MEMORANDUM REPORT

U. S. AIR FORCE
AIR MATERIEL COMMAND
WRIGHT-PATTERSON AIR FORCE BASE
DAYTON, OHIO

HIGH ALTITUDE BAILOUTS

MCREXD-695-66M   18 SEPTEMBER 1950

HEADQUARTERS

AIR MATERIEL COMMAND

WRIGHT-PATTERSON AIR FORCE BASE, DAYTON, OHIO

ENGINEERING DIVISION
MEMORANDUM REPORT ON

No. of Pages: 44
VM/ heo
Date 18 September 1950

SUBJECT: High Altitude Bailouts

102997

OFFICE Aero Medical Laboratory **Contract or Order No.** ......

SERIAL No. MCREXD-695-66M **Expenditure Order No.** 695-61

A. PURPOSE:

1. To present the experimental results of fourteen (14) human tests accomplished at Holloman Air Force Base which (a) prove the feasibility of escape at high altitude from a physiological standpoint, and (b) demonstrate the practicability of automatic equipment for ejection seat and free bailout methods of escape.

B. FACTUAL DATA:

2. High altitude parachute jumps have always been extremely hazardous and usually resulted in either injury or death. Personnel flying at high altitude today are still without any tested or proven means of a safe method of escape. The purpose of the high altitude bailout tests conducted at Holloman Air Force Base, New Mexico, was to prove that such jumps are feasible when proper precautions are taken and when reliable automatic equipment is used. The background to these tests is discussed further in Appendix I.

3. A B-17 specially equipped for high altitude flying was used to conduct the tests. Fully automatic ejection seat drops and free-fall bailouts were accomplished using a modified bomb-bay as an exit. Both standard and experimental clothing and equipment were used during the tests. Six experienced volunteer parachutists were selected as subjects after undergoing a thorough examination and indoctrination. Various telescopic cameras recorded data for determining altitude velocity and time sequence data. Physiological data prior to and during the drops were telemetered to a ground receiving station. Further details of the equipment and methods are presented in Appendix II.

4. A stabilization chute was used on all ejection seat drops, but stability around the vertical axis was difficult to maintain with the result that various rates of spinning were experienced during the seat drops. The free-fall bailouts conducted at the last part of the program were favored by the subjects in preference to a spinning seat. No adverse physiological reactions were recorded by the telemetered records of the subjects although some subjects experienced nausea during the parachute descent on the seat tests. The tests show that high altitude bailouts with proper equipment are not only feasible, but

can be accomplished without injury. A detailed account of the results, including a brief summary of each subject's jump is presented in Appendix III.

5. Sketches and photographs of the subjects and the various items of equipment are included in Appendix IV.

C. CONCLUSIONS:

6. No physiological changes were encountered which would prevent adequate performance of normal and emergency procedures; however, disorientation, blurring of vision and excitement were the physiological factors which caused the most difficulty.

7. The greatest danger in high altitude escape is the inability to judge altitude above the terrain either by visual means or estimating the time of fall. This danger makes the use of an automatic opening device advisable. Under conditions of the tests described herein, standard parachutes with automatic opening devices are suitable for high altitude emergency escape, up to 43,000 feet.

D. RECOMMENDATIONS:

8. None.

CONCURRENCE BY: W. P. Alexander
for R. W. BARNES
Major, USAF
Parachute Branch
Equipment Laboratory

PREPARED BY: Vincent Mazza
VINCENT MAZZA
Captain, USAF
Aero Medical Laboratory

APPROVED BY: W. H. McCandless
for BRUCE E. PRICE
Colonel, USAF
Chief, Equipment Laboratory

PREPARED BY: Randall W. Briggs
R. W. BRIGGS
Captain, USAF (MC)
Aero Medical Laboratory

PREPARED BY: C E Carroll
C. E. CARROLL
Equipment Laboratory

APPROVED BY: Robert H Blount
ROBERT H. BLOUNT
Colonel, USAF (MC)
Chief, Aero Med. Operations

PREPARED BY: Richard V. Wheeler
R. V. WHEELER, Capt., USAF
Equipment Laboratory

APPROVED BY: Walter A. Carlson
WALTER A. CARLSON
Colonel, USAF (MC)
Chief, Aero Medical Laboratory

APPROVED BY: Henry M. Sweeney
HENRY M. SWEENEY, Lt.Col., USAF
Aero Medical Laboratory

APPENDIX I
INTRODUCTION

It was believed, prior to 1943, that if the parachute were opened at high altitude a severe opening shock would be avoided because of the decreased density of the atmosphere. Such a jump would require the prolonged use of oxygen during the descent in the parachute, as well as adequate clothing for protection against the extreme cold at altitude. An experimental jump of this type from 40,000 feet was accomplished by Col. W. R. Lovelace, II., M. C. on 24 June 1943. (Memorandum Report Engineering Division No. 49-695-1K dated 9 July 1943). He suffered an extremely hard opening shock which rendered him unconscious and caused him to lose both gloves from the left hand. When he recovered he had a frozen left hand and was suffering from shock. The nylon glove on the right hand served to protect it from frostbite.

On 3 July 1943, Major P. J. Ritchie made an emergency jump without oxygen from 32,000 feet. He delayed pulling the rip cord until he felt he was about to lose consciousness. He remembered a terrific opening shock as his chute opened, and lost consciousness shortly afterward. Examination showed he had a dislocation of the lumbar vertabrae.

In 1944 a series of high altitude dummy tests (Memorandum Report #Eng. 49-696-66, dated 8 July 1944) gave data which definitely proved that parachute opening shock is greater at high altitudes and indicated that the best method of performing a high altitude parachute jump was to free-fall to a relatively low altitude before inflating the main canopy. In this the hazards of exposure to cold, low oxygen pressure, and high opening shock at altitude are minimized. Below 30,000 feet the oxygen problem is not critical and the normal subject will not lose consciousness during a free-fall.

Using the above information Lt. Col. M. W. Boynton received permission to make an experimental free-fall parachute jump from 42,000 feet. He chose not to use an automatic parachute opening device, and in August 1944 he plummeted to his death. He apparently had made no attempt to pull the rip cord.

The mystery of what occurred during Col. Boynton's jump encouraged further research for safe methods of escape from altitudes of 40,000 feet and above. Since little was known of the free-fall rate of descent, the effects of prolonged tumbling, or the possibility of physiological reactions due to sudden cold and shock, a program of experimental jumps by a group of volunteers was planned at the Aero Medical Laboratory in 1945 but the end of hostilities interrupted the completion of the plan.

Since regular flights at the present time are conducted at 40,000 feet and above it was considered urgent that such a test program be conducted. Delayed free-fall tests of this type were considered feasible since a reliable automatic parachute opening device employing an aneroid timer had been developed. (See Air Force T. O. 13-5-1 dated August 1950)

The selection of a site to conduct these tests was finally narrowed down to El Centro Naval Air Station, California; Edwards Air Force Base, Muroc, California; and Holloman Air Force Base, Alamogordo, New Mexico. The deciding factor in favor of Holloman Air Force Base was the instrumentation facilities available there. The main disadvantage was the altitude of the terrain (4090 ft.M.S.L.) This necessitated opening the parachute at a higher altitude and landing at a higher rate of descent than at sea level. It was felt, however, that the improved parachute (B-14) which was to be used, would off-set these disadvantages.

The project was a joint effort of the Aero Medical Laboratory and Equipment Laboratory of the Engineering Division, Wright-Patterson AFB and consisted of the following personnel.

*Capt. Vincent Mazza	Project Engineer, Aero Medical Laboratory
*Capt. Richard V. Wheeler	Asst. Project Engineer, Equipment Laboratory
Capt. Thomas C. Hill	Medical Officer, Aero Medical Laboratory
Capt. Randall W. Briggs	Medical Officer, Aero Medical Laboratory
Capt. Philip J. Maher	Pilot, Aero Medical Laboratory
Mr. Charles E. Carroll	Parachute Engineer, Equipment Laboratory
Mr. Joseph A. Calhoun	Asst. Parachute Engineer, Equipment Laboratory
Mr. Miles A. McLennan	Telemetering Engineer, Aero Medical Laboratory
Mr. Edward G. Correll	Electronic Technician, Aero Medical Laboratory
Mr. Andrew M. Marcinko	Electronic Technician, Aero Medical Laboratory
*M/Sgt. Jay D. Smith	Holloman AFB Liaison, Holloman AFB
M/Sgt. Isadore Rosenberg	Parachute Equipment Technician, Equipment Laboratory
*T/Sgt. Joseph F. Krul	Packer and Rigger, Equipment Laboratory
*T/Sgt. Victor A. James	Asst. Parachute Equipment Technician, Equipment Lab.
*T/Sgt. George Post	Packer and Rigger, Equipment Laboratory
T/Sgt. Kenneth Roe	Crew Chief, Flight Test Division
S/Sgt. Wm. R. Sink	Crew Chief, Flight Test Division

Holloman AFB supplied general facilities and technical assistance, and conducted photographic and electrical recordings of the tests.

* Also served as subjects for the tests.

APPENDIX II
TEST EQUIPMENT AND PROCEDURES

At the inception of the tests, which were to involve the dropping of human subjects from an aircraft flying at altitudes ranging from 25,000 to 40,000 feet, it was decided that the use of an ejection seat as a vehicle for the subjects during most of the falls would be the safest procedure for the following reasons:

A. Men could be seated in an ejection seat mounted on vertical rails in the bomb-bay of an aircraft so that they could be dropped in a controlled manner, thus reducing chances of losing oxygen due to an irregular exit.

B. Bulky and extensive instrumentation and oxygen equipment could be more satisfactorily mounted on the seat than on the man.

C. Automatic parachute system could be used which had proven to be dependable by extensive previous tests. This system presented an advantage in that it allowed the man to separate from the seat and heavy instrumentation equipment prior to the opening of his parachute, thereby reducing the opening and landing shocks.

D. A stabilization parachute could be installed and positively deployed by static line to stabilize the fall of the seat and man combination until safe altitude for opening of the personnel parachute was reached. A stabilized fall was considered desirable in order to minimize possible causes for disorientation, loss of oxygen, and to make possible a fairly accurate calculation of the rate of descent.

Four ejection seats were prepared for a series of twelve tests to be conducted as follows:

Three at 25,000 feet
Three at 30,000 feet
Four at 35,000 feet
Two at 40,000 feet

Two free-fall bailouts were planned to follow these tests.

The following parachute and accessories were installed on each seat:

A. One parachute, stabilization, 40-inch diameter, Type M-1.

B. One parachute, seat retarder, experimental, 16 foot diameter.

C. One release device, stabilization parachute, experimental.

D. Two release, parachute rip cord automatic, Type F-1.

E. One belt, safety, lap automatic, ejection seat, Type F-1.

The stabilization and retarder parachutes were stowed in a compartment on the seat immediately aft the headrest. The stabilization parachute release device was installed between principal members of the seat structure approximately aft of the occupants shoulder line. The two F-1 automatic releases were mounted side by side above the stabilization parachute release device. The automatic lap safety belt was actuated by a control cable routed around the left side of the seat and up to a position under the stabilization parachute release where it joined to the left riser of the stabilization parachute.

Upon leaving the aircraft the stabilization parachute was withdrawn from its compartment and deployed by a static line approximately fifteen feet in length. The stabilized seat and the man then fell to the altitude of approximately 14,000 feet, which was pre-set on the F-1 type automatic release devices. The automatic releases then actuated the stabilization parachute release which freed the stabilization parachute allowing it to pull the control cable to open the lap belt and then act as a pilot chute to withdraw the retarder parachute. The man was then free to fall away from the seat as the 16-foot diameter retarder parachute was deployed. A static line from the seat to the man served to pull the rip cord of his parachute.

The seat accessories installation, sequence of operation, along with details of the personnel parachute are described in detail in Engineering Division Memorandum Report No. MCREXA7-45341-4-1, dated 15 August 1949, subject: "Pilot Ejection Flight Tests Conducted with a TF-80C Airplane at Muroc and Hamilton Air Force Bases." AF Photos Nos. 305836, 305839, 305841, and 305842 show details of the ejection seat used. Nos. 306259, 306260, 306261, Appendix IV, show the parachute assembly used by the man.

A B-17 airplane No. 44-85570, especially equipped for high altitude flying, was used as the test vehicle. Flooring was installed in the bomb-bay except for the right forward section. This opening served as the exit for the seat and/or seated subject. Installed vertically at the rear part of this opening was a set of rails which retained the rollers of the ejection seat. The seat was supported on the bottom by a steel bar which was connected to a bomb shackle. Releasing the bomb shackle allowed the bar to pivot, thus dropping the seat.

For the free-fall tests, conducted after the seat drops, the rails were removed from the bomb-bay and the subject sat on the edge of the platform facing forward with his feet extended through the opening. At the proper moment he rocked forward and out of the aircraft. Each man was equipped with an automatic opening parachute similar to those used on the dummies except that provisions were made for an automatic opening chest reserve parachute and an extended skirt main canopy 35 feet in nominal diameter. (See AF Photos Nos. 305843, 305844, 305845, and 305846.) The main parachute was equipped with a deployment bag.

The rip cord release in the main parachute on the man's back was adjusted to open the pack at a pressure altitude of fifteen thousand (15,000) feet on the free-fall tests. The chest reserve was adjusted to open at 12,500 feet in the event of failure of the main parachute. The F-1 type rip cord release in the chest reserve was modified so that the arming pin could be re-inserted after opening of the main parachute to prevent the opening of both parachutes.

Prior to each live test throughout the program a dummy was dropped from the altitude at which the test was to be conducted. Each dummy was equipped with a standard automatic opening back parachute constructed essentially in accordance with AF Part No. 50C7024-10 using an F-1 Type Automatic Rip Cord Release Device. (See AF Photos Nos. 284913 and 284916). These tests served the purpose of supplying further tests for the automatic opening parachute devices, determining the approximate impact point of the subject, and furnishing information on the rates of free-fall for the live free-fall tests to be conducted at the latter part of the program.

Six subjects were selected from volunteers from the Parachute Branch, Equipment Laboratory, the Special Parachute Unit, Holloman Air Force Base, and the Biophysics Branch, Aero Medical Laboratory. They were required to have basic parachute experience including static line and free-fall jumps. The standard physical examination for flying was passed successfully by each man, with uncorrected visual acuity of 20/20. The subjects showed no unusual instability in the following physiological and psychological tests: "Harvard Step", Cold Pressure, "Flack", Minnesota Multiphasic Personality Inventory, Rorshach, and a general clinical interview by the Flight Surgeon. In addition, the acceleration required to produce blackout or unconsciousness was determined for each subject on the human centrifuge. A comprehensive program of high altitude indoctrination was given each man in both the room temperature and refrigerated chambers, this program involved the use of oxygen equipment, pressure breathing, use of heated clothing, and simulated free-falls from 43,000 feet. A thorough indoctrination was given in special procedures, such as the use of the reserve seat chute, reserve bailout bottle, two-way radio, stop watch, altimeter, and emergency procedures. All subjects volunteered to complete the series of jumps including those at the highest altitudes. The project Flight Surgeon was assigned the responsibility of selecting individuals to make the 35,000 and 40,000 foot jumps on the basis of all data available at that point in the program.

Clothing assemblies in all jumps were composed of standard items, although there were slight variations due to individual preferences and to the requirements for positioning of telemetering leads. In most cases the assembly consisted of the P-1 helmet with visor and oxygen mask, light-weight cotton undershorts and T-shirt, K-2 cotton gabardine flying suit (summer), A-11 flying trousers, B-15 jacket with fur collar, one pair light-weight cotton or nylon socks and two pairs of medium-weight wool socks, combat boots or standard issue high-top shoes and knit wool gloves under leather gauntlet gloves. In several of the jumps the B-15 jacket and A-11 trousers were replaced with a light lined nylon experimental flying suit, type B-78. These assemblies provided an insulation value of approximately 2.0 - 2.5 clo. For the two final free-fall jumps an additional thin nylon coverall, dyed a luminous red for identification purposes, was worn over the outer clothing.

Oxygen equipment consisted of the A-13 mask to which was connected the H-2 bailout bottle by means of the A-2 adapter, providing oxygen under pressure for the duration of the fall. An extra H-2 bailout bottle with a simple pipe-stem was provided in case of failure of the primary pressure oxygen system. Both bottles were started and the flow was checked prior to departure of the subject from the aircraft.

Each subject wore a stop-watch and an altimeter sewed to the sleeve of his outer garment, and a knife sewed to the trouser leg. He carried bright colored signal panels in a pocket in case location of the impact point proved difficult to rescue parties. Care was taken to insure that adjacent articles of clothing were overlapped securely, using masking tape at the ankles and around the exit point of telemetering leads.

In the seat drops, physiological data were telemetered to the ground from pickups on the subject leading to a transmitter on the seat. At various times pulse, respiration and skin temperatures were recorded for later analysis. Pulse rates were obtained from chest electrocardiograph leads at the base and at the apex of the heart. Respiration rates were obtained from a resistance thermometer mounted above the exhalation valve in the oxygen mask. Skin temperatures were obtained from resistance thermometer elements placed usually at the back of the neck, the dorsum of the hand and the dorsum of the foot.

In conducting the tests one radar station tracked and directed the pilot of the aircraft throughout the flight pattern and controlled the release point. This release point placed the aircraft in a position to obtain optimum instrumentation data. Another radar station having an expanded scale was able to track the aircraft just prior to the drop and then track the seat, subject or dummy to obtain the approximate release altitude, and the time and altitude of opening sequences.

The optical group tracked the object as it was released from the airplane. Five Askania cine-theodolite stations (Focal length 20") recorded altitude, azimuth and time, from which the data reduction group was able to determine the velocity, acceleration, position, and time of occurrence data. Two servotracked Mitchell cameras (Focal length - 40inches) and a telescopic camera located on Mule Peak (Focal length 300 inches) were used for an historical film record of the series of events. Unfortunately the ground haze caused the pictures taken from Mule Peak to be somewhat blurred.

The time and communications group supplied continuous time signals to all stations so as to synchronize all instrumentation data. The operations group coordinated and guided the entire organization including the telemetering receiving station located at Tula Peak.

TABLE I

TESTS WITH HUMAN SUBJECTS

Test No.	Date of Test	Total Drop Weight	Drop Altitude	Altitude of Separation	Total Free-Fall Altitude	Sub	Free-Fall Time
1-B	5/11/50	350#	25,708	13,870	11,838	Wheeler	55.6
2-B	5/15/50	340#	25,808	14,582	11,226	Krul	52.0
3-B	5/17/50	340#	26,103	8,191	17,912	Post	83.0
4	dummy test						
5	dummy test						
6-B	6/6/50	357#	31,718	16,936	14,782	James	65.0
7-B	6/7/50	373#	31,808	14,476	16,332	Smith	75.0
8-B	6/16/50	342#	31,624	13,166	18,458	Mazza	78.0
9-B	6/20/50	358#	36,666	14,346	22,320	Wheeler	96.0
10-B	6/21/50	320#	36,651	15,101	21,550	James	94.0
11-B	6/23/50	344#	36,829	14,680	22,149	Krul	96.0
12-B	6/29/50	332#	36,781	14,341	22,440	Mazza	94.4
13-B	8/1/50	371-1/4#	42,048	/	/	Wheeler	/
14-B	8/9/50	347#	42,176	/	/	Mazza	/
*15-B	8/10/50	243-1/2#	37,066	/ (Chute Opened)	/	Wheeler	/
*16-B	8/15/50	227#	41,586	/ (Chute Opened)	/	Mazza	/

* Free-Fall Tests.

/ Data reduction not completed.

TABLE II
DUMMY DROPS

Test No.	Date of Test	Total Drop Weight	Drop Altitude	Altitude of Separation	Total Free-Fall Altitude	Free-Fall Time
1-A	5/11/50	180-1/2#	25,768	(15,550)[r]	(10,268)[r]	(47.3)[m]
2-A	5/15/50	180-1/2#	(25,730)[r]			42.6
3-A	5/17/50	216-1/2#	26,290	14,989	11,301	42.6
*4-A	5/19/50	340#	30,971	12,150	18,821	61.0
*5-A	5/26/50	325#	(25,680)[r]	(11,960)[r]	(13,720)[r]	(65.0)[r]
6-A	6/6/50	216-1/2#	(31,850)	(13,850)	(18,000)	59.4
7-A	6/7/50	216-1/2#	(31,340)[r]	(13,380)[r]	(17,960)[r]	60.0
8-A	6/16/50	216-1/2#	(13,875)	15,410	16,465	56.0
9-A	6/20/50	216-1/2#	36,485	(12,435)[r]	(24,050)[r]	(84.0)[r]
10-A	6/21/50	216-1/2#	36,709	(11,600)[r]	(25,109)[r]	(98.4)[m]
11-A	6/23/50	216-1/2#	36,801	14,721	22,080	69.2
12-A	6/29/50	218-1/4#	36,654	14,110	22,544	71.0
13-A	8/1/50	218-1/2#	42,151	/	/	/
14-A	8/9/50	218-1/2#	41,674	/	/	/
15-A	8/10/50	218-1/2#	36,792	/	/	/
16-A	8/15/50	218-1/2#	41,498	/	/	/

* Dummy drops in ejection seats

( ) Denotes approximate data

)r Data obtained by radar

)m Data obtained by Mitchell camera

/ Data reduction not complete

APPENDIX III
RESULTS

During tests Nos. 1 and 2 the subjects reported a decided tendency for the seat to spin around the vertical axis through the suspension line of the stabilization parachute. (Ref. Fig. I App. IV.) During Test No. 3 this spinning caused the suspension lines to twist and force a collapse of the stabilization parachute. Without benefit of the stabilization parachute to provide the drag power to operate the lap belt automatically, the subject was forced to manually release the belt. Corrective action was taken by the installation of a swivel between the seat and the stabilization parachute, to absorb the twists. Two dummy tests (No. - 4A & 5A) were successfully conducted with this arrangement and live tests were resumed.

Spinning of the seat was believed to have been caused by airflow over the irregular surfaces of the seat and man. The drag force from the stabilization parachute was intended to resist pendulum or rocking motions of the seat, however, little of this force could be expected to resist twisting movement.

During tests Nos. 9 thru 14 action was taken to reduce or eliminate the spinning descent. A flat plate drag area, the angle of which could be controlled by the subject was installed on the left side of the seat (See AF Photo No. 305839). This drag area was intended to create a force to spin the seat to the left in opposition to the tendency of the seat to spin to the right. Due to limited space in the bomb bay of the test aircraft the drag area could be extended only fifteen inches from the center of rotation with an area of fifty to sixty square inches. Three subjects reported they were unable to completely counteract the spin with the controllable drag; however, one subject was able to stop the spin by extending the left leg in a manner to augment the drag of the controlled area.

During tests Nos. 13 and 14 the seat and man spun to the left, whereas in all other tests spinning was to the right. This is believed to have been caused by a change which had been made in the weight and arrangement of the telemetering equipment on the seat, which would indicate that the balance of air drag pressures was very critical to impart the spin either direction.

During the entire series of twelve (12) live and two (2) dummy seat drop tests, there were twenty eight (28) operations of the type F-1 Automatic Ripcord Release, without malfunction. Collapse of the stabilization parachute due to spinning of the seat during Test No. 3-B was the only malfunction of any component of the automatic accessories during the series of tests. On Test No. 6-B the subject released himself prior to the occurrence of the automatic sequence because of a loss of depth perception due to the spinning of the seat. During Test No. 14-B the retarder parachute was severely damaged due to an overload by a delayed separation of the man from the seat.

Exits from the test aircraft on the free-fall tests (No. 15-B & 16-B) were accomplished by the subject sitting on the edge of a rectangular opening in the bomb-bay floor and rolling forward and out of the aircraft. In the first drop from 37,066 feet the subject free-fell 80 seconds prior to automatic opening of the parachute. In the second drop from 41,586 feet the subject free-fell 90 seconds. Ground personnel tracking the drops by radar estimated the openings to occur at approximately 15,000 feet above sea level. A comprehensive reduction of the data gathered by ground and air observations will be recorded in a future report.

Comments from the subjects indicated that they experienced less discomfort and stress while accomplishing the free bailout tests, than during preceding tests conducted using the stabilized seat.

The tests indicate that stability of seats around the vertical axis is critical. Various aircraft seats will probably differ, causing some seats to spin to the right and others to the left. This instability can be partially controlled by trained subjects, but it would not be practical to expect this of service personnel. The spinning, if prolonged and rapid, may cause blurring of vision and probably contributes to the nausea, which was experienced on some of the tests, during the main parachute descent.

Depth perception or ability to estimate when to expect the automatic sequences to occur (10,000 ft. above the terrain) was virtually impossible over the desert and probably would be over water. It is believed that without automatic equipment, or some indication of the time of fall, or altitude, a manual bailout from high altitude would be extremely hazardous.

The present system for automatic release from an ejection seat was planned several years ago on the assumption that it would be desirable to put the emergency oxygen supply on the seat and have the man descend from high altitude in a seat stabilized by a drag chute. This system relieved the man of another item of equipment and avoided the possible disadvantages of tumbling on a long descent.

The current series of tests have emphasized the heretofore unsuspected hazard presented by the critical nature of the stability of the seat about the vertical axis on a long descent. With these facts in mind, it is appropriate at this time to reconsider the automatic release sequences on ejection seats, particularly if the stability problem is not readily solvable.

If the emergency oxygen supply is attached to the man, he could be released from the seat soon after separation from the airplane. The automatic opening devices would then be an integral part of the parachute, and accessory equipment now required on ejection seats could be eliminated or simplified as follows:

A. The retarder parachute could be eliminated.

B. The lap belt release could be simplified to a time delay device.

C. Drag chutes could possibly be eliminated.

D. Relocation of the bailout bottle.

This problem will require careful consideration by all laboratories concerned and additional tests, if necessary, to assist in arriving at an early decision.

Table No. 1 presents essential information on each jump. An account of each jump follows:

APPENDIX III

Summaries of Personal Accounts of Tests

TEST 1-P

Subject:	Captain Wheeler	Altitude:	25,708 feet
Type:	Seat Drop	Date:	11 May 1950
		IAS:	130 mph

The subject left the aircraft and within 5 seconds was "reasonably sure" the drag chute was out, and soon the clockwise spinning of the seat, without tumbling, confirmed this. He reported a "strong air blast that rushed in and around my face. It raised my helmet about an inch from my head, pulled my oxygen mask slightly away from my face, created a loud rushing sound, and caused tears to come into my eyes." This prevented his hearing radio transmissions from the ground, but he was able to report one altitude and several stop-watch time intervals, which were recorded understandably on a tape recorder. The spinning decreased just prior to separation. He experienced an opening shock that was "much more than I had anticipated." He felt "extremely weak and nauseated for about 1/2 minute or so after chute opening." The parachute opening was fully automatic and the landing was uneventful.

TEST 2-P

Subject:	M/Sgt. Krul	Altitude:	25,808 feet
Type:	Seat Drop	Date:	15 May 1950
		IAS:	130 mph

The subject heard the "static line on the drag chute break loose" as soon as he left the aircraft, then he noticed "the ground below spin very rapidly." He was able to transmit and receive radio messages. He was unable to read his altimeter and therefore checked his altitude by reference to stop-watch and ground. The seat was "turning but not fast enough to make me sick." The parachute opening was fully automatic with a very gentle opening shock and an uneventful landing.

TEST 3-B

Subject:	T/Sgt. Post	Altitude:	26,103 feet
Type:	Seat Drop	Date:	17 May 1950
		IAS:	130 mph

The subject noticed clockwise rotation of the seat soon after leaving the aircraft. He transmitted a report but could receive nothing but a buzz from the ground. As previously instructed, he stuck out his right foot to attempt to stop the rotation; this was successful, so he left his leg extended. At 55 seconds (stop-watch time) he was preparing to transmit his altitude when the seat started "turning backwards, sideways, etc." He waited until 64 seconds (the time of anticipated separation) and then discovered the drag chute was "streaming." He grasped the risers and tried to shake the chute so it would inflate, but this was unsuccessful. At about 78 seconds he transmitted emergency twice and pulled the emergency handle. Nothing happened so he released his lap belt, left the seat and had a static line chute opening. The opening shock was moderate and he checked the time of opening by stopping his stop-watch. He reported feeling tired, but not sick. About three minutes after landing, the subject was momentarily unable to use his voice in spite of obvious efforts. No other untoward reactions occurred. His opening altitude was approximately 7,500 feet (3,500 feet above the terrain).

TEST 6-B

Subject:	S/Sgt. James	Altitude:	31,718 feet
Type:	Seat Drop	Date:	6 June 1950
		IAS:	130 mph

The seat was stable immediately on leaving the aircraft. The subject could not transmit or receive due to a break in his headset. He moved his head in all positions possible as a means of testing the helmet--mask combination--there was no tendency of the mask to pull off and no wind blast got under the visor. A slow clockwise spin started and the subject found that sticking his foot out increased the rate of spin. He began to get very dizzy, his vision was blurred, and he "lost all sense of depth perception." With no further checks on altitude or time possible, he decided to pull his emergency handle and received a static line opening with only a very slight shock. He was very "dizzy," became nauseated and vomited. Landing was uneventful.

TEST 7-B

Subject:	M/Sgt. Smith	Altitude:	31,808 feet
Type:	Seat Drop	Date:	7 June 1950
		IAS:	130 mph

On leaving the aircraft, the subject swung face down, then face up, but soon these oscillations were gone and the seat was stable. He transmitted an O.K. signal and noticed his stop-watch was inoperative. He reported this, as well as his intention to stay with the seat as long as he thought it safe. The seat started spinning and this became so severe as to cause dizziness, blurring of vision and difficulty in concentrating. At the time he realized his altimeter had passed through 15,000 feet indicated, the separation occurred automatically. The opening shock was mild and the landing uneventful.

TEST 8-B

Subject:	Captain V. Mazza	Altitude:	30,000 feet
Type:	Seat Drop	Date:	16 June 1950
		IAS:	130 mph

The seat was stable for a few seconds after leaving the aircraft and then started a clockwise rotation, gradually picking up speed. The subject tried various ways of reducing this rotation, including the use of an experimental airfoil, and was successful for a short period of time. Prior to separation, the rotation started again, but he was able to continue keeping track of time. The separation was automatic, but the subject became nauseated during parachute descent and subsequently vomited. The landing was uneventful.

TEST 9-B

Subject:	Captain Wheeler	Altitude:	36,666 feet
Type:	Seat Drop	Date:	20 June 1950
		IAS:	130 mph

The subject fell for about 10 seconds before rotation started and was able to transmit an O.K. signal. He concentrated on experimenting with methods to control the spinning, but was relatively unsuccessful. Finally, he "decided to concentrate on my watch in order not to get dizzy." He transmitted times until automatic separation and had a moderate opening shock, during which "my head was snapped forward which caused the visor on the helmet to jam." The landing was uneventful.

TEST 10-B

Subject:	S/Sgt. James	Altitude:	36,651 feet
Type:	Seat Drop	Date:	21 June 1950
		IAS:	130 mph

About 20 seconds after leaving the aircraft, the seat started slow turns to the right. The subject tried various methods of controlling this, and was partially successful, although one procedure produced a temporary rapid spin. He felt a "slight wind blast consistently coming up under my visor causing my eyes to water." Prior to separation, his eyes were watering so badly that he could not read his watch or judge his altitude, but he was not dizzy. The separation was automatic. The subject felt nauseated after his main chute opened. The landing was uneventful.

TEST 11-B

Subject:	M/Sgt. Krul	Altitude:	36,829 feet
Type:	Seat Drop	Date:	23 June 1950
		IAS:	130 mph

The subject noticed that the seat seemed too small for him before he left the aircraft. Immediately after release, his feet left the stirrups and he was unable to return them to the proper position. He was able to transmit and receive with his two-way radio. Later the seat started spinning to the left and this was uncontrollable, but it stopped altogether by 80 seconds and started a slow spin to the right prior to separation. The subject considered using the emergency system but decided not to, and the opening was automatic with an easy opening shock. He felt nauseated and used the reserve oxygen bottle with the pipe-stem. He believes this made him "feel better right away," although the nausea continued at intervals and he sucked on the oxygen tube until about 2,000 feet from the ground. The landing was uneventful.

TEST 12-B

Subject:	Captain V. Mazza	Altitude:	36,781 feet
Type:	Seat Drop	Date:	29 June 1950
		IAS:	130 mph

The subject noticed that the seat started to spin to the right as soon as it left the airplane. He tried various corrective measures, but these were unsuccessful. However, he did not report any dizziness. His feet were cold before he left the airplane, but this produced nothing worse than discomfort. The parachute opening was automatic with slight opening shock and the landing was uneventful.

TEST 13-B

Subject:	Captain Wheeler	Altitude:	42,048 feet
Type:	Seat Drop	Date:	1 August 1950
		IAS:	117 mph

The seat started a slow spin to the left, which increased in velocity. In attempting corrective action, the subject's right foot slipped from the stirrup, then his left foot slipped, and later he slid out of the seat and believes he was sitting on the foot stirrups with the hand rests under his armpits. This created an unusual and unsteady spin condition but the subject did not feel dizzy and was able to check his times. The parachute opening was automatic with a moderate opening shock. "I felt very relieved when the main chute opened but then almost immediately I started to feel sick." He vomited four times. The landing was uneventful.

TEST 14-B

Subject:	Captain Mazza	Altitude:	42,176 feet
Type:	Seat Drop	Date:	9 August 1950
		IAS:	117 mph

Again the subject spent the falling time attempting to control the spin characteristics of the seat. At separation, he did not attempt to push himself away from the seat when his lap belt released, but stayed sitting in it "to see what would happen to an unconscious subject making no effort to leave the seat." He was forcibly separated from the seat by the opening of the retarder chute. "The added weight of a heavy seat and subject was evidently too much for the retarder chute and I saw it stream by about 45 feet in front of me. (We found later that the opening shock had sheared all but two suspension lines.)" The parachute opening was automatic. "I felt quite nauseated at about 10,000 feet and was very uncomfortable due to the heavy clothing." The landing was uneventful.

TEST 15-B

Subject:	Captain Wheeler	Altitude:	37,066 feet
Type:	Free Fall	Date:	10 August 1950
		IAS:	130 mph

The subject sat on the forward edge of a platform in the bomb-bay, in a forward facing position. The cold air from the opening of the bomb-bay doors caused his visor to fog momentarily, but it was clear before exit. He left the aircraft by rocking forward, head down and fell smoothly for about 15 seconds. "I at once thought this method of jumping was easier than the method wherein a spinning seat is ridden down." He later "began to spin and tumble rather violently" and was able to test various methods for controlling this. He continued to check his time and was well prepared for the opening shock. "I received a good jolt from the opening, but it was not severe. The jar caused my visor to spring up away from my face. I did not black out at all but felt a little limp in the sling for 30 seconds or so." The parachute opening was automatic and the aneroid-activated warning buzzer operated at the proper altitude. He felt sick and "spit up a few times, but did not vomit." The landing was very hard, but no injuries were sustained.

TEST 16-B

Subject:	Captain V. Mazza	Altitude:	41,586 feet
Type:	Free Fall	Date:	8 August 1950
		IAS:	117 mph

The subject left the aircraft in the same fashion as the previous free-fall subject. He immediately began tumbling "in a head over heels fashion." Later, "the gyrations were hard to distinguish," but he was able to try various methods of control and to stabilize his position occasionally. He carried a flare in his hand and released it prior to expected opening, but it was a dud. He was able to flip himself over to a face-down position to prepare for the opening shock, which was automatic and "easy." "During the descent in the parachute it got quite warm but I did not feel any nausea. I had an easy landing and except for feeling a little tired, felt no ill effects from the experience. I believe it is more pleasant to free-fall than to ride a spinning seat."

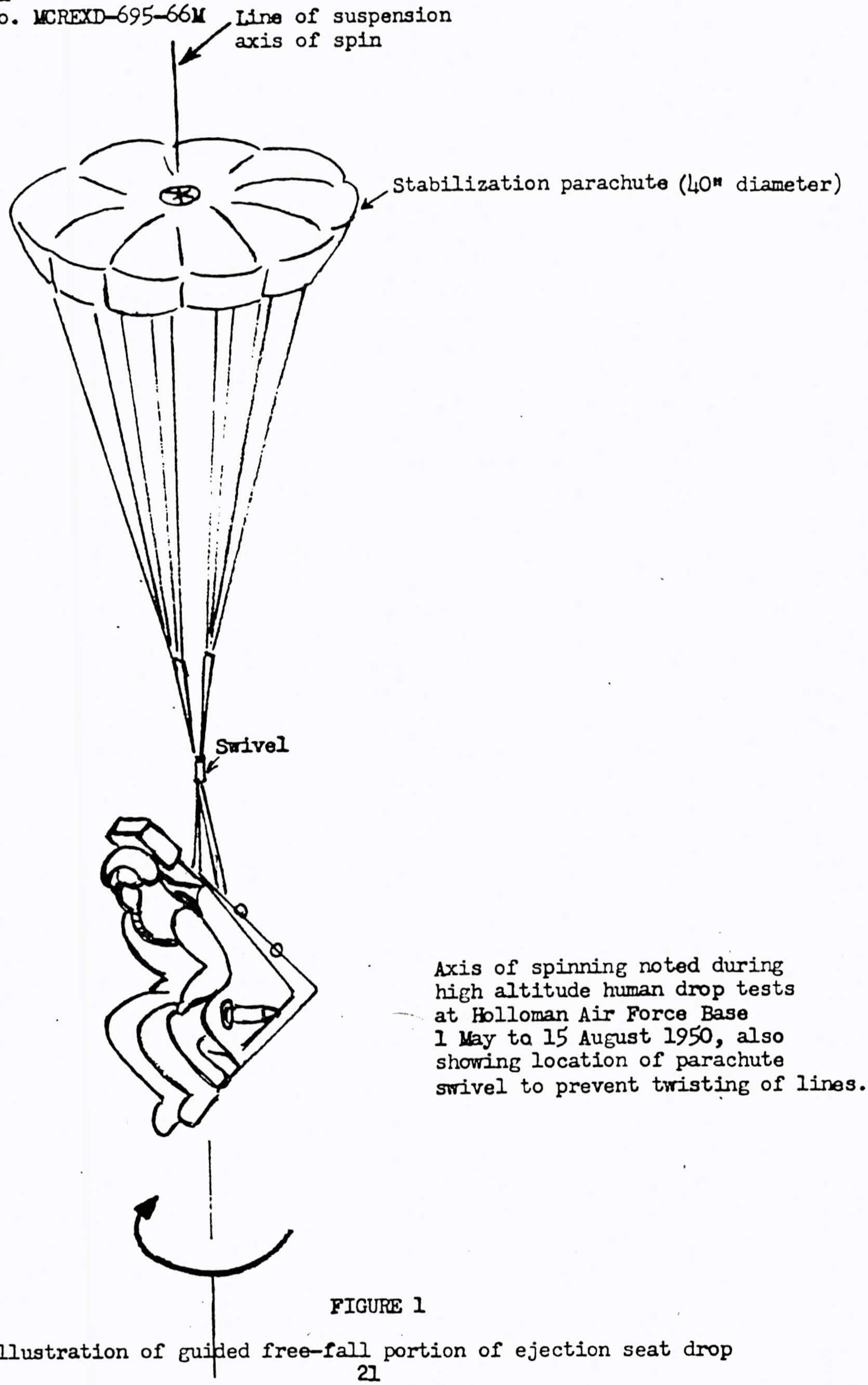
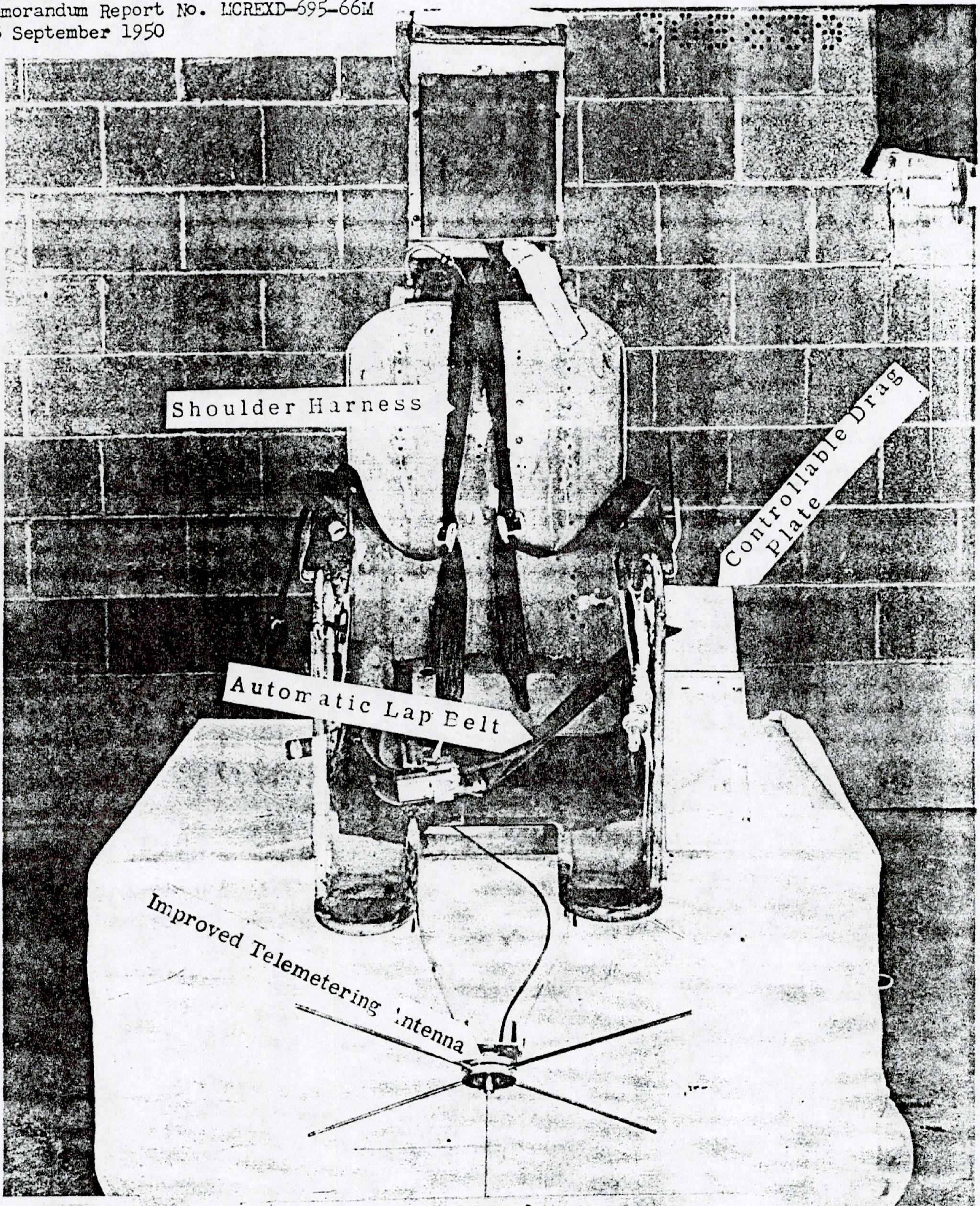


FIGURE 1

Illustration of guided free-fall portion of ejection seat drop



AF Photo
305839

FIGURE 2
High Altitude Drop Vehicle, (Seat)

Engineering Division
Memorandum Report No. MCREXD-695-66M
18 September 1950

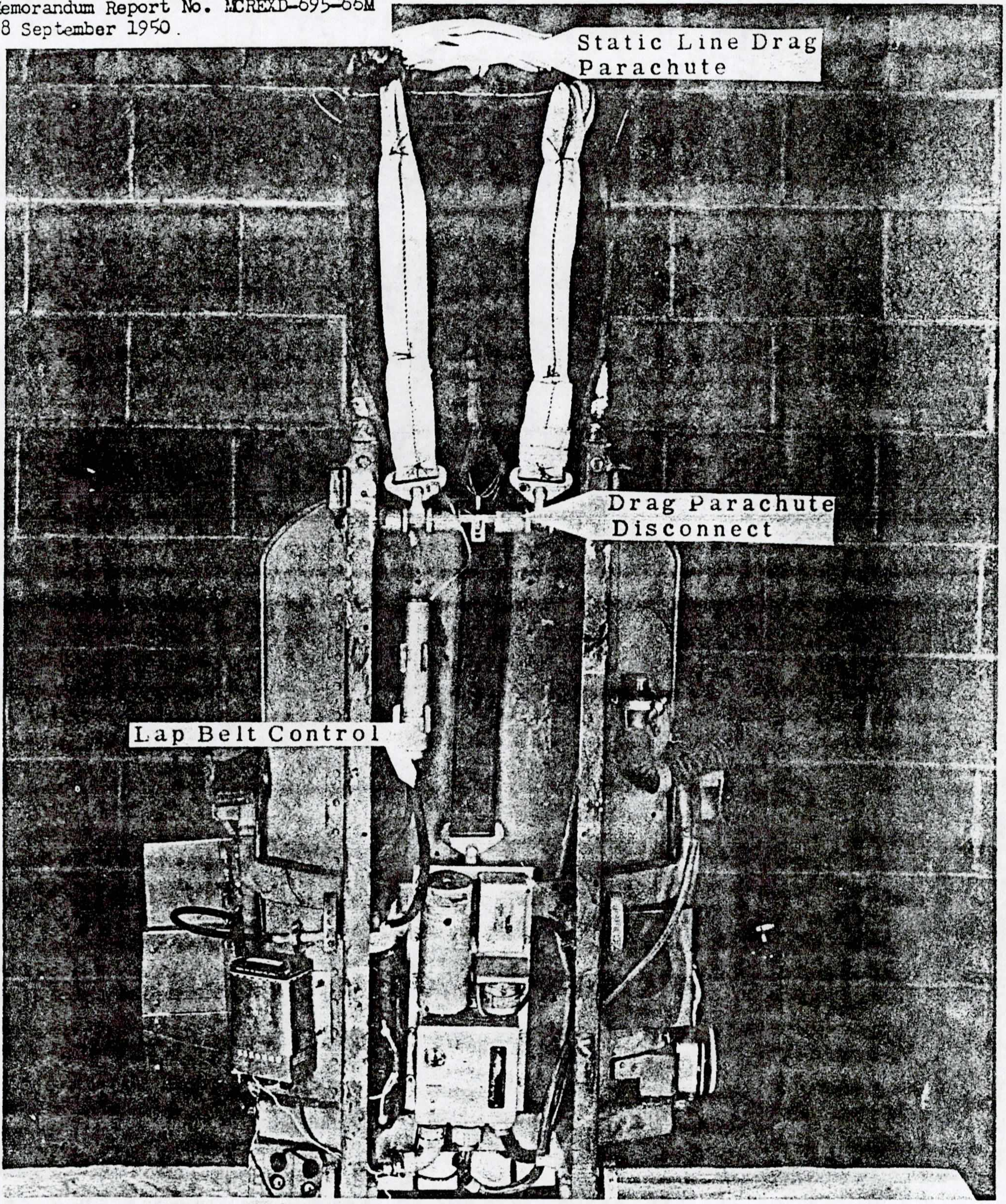
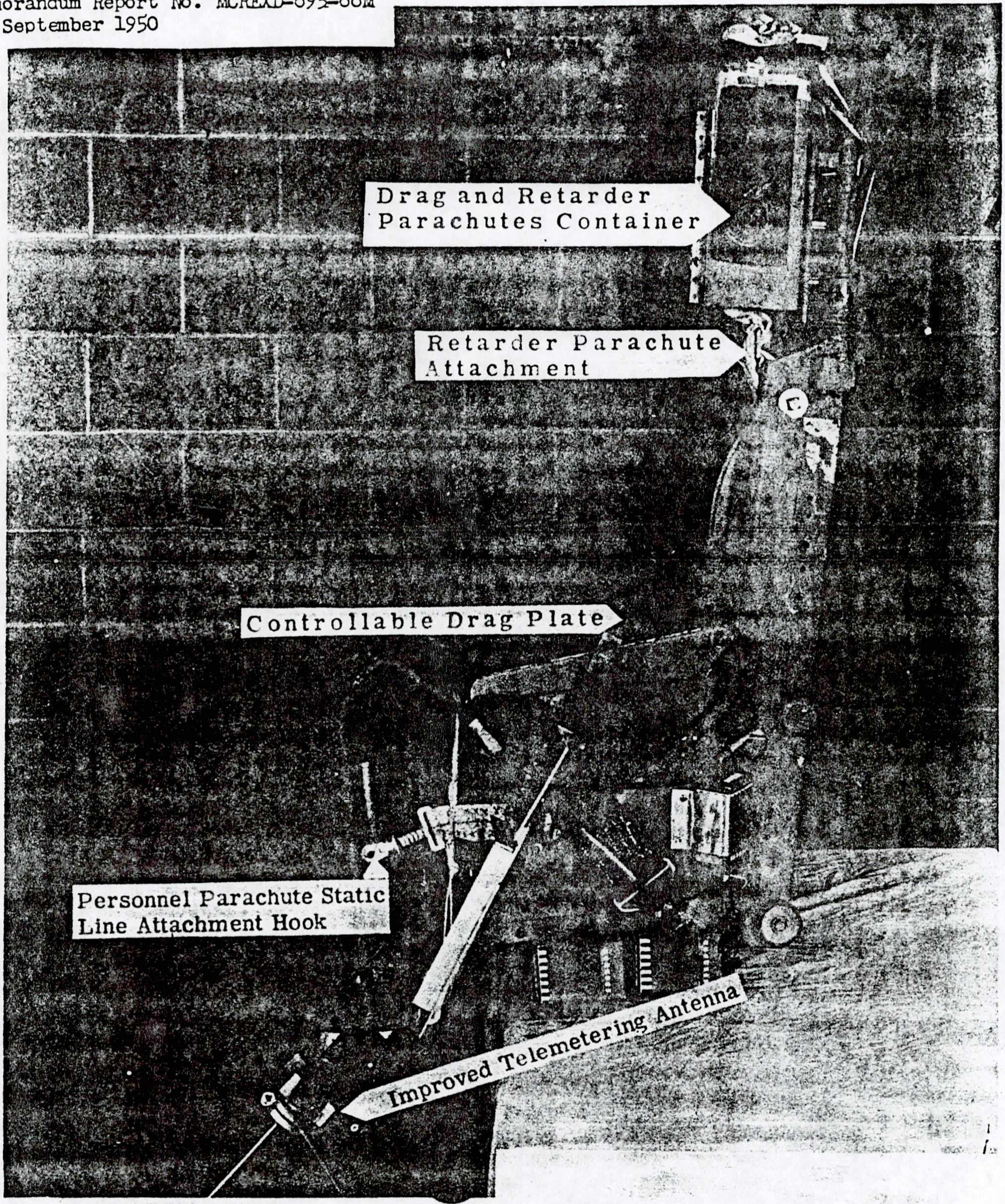


FIGURE 3

A F Photo
305841

High Altitude Drop Vehicle

Engineering Division
Memorandum Report No. MCREXD-695-66M
18 September 1950



AF Photo
305842

High Altitude Drop Vehicle
(Ejection Seat)

FIGURE 4

FIGURE 5
AF Photo 306259 Flight Clothing and Accessories for High Altitude Ejection Seat Drops

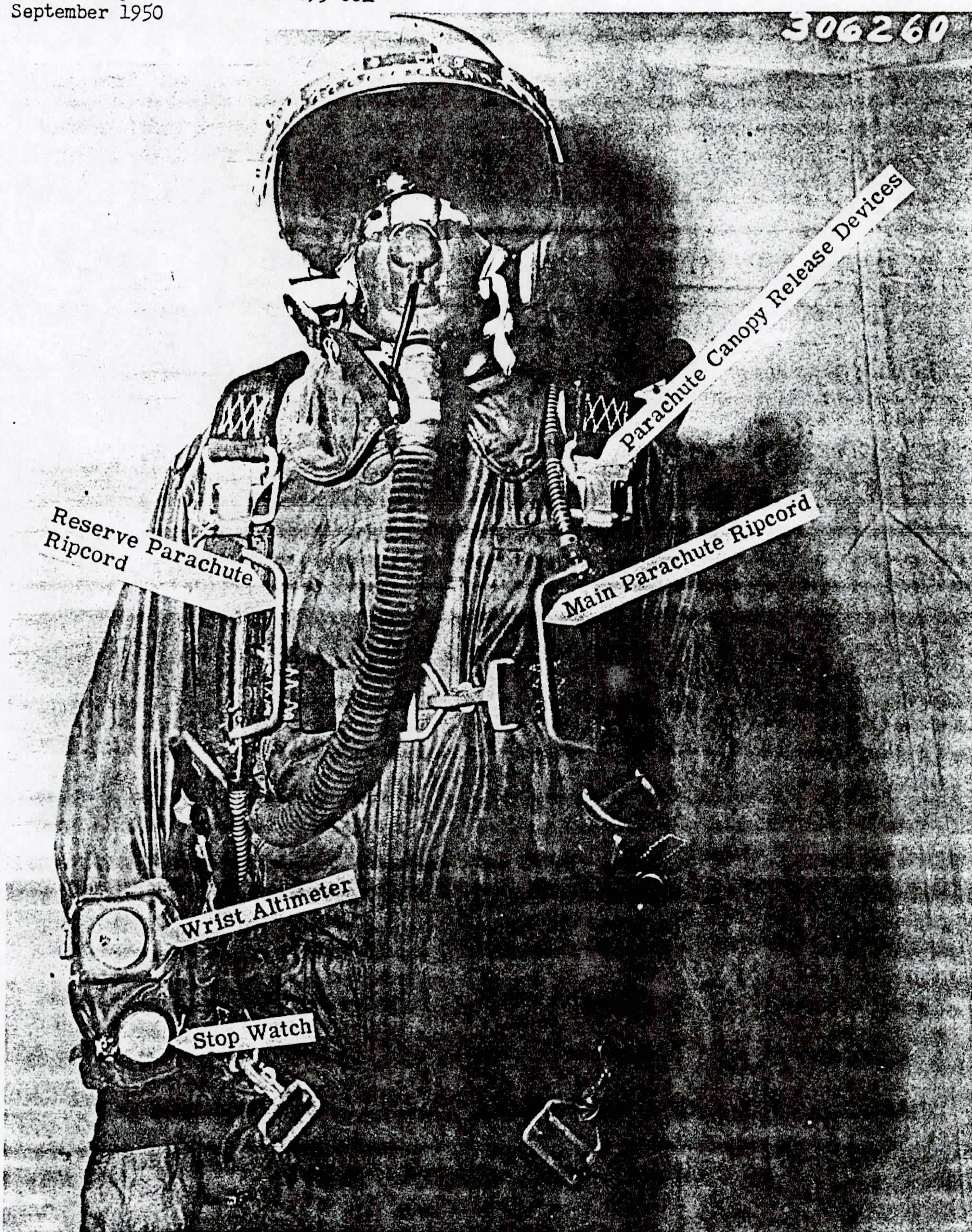


FIGURE 6
AF Photo 306260 Flight Clothing and Accessories for High Altitude Ejection Seat Drops

FIGURE 7

AF Photo 306281 Flight Clothing and Accessories for High Altitude Ejection Seat Drops

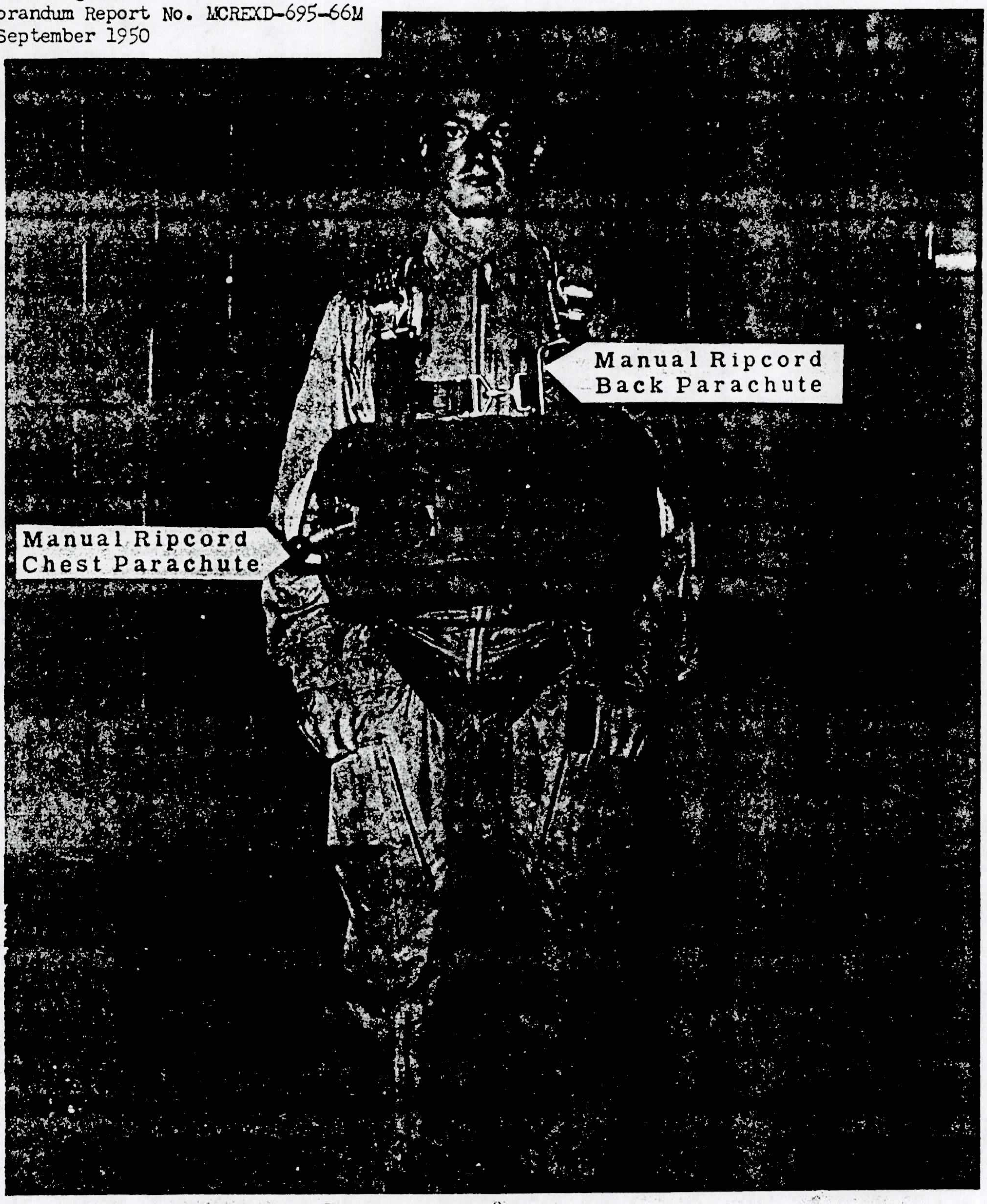


FIGURE 8
Parachute Assembly for Free Fall Bailout

AF Photo
305843

AF Photo
305844

FIGURE 9
Parachute Assembly for Free Fall Bailout

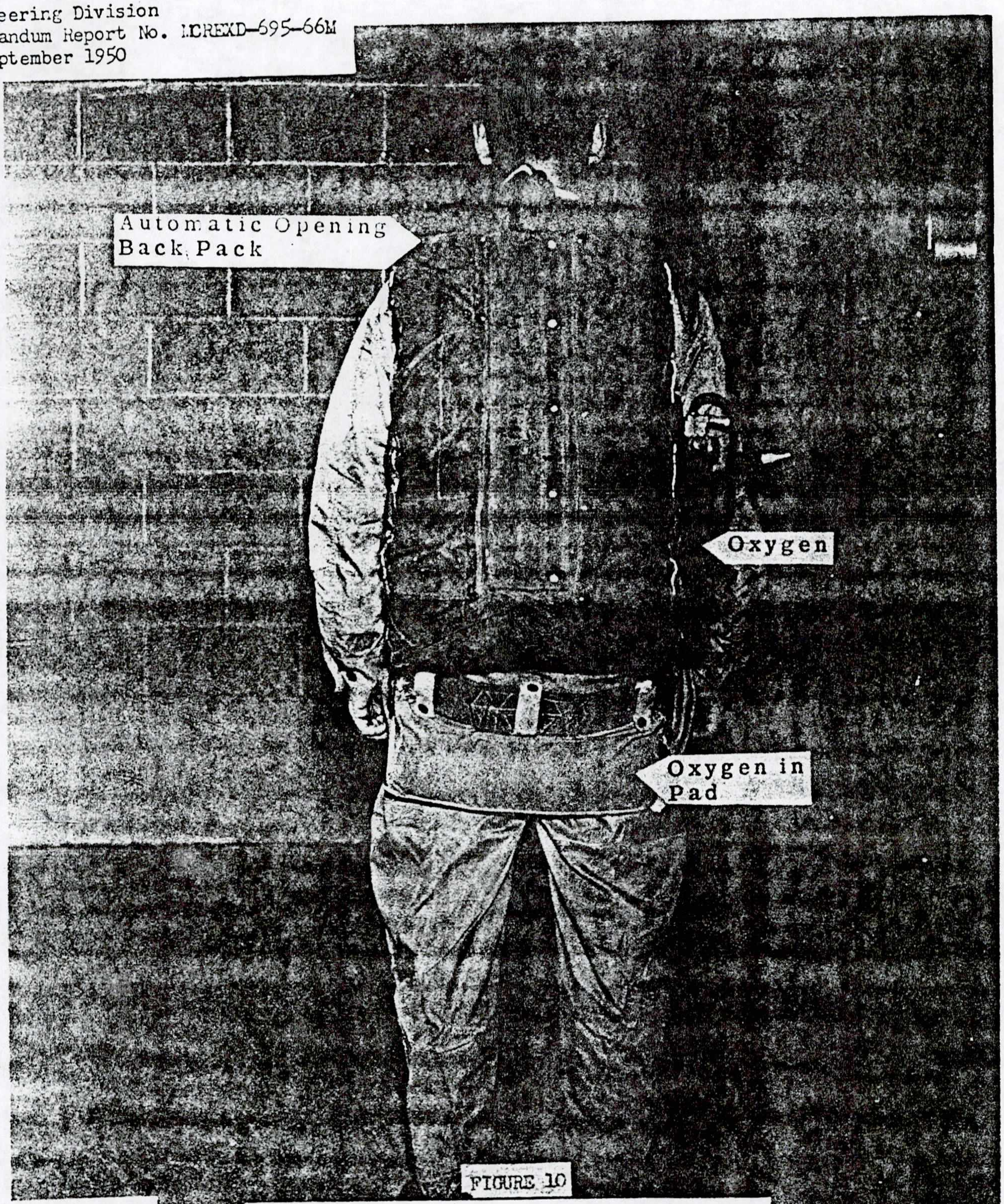


FIGURE 10

AF Photo
305845

Parachute Assembly for Free Fall Bailouts

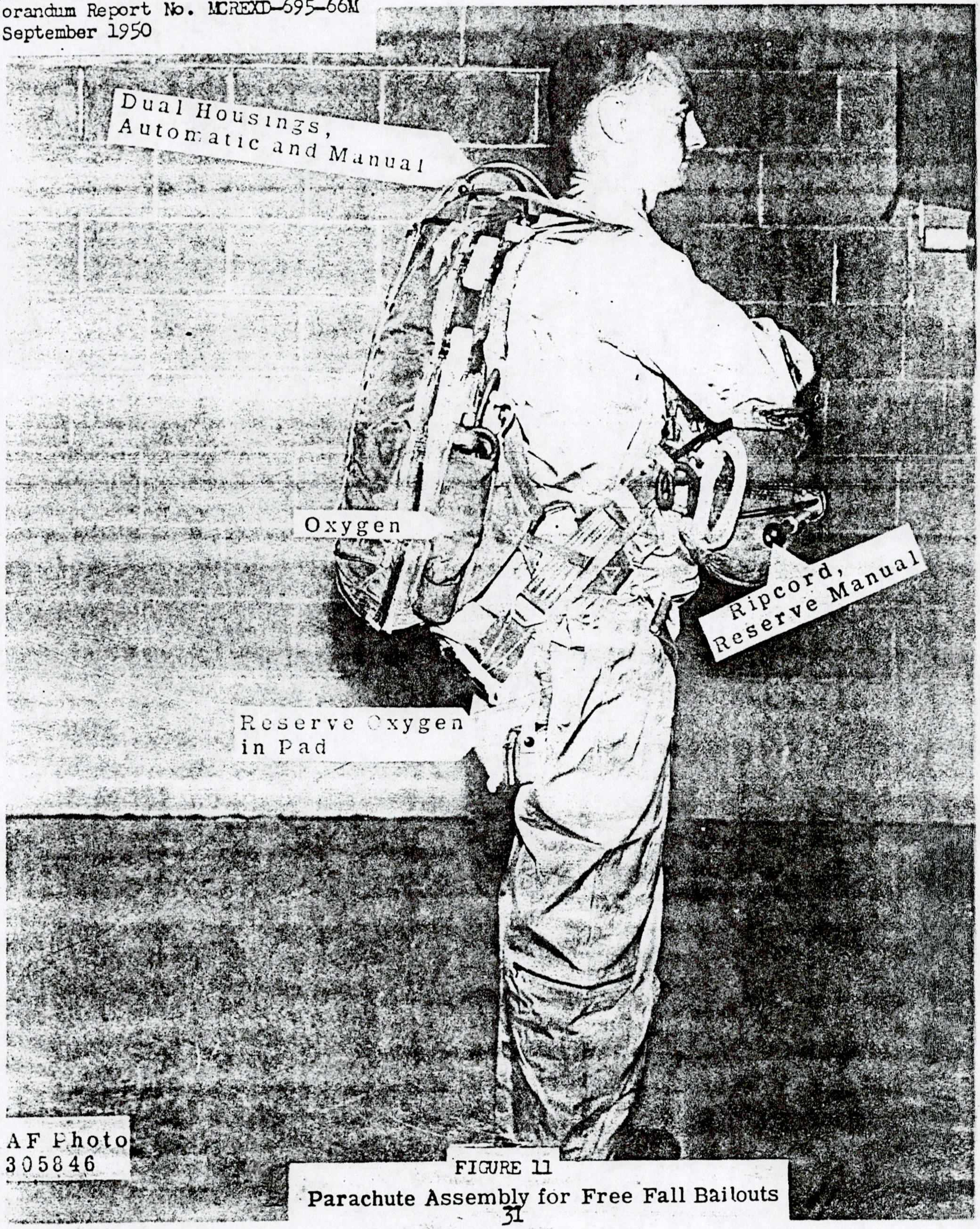


FIGURE 11
Parachute Assembly for Free Fall Bailouts

284913

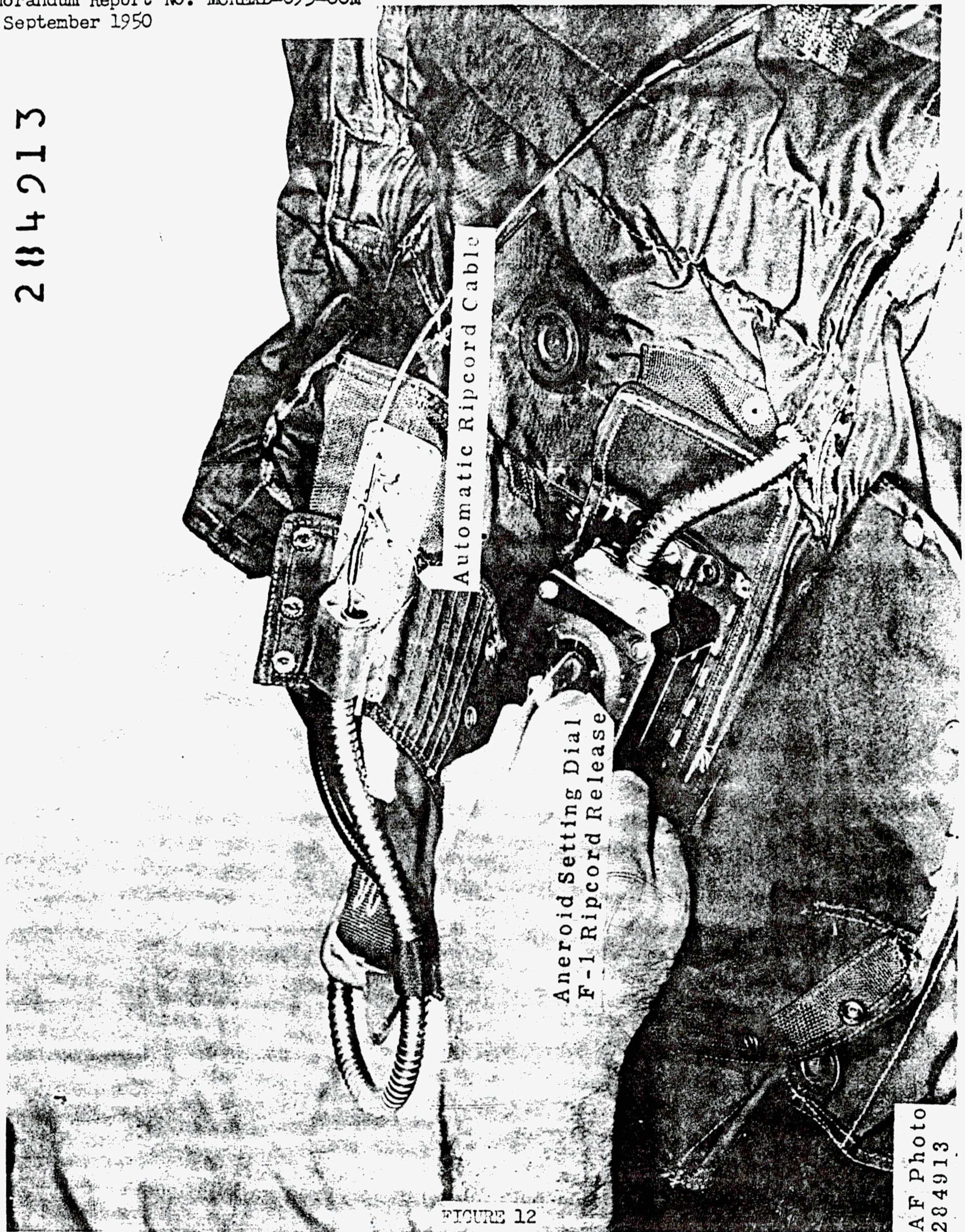
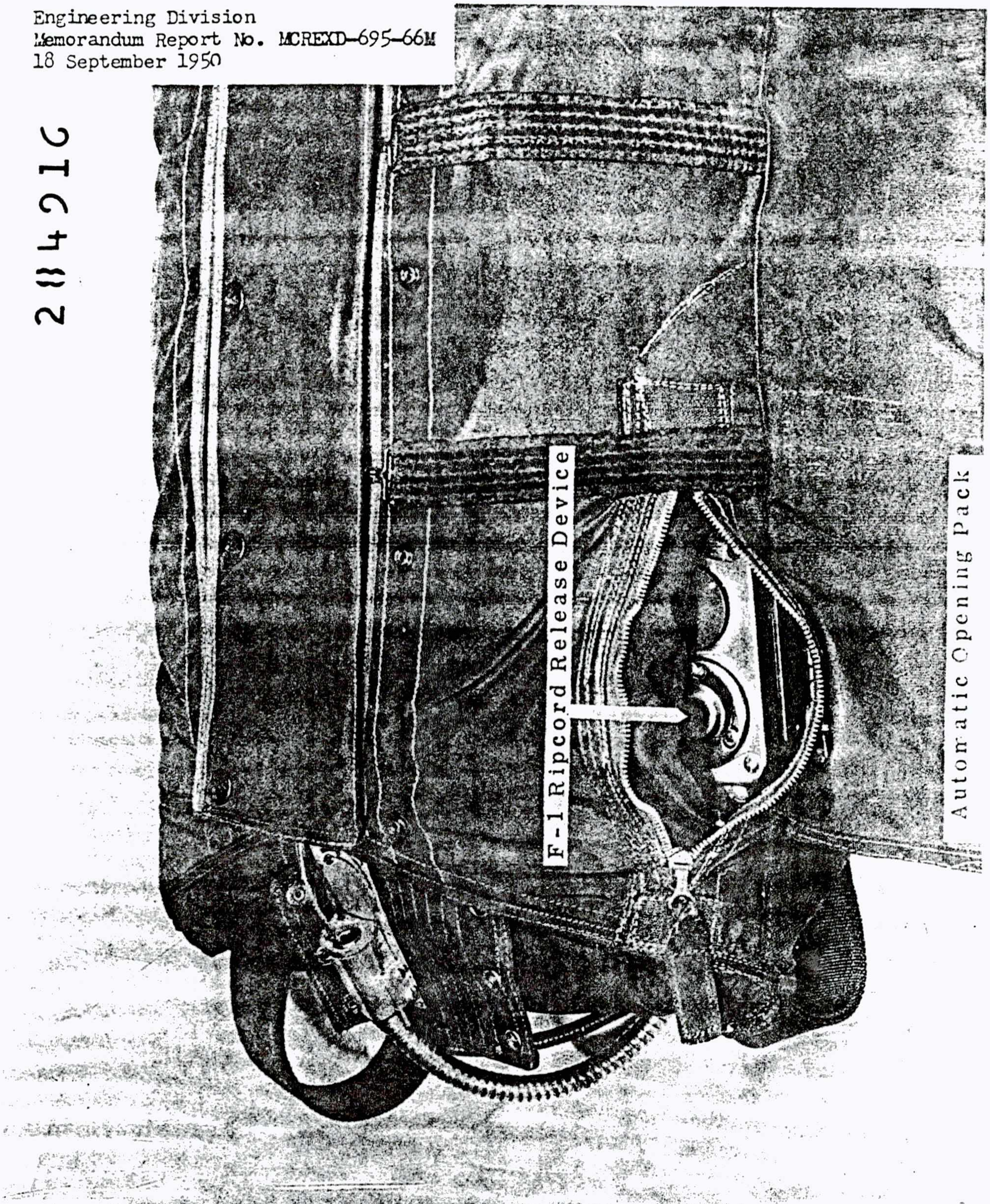


FIGURE 12

284916



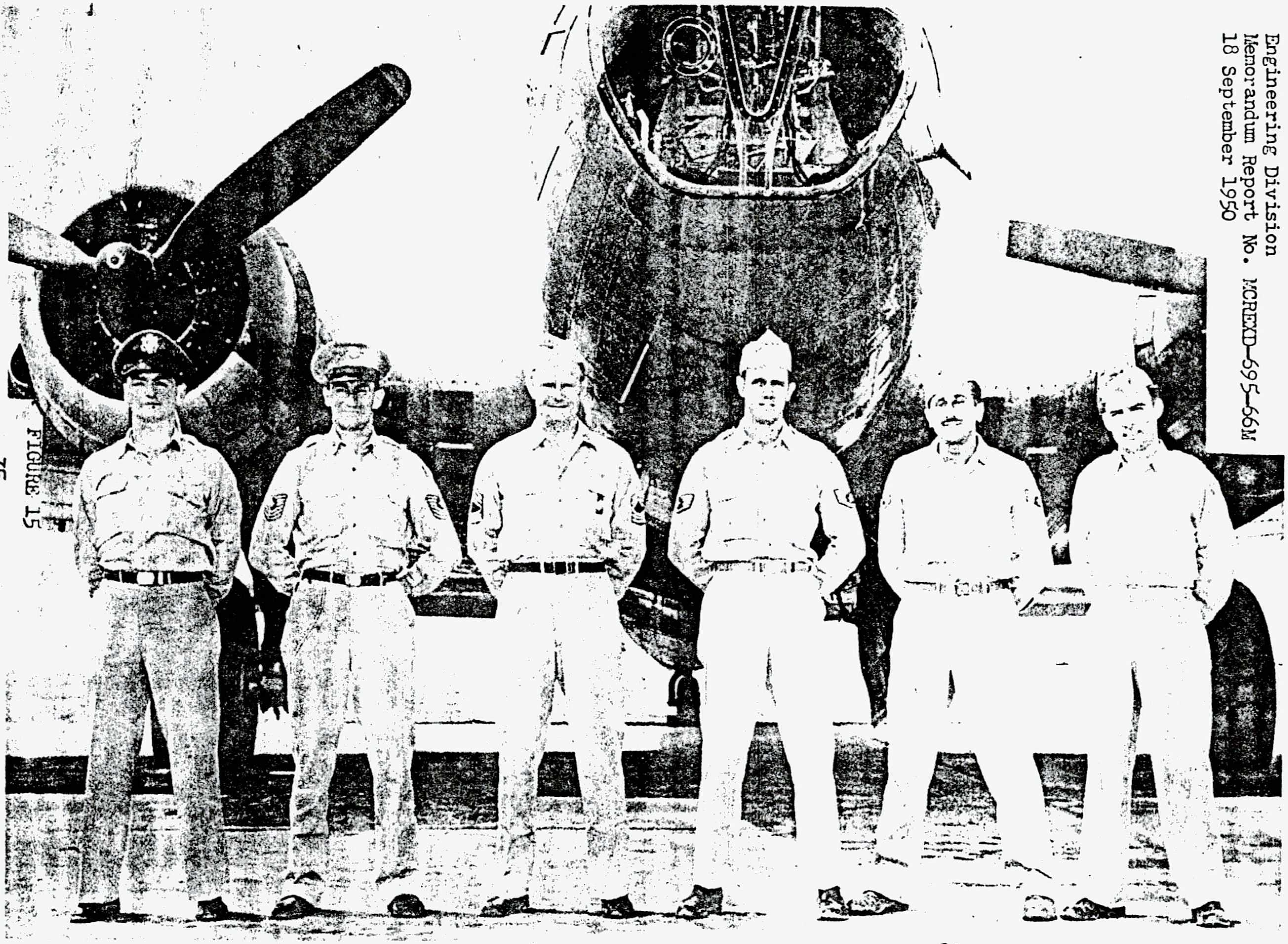
AF Photo
284916

FIGURE 13

FIGURE 14

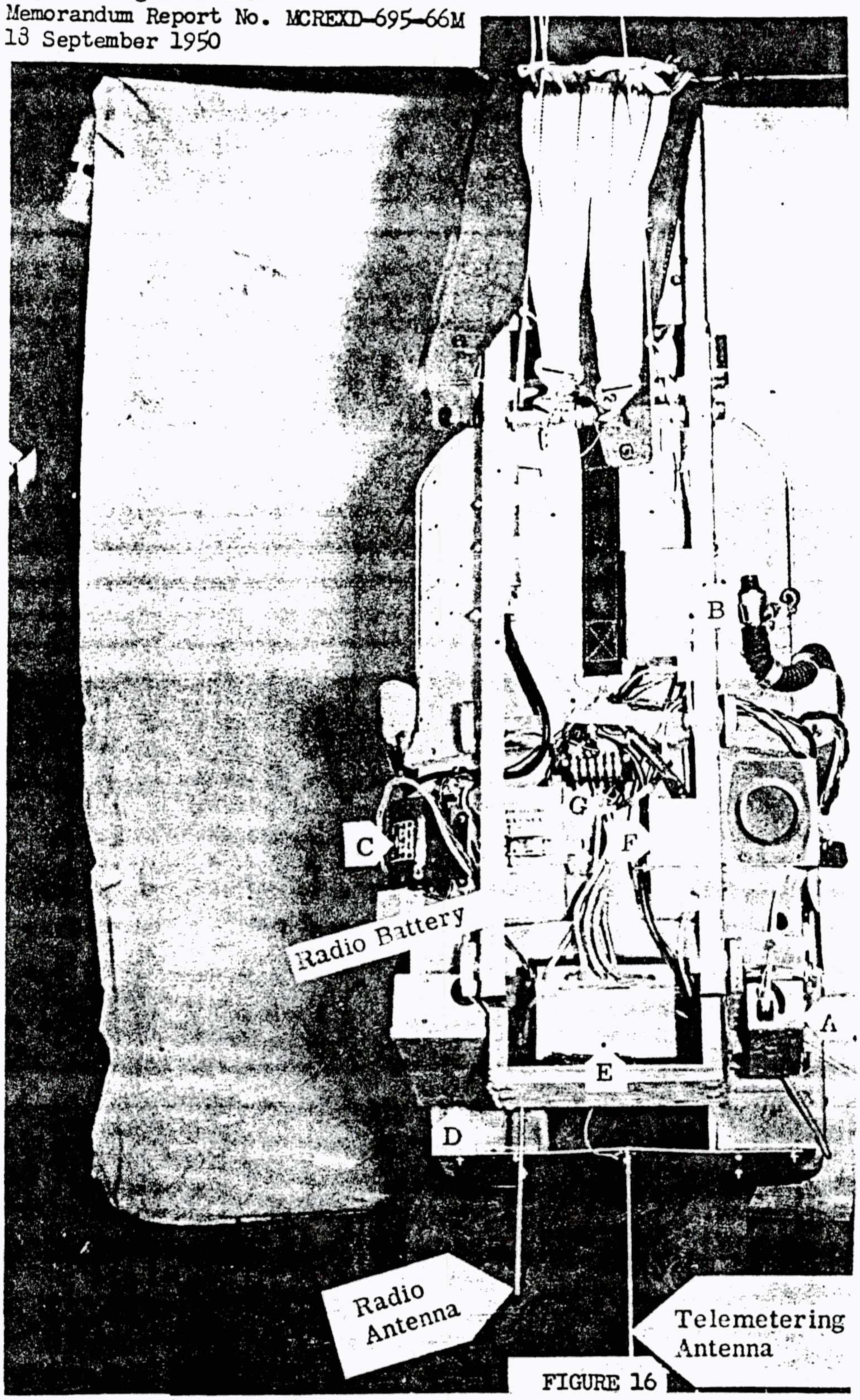
AF Photo 306254 Parachute Assembly for High Altitude Ejection Seat Drops

FIGURE 15



Test Jumpers

Capt. R.V. Wheeler, M/Sgt. J.F. Krul, M/Sgt. J.D. Smith, T/Sgt. G.A. Post, T/Sgt. V.A. James, Capt. V. Mazza



AKT-10
Telemetering System

A- EKG Amplifier
B- Telemetering Carrier Generator
C- Dynamotor
D- Battery Box (24 Volt)
E- Sub-carrier Generator
F- Junction box
G- Junction box

AF Photo
6857

FIGURE 16
Ejection Seat Equipped with Telemtering

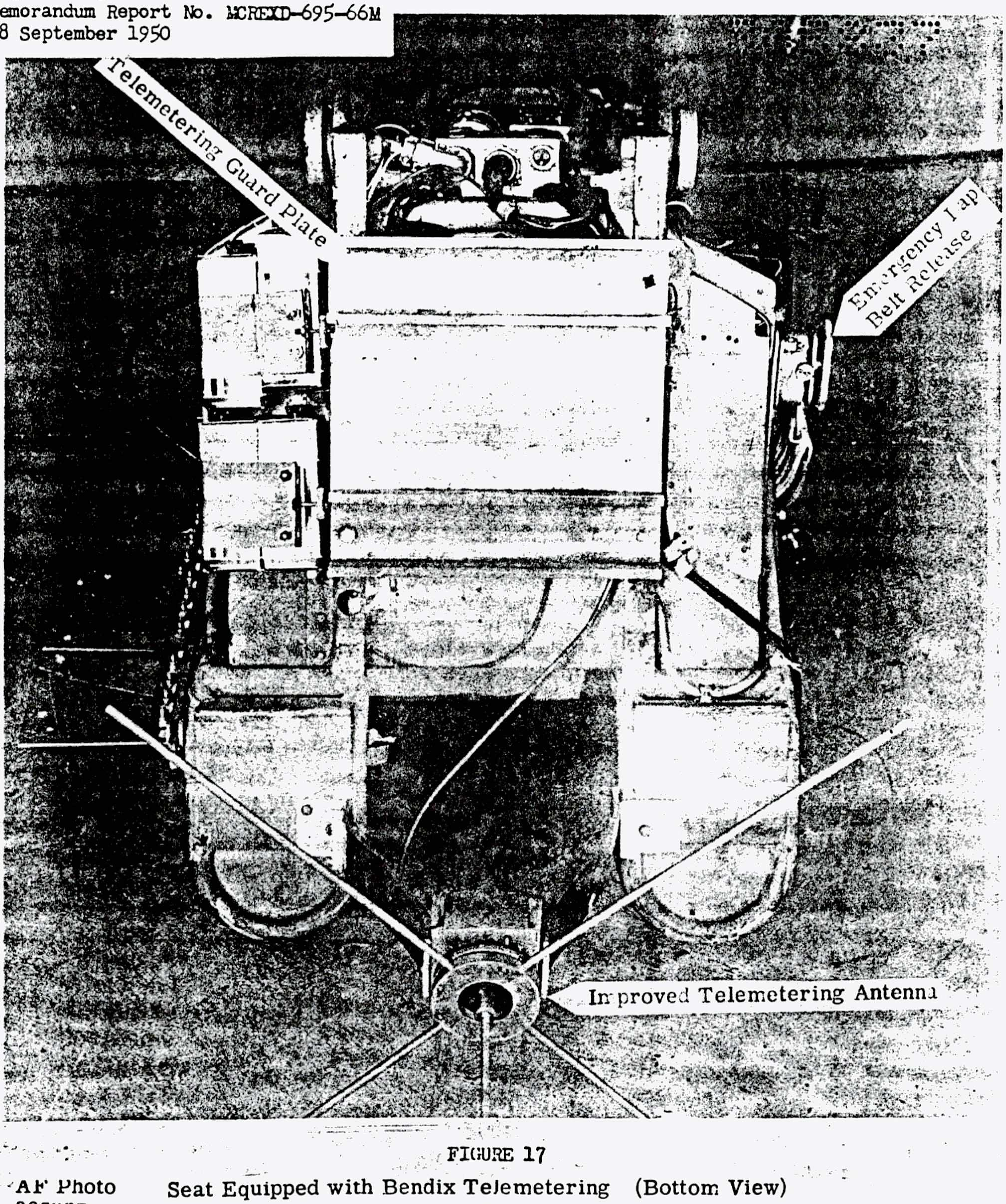


FIGURE 17

AF Photo 305837

Seat Equipped with Bendix Telemetering (Bottom View)

Engineering Division
Memorandum Report No. MCREXD-695-66M
18 September 1950

305836

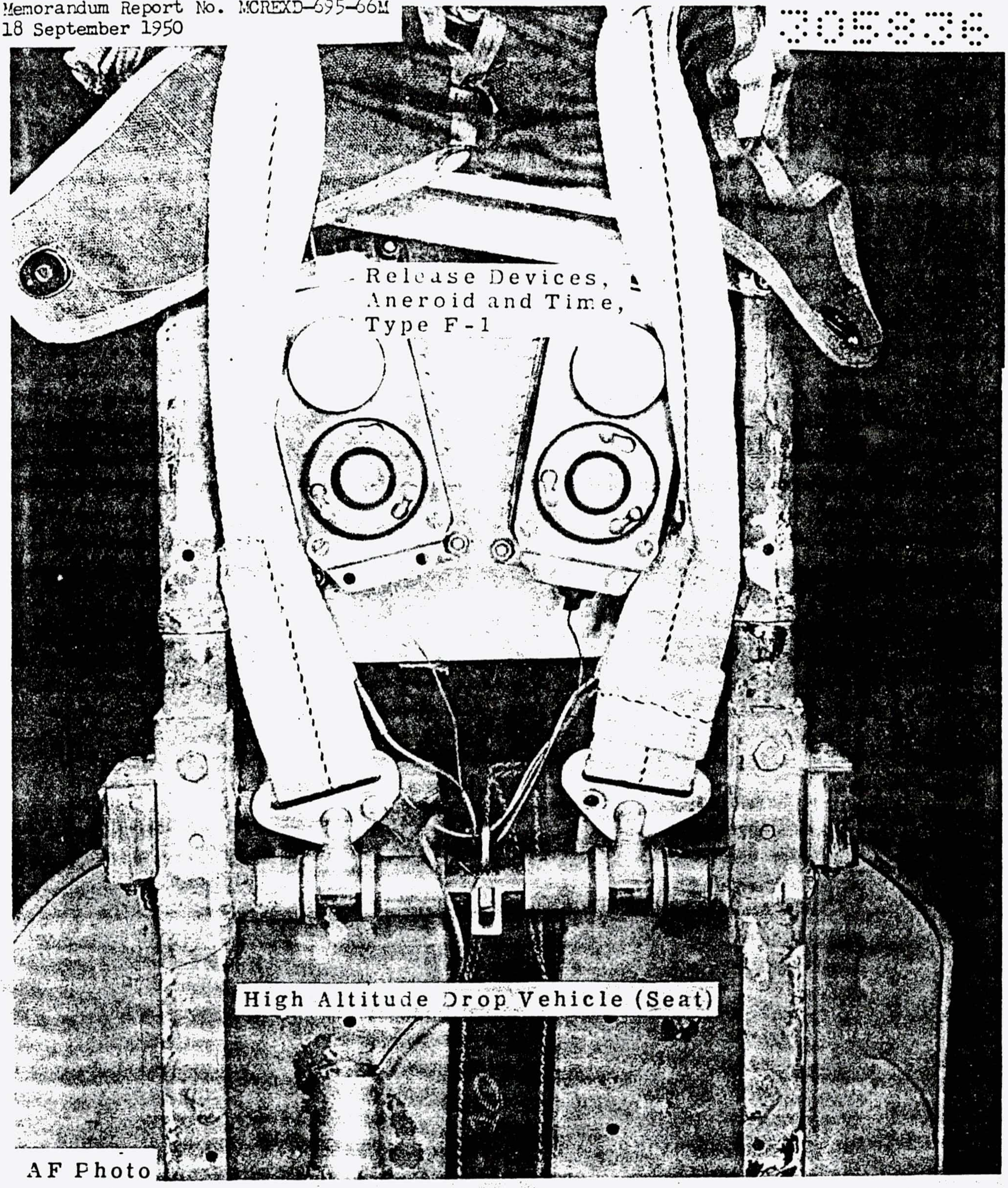


FIGURE 18

Engineering Division
Memorandum Report No. MCREXD-695-66M
18 September 1950

DISTRIBUTION

Director of Flight Safety Research
The Inspector General, USAF
Norton AFB, California
ATTN: Colonel W. Harris
Colonel C. N. Rogers

Commander
U. S. Naval Air Development Center
Johnsville, Pennsylvania
ATTN: Major T. J. Rail, Jr.
AMC Engineering Field Office

Commanding Officer
Bergstrom AFB
Austin, Texas
ATTN: Base Surgeon
27th Fighter Wing

Guggenheim Aviation Safety Center
Cornell University
2.E. 64th St., New York, N. Y.
ATTN: Mr. R. M. Woodham

141st General Hospital
APO 660
c/o Postmaster
San Francisco, California
ATTN: Colonel Walter H. Moursund, Jr.

V.J. Baczewski
Major USAF (MC)
57th Medical Group
APO 942
c/o Postmaster
Seattle, Washington

Wm. H. Ames
Department of Neurology
University Hospitals
The State University of Iowa
Iowa City, Iowa

Commanding General
Air University
Maxwell Air Force Base, Alabama

The Commandant
School of Aviation Medicine
Randolph Air Force Base
Randolph Field, Texas (196)

Automobile Manufacturer's Association
New Center Building
Detroit 2, Michigan
ATTN: Mr. W. F. Sherman

Army Medical Library
7th and Independence, S. W.
Washington 25, D. C.
ATTN: Aquisition Division

E. J. Blades, M. D.
Aero Medical Unit
Mayo Clinic
Rochester, Minnesota

Dr. H. R. Bierman
University of California Hospital
Parnassus and Third Avenue
San Francisco, California

British Supply Office
P. O. Box 680
Benjamin Franklin Station
Washington, D. C.
(C. E. Kerr, Aircraft Branch
Technical Services)

Department of Commerce
Civil Aeronautics Administration
Medical Division
Washington 25, D. C.

Distribution, Cont'd.

California Institute of Technology
Department of Aeronautical Research
Los Angeles, California

Cornell Aeronautical Laboratory
of Cornell Research Foundation, Inc.
4455 Genesee Street
Buffalo 21, New York
ATTN: Miss Elma T. Evans, Librarian

Cornell University Medical College
1300 York Avenue
New York 21, New York
ATTN: Dr. Emerson Day

Dr. Hugh DeHaven
NRC Crash Injury Research
Cornell University Medical College
1300 York Avenue
New York 21, New York

Commanding General
Air Proving Ground
Elgin Air Force Base, Florida

W. R. Franks
RCAF Accelerator Section
1107 Avenue Road
Toronto, Ontario, Canada

Dr. John Fulton
Yale School of Medicine
New Haven, Connecticut

Victor Guillemin, Jr.
University of Illinois
Physical Environment Unit
1853 W. Polk Street
Chicago 12, Illinois

Library of Congress
Aeronautics Division
Washington, D.C.

Joint Research & Development Board
Library Section
Third Floor
Washington 25, D. C.

University of Southern California
Aero Medical Unit
Los Angeles, California
ATTN: Dr. Lombard

Dr. George L. Maison
Boston University School of Medicine
80 East Concord Street
Boston 18, Massachusetts

Dept. of Aeronautical Research
Massachusetts Institute of Technology
Cambridge, Massachusetts

Department of Air Force Library
Maxwell Air Force Base, Alabama

Aero Medical Unit
Mayo Clinic
Rochester, Minnesota

Library
Harvard School of Public Health
695 Huntington Avenue
Boston 15, Massachusetts
ATTN: Dr. Ross A. McFarland

National Institute of Health
Bethesda, Maryland
(Dr. J. N. Stannard)

National Advisory Committee on Aeronautics
Langley Memorial Aeronautical Laboratory
Langley Air Force Base, Virginia
Thru: Air Materiel Command Engineering Liaison Officer

Distribution, Cont'd

National Advisory Committee
on Aeronautics
Flight Propulsion Research
Laboratory
Cleveland Airport
Cleveland, Ohio

National Advisory Committee
on Aeronautics
Ames Aeronautical Laboratory
Moffett Air Force Base, California

National Advisory Committee
on Aeronautics
Washington, D. C.

National Research Council
2101 Constitution Avenue
Washington, D. C.
ATTN: Detlev W. Bronk
Chairman, Committee on
Aviation Medicine

Director
Aviation Medical Research Laboratory
Naval Air Development Center
Johnsville, Pennsylvania

Aero Medical Laboratory
Fairbanks, Alaska

Naval Air Materiel Center
(Naval Aircraft Factory)
Philadelphia, Pennsylvania

Naval Air Materiel Center
(Naval Air Experimental Station)
Philadelphia, Pennsylvania

Office of Naval Research
Special Devices Center
Port Washington, Long Island
New York

Bureau of Medicine & Surgery
Navy Department
Washington 25, D.C.

Naval Medical Research Institute
National Naval Medical Center
Bethesda, Maryland

Aero Medical Unit,
Naval Air Materiel Center
Naval Air Experimental Station
Philadelphia, Pennsylvania

Naval School of Aviation Medicine
Pensacola, Florida

Bellanca Aircraft Corporation
New Castle, Delaware

Commanding Officer
Strategic Air Command
Offutt AFB
Omaha, Nebraska

Commanding General
Langley AFB, Virginia

Scientific Advisory Board
U. S. Air Force
Pentagon Building
Washington 25, D. C.

Cessna Aircraft Company
Wichita, Kansas

Gruman Aircraft Engineering Corp.
Bethpage, New York

Ryan Aeronautical Company
San Diego, California

Culver Aircraft Corporation
Wichita, Kansas

Distribution Cont'd.

Chance Vought Division
United Aircraft Corporation
Bridgeport, Connecticut

Sikorsky Aircraft Division
United Aircraft Corporation
Bridgeport, Connecticut

Beech Aircraft Corporation
Wichita, Kansas

Bell Aircraft Corporation
Niagara Falls, New York
ATTN: Mr Roy Sandstrom

Boeing Aircraft Company
Seattle, Washington
ATTN: Mr. E. C. Wells

Chase Aircraft Company, Inc.
West Trenton, New Jersey
ATTN: Mr. Stroukoff

Consolidated Vultee Aircraft Corp.
Fort Worth Division
Fort Worth 1, Texas
ATTN: Mr. R. S. Seabold
Thru: USAF Plant Representative

Consolidated Vultee Aircraft Corp.
San Diego Division
San Diego, California
ATTN: Mr. A. W. Abels

Curtiss-Wright Corp.
Airplane Division
Columbus, Ohio
ATTN: Mr. K. Ebel

Douglass Aircraft Co., Inc.
3000 Ocean Park Boulevard
Santa Monica, California
ATTN: Mr. Lusking

Douglas Aircraft Co., Inc.
El Segundo, California
ATTN: Mr. H. E. Himemann

Fairchild Aircraft Division
Hagerstown, Maryland

Glenn L. Martin Company
Baltimore, Maryland
ATTN: Mr. R. Shoultz

Goodyear Aircraft Corporation
Akron, Ohio
ATTN: Mr. D. W. Brown

Hughes Aircraft Corporation
Culver City, California
ATTN: Mr. H. E. Hopper

Lockheed Aircraft Corporation
Burbank, California
ATTN: Mr. C. L. Johnson

McDonell Aircraft Corp.
Lambert-St. Louis Municipal Airport
St. Louis, Missouri
ATTN: Mr. G. Covington

Northrop Aircraft, Inc.
Hawthorne, California
ATTN: Mr. Cerney

Republic Aviation Corporation
Farmingdale, Long Island, New York
ATTN: Mr. Alexander Katzeli

Commanding Officer
Holloman AFB
Alamogordo, New Mexico

Distribution Cont'd

Director, Research and Development
United States Air Force
Washington 25, D. C.
ATTN: AFDEN - Mr J. A. Ranasey

Chief of Staff, USAF
ATTN: Director of Intelligence, AFOIN

Requirements Division,
Army Field Forces
Washington, D. C.
Thru: Research and Development

Chief of Staff, USAF
Scientific Liaison of Research & Engineering Division
Room 4E-135, Pentagon Bldg.,
Washington, D. C.

Director, Research & Development, USAF
Washington 25, D. C.
ATTN: AFDRD-AV-2

Bureau of Aeronautics General Representative, Central District, USN
Wright-Patterson AFB
Dayton, Ohio

NAAS - Officer-in-Charge,
Parachute Experimental Unit
Naval Air Station
El Centro, California

NAF - Manager, Naval Air Materiel Command
Naval Aircraft Factory
U. S. Naval Base Station
Philadelphia 12, Pennsylvania
ATTN: Parachute Engineer

Naval Ordnance Laboratory
White Oak, Maryland

AMC Engr. Liaison Officer with BuAer for transmittal to BuAer

BuAer, Airborne Equipment Section
Washington, D. C.

Naval Air Station
Lakehurst, New Jersey

Office of Q. M. General, Military Planning Division
Room 2009, Temp. Bldg. "A"
Washington 25, D. C.

Civil Aeronautics Administration
(W-301) Equipment Section
Washington, D. C.
ATTN: Mr. J. Vitol

AMC Engrg. Liaison Officer, NACA
Langley Field, Virginia

AMC Engrg. Liaison Officer, NACA
Ames Aero. Laboratory
Moffett Field, California

Director, Ames Aeronautical Laboratory
Moffett Field, California

Commanding Officer, Holloman AF Base
Alamogordo, New Mexico

C. O., 3345th Tech. Training Group
Chanute Field, Illinois
ATTN: Personnel Equip. Technician Course

M. Steinthal and Co., Inc.
222 Fourth Avenue
New York, New York

Reliance Manufacturing Co.,
2121 West Monroe Street
Chicago, Illinois

General Textile Mills, Inc.
450 Seventh Avenue
New York, New York