

RADAR IGNITION OF PHOTOFLASH LAMPS

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SUMMARY

This report refers to tests on the ignition of photoflash lamps when subjected to the effects of microwave energies in the 3, 10, and 23 centimeter bands. Specifically it was proposed to determine the ignition effect, if any, of photoflash lamps by airborne radar including the possibility that standard wave forms exist within the fuselage of an aircraft as a result of airborne energy sources. It was also proposed to determine the shielding effect, if any, provided by metal air carrier type aircraft when subject to ground radar energy, to include the possibility that migratory wave forms might be set up in the interior of an aircraft due to the penetration of plexiglass windows and open ports by radar energy outside the aircraft.

INTRODUCTION

These tests were initiated by a request from the Investigation Division, Safety Bureau, of the Civil Aeronautics Board. A number of fires have been started by the flashing of photoflash lamps that were exposed to microwave radio frequency energy. These fires were, in most cases, confined to warehouses or loading platforms where relatively large quantities of the photoflash lamps were stored in the original factory cartons. Tests conducted at Wright Field have shown that these lamps can be ignited by repeated or sustained exposure to microwave energy under certain conditions. Because of the possibility that aircraft fires could conceivably be started by similar exposure to microwave radar energy, the tests described herein were conducted to determine what safety measures would be required for shipment of photoflash lamps by air carriers.

DISCUSSION

The tests consisted of a suitable quantity of Wabash Press #40 and General Electric #11 photoflash lamps of the standard package quantity in the standard shipping containers placed in the front and rear baggage compartments of a C-47 type aircraft. The forward baggage

compartment was open to the cockpit and the door between the cabin and the rear baggage compartment was likewise open during the tests. There were no heat wires in the panes of the windshield.

Tests were divided into two categories (a) Flight tests to determine the effect of airborne radar and flight through ground radar beams, and (b) Ground radar directed at the aircraft on the ground. Details of the tests are described herein. The APN-1 radio altimeter was operating on all flight tests.

FLIGHT TESTS

FLIGHT #1

Two cases each of the GE #11 and Wabash #40 lamps were placed in the forward and rear baggage compartments of a C-47 aircraft. During the flight the aircraft made a low approach over a three centimeter radar. The altitude at the instant the aircraft passed through the antenna beam was approximately 100 feet above ground. The power output from the radar was approximately 40 kw. Exposure to the radar beam was head on.

FLIGHT #2

This flight was the same as flight #1 except that the aircraft was exposed to a ten centimeter energy from an 80 kw radar. The approach direction was such that the aircraft was in the antenna beam during the entire approach.

FLIGHT #3

Flight #1 was repeated with the approach direction changed 90 degrees to give a broadside exposure to the three centimeter radar.

FLIGHT #4

Flight #2 was repeated except that the approach direction was shifted 90 degrees. The exposure was broadside.

FLIGHT #5

The aircraft made a low approach, head on into the beam of a ten centimeter radar with a power output of approximately 175 kw. The aircraft altitude, over the radar equipment, was approximately 100 feet above ground.

FLIGHT #6

Flight #5 was repeated except that the approach direction was shifted 90 degrees to permit a broadside exposure to the radar beam

FLIGHT #7

On this flight the aircraft was exposed to a 23 centimeter radar with output power of approximately 250 kw. The approach was flown with the radar antenna beam directed at the nose of the aircraft. The aircraft flew over the radar antenna at an altitude of approximately 100 feet above ground.

FLIGHT #8

This was the same as flight #7 except that the aircraft approach direction was changed 90 degrees to effect a broadside exposure

GROUND TESTS

The ground tests were made with the same quantities of flash lamps in the forward and rear baggage compartments. An A/N-GPN-2 ten centimeter radar was positioned in front of the aircraft and the antenna oriented to direct energy through the windshield of the aircraft. The radar was turned on and left running for a 20-minute period. After the first 15 minutes had elapsed, the flashlamp cartons in both compartments were shaken and oriented through all conceivable positions in an attempt to ignite the lamps. The radar antenna was approximately 20 feet from the nose of the aircraft. See Fig. 1

In the successive ground tests, the radar was repositioned at the side and tail sections of the aircraft as shown in the photographs. The distance from the radar antenna to the cabin wall was approximately 35 feet. Twenty-minute exposures were made at each position

The flash lamp cartons were oriented and shaken during the last five minutes of each exposure.

It is interesting to note that during one of the ground tests one carton of flash lamps was positioned directly in front of a plexiglass window in the forward baggage compartment. The radar antenna was at a wing-tip position. Figs. 2 and 5 show the relative positions of radar and flash lamps during this test. Figs. 1 through 4 show the relative positions of the aircraft and radar during the ground tests. Figs. 8, 9, and 10 show the positions of cartons in the forward compartment as they were placed for both the flight and ground tests. Figs. 6 and 7 indicate the carton positions in the rear compartment

CONCLUSIONS

The tests described above show that photoflash lamps of the types tested will not ignite from energy received from radars operating in the 3, 10, and 23 centimeter bands when the rated transmitter power does not exceed 250 kw, and the exposure time is less than 20 minutes. Four cartons each of the General Electric #11 and Wabash #40 lamps were used in each test. None of the 960 lamps had flashed at the conclusion of the tests. It is believed that the distance from the aircraft to the radar antenna was much less than would normally exist and, further, that the radar energy was aimed at the most vulnerable points on the aircraft. Standard DC-3 air carriers and larger aircraft would probably offer better shielding to radar energy than the C-47 used in these tests

Radar installations in use at this time on airports do not operate at power levels above 250 kw except at experimental bases operated by the military services

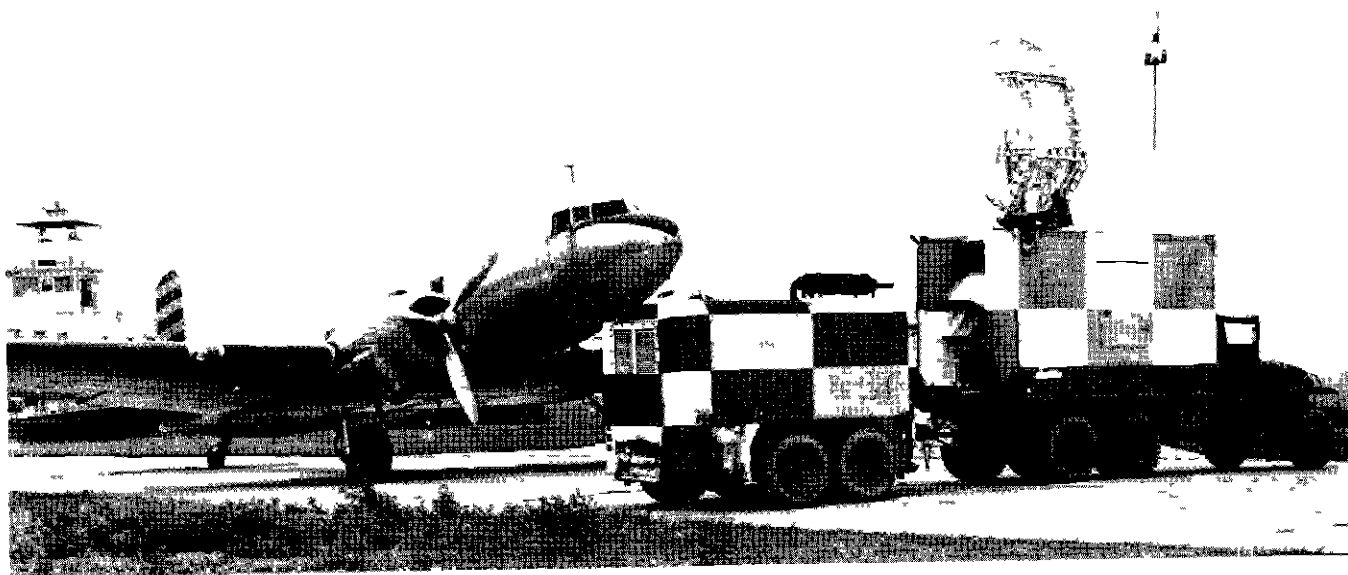


Fig 1 Relative Position of Aircraft and Ten Centimeter Radar

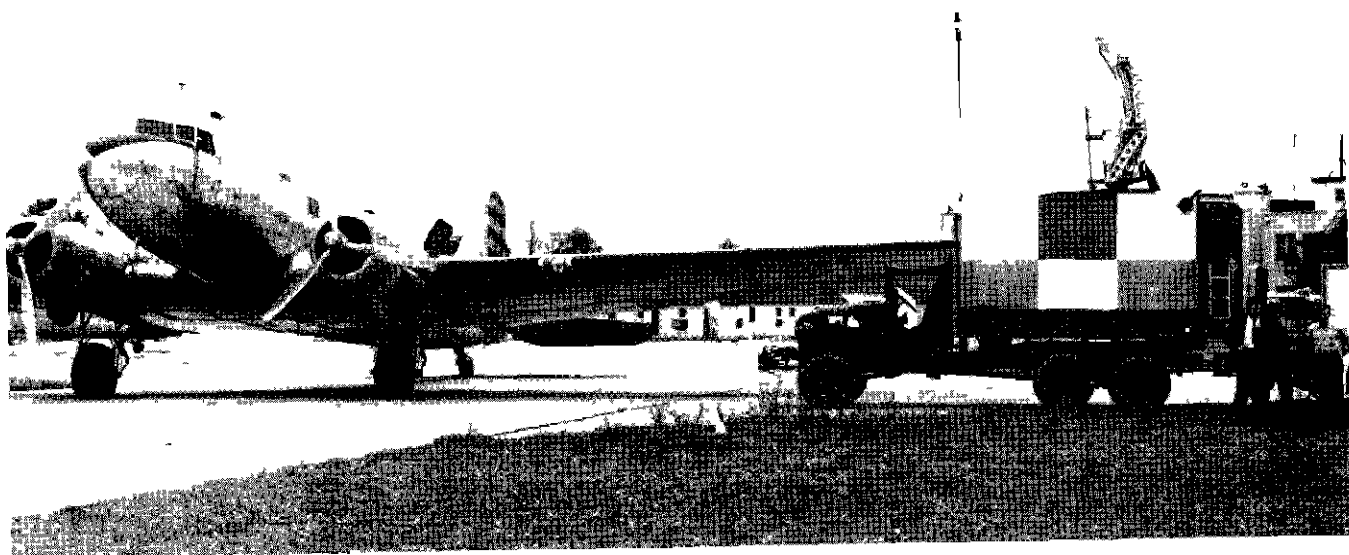


Fig. 2 Radar Directed at Forward Baggage Compartment of C-47

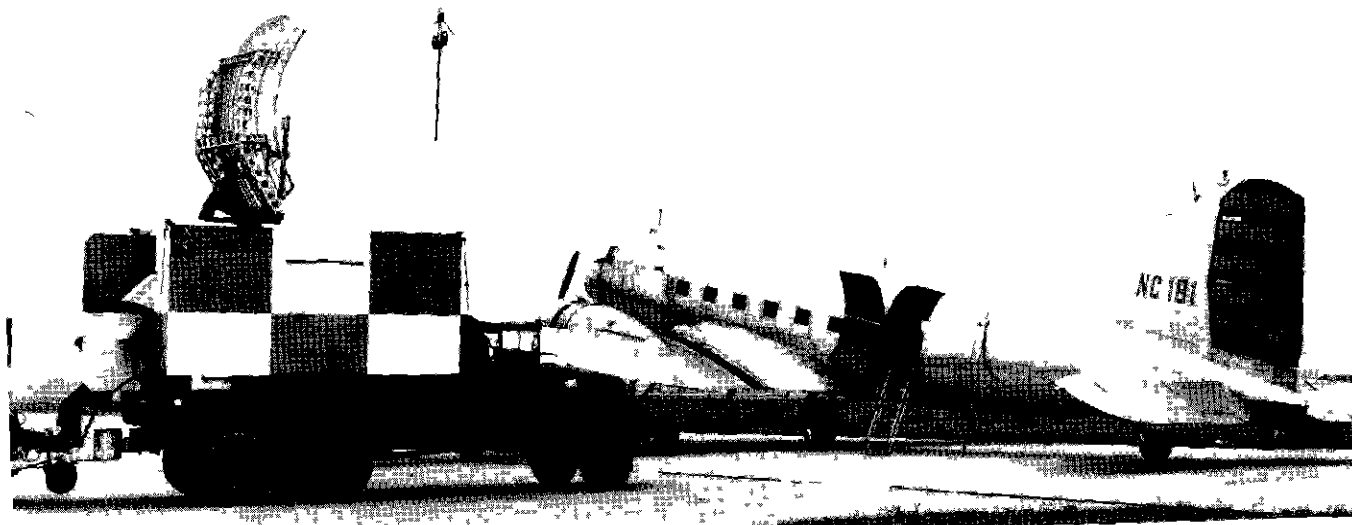


Fig 3 Radar Directed at Rear Compartment of C-47

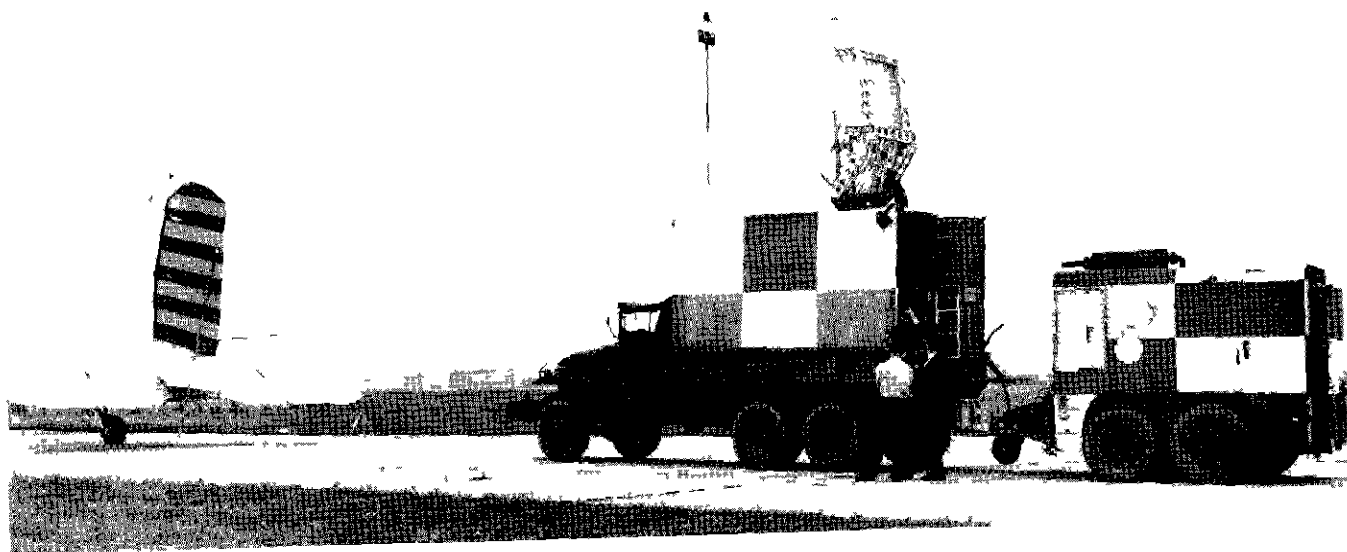


Fig 4 Radar Directed at Tail Section of C-47

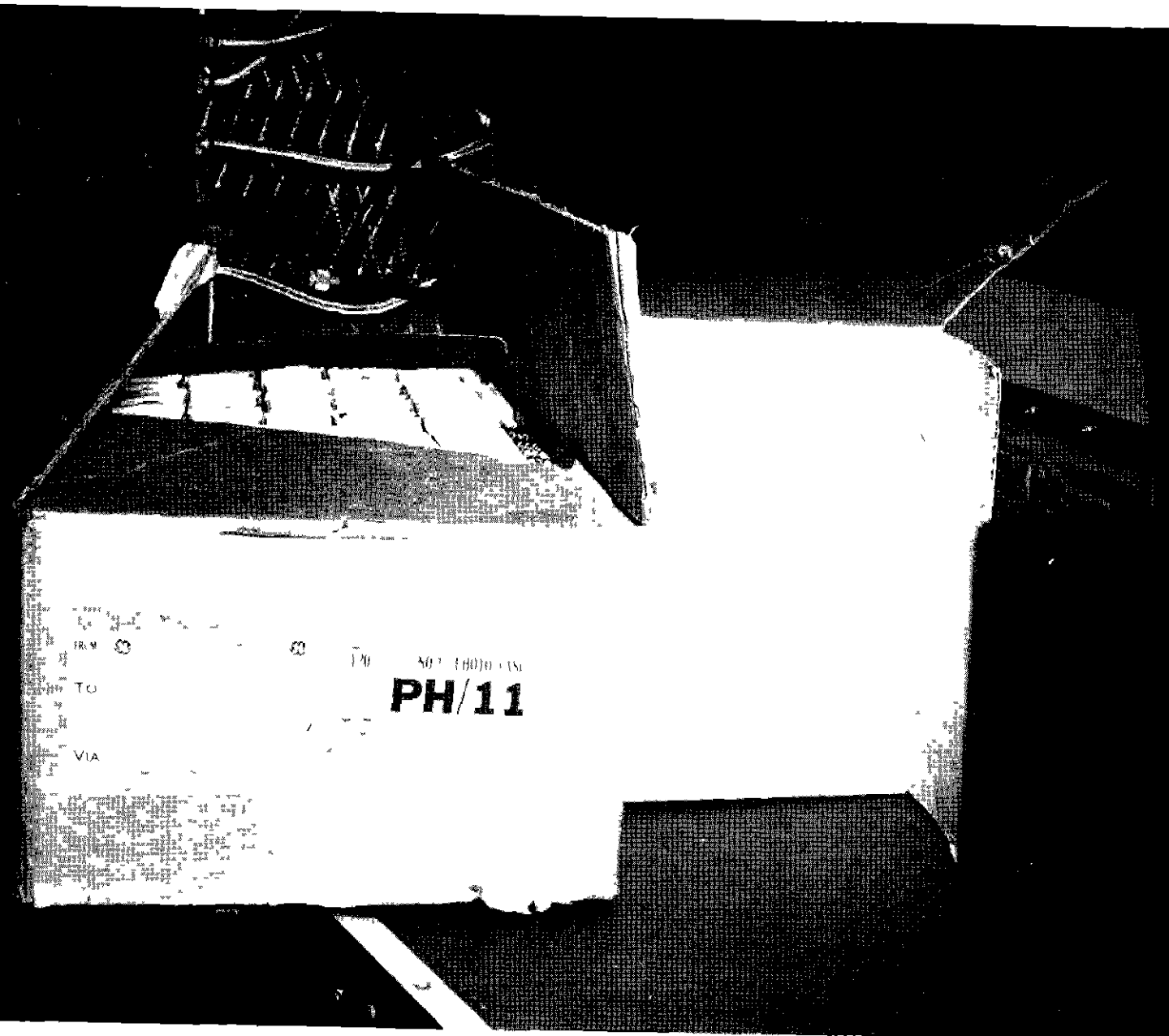


Fig 5 Radar Directed at Flash Lamps Through Plexiglass Window

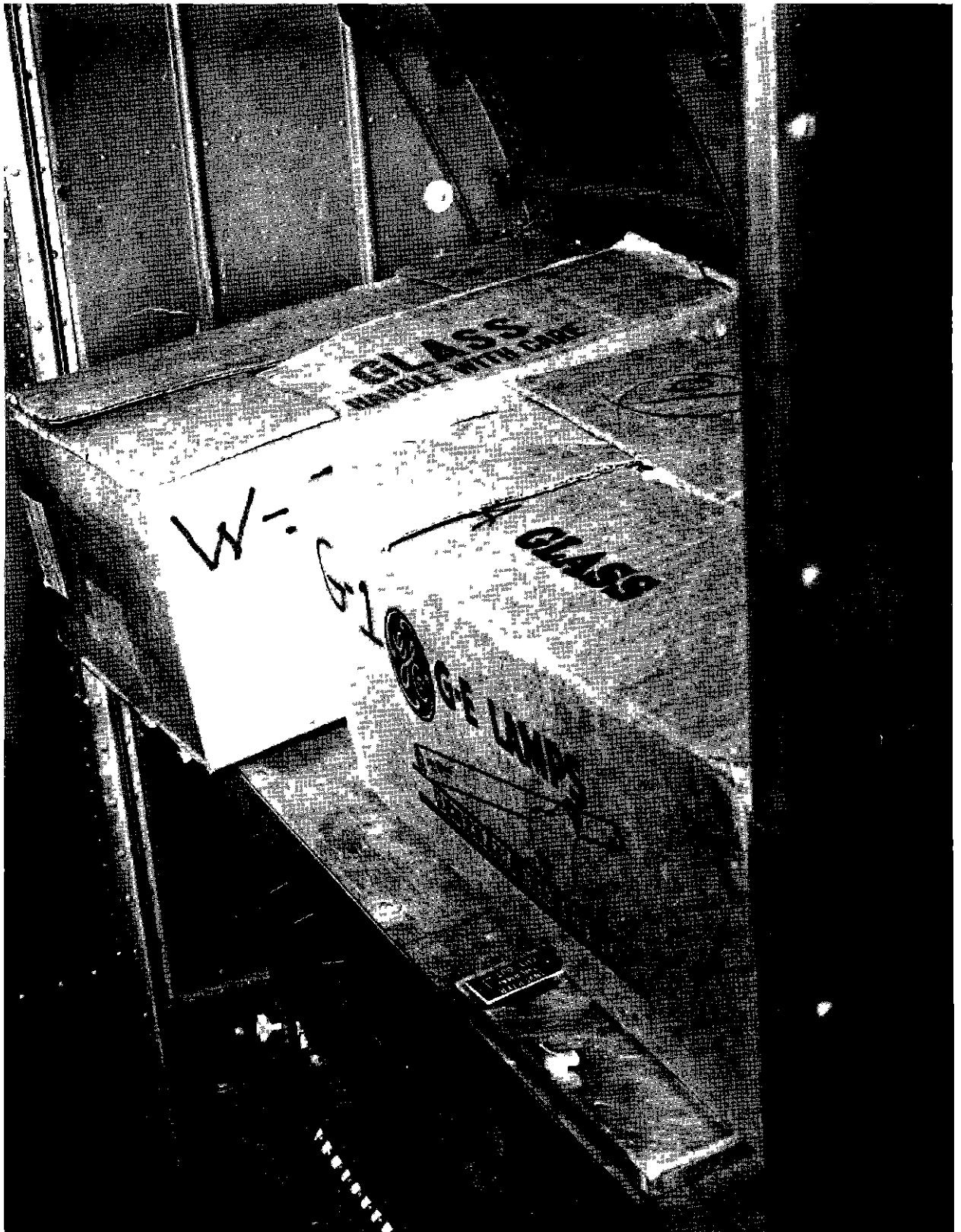


Fig 6 Position of Flash Lamp Cartons in Rear Compartment



Fig 7 Position of Flash Lamps in Rear Compartment



Fig. 8 Position of Flash Lamp Cartons in Forward Compartment

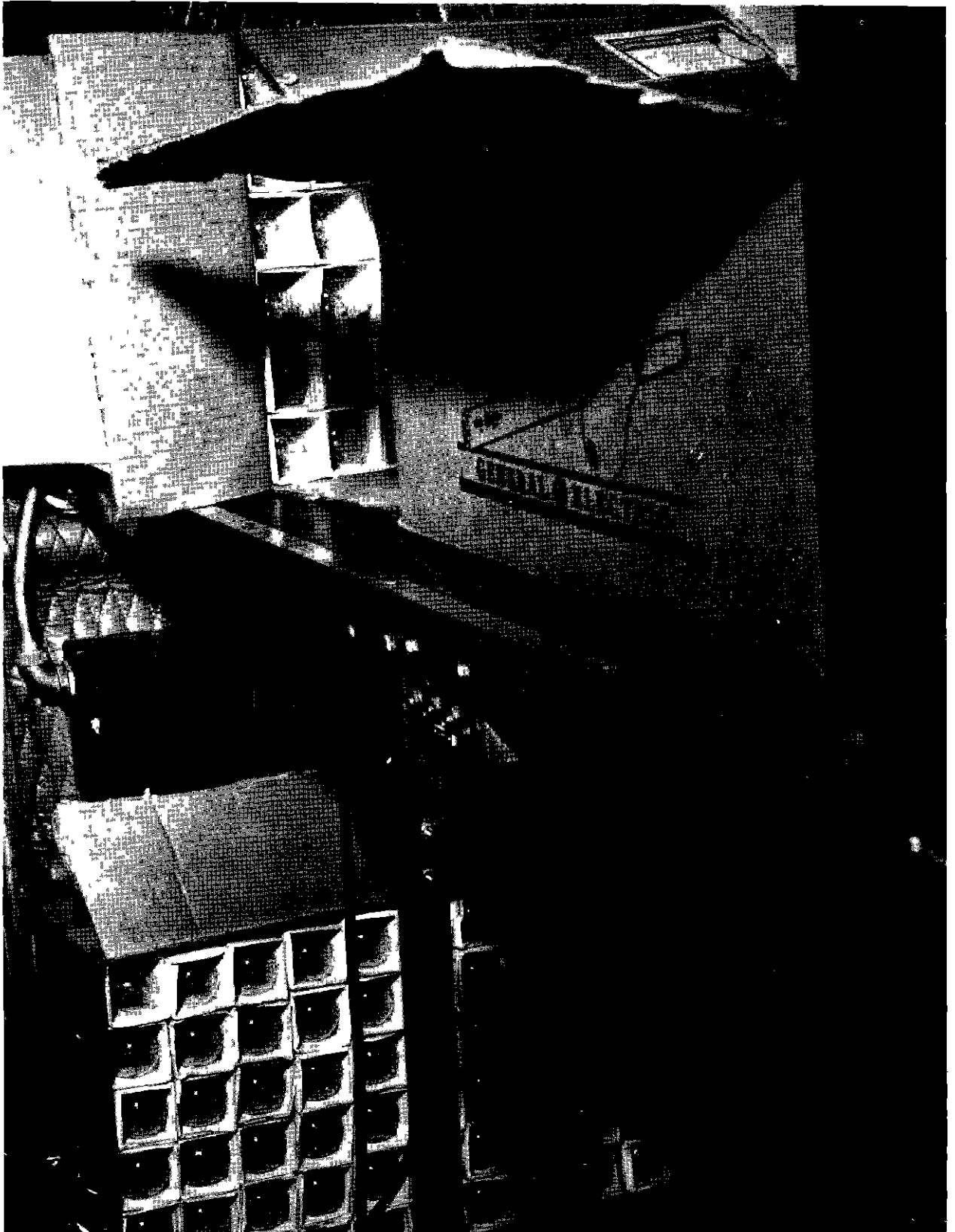


Fig 9 Position of Flash Lamp Cartons in Forward Compartment

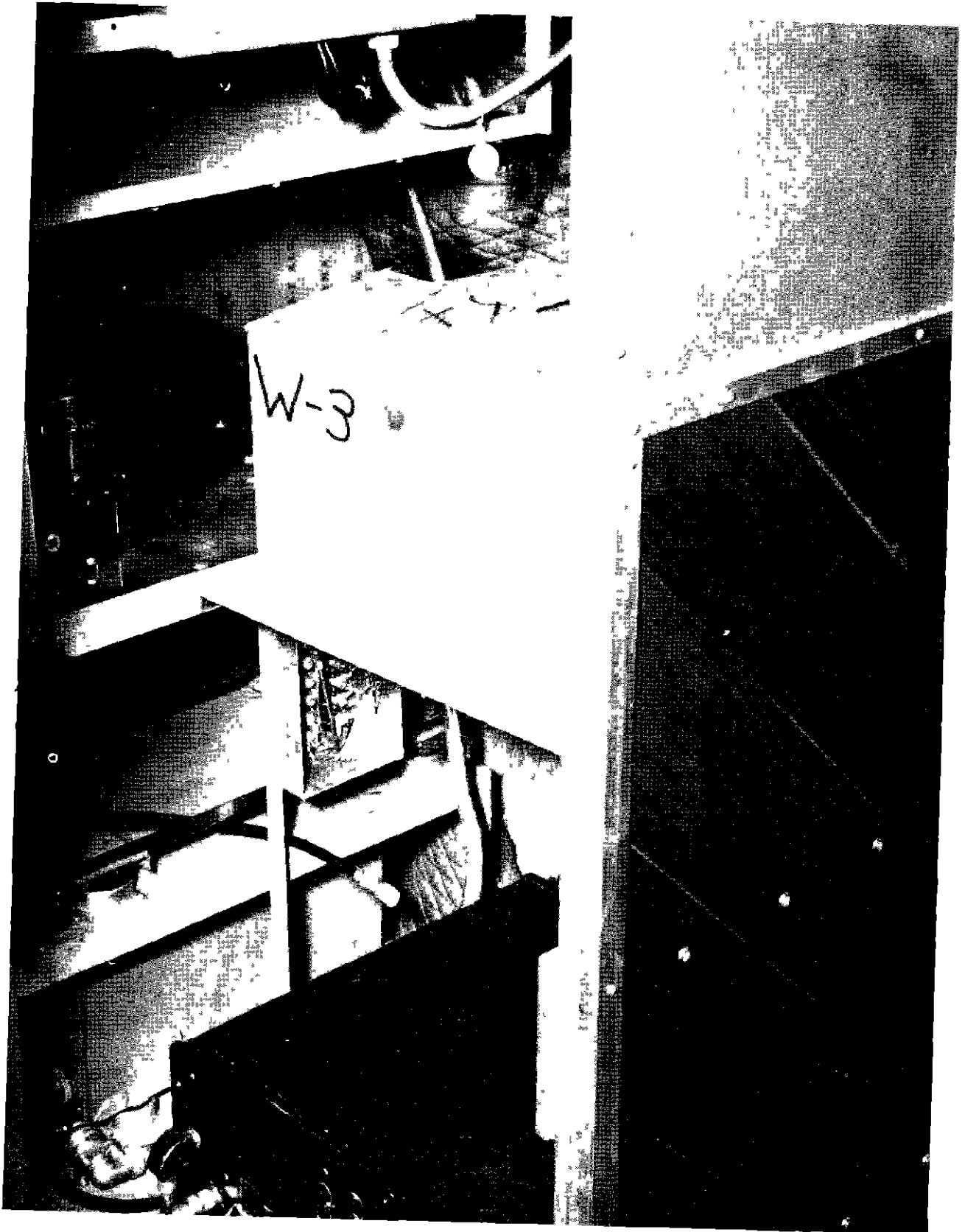


Fig. 10 Position of Flash Lamp Cartons in Forward Compartment