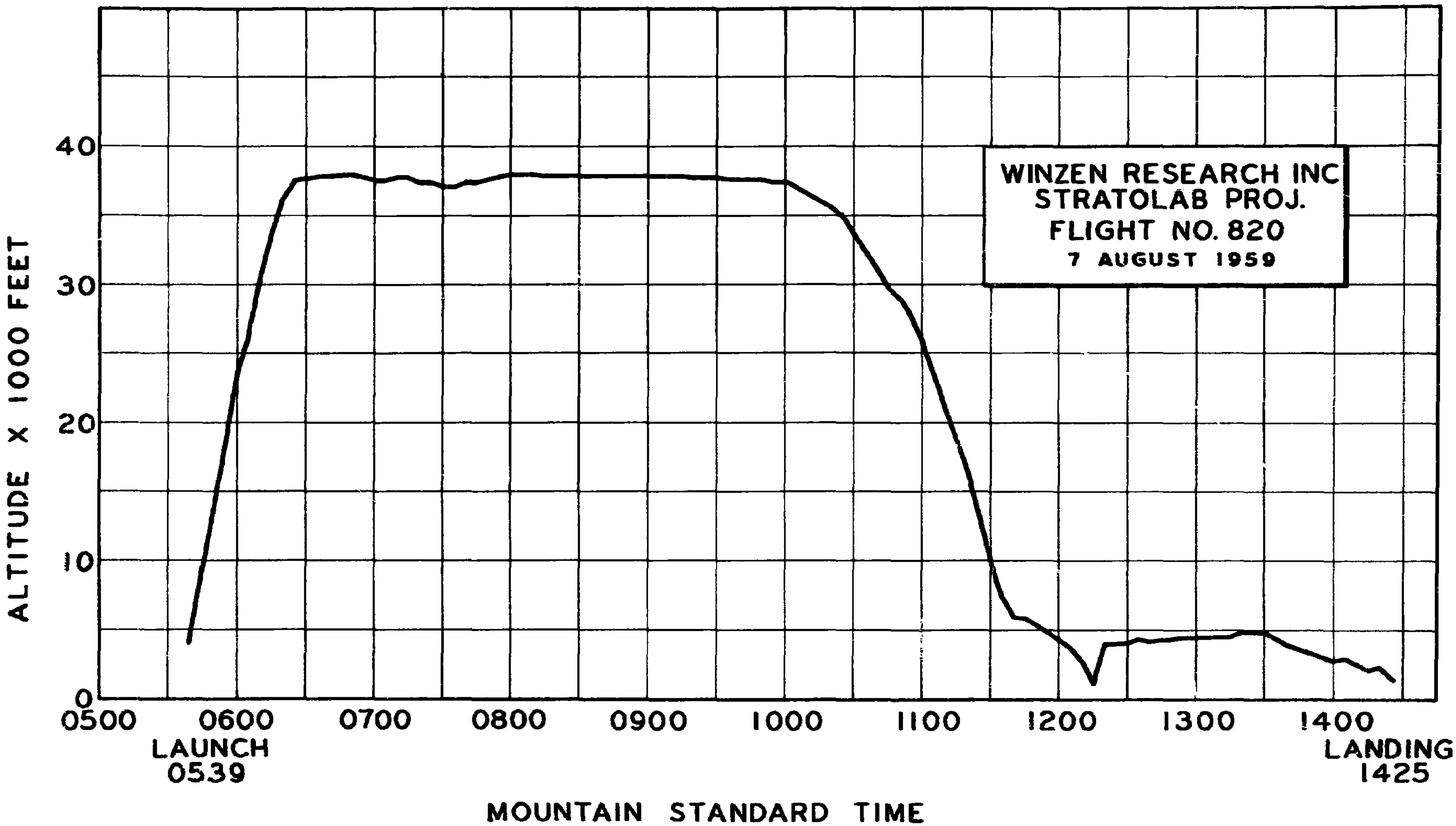
Knives	2
Plumb Bob	1
Radio	5
Recorder and Antenna	14
Storage box	2
Food and Water	16
Ballast (8 25# bags)	200
Total Weight	2336

C. FLIGHT PROFILE AND TRAJECTORY

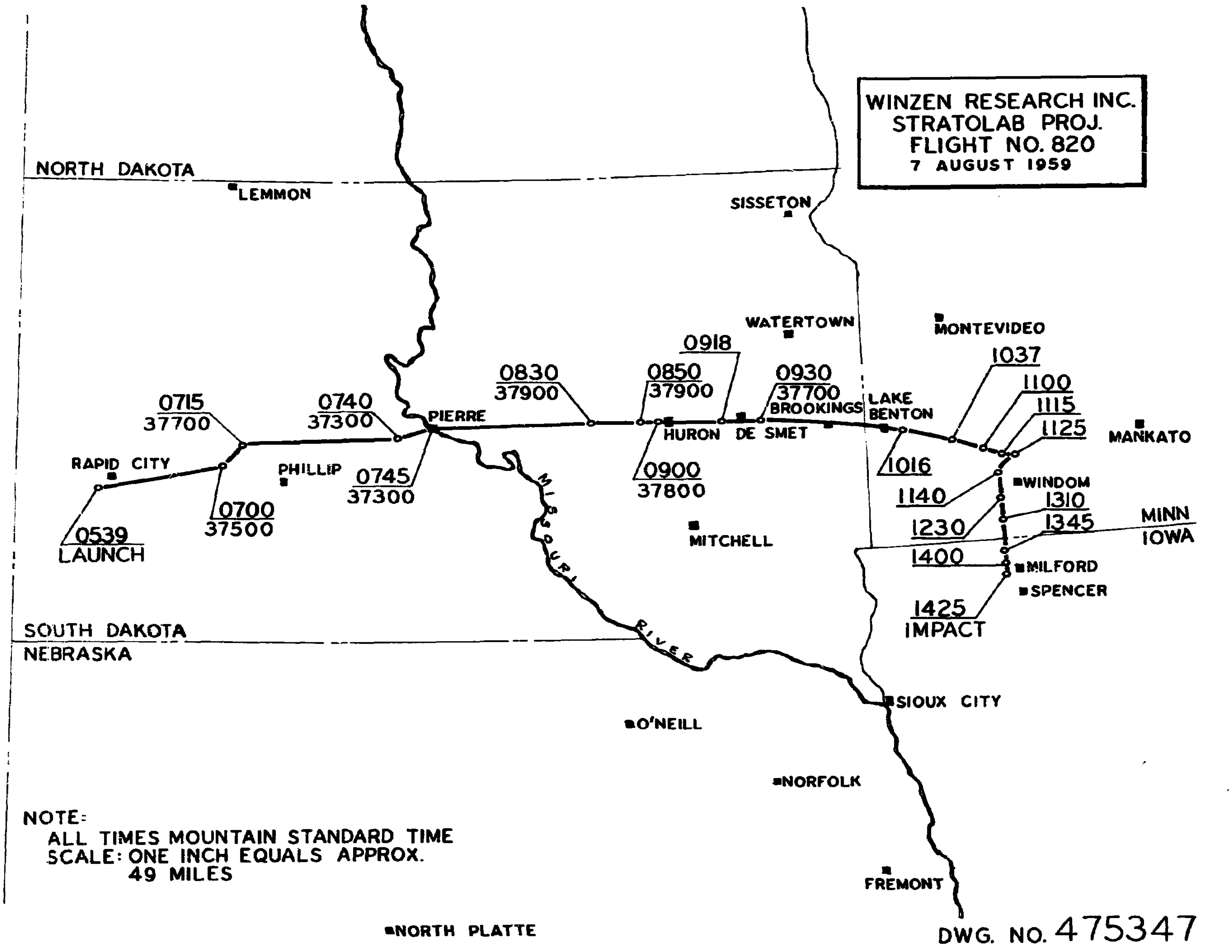
The flight profile and trajectory are shown on Drawings No. 475348 and 475347. It had been anticipated that the flight would be leveled off at approximately 10,000 feet to allow for equipment checks and adjustments and the flight crew to start using the oxygen system before initiating a slow ascent to ceiling altitude. The plan was altered and the ascent made directly to ceiling altitude because of the presence of thunderstorms in the projected flight path.

The clouds extended east from a point approximately fifteen miles east of Ellsworth Air Force Base for a distance of fifty miles. The ceiling altitude was reached before the clouds were encountered. The height of the clouds were such that at ceiling altitude the flight was just skimming their tops.

In addition to the clouds, the flight was characterized by an extremely high rate of travel. A jet stream was encountered at altitude and from 0715



DRW. NO. 475348



NOTE:
ALL TIMES MOUNTAIN STANDARD TIME
SCALE: ONE INCH EQUALS APPROX. 49 MILES

DWG. NO. 475347

until 0930 speeds of approximately 125 knots were encountered.

The descent was initiated at approximately 1000 hours after the observations at altitude had been completed. An initial landing attempt at 1215 was aborted when it became apparent farm buildings and livestock enclosures could not be cleared.

The flight trajectory, after the initial landing attempt, carried the flight over an area of small lakes. The landing was finally made at 1425 after clearing the lake area. The landing was made in a corn field. The balloon was released just as the gondola first touched the corn. The gondola landed upright, but with a jolt sufficient to cause the crew's seats to break, and remained up-right until the parachute billowed out on falling and pulled the gondola over.

D. TRACKING AND RECOVERY

Several factors arose which affected the tracking and recovery operation as outlined in the operations plan.

Communication difficulties were initially encountered just prior to launch. It was determined the altitude beacon caused VHF interference and therefore the beacon was not operated. This action removed the ADF signal and the capability of CW operation on 1710 KC. After launch VHF transmissions from the gondola began to fail after the flight crew donned oxygen equipment and were lost completely before the gondola reached ceiling altitude. Although gondola transmissions were not received, the gondola received all transmissions from the tracking vehicles.

Another serious problem was caused by the high rate of speed of the gondola at altitude. The gondola proceeded to out-run all the tracking ground vehicles. In addition, the Navy ambulance broke down shortly after leaving the launch scene and was not able to carry out its mission.

To assist in the tracking and recovery an ambulance and helicopter were dispatched from the Naval Air Station in Minneapolis. In addition, additional Winzen Research Inc. personnel from the Minneapolis plant were dispatched to assist in tracking and recovery.

The R5D, Apache and helicopter were orbiting the flight when the landing was made. Of the ground vehicles, the ONR truck was the first to reach the landing site followed by the vehicle from Minneapolis and the stake truck.

The flight crew was transferred to the Spencer, Iowa Airport by the helicopter and returned to Minneapolis in the Apache. Recovery of the gondola and equipment was made by the ground tracking personnel.

E. SYSTEM PERFORMANCE EVALUATION

1. Communications.

A thorough post flight examination was made of the communications system. It disclosed that the most probable cause of failure was that the carbon microphones of the O_2 masks had absorbed excessive moisture and that this in combination with the low temperatures involved caused them to be inoperative. The post flight check showed the microphones to have very low sensitivity indicating they still retained some of the moisture. Immediately after the landing the VHF was found to be operative when using the hand microphone.

As a result of this flight, in future flights involving oxygen masks a ribbon type microphone will be used.

2. During the course of the flight at altitude, Mr. Cooper suffered physical discomforts ranging from severe pain in the knees and chest to feeling nauseated. During the period he changed to his alternate oxygen regulator.

A post-flight examination of the oxygen regulators disclosed that those Mr. Cooper used apparently functioned normally but that Commander Ross' alternate regulator was inoperative. It allowed a continuous flow of oxygen in either the normal or 160 per cent oxygen flow position. This regulator was not used during the flight.

Post-flight consideration of the physiological difficulties suffered by Mr. Cooper and a physical examination by Dr. Barr and Dr. Sanville, MC, USN, indicate the problem was probably hyperventilation and a very low CO_2 tension. There apparently was no connection to the operation of the oxygen system.

3. Suspension System.

In using the orienter to control the azimuth of the gondola some counter-rotation of the balloon was encountered instead of rotation of the gondola. Acquisition of the sun was accomplished though by a combination of the use of the orienter and gimbal mounting of the telescope. Residual movement was left after orientation was made but this was well within the manual adjustment of the coronagraph.

As stated previously, the orienter was designated for use with a two million cubic foot balloon with a 172 foot diameter. In operation with the 72 foot diameter balloon of this flight the counter-rotation encountered is not surprising when the difference in the moment of inertia between the two balloons is considered.

The extended parachute stability appeared to be very good with no visual evidence of twisting in the shroud lines. It appears though from the problems associated with the landing that a mechanical release mechanism would be desirable to prevent the parachute from turning or dragging the gondola after landing.

4. Sky Car.

No major problems were encountered with the basic Sky Car. It was found that the seat belts could have been longer to better accommodate the bulky exposure clothing. A desirable addition would be installation of shoulder harnesses.

5. Balloon.

The ceiling altitude of the flight was 38,000 feet compared to a theoretical ceiling altitude of 40,000 based on a volume of 150,000 ft.^{3}. This difference in altitude can be explained by the fact that the design payload of the balloon was 250 pounds as compared to the 2336 actually flown. The balloon therefore did not obtain its design natural shape but assumed a more oblate shape with a reduction in volume. Computations based on the ceiling altitude obtained and gross load disclose the actual volume was 142,349 cubic feet.

Experience has shown that a payload exceeding the design payload may be safely flown but with a resulting loss in theoretical altitude. Other than this loss in altitude, which did not affect the scientific experiment, the performance of the balloon was faultless.

VI. CONCLUSIONS

The flight, in terms of the performance of the open gondola balloon system as such, can be termed successful. It clearly demonstrated the capability of the system as a means of allowing scientific investigators to enter and conduct experiments in the region of the stratosphere.

Definitive conclusions as to the limitations or capabilities of the system will have to be based on the results of the scientific experiments in conjunction with the performance characteristics of the balloon system.