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DEV. OF HIGH WIND LAUNCHING SYSTEM

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ENGINEERING RESEARCH & DEVELOPMENT DEPARTMENT

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* 13 Photographs

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Mechanical Division
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Minneapolis 13, Minnesota

DEVELOPMENT OF HIGH WIND LAUNCHING SYSTEM

By
P. E. YOST

Project 85028
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Prepared for:
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INTRODUCTION

The art of ballooning has progressed rapidly in the past few years. This has been accomplished primarily by the use of newly developed construction materials, modern manufacturing techniques, and new balloon designs.

Unfortunately, an inflated balloon is a very large vehicle and, consequently, it is also a large obstruction for surface winds to strike.

The balloon industry has constantly been plagued by the problem of launching a unit under adverse weather conditions.

To meet the requirements of a scientific group who wished an all-weather operation, it was decided to attempt to develop a high wind inflation and launching system.

The balloon to be used in the final phase of this operation would have a volume of 16,000 cubic feet and would be fully inflated (or nearly so) at the time of launching.

This report will very briefly describe some of the problems which were encountered and the action taken to further improve the system.

Although much progress has been accomplished during these experiments, it must be understood that a vast amount of knowledge remains to be obtained. A feasible high wind launching technique for any type or size of balloon can be developed by further investigation and experimentation.

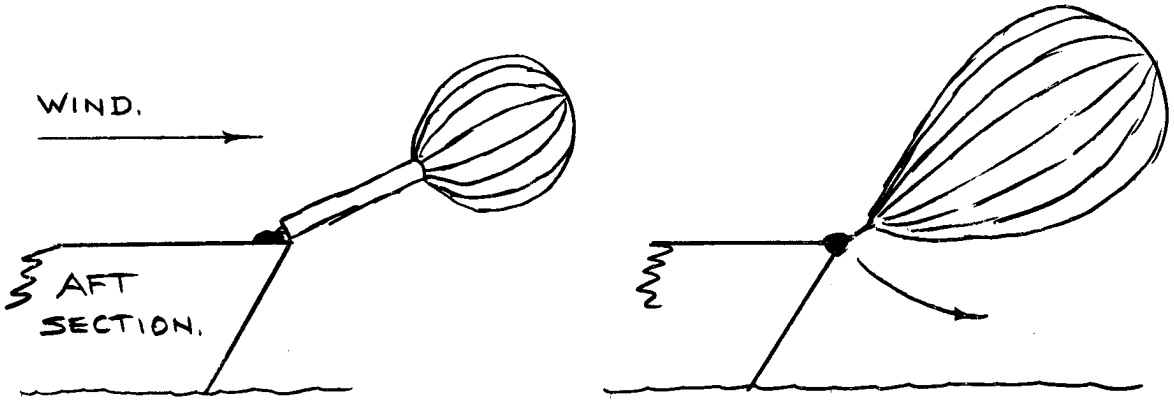
DEVELOPMENT OF A HIGH WIND LAUNCHING SYSTEM

A preliminary study was conducted in order to ascertain the most feasible method of conducting a satisfactory launching program with surface wind velocities up to twenty miles per hour.

Two types of inflation methods seemed to be adaptable and it was decided to conduct scale model inflations under actual high surface wind conditions.

The first type of inflation conducted was a method whereby the balloon was encased in a shroud. This test was conducted on the afternoon of June 10, 1955, and the surface wind velocities were fifteen to twenty miles per hour. In this experiment an old 25-foot diameter shelf balloon was used as the vehicle and the encasing shroud was a standard flat 24-foot diameter parachute. Although this operation was completely unsuccessful, it presented much information which could be analysed for the development of a refined launching program for future operations.

The second type of inflation used was a horizontal downwind method. This test was conducted on the afternoon of June 11, 1955. Surface wind velocities were again fifteen to twenty miles per hour and very suitable for this type of experiment. The aft section of a helium trailer was used as a platform to support the payload as far as possible from the ground. When inflation is begun, a tight bubble is maintained at all times; and, when inflation is completed, the load would be released and would swing under the balloon. This experiment, too, was unsuccessful; but enough information was gathered to indicate that, with minor balloon structure changes, successful launchings could probably be conducted from land or water in very high surface winds.



On the afternoon of June 23, 1955, a surface wind of fifteen to twenty miles per hour provided satisfactory conditions for the first simulated launching using a large balloon. A sixty-four foot diameter flat parachute was used as a protective shroud over a 34-foot diameter natural shape, open appendix balloon. The launching area was restricted to a rectangle having dimensions of 22' x 25', thus simulating the actual size which would be used in the final operation. A screw in type ground anchor was installed in each of the four corners of the rectangular working area. These were used as attachment points to connect and restrict the shroud during the inflation process.

The balloon vehicle and attached gondola were completely enclosed in a box which could be opened and disassembled after inflating and prior to launching. Refer to attached photographs for method of diffuser attachment and accordion type of balloon folding used to enable a box-type of inflation.

The inflation procedure progressed very satisfactorily, although it was noted that some changes would be necessary to improve the system for future use. After the balloon was completely inflated, it was decided to attempt a launching in order to gain as much information as possible from the experiment.

Two nylon safety lines, each 150 feet long, were attached to the balloon and extended downwind, where they were attached to ground anchors. These were to allow the balloon to be launched from the shroud but to maintain it in a captive form, so that it could then be destroyed. The downwind restraining lines of the shroud were released, thus allowing the balloon to make an "Under the Side" launch. The balloon became airborne in a satisfactory manner, but the nylon safety lines yielded, thus allowing the balloon to make an unplanned flight carrying 750 pounds of sand.

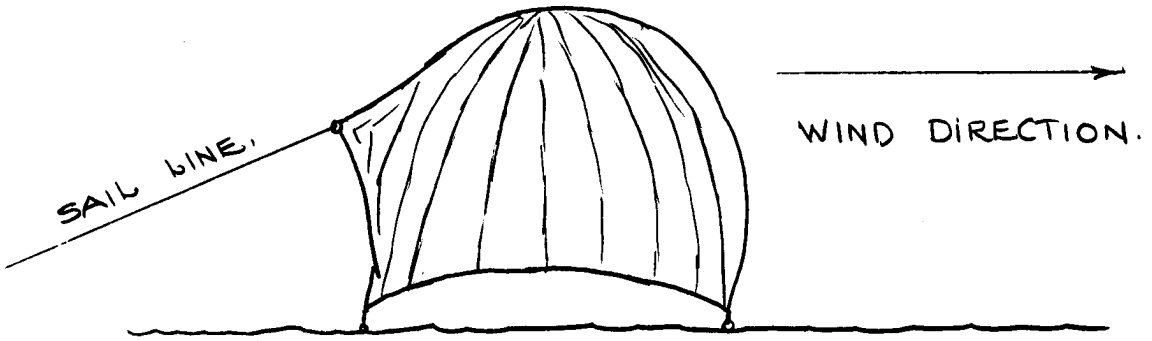
Enough information was gathered to establish a definite launching procedure and to design a restraining shroud for the purpose of launching this type of balloon. The new type of shroud would:

1. Be manufactured from Orlon material to minimize the generation of a static electrical charge. (New York University Technical Report No. 208.04 prepared for Signal Corps Engineering Laboratories.)
2. Be circular in shape.
3. Be manufactured in two sections, which could be released rapidly by a chain-type of lacing for rapid launching.

A demonstration launching was planned and conducted on June 28, 1955 - Flight No. 1434. This day provided the most severe surface winds which we had encountered throughout this series of tests. The new type of Orlon shroud was not yet completed, so it became necessary to resort to the 64-foot diameter parachute as a launching shroud. The inflation process and launching were conducted without mishap, and a routine manned balloon flight ensued.

The next demonstration flight was conducted on June 30, 1955 - Flight No. 1435 - and was accomplished with the aid of the manufactured launching shroud. Although this experiment was very successful in all phases, it was noted that many modifications in the system would be required in order to simplify the inflation and launching process. A study of the experiment and photographs acquired during the test suggested the following changes:

1. The accordion-type of balloon folding and box-type of inflation would not be necessary.
2. A system employing four block and tackle assemblies at the anchor points would ease the inflation process. The four controlling lines to the blocks could be extended above the ground to a central location, thus allowing one man to raise the shroud as inflation progressed.
3. One line attachment point on the upwind side of the shroud would be beneficial for the purpose of forming a sail during the inflation. This line would be attached to a ground anchor upwind of the shroud and maintained taut until the balloon began to fill the shroud completely. The effect of this practice would be to maintain the bubble in a vertical position during early stages of inflation and to minimize the whipping of the shroud material by the wind.

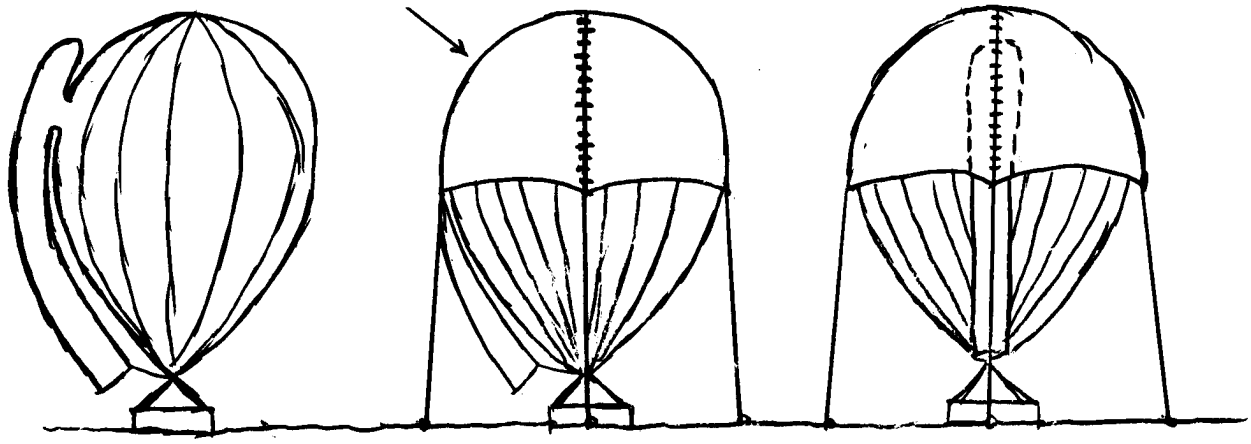


The system was prepared and used in the launching of balloon Flight No. 1445 on the morning of July 21, 1955.

This is the only balloon which received any damage throughout the tests by the shroud type of launching.

The balloon used was a 343P, which was equipped with an external duct appendix.

The duct was situated at a 90° angle to the shroud opening during inflation; and, upon shroud release at launch time, the entire shroud section passed over the duct and duct attachment, which caused a small fracture in the balloon envelope. Future production balloons should use the new type of integral duct, which would eliminate this possibility of balloon damage. On the standard present type of balloon, the duct will not be damaged if it is guided into a position directly under the lacing during inflation. Thus, during the launching process, a minimum amount of shroud material will pass over the duct.



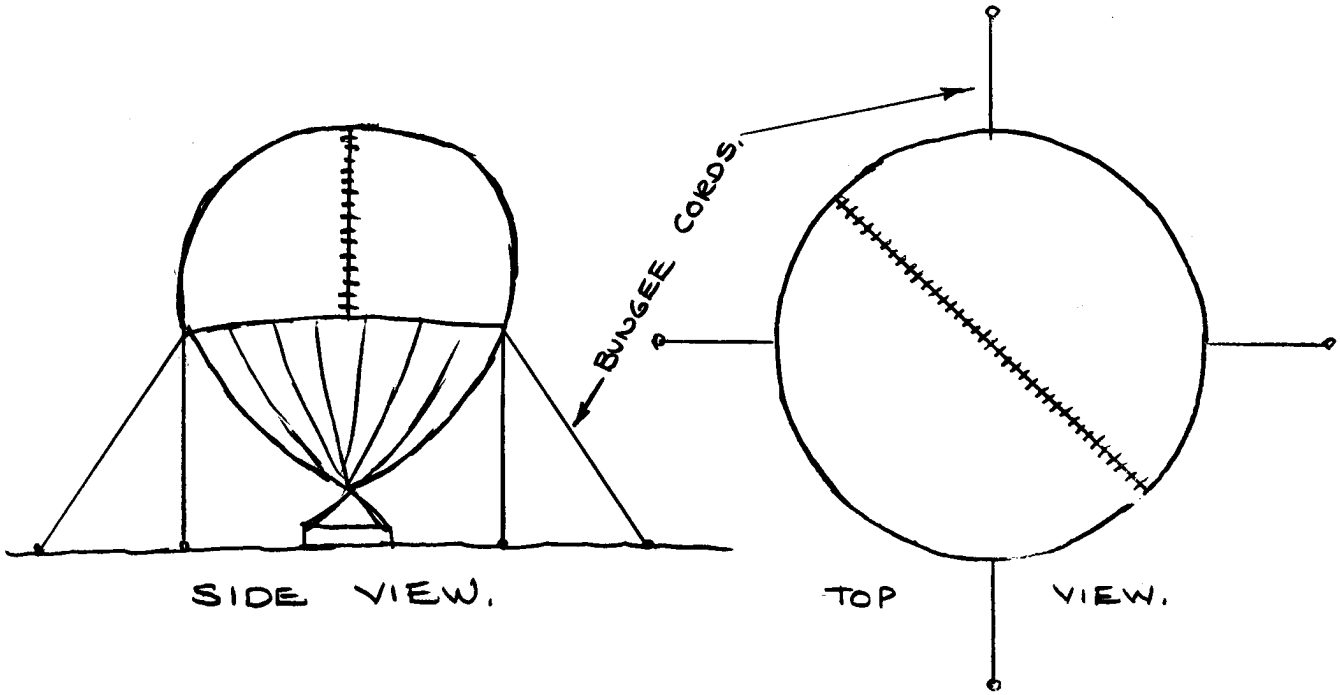
PRESENT TYPE OF EXTERNAL DUCT. (302P & 343P.)

BALLOON DAMAGED AT ARROW WHEN SHROUD RELEASED

DOTTED LINE SHOWS DUCT POSITIONING TO ELIMINATE DAMAGE.

Other changes suggested by a study of the preceding experiment are:

1. To simplify the unlacing system, whereby the present chain stitch type of lacing would be replaced by a system of interlocking attached loops.
2. To add a swivel eyelet at the top of the balloon, which would be held in place by the shroud release pin. This would keep the balloon centered in the shroud during inflation.
3. To tailor the shroud into the shape required to fit a fully inflated, shroud-restrained balloon. The shape was derived by a method of photographic abstraction using former flight shroud photographs as models.
4. To attach a bungee cord between the four anchor points of the shroud and a ground anchor at the base of each corner. These units would provide an additional force which would accelerate the removal of the shroud from the balloon at release time.



Upon completion of the aforementioned modifications, a field trip to Huron, South Dakota, was made to test the shroud's operating characteristics.

The first flight was conducted on October 18, 1955 (Flight 1527), which was a 180 system experiment, using a partially inflated 33.8 balloons. Surface winds were light, and no difficulties were encountered throughout the inflation and launching processes. A great improvement was noted in the operation of the interlocking loop type of shroud release, the balloon cap centering attachment to the shroud, and in the tailored shape of the shroud which was both adequate in size and shape.

The second flight was launched on October 19, 1955 (Flight 1480), which utilized a type 302P personnel-carrying balloon. The surface winds were very light before and during the inflation process; but, due to the urgency of the development program, it was decided to proceed, rather than to wait for high wind velocities. Upon launching, it was noted that the balloon had slight difficulty in freeing itself from the shroud. A post-launch discussion revealed that a surface wind is beneficial for a shroud-type of balloon launching, due to the added forces provided, which aid in the release action. It was decided to modify the shroud in order to obtain a four-way releasing action, which would separate the shroud into four separate sections before conducting the next flight.

This modification was incorporated and preparations were made to launch Flight No. 1528 (a 180 system experiment) on October 25, 1955. When the shroud release pin was tripped, the unlacing action began to function in all four quadrants; but, due to the unequal forces prevailing at each release seam, the unlacing action began to malfunction.

The shroud again was constructed so as to release into two sections, and very successful operations were conducted on October 26, 1955 (Flight No. 1529) and October 27, 1955 (Flight No. 1530), both of which were 302P personnel carrying balloons.

After reviewing all of the information gathered in the preceding experiments, it was now possible to design and construct a shroud of refined and finished proportions.

This was accomplished using a lightweight Orlon material, which was cut into tailored gores and sewn together to form the two halves of the completed shroud. Many other structural design improvements of lesser importance were incorporated in the manufacture of the refined launching shroud.

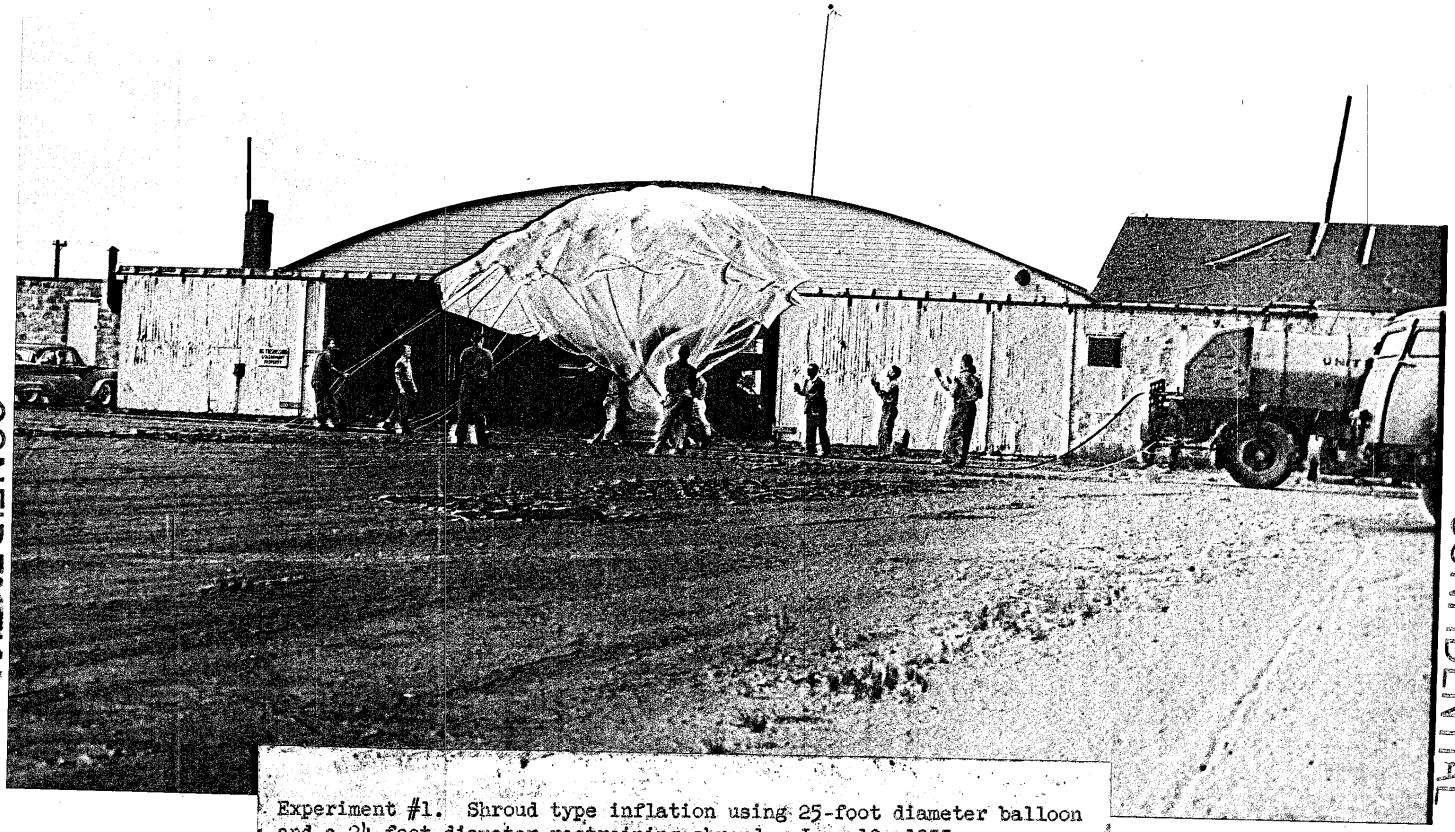
In order to verify a satisfactory operation of the new shroud, two flights (No. 1613 - 12/20/55 and No. 1614 - 12/21/55) were flown with ease and the shroud development program was considered completed for this type of operation.

An invitation to witness a series of demonstration launchings was extended to our sponsors of the program, and a series of four flights ensued.

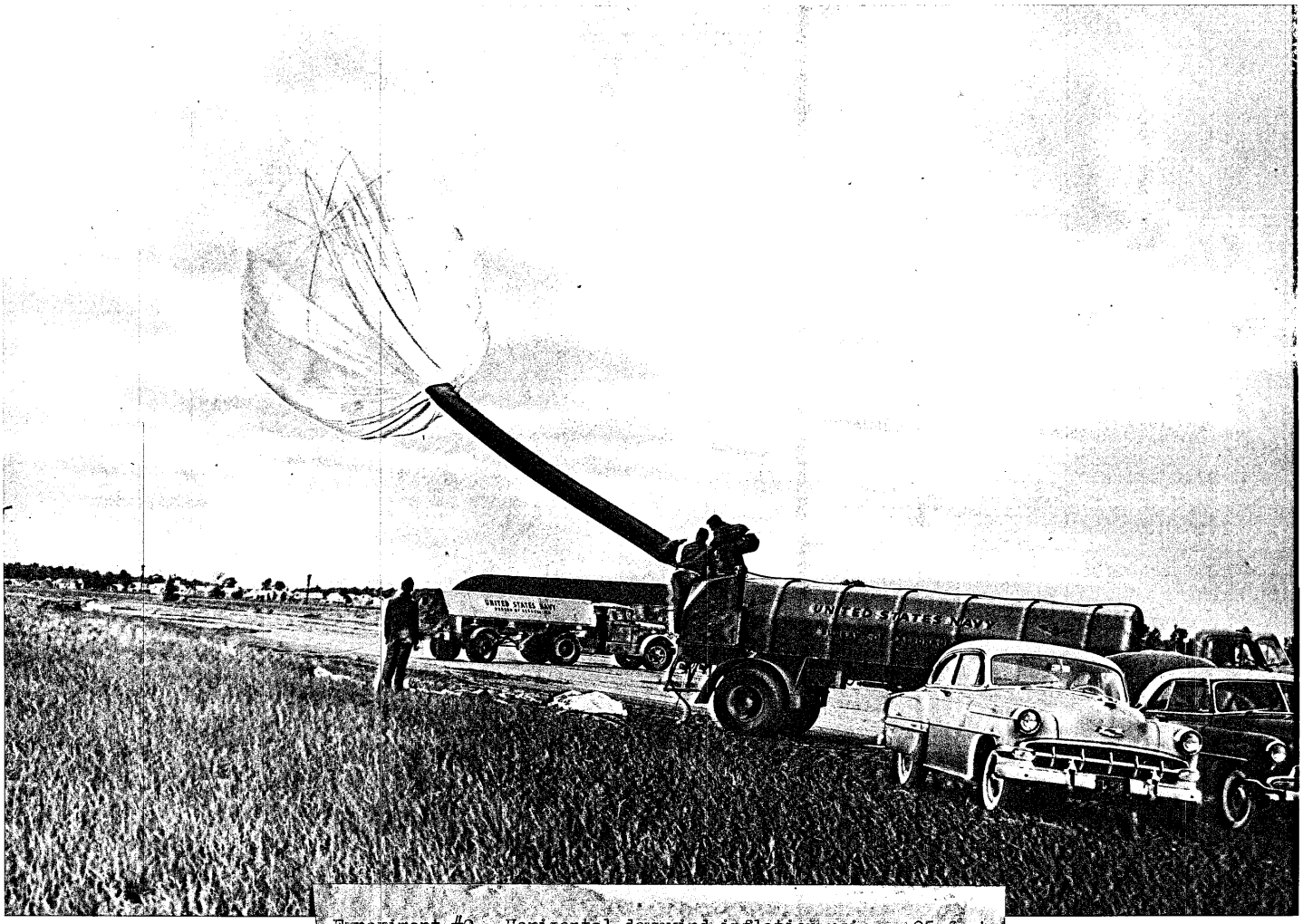
Each of the four flights was launched by a three-man crew. The balloons were rendered airborne under adverse weather conditions without difficulty, whereas an operation of this sort would have been impossible prior to this development program .

I wish to thank all of the people who participated so energetically with great cooperation throughout this series of experiments. Although many hazards existed and many unknown factors prevailed, no person objected at any time.

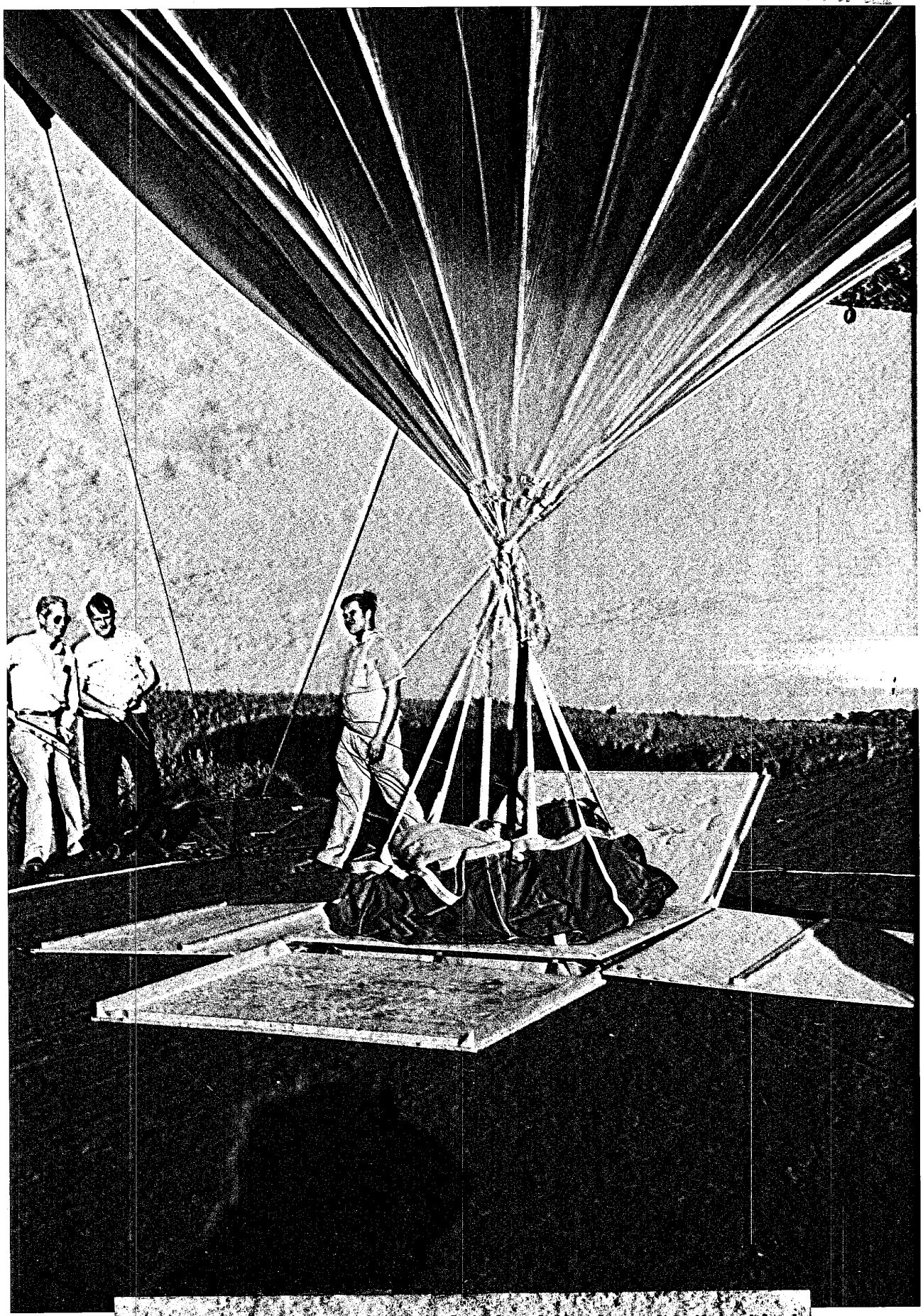
Our group can be very proud to have developed a launching system so satisfactorily in such a short period of time. This system will enable the balloon industry as a whole to progress more rapidly and perhaps more successfully.



Experiment #1. Shroud type inflation using 25-foot diameter balloon and a 24-foot diameter restraining shroud. June 10, 1955.

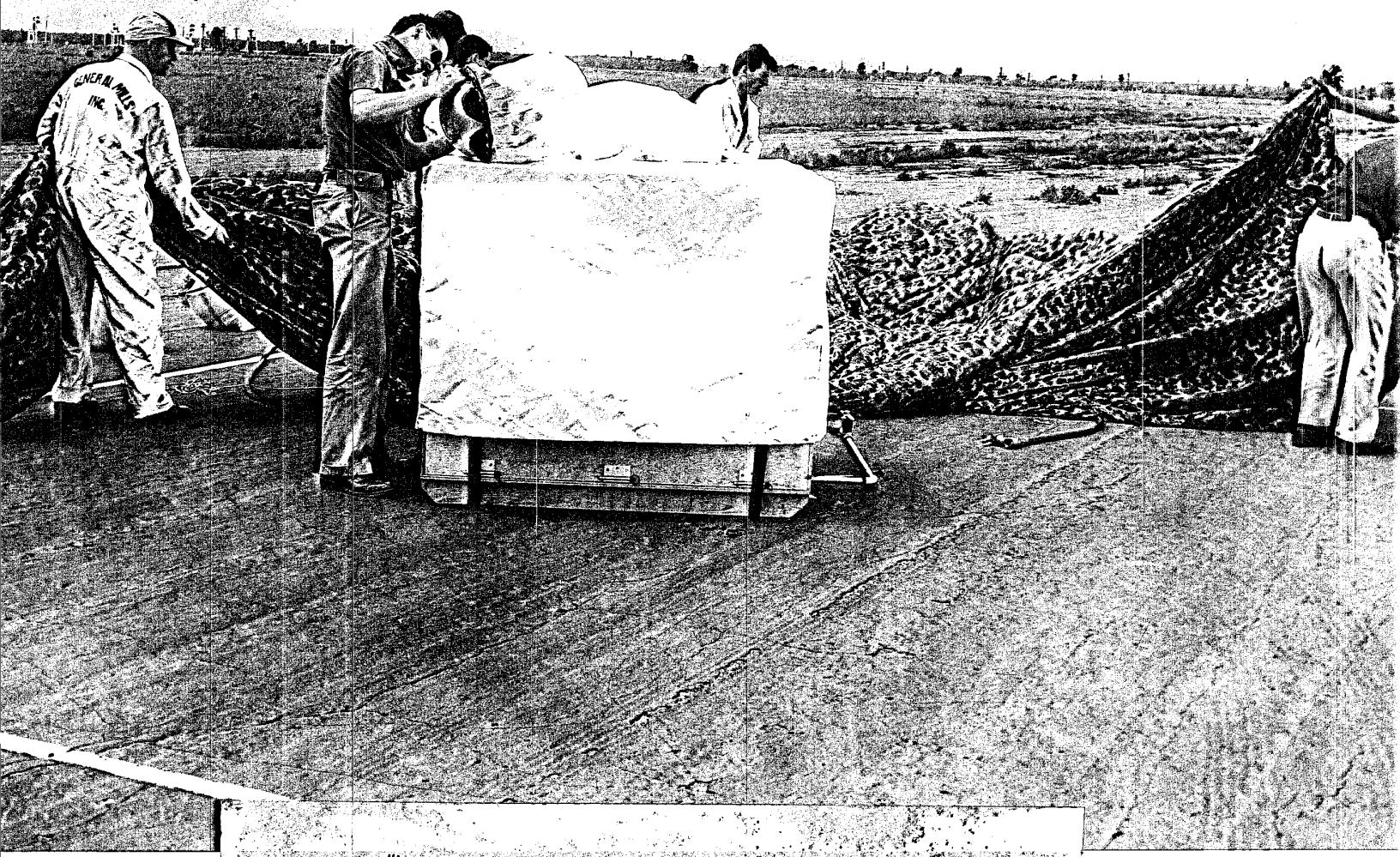


Experiment #2. Horizontal downwind inflation using a 25-foot diameter balloon. June 11, 1955.

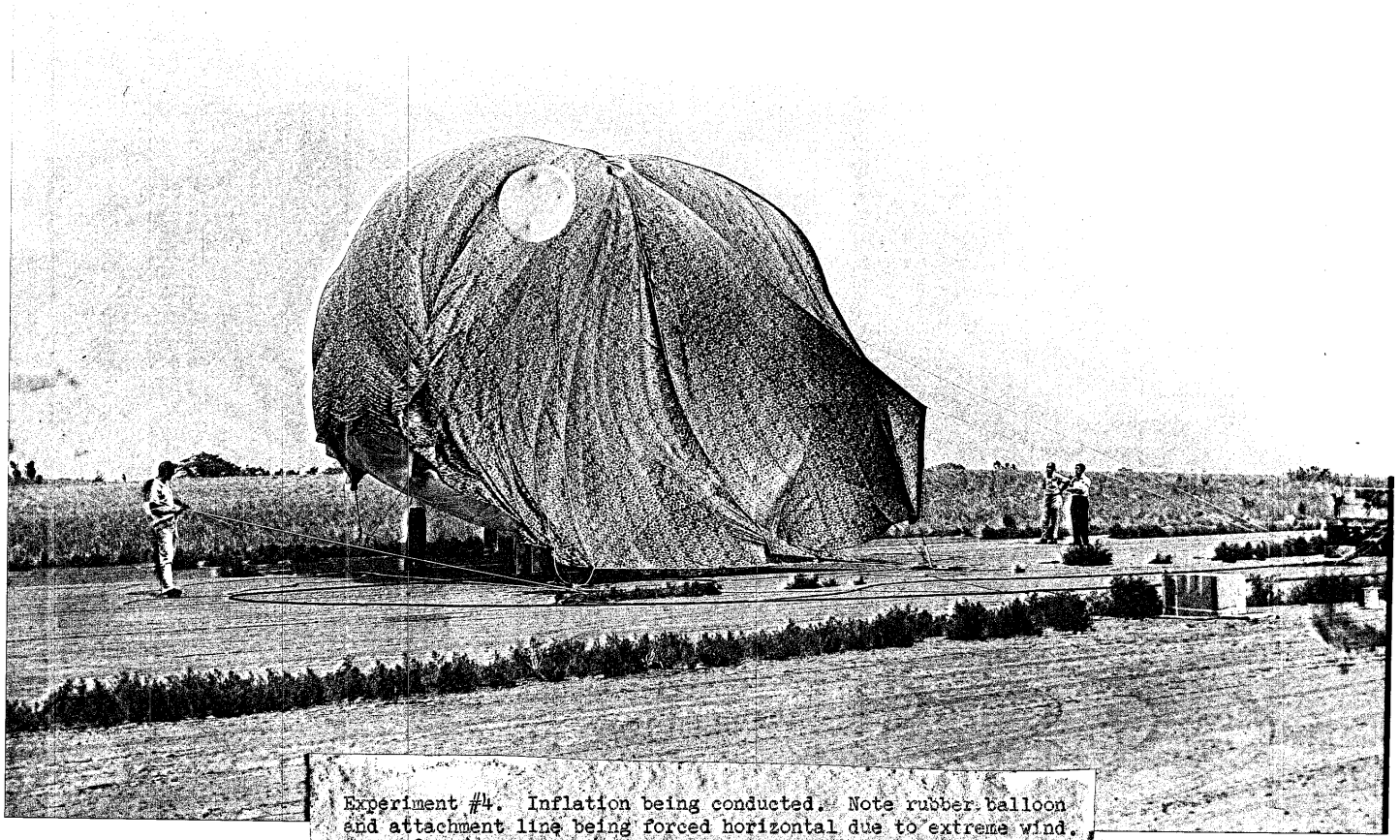


Experiment #3. Inflation completed and box opened. Note black inflation hose with diffuser attached.

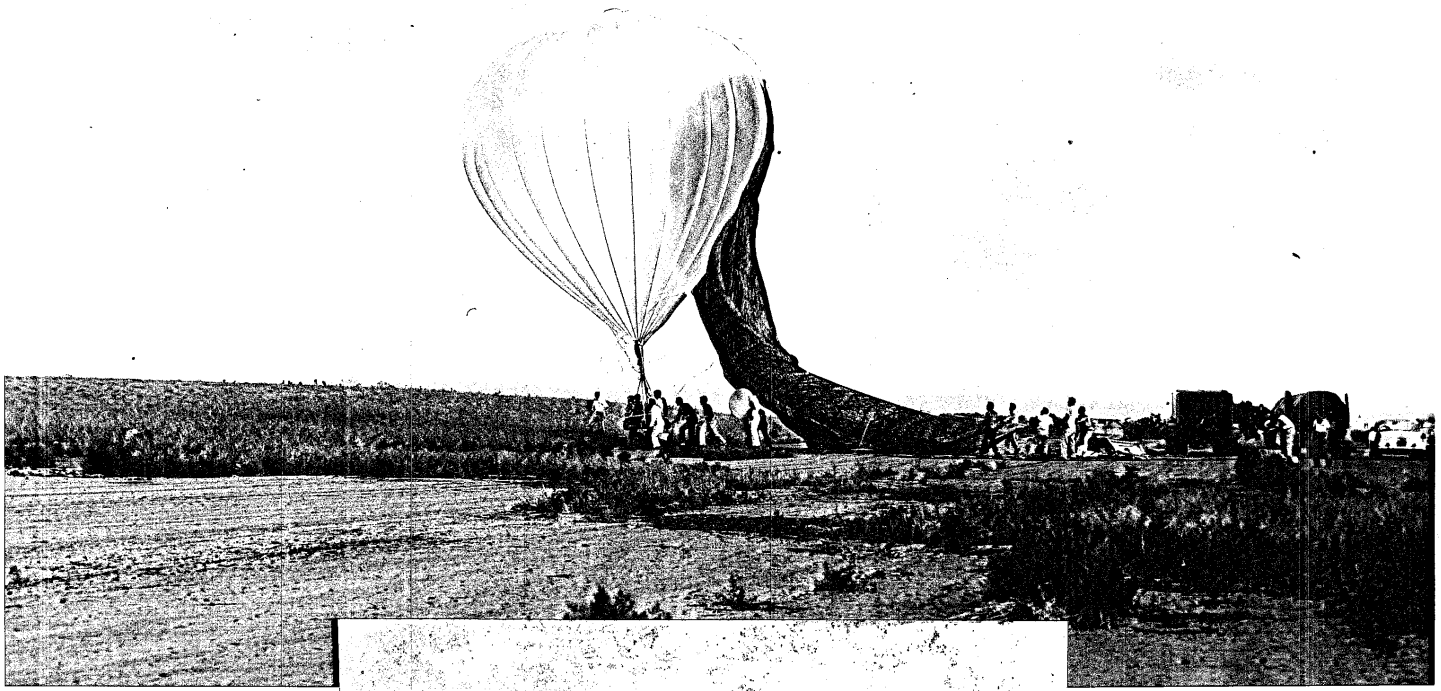
Experiment #3. "Under the Side" launching. June 23, 1955.



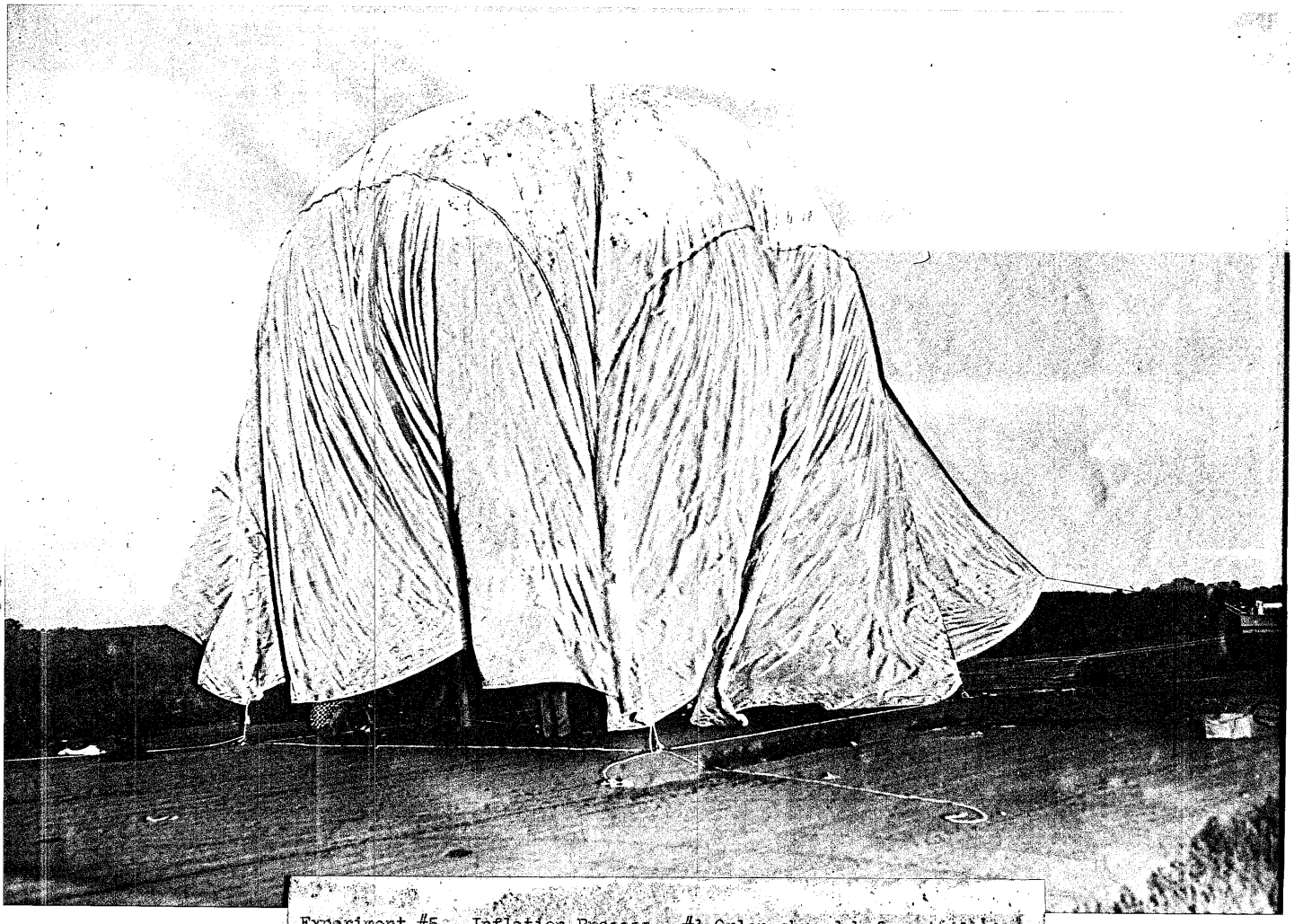
Experiment #4. Layout prior to inflation. Note aluminum shell over gas valve for protection against damage. June 28, 1955.



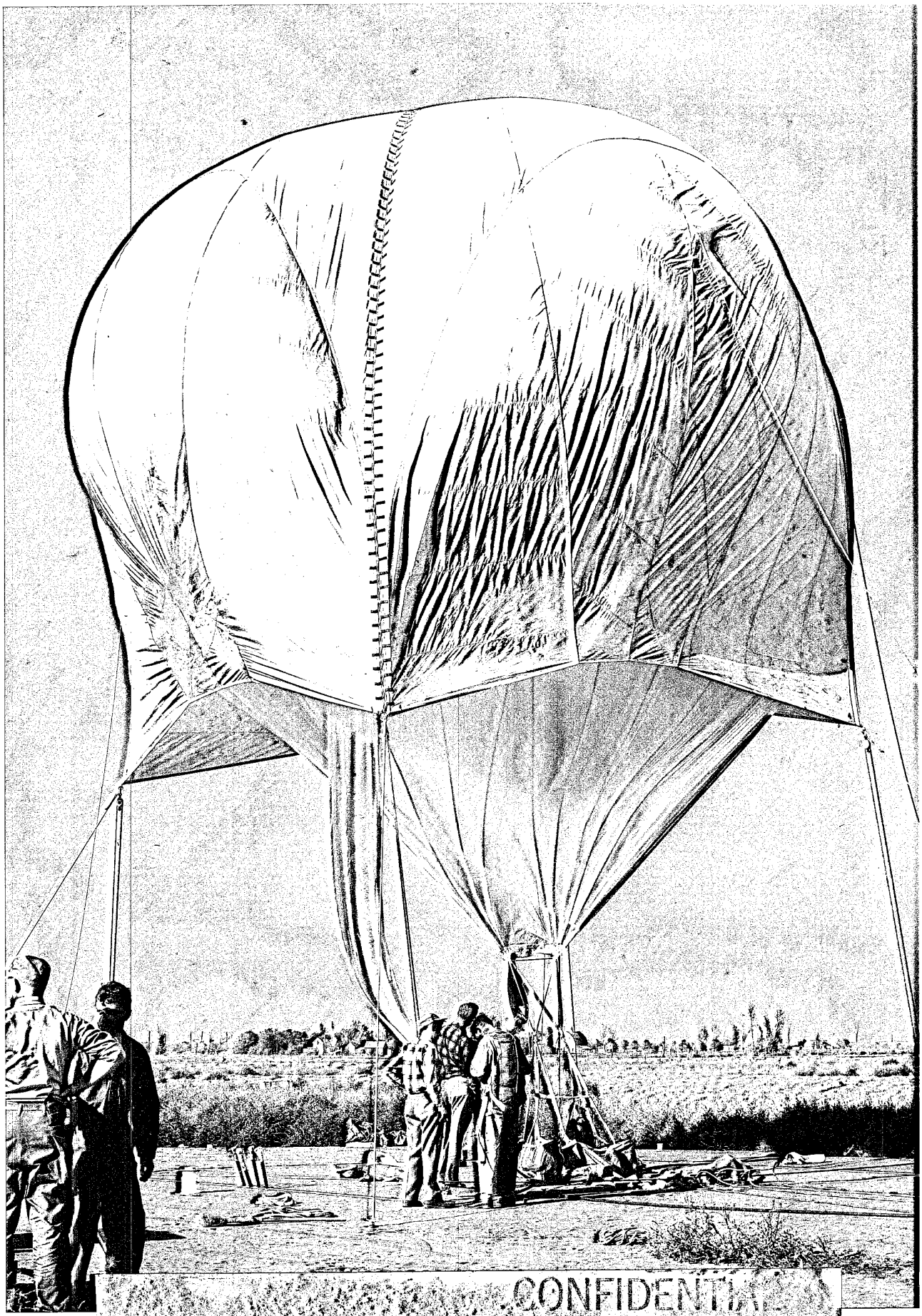
Experiment #4. Inflation being conducted. Note rubber balloon and attachment line being forced horizontal due to extreme wind. June 28, 1955.



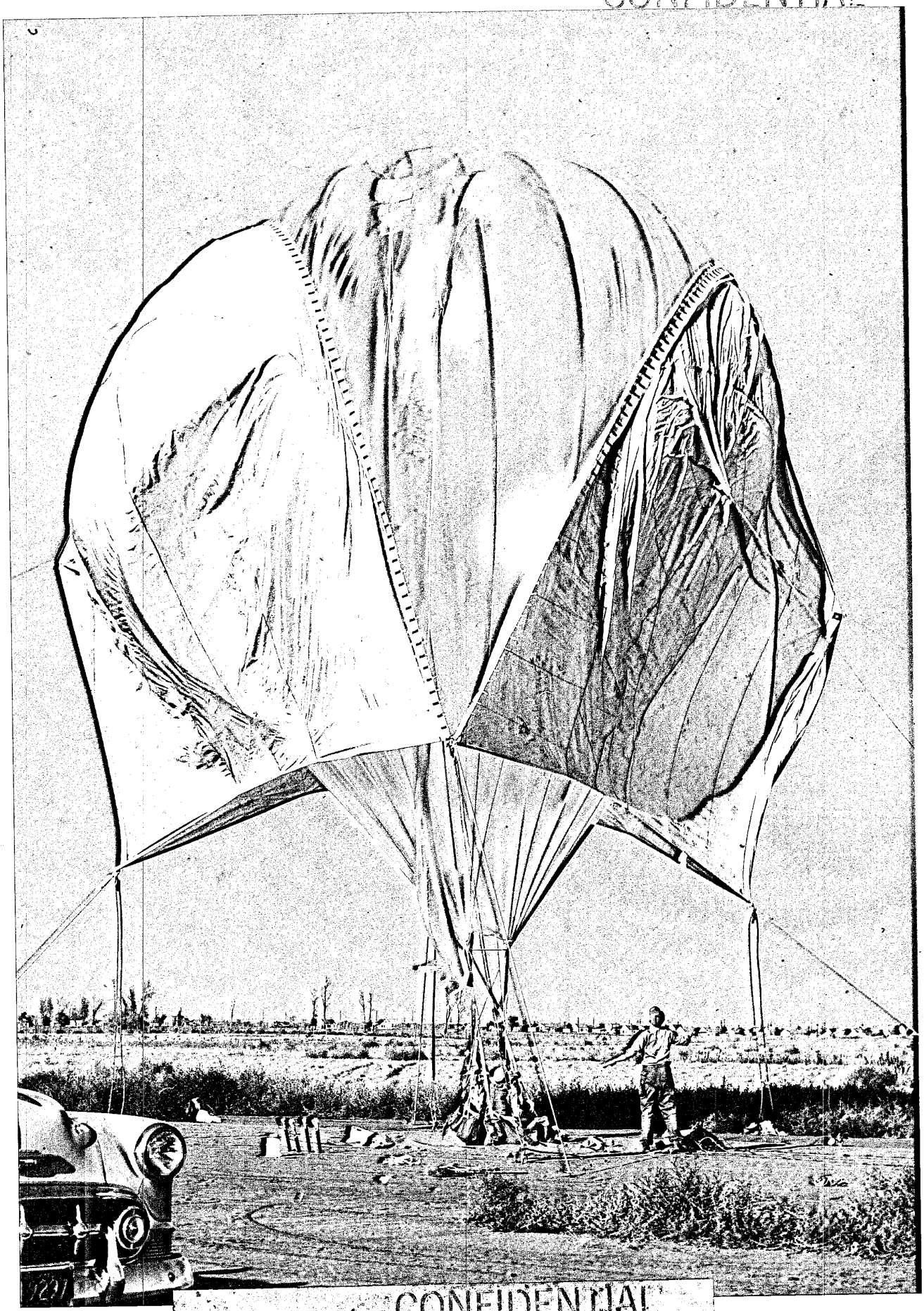
Experiment #4. "Under the Side" launching. June 28, 1955.



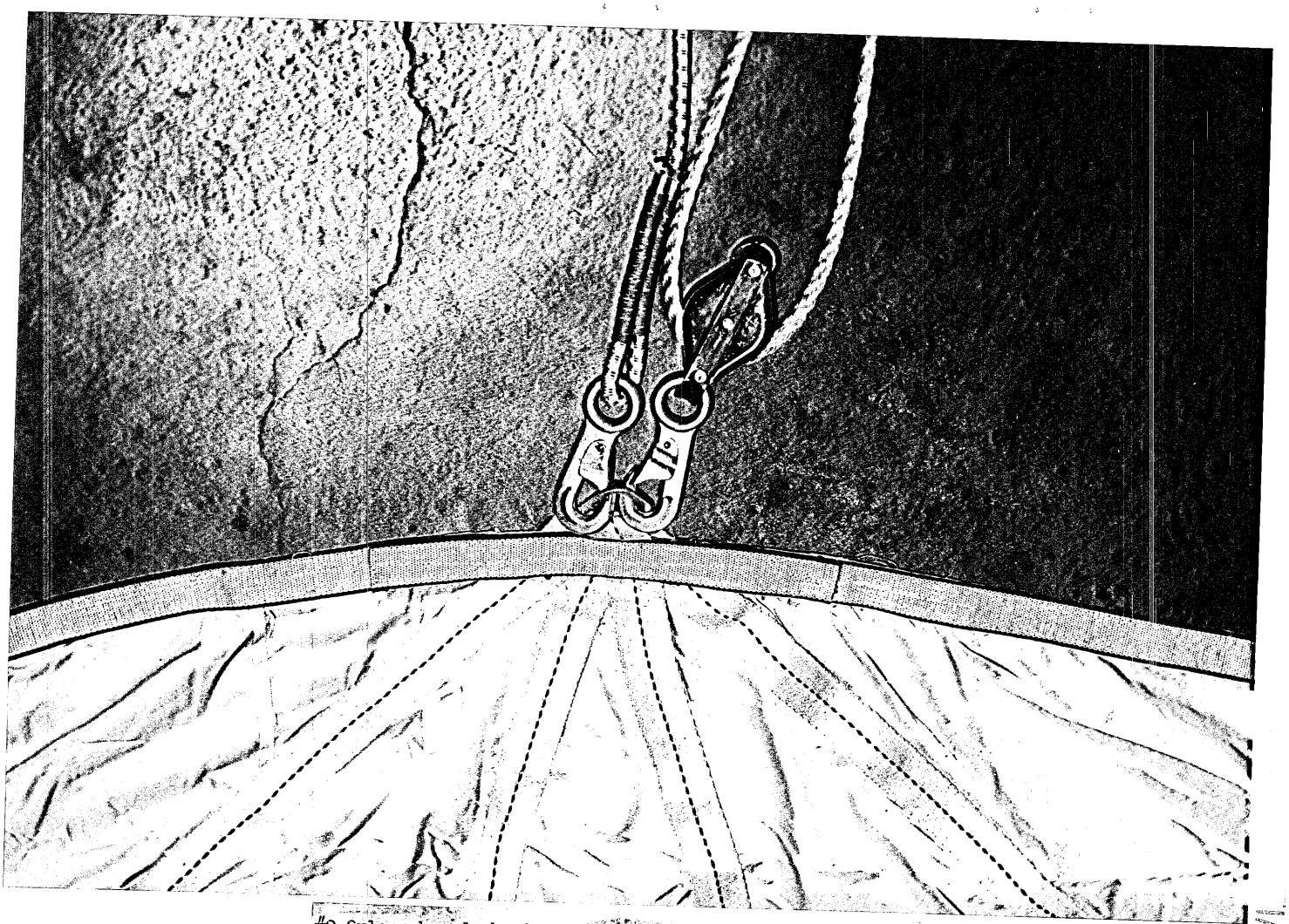
Experiment #5. Inflation Process. #1 Orlon shroud before tailoring. Note excess material at base. June 30, 1955.



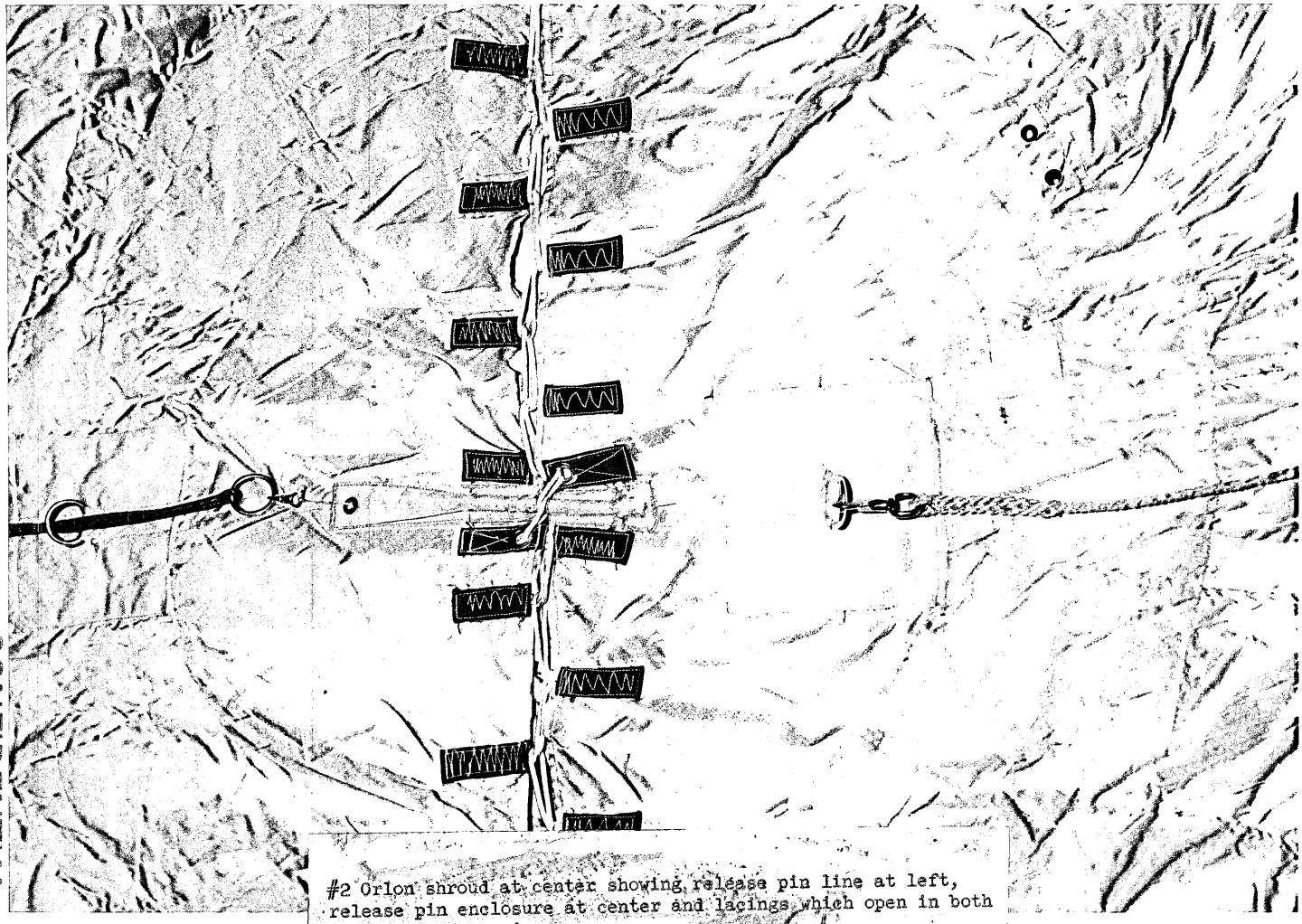
#1 Orion shroud after tailoring to remove excess material at base.



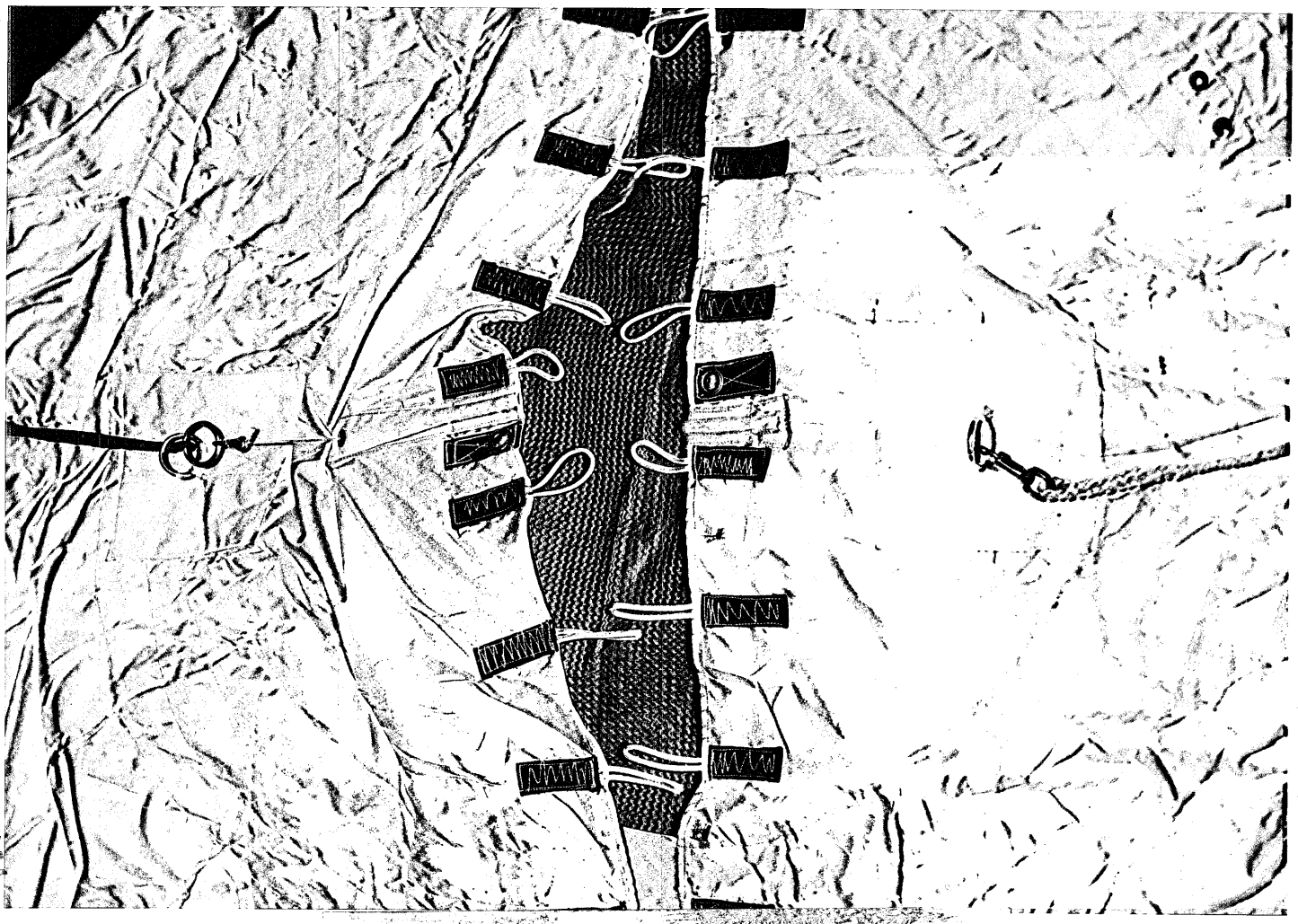
- #1 Orlon shroud in operating release position.



#2 Orlon shroud showing attachment point for restraining block and bungee cord.



#2 Orlon shroud at center showing release pin line at left, release pin enclosure at center and lacings which open in both directions from pin.



#2 Orlon shroud showing action when release pin is actuated.