ARMORED MEDICAL RESEARCH LABORATORY
Fort Knox, Kentucky

Project No. T-4
710 SPMEA

8 December 1944

1. PROJECT: T-4 - Report on Test of Injuries and Burns from Rocket Launchers.

a. Authority - 1st Indorsement, Headquarters Armored Command, Fort Knox, Kentucky; File 700.2/1 (25 Sept. 43) GNOHD dated 1 October 1943.

b. Purposes

(1) To determine the cause and character of injuries to the exposed skin and eyes of personnel when firing the rocket launchers M1A1, M9 and M9A1;

(2) To determine the relative hazard of firing in cold weather.

(3) To test the suitability of various protective face masks.

2. DISCUSSION:

a. Cuts and burns are caused by the blast of the rocket as it leaves the muzzle of the launcher. These injuries are reported to be more severe during cold weather and have constituted a drawback to the use of the weapon.

b. The following materiel was used:

(1) Rocket launcher M1A1.
(2) Rocket launcher M9 (see note 1).
(3) Rockets, practice, M7A1 and M7A3 (125 rounds) (see note 2).

c. Procedures:

(1) The gunner and loader fired the rocket launchers from the usual positions. They had no protection for the exposed skin and the type of injury was noted.

Note 1. The latest model launcher M9A1 was not used, but conclusions derived from the study of the launcher M9 are valid for Model M9A1.

Note 2. The practice rockets M7A1 and M7A3 have the same tail construction and propulsive charge as rockets used in the field and are assumed to have identical blast properties.

(2) The launchers were fired with a filter paper screen interposed between the gunner and the muzzle. The blast was analyzed for the character and number of particles and their penetrating properties. Evidence of burning was investigated.

(3) The effect of cooling the rockets was studied.

(4) Various experimental protective face shields were worn and their efficacy noted.

d. Details of procedure and analysis of the results are given in the appendix.

3. CONCLUSIONS:

a. There is a backward blast from the rocket as it leaves the launcher. This is considerable with the M1A1 launcher but very slight with the M9 and M9A1 models. This blast becomes increasingly severe as the rocket temperature is lowered.

b. The blast contains particles of unburned and burning ballistite, which is the propellant charge. The particle velocity is great enough to cause penetration and laceration of the skin of the face and hands. At temperatures above 32°F these injuries are slight but at lower temperatures, may be serious. At all temperatures there is danger of serious injury to the unprotected eyes.

c. There is danger of flash burn. There is also a possibility of minute burns of the skin from hot particles, particularly at temperatures near 32°F.

d. The character of the blast varies greatly with individual rockets.

e. The M9 and M9A1 launchers present far less hazard to the gunner and loader. This is probably due to a longer barrel and a more efficient muzzle flash deflector.

f. The flash deflector screen of the M1A1 model affords partial but always inadequate shielding against particles. In the field the screen might readily be lost or damaged, necessitating firing with no protection.

g. Suitable face masks and gloves will afford protection.

4. RECOMMENDATIONS:

a. When firing the rocket launcher models M9 and M9A1, no protection for the exposed skin is necessary unless the temperature is below 32°F. Protection for the eyes is always desirable.

b. When using the rocket launcher model M1A1, protection should always be provided for the exposed skin of the hands, face and neck. Protection for the eyes is most important.

c. Protection may consist of goggles, glasses, or shields for the eyes and a cloth screen for the exposed skin of the face and neck. The cloth screen

should extend laterally and downward sufficiently to ensure adequate shielding of the ears and lower neck. Gloves should always be worn.

d. Non-inflammability of protective devices is desirable.

e. All precautions should be rigorously observed when firing at temperatures below freezing.

f. Several face masks consisting of goggles or plastic eye shields fitted with protective cloth screens for the face and neck, now under development by OQMG, may be considered adequate.

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2 Incls.
#1 - Appendix
#2 - Photographs 1 thru 5

APPENDIX

1. General: Cuts and burns have been reported occurring among personnel firing the rocket launcher. These are caused by the blast of the rocket as it leaves the muzzle of the launcher. Inasmuch as injuries are apparently more frequent in cold weather, the effect of cooling the rockets was studied. The well-recognized hazard to personnel from blast at the rear of the launcher was not considered in this study.

2. Details of Tests and Results.

a. Description of launchers and rockets investigated:

(1) The older model M1A1 has a fifty-four and one-half ($54\frac{1}{2}$") inch barrel and is provided with a detachable wire screen muzzle flash deflector. This is clamped to the barrel just behind the muzzle and extends laterally two and one-half ($2\frac{1}{2}$") inches.

(2) The newer model M9 has a sixty-one (61") inch barrel. A solid metal flash deflector is welded to the muzzle of the launcher and extends laterally one (1") inch. (The latest model M9A1 differs only in the barrel locking and trigger construction).

(3) The ammunition used consisted of practice rockets M7A1 and M7A3. These are identical in construction and in propulsive charge to rockets used in combat but the head is inert. The blast characteristics were assumed to be the same.

b. Tests Conducted at Temperatures near 70°F.

(1) The common type of injury:

(a) Test: The gunner and loader fired the launchers from the usual positions without protection for the face and hands. Goggles were worn when using the older M1A1 model.

(b) Observations: As had been reported occasional small cuts about the face and hands were incurred. None of these were serious or painful, but might have been so if sustained in the eyes. Their occurrence could constitute a psychological and physical impediment to the most efficient use of the weapon. No burns were noted. When firing the M9 launcher there were no injuries of any kind.

(2) The character of the blast:

(a) Test: The rocket launcher was placed through a fitted hole in a board four by eight (4 x 8) feet. The launcher was at right angles to the board and was so placed that the plane of the board was at any desired position along the barrel between muzzle and trigger guard. The forward surface of the board was covered with a white sheet of drawing paper. Five (5") inch Whatman #2 filter papers were secured concentrically about the opening through which protruded the launcher. The papers served to catch flying particles and detect their burning properties. The launchers were fired in two positions: first, with the papers approximately two (2") inches from the muzzle; second, with the papers at the trigger guard or seventeen (17") inches from the muzzle. The first position served for the study of the most severe conditions to which the hands of the gunner or the exposed skin of the loader might be subjected. The second position represented a somewhat more severe exposure than the face of the gunner would receive. The burning effect, number, character and pattern of the blast particles were then determined.

(b) Observations: The blast originated from the tail of the rocket as it left the muzzle. The force of the blast was not great enough to constitute any hazard or difficulty in using the launcher. The blast had a slight general burning effect and in addition contained hot particles which produced minute burns on the paper. (No burns of the skin were noted during this study, but their occasional occurrence seems likely.) The most important aspect of the blast arose from the fact that numerous particles of a green translucent material were driven backward with such velocity that they developed considerable penetrating power. These were the obvious cause of skin lacerations. The particles were chemically identified as unburned ballistite which composes the propulsive charge. They varied in size from minute specks to flakes one-half (½") inch in length. The blast pattern of these particles varied greatly from one projectile to the next.

When firing the M9 model, very few (0-5) particles were received on the filter papers at the level of the trigger guard. But with the older model M1A1 a ring was formed around the barrel twelve to thirteen inches in diameter containing up to two hundred (200) particles. Of these, a small but significant proportion had penetrating properties sufficient to cause injury. With the flash deflector screen removed, the number of particles was definitely greater but it was obvious that the screen provided only partial protection at best. The screen was also readily displaced and distorted.

With the filter papers placed two (2") inches from the muzzle, the pattern produced was larger and denser and the penetration greater. Lacerations of the skin at this point would be numerous and disagreeable. Again the model M9 showed a much lighter pattern density than the model M1A1.

(3) Face Masks:

(a) Test: Large sheets of filter paper formed into face masks and attached to goggles were worn by the gunner. He fired from the standing position.

(b) Observations: When firing the M9 launcher no particles of any sort reached the paper. Occasional particles struck the mask when firing the M1A1 launcher with the wire flash deflector in place, and many when the deflector was removed. A few particles had penetrating power. These observations confirmed the impression that when launchers M9 and M9A1 are fired, no protection for the skin is necessary but that goggles are desirable. When firing model M1A1 with or without flash deflector, protection of the face and eyes is indicated.

(c) Test: Several protective face masks were supplied by Major Herin, QMC of Jeffersonville, Indiana. These consisted of cellulose acetate eye screens or goggles from which hung various types of fabric, covering the face and neck and extending laterally to protect the ears.

(d) Observations: The masks were satisfactory for firing at temperatures above freezing. In general, the following specifications are indicated. A mask should be light, durable, and easily folded. It should provide wide vision but must not protrude laterally and interfere with the apposition of the gunner's head to the launcher barrel. Fogging of the eye screen by expired air must be prevented. Above all, the mask must give adequate protection against blast particles and burning. (See Par. c. (2)).

c. Tests conducted at low temperatures.

(1) The flash pattern and particle blast:

(a) Test: The effect of cold was studied in the following manner: In one rocket a thermocouple was fitted in the core of one ballistite stick of the propellant charge. This rocket together with 50 other rockets to be tested were then cooled until the thermocouple indicated -10°F. Inasmuch as all rockets were kept together and handled in similar fashion, it was assumed that the thermocouple would register the approximate temperature of the

ballistite in all rockets. The projectiles were then fired at known temperatures as they warmed to the environment. A filter paper screen as previously described was used to determine the blast characteristics. Photographs were taken.

(b) Observations: The flash pattern was altered: The flash forward of the muzzle was elongated and narrowed in proportion to the cooling of the charge. Using the M1A1 launcher, at all temperatures tested, flame flashed back from the muzzle of the launcher along the barrel toward the gunner. Near 0°F this flame was thin and its extension from the muzzle not more than 6 inches but above 14°F the flame would at times extend back 24 inches and easily reached the gunner's face. Using the M9 launcher this backward flash was laterally deflected at all temperatures.

The number and size of particles in the blast changed markedly. Particles were larger, greater in number, and had a much higher velocity and penetrating power at low temperatures. At -10°F, particles of 3 x 4 x 2 mm with sharp edges and great penetrating power were common, and could obviously cause serious injury. As the temperature was raised the particles became smaller, less numerous, and of less penetrating power though always remaining a hazard to the unprotected gunner. At low temperatures even the M9 launcher failed to give adequate protection, though it was vastly superior to the M1A1.

(2) Burning properties:

(a) Test: Cold rockets were fired with the filter paper screen in place as described above. In addition the gunner fired with the screen removed wearing thick woolen gloves for protection of the hands.

(b) Observations: Some blast particles produced burns at the point of impact on the filter papers. These burning particles became more frequent at temperatures above 15 degrees. No generalized burning of the filter papers was noted. On the other hand scorching burns of the woolen gloves occurred, and the same type of wool was also burned at the level of the gunner's face. This was due to flash back. The apparent discrepancy of the tests is probably due to the short duration of the flame, and indicates that serious flash burn of the skin is unlikely.

(3) Protective face masks:

(a) Test: One face mask was tested. This was of the type already described. (Par. b. (3)(c)).

(b) Observations: Several undesirable features were noted:

1. Occasional particles penetrated the cloth.
2. Particles became densely adherent to the cellulose acetate and were very difficult to remove without scratching the surface.
3. The cloth screen caused a stinging slap against the face with each rocket blast.
4. The ears were insufficiently protected.
5. Fogging of the eye screen occurred.

(4) Miscellaneous effects of cold:

(a) At temperatures between -10° and +30°F there was often an appreciable lag between closing the electrical circuit and the detonation of the charge. Often 2 separate explosions could be distinguished, the first probably due to the igniter and the second to the burning of the propellant ballistite.

(b) There was a considerable recoil when firing rockets below 32°F.

(c) The range of the rocket was reduced.

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FIRING LAUNCHER M1A1 AT 0°F

#1

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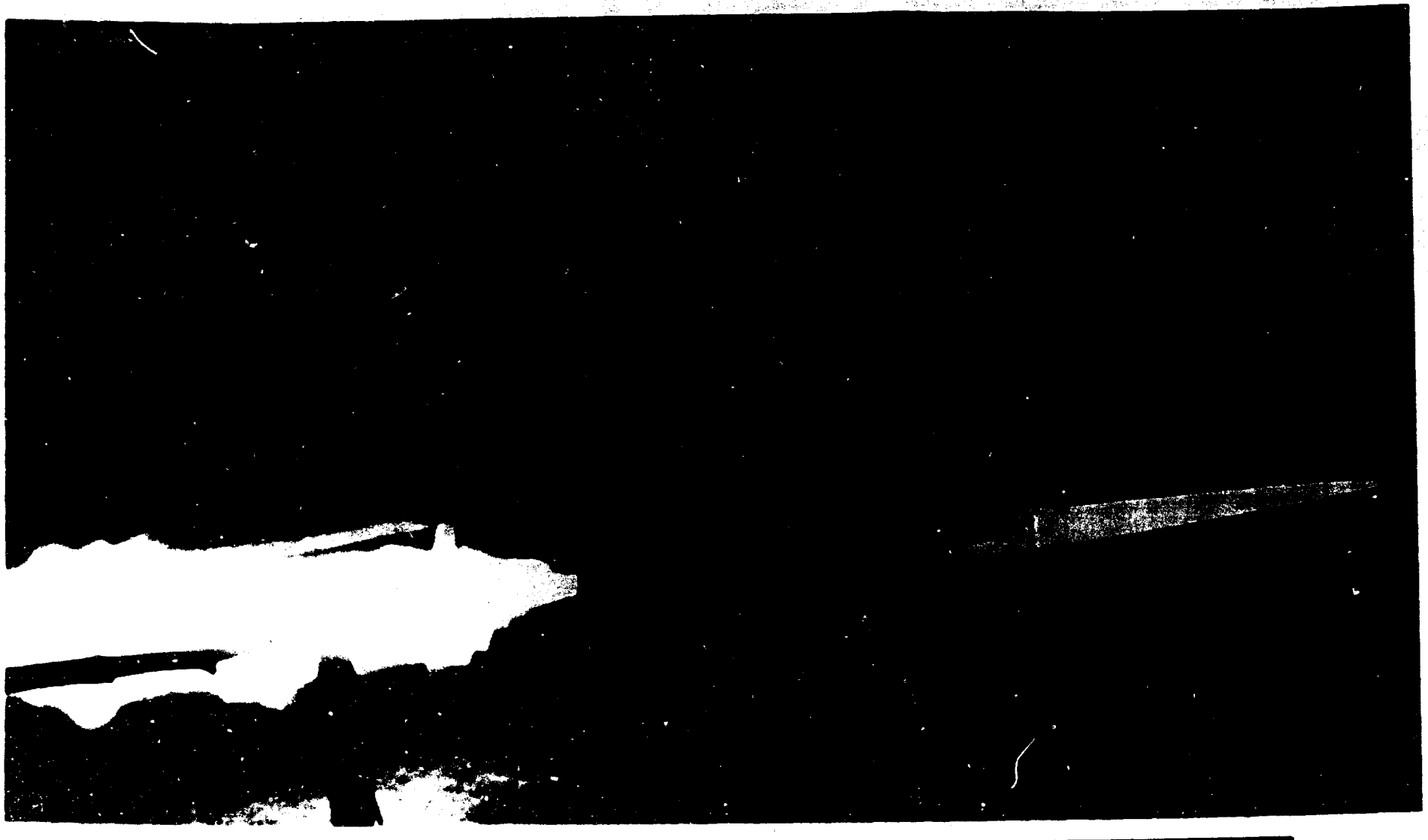

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FIRING LAUNCHER MIAI AT 14° F

#2

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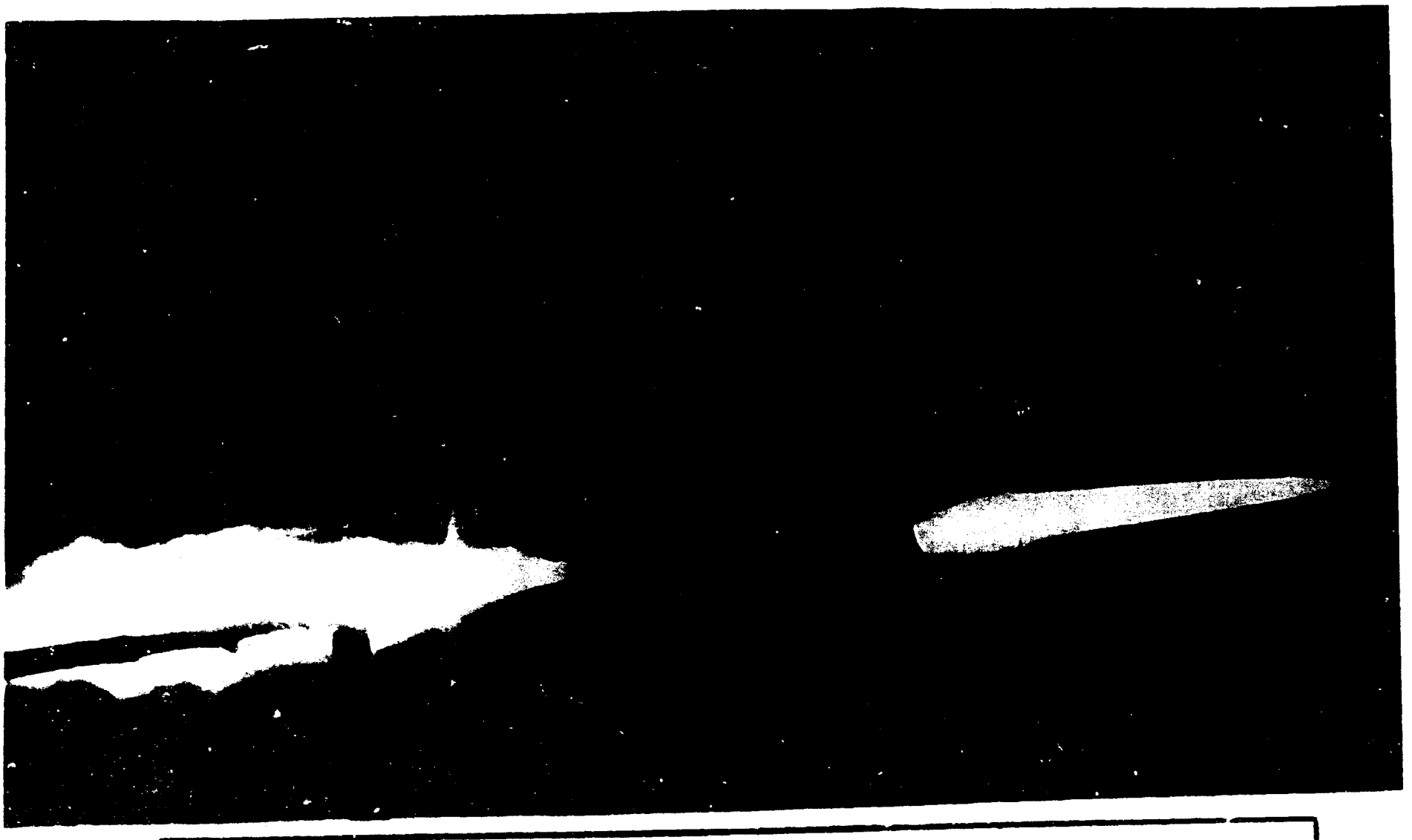

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FIRING LAUNCHER XLA1 AT 41°7

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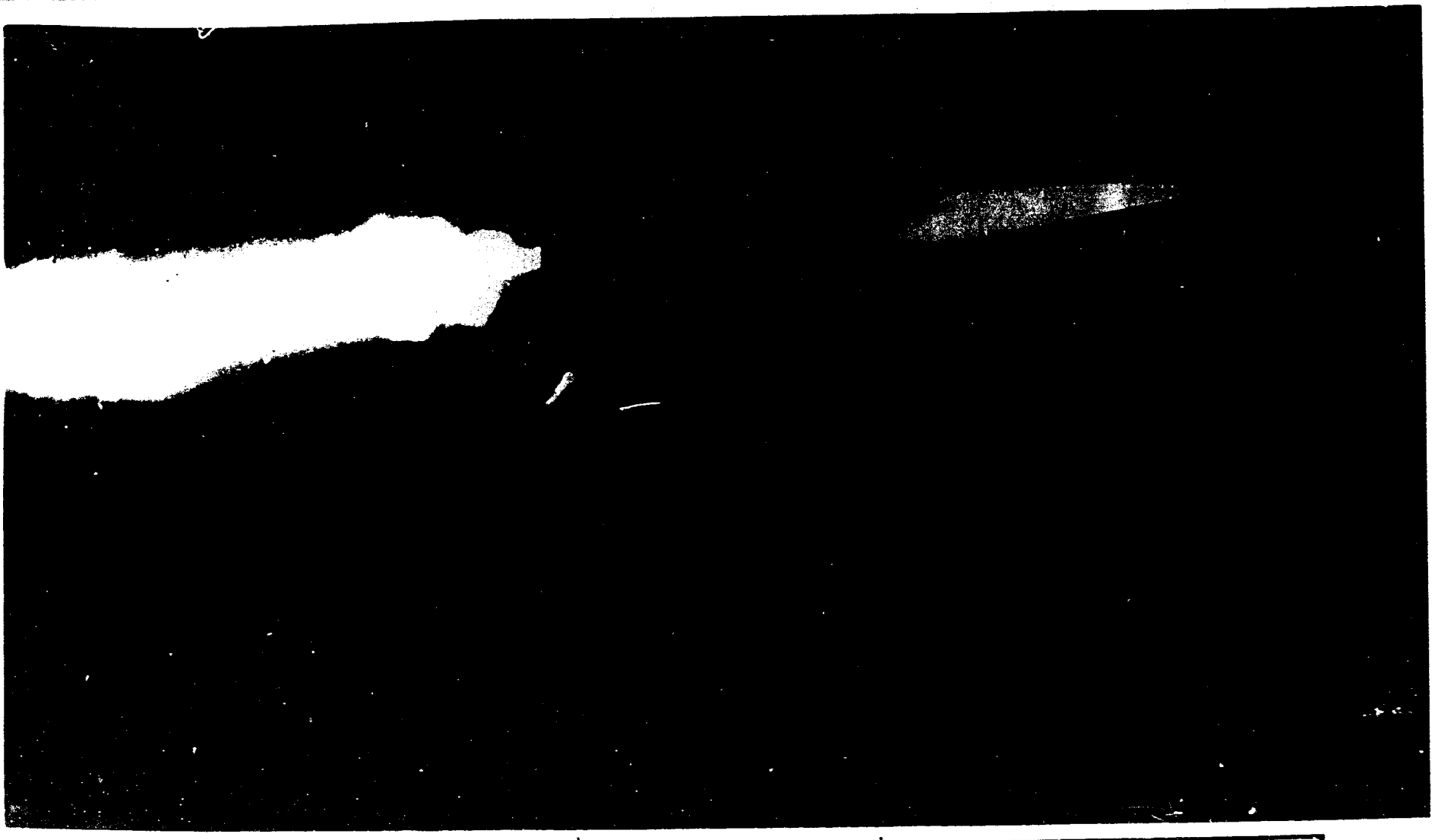

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FIRING LAUNCHER M1A1 AT 51° F

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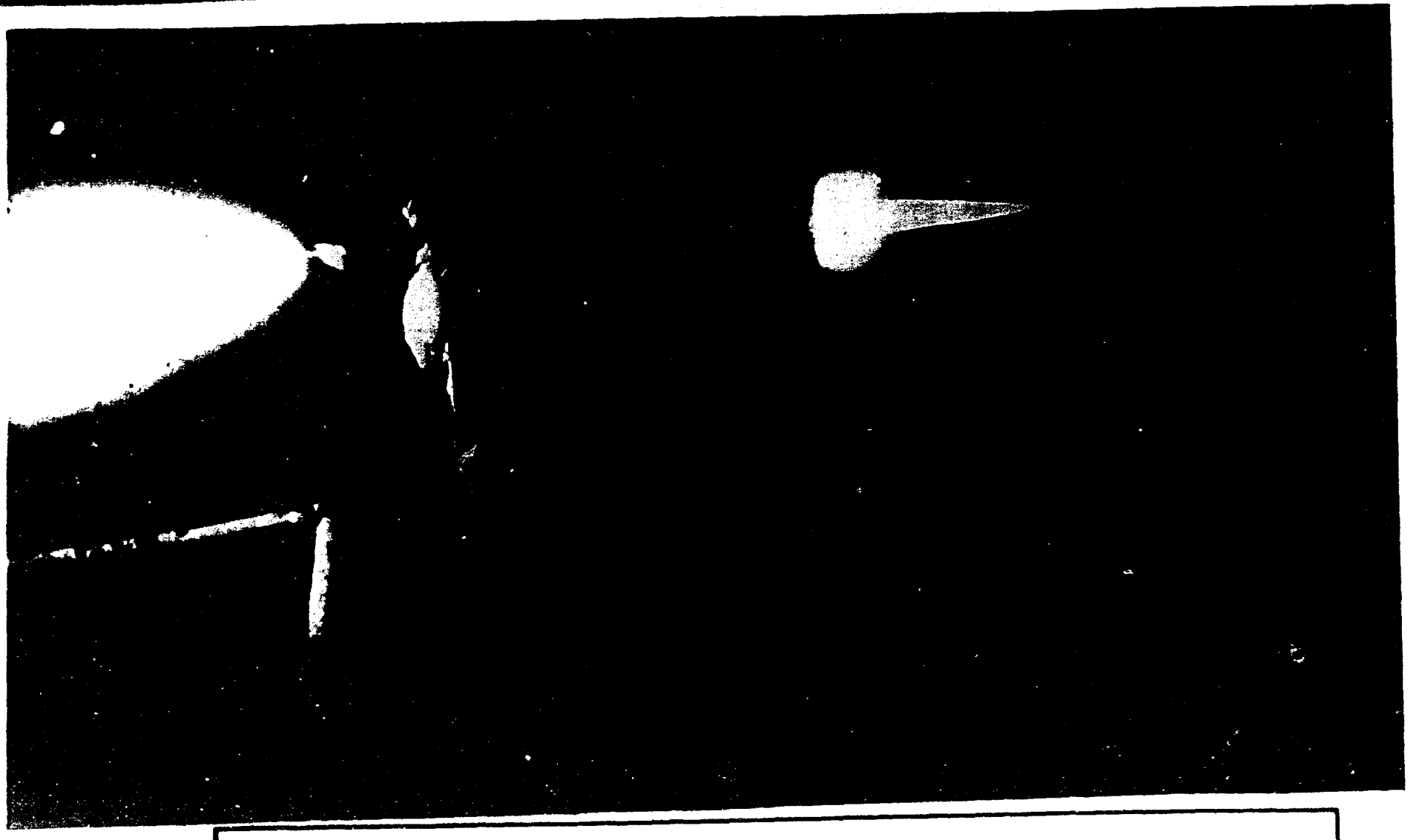

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FIRING LAUNCHER M9 AT 51°F
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