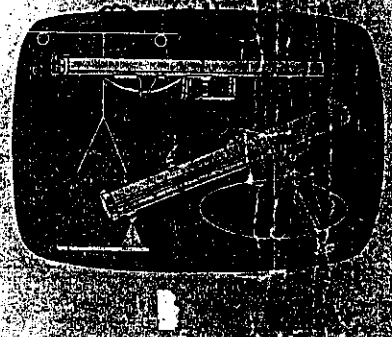
GERMAN AND JAPANESE SOLID-FUEL ROCKET WEAPONS



MILITARY INTELLIGENCE DIVISION • WAR DEPARTMENT • WASHINGTON, D. C.

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CONTENTS

INTRODUCTION

This publication is intended as a reference to all available data concerning German and Japanese solid-fuel rocket weapons. To this end the two parts have been broken down to cover all aspects of the subject matter. It is appreciated, however, that this publication is not complete in its present form and that the examination of experimental establishments in Germany and Japan will almost certainly yield further information on the subject of rocket weapons. Also, in many cases where specimens of the projectiles under consideration have been captured only recently, data is incomplete; spaces have been left, therefore, which may be filled in when further information becomes available.

The available material on the rocket weapons of each of the two nations has been divided into sections on projectiles, fuzes, propellants and fillings, firing systems, and launchers. Each section is sub-divided into basic categories and assembled in a way to permit new items, should they appear, to be inserted in the appropriate subdivision. A special numbering system was adopted for convenience in reference and to aid in establishing the proper place for inserting future items. These key numbers appear at the top of each column beginning a discussion of a new subject. For example, I–B.101 indicates an item in Part I (German Rocket Weapons) under section B (Discussion of Individual Projectiles), sub-section .100 (Standard Ground Projectiles), and the last figure (1) refers to the first rocket discussed in that sub-section.

Much of the preparation of this publication was done by officers of the British Army and as a result some technical terms appearing in the text are different from U. S. terms. Since this publication is intended for use by both American and British personnel, wherever clarity for all readers makes it necessary equivalent U. S. phraseology will be found in parenthesis immediately following the British terms. In cases of only minor differences in spelling, U. S. usage has been followed. The word "filling" has been used throughout to indicate the contents of projectiles, whether this is an HE bursting charge, a chemical filling, or some special contents such as propaganda leaflets.

A glossary of terms used in connection with reaction propulsion is included as Appendix A.

Part II, Japanese Rocket Weapons, was prepared and edited prior to Japan's surrender and consequently the text was written from the viewpoint that the war might continue for some time.

PART I. GERMAN ROCKET WEAPONS

Section I

REVIEW OF DEVELOPMENT

GENERAL

Although the German military leaders, like those of other countries, had acknowledged for some time the possibilities of the military rocket, it was not until shortly before the recent war that they began to give serious attention to the development of this class of weapons. Allied rocket weapons have now reached and generally surpassed the performance standards of the German projectiles. It should be remembered, however, that the Germans initially took and for some time held the lead in this field.

The importance which the Germans attached to rocket weapons has been demonstrated by the evidence gathered at experimental establishments visited since the collapse of the Reich. This evidence has shown that probably more time and money were devoted to the development of rocket weapons and guided missiles than to any other type of ordnance. The greater part of this effort was devoted to guided missiles. Rockets were not neglected, however, and after the war began the Germans developed these weapons to a considerable degree and investigated a great number of possibilities for further application of the inertia principles as a means of propulsion.

GROUND-TO-GROUND PROJECTILES

It was known that the Germans used rockets on the Eastern Front as early as 1941. But they were not used against Allied forces in other theaters until two years later, during the final stages of the North African campaign in 1943. At that time the Germans considered the use of rocket weapons highly secret. This was demonstrated by the extreme security measures adopted; typical of such measures were photographs in the "Illustrated Press" showing the *15-cm Nebelwerfer 41* under the caption "Captured Soviet Rocket Launcher."

In May 1943 the first rocket projectiles were captured by the Allies. These were the 15-cm and 28-cm HE rockets and the 32-cm incendiary rocket, all spin-stabilized projectiles. The 15-cm rocket, weighing 76 pounds and having a filling of 4.4 pounds of TNT, was fired from the six-barreled *Nebelwerfer 41* up to a maximum range of about 8,000 yards. This was the first appearance of a tube-type launcher; the only others known at that time were Red Army frame-type launchers. An interesting feature of the German 15-cm projectile is the tractor-type rocket motor; most later types employed the pusher-type motor, which does not necessitate the same sudden mid-length reduction in the diameter of the projectile and which is therefore sounder aerodynamically. The 28-cm HE rocket has a filling of 80 pounds of TNT and a maximum range of about 2,300 yards. The 32-cm rocket, with a filling of 11 gallons of liquid incendiary mixture, had approximately the same range.

Although the initial effect of the use of rocket weapons was considerable, a large proportion of this effect was psychological, due to the sound and appearance of the projectiles. The Germans soon realized that the trail left along the rocket's trajectory was a serious disadvantage since it necessitated frequent changes of launcher position. They later partially offset this disadvantage by making the launchers mobile. The *15-cm Nebelwerfer 41* made an appearance as a 10-barreled launcher mounted on a half-track armored personnel carrier. Brackets were designed for mounting the crates for the 28-cm and 32-cm rockets on the sides of a similar vehicle; three frames were mounted on each side, all firing forward.

The 15-, 28-, and 32-cm rockets were followed by 21-cm and 30-cm projectiles. The 21-cm is a larger version of the 15-cm rocket, but employs a pusher instead of a tractor-type motor. The 21-cm rocket was fired originally from an experimental launcher, a scaled-up version of the six-barreled *15-cm Nebelwerfer 41*. This experimental launcher was quickly abandoned, apparently because it was unstable, in favor of a five-barreled type of similar design. The projectile has a filling of 21 pounds of amatol and a maximum range of about 10,000 yards. The 30-cm projectile represents in appearance a cross between the 21-cm and 28-cm rockets. The warhead is larger than the rocket motor, but there is not such a large variation in diameter as with the 28-cm projectile. It is launched from the *30-cm Nebelwerfer 42*, a six-frame launcher on a two-wheel mount with a split trail to enable it to be towed. The projectile has a filling of 98 pounds of amatol and a range of about 5,000 yards.

These five calibers—15, 21, 28, 30, and 32 cm—represent the initial series of German rocket weapons. For some time no new calibers were developed, though variations in fillings, such as the 15-cm smoke and chemical warfare projectiles, were introduced. This restriction to five basic calibers and six basic projectiles (the chemical warfare projectiles were never used) conformed with the German principle of adhering to a few well-tried designs instead of producing a large number of more varied models.

The next aspect of rocket weapons to which the Germans gave their attention was the production of an equivalent to the U. S. "Bazooka." In this field they produced two projectiles, the *8.8-cm R.Pz.B.Gr.4322* and the *8.8-cm R.Pz.B.Gr.4312*, both incorporating the hollow-charge principle, upon which the Germans had been working for some time. The *4322* is fired from a tube similar to but larger than the U. S. launcher and has proved a highly successful weapon; it is capable of penetrating more than 6 inches of armor plate. The *4312* is a similar rocket but is fired from a different type of launcher, the *Raketenwerfer 43*, which consists of a barrel mounted on a small two-wheel carriage with a fixed trail. Although the projectile has a longer range than the *4322*, this advantage is probably offset by the somewhat cumbersome nature of the launcher, which cannot be as readily moved as the simple tube launcher.

Only four other types of ground-to-ground projectiles of interest were developed. These are the 8-cm HE and smoke rockets and the 38-cm HE and hollow-charge rockets. The 8-cm HE projectile is a fin-stabilized aircraft rocket which also was developed as a smoke projectile for ground use. The 38-cm, fired from a special launcher mounted on a Tiger tank chassis, is the only super-heavy rocket the Germans produced. It is a 760-pound, spin-stabilized rocket with a filling of 270 pounds of amatol. The hollow-charge rocket was apparently meant for use against concrete obstacles and buildings.

The 38-cm rockets complete the series of German ground-to-ground projectiles; although only a small number of rockets appeared, they were all well-tried models and quite successful. The Germans, unlike the Soviets, confined themselves almost entirely to spin-stabilized projectiles, and, in the smaller calibers, to tube-type launchers, as opposed to the fin-stabilized projectiles and cruder frame-type launchers used by the Red Army.

ANTIAIRCRAFT PROJECTILES

The first German antiaircraft rockets appeared approximately two years ago; since then only five types have been recovered, all of which are low-altitude projectiles. The German lack of interest in this field was probably due to their initial air superiority, their development of efficient antiaircraft guns (such as the *8.8-cm Flak* series), and their belief that no antiaircraft rocket could compare as favorably with existing antiaircraft guns as ground rockets could compare with other ground weapons.

Although numerous reports of high-altitude rockets were received from air crews, no specimens of such projectiles have been recovered. It is known, however, that experimental work was carried out in this field by the Germans, but such work was concerned primarily with production of rocket projectiles having some form of proximity fuze

and a remote control mechanism. Such weapons fall into the category of guided missiles and therefore are not within the scope of this publication.

Of the five antiaircraft rockets recovered, the first three were of the parachute-and-cable type, whereby a cable was projected into the air and suspended by means of a parachute. These were made in three calibers, 8 cm, 15.2 cm, and 20 cm, and were designed for use in large numbers to form a barrage against low-flying aircraft. The other two types were a development of the 8-cm rocket, in which the parachute and cable were replaced by an HE filling, and a 7.3-cm HE rocket, which was fired from a frame launcher designed to permit 35 rockets to be launched simultaneously. Both these rockets were used against low-flying aircraft.

AIRCRAFT PROJECTILES

Only one German rocket designed specifically for firing from aircraft has been recovered; this is the 8-cm HE projectile, which is also fired from a ground launcher and appears to be a close copy of a U. S. S. R. fin-stablized rocket. The 21-cm ground projectile is also reported to have been used from aircraft, but it is doubtful if this experiment met with any success. This rocket is spin-stabilized and would be highly inaccurate unless launched from a tube, which might be inconvenient to mount on aircraft.

OTHER TYPES OF PROJECTILES

Only two types of unconventional, true rocket projectiles have been recovered. One of these is a 7.3-cm leaflet rocket, designed for the projection of propaganda leaflets into enemy lines at short ranges. The other is a recently discovered flare rocket, used as a decoy during air attacks. The rocket contains a flare intended to represent target-marking flares dropped by attacking aircraft.

In addition, the Germans produced two types of rocket-assisted artillery shells, and others were under development. The rocket motor was incorporated to increase the range of the projectile.

Section II

DESCRIPTION OF INDIVIDUAL PROJECTILES

CONTENTS

STANDARD GROUND PROJECTILES

7.5-cm HE Projectile.

Fired from: 7.5-cm multiple fortress projector.

No specimen of this projectile has been received, but its existence is inferred from the recovery of the multiple fortress projector (see I–F.201) and a projectile container. Judging from the size of the container, the complete projectile would appear to be about 58 inches long. The nature of the launcher indicates that the projectile is percussion-fired and possibly fin-stabilized.

8-cm Raketen Sprenggranate.

(8-cm HE Projectile.)

Fired from: Aircraft and *8-cm Raketen Vielfachwerfer*.

1. Description. *a. General.* This is a fin-stabilized projectile (Figure 1) with an appearance typical of that of small caliber aircraft rockets. The internal arrangement of the projectile suggests that it was possibly copied or adapted from a standard Russian aircraft rocket. Although this rocket almost certainly was designed primarily as an aircraft weapon, it was also fired from a multiple-frame ground launcher known as the *8-cm Raketen Vielfachwerfer* (see I–F.202). The projectile consists basically of an HE head, a rocket motor, and a tail unit incorporating a single venturi and stabilizing fins.

b. Head. The head (Figure 2) of the projectile is a steel cylinder with an ogival nose into which is built a fuze system. The rear of the head is closed by an adapter plug which also forms the junction with the rocket motor.

The main HE filling consists of 1 pound 5.5 ounces of pressed flake TNT and is built up from three perforated pellets which fit around the exploder tube incorporated in the fuzing system. At the nose end is a small cardboard washer; at the base are two waxed-paper washers; and around the exploder magazine is a waxed-cardboard tube. Between the shell wall and the explosive is a thin layer of bituminous material. The outer surfaces of the pellets are waxed.

c. Fuzing system. The arrangement of the fuzing system is shown in Figure 3. The fuze proper consists of a steel nose piece (1), screwed into the warhead and closed by a copper disc, containing a light alloy striker (2) supported by a light raising spring (3). Below the nose piece is a steel magazine tube (5), into the forward end of which is screwed a detonator (4) housed in a steel body.

The detonator, which has a steel shell, contains two increments (C and D) of HE, the upper increment (C) being annular and containing a core of initiator (B). This is topped by a layer (A) of igniting mixture. The detonator is closed by a brass thimble (12) with a central hole which is sealed by a tinfoil disc. The base of the detonator is perforated and is in contact with the uppermost of the four pressed pellets in the exploder tube. The lower end of the exploder tube is crimped to the spring-loaded plunger (7) at the lower end of the HE head.

The spring-loaded plunger is held in a sleeve (8) screwed into the adapter, the lower end of the sleeve being located in the hollow spigot extending into the motor unit (Figure 2). In the safe position, the plunger is held back against the force of the spring (9) by the screw (10), the mushroom head of which bears against the fusible metal ring (11) fitting closely inside the spigot.

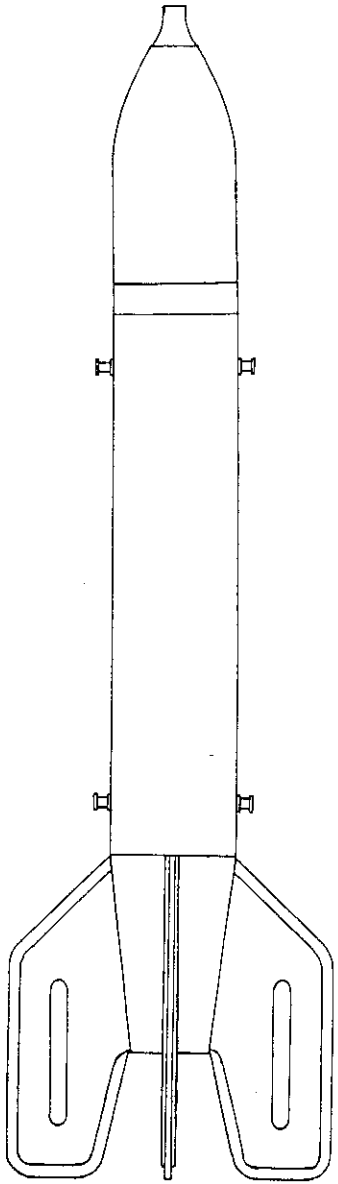

Figure 1.—Complete 8-cm HE projectile.

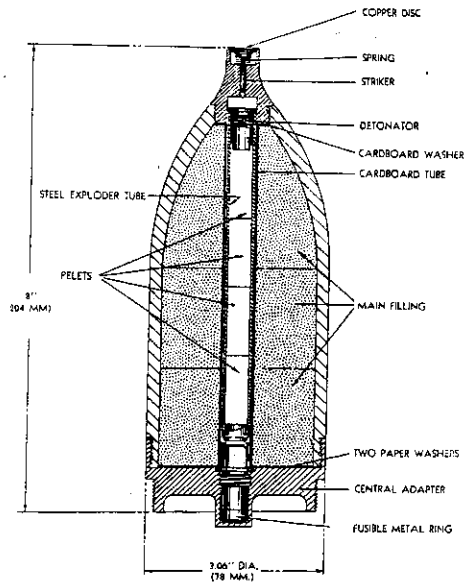

Figure 2.—Internal arrangement of warhead in 8-cm HE projectile.

When in the position shown in Figure 3, the detonator is beyond the reach of the striker. When the rocket is fired, the heat of the burning propellant is conducted through the wall of the spigot and melts the fusible metal ring. The plunger, magazine, and detonator are then free to move forward under the action of the spring (9). The extent of this forward movement depends upon the acceleration of the rocket. Approximate measurements indicate that if this is less than 40–50 g. the detonator is sufficiently far forward to be fired by the striker. It appears likely that if the projectile strikes a substantial target at almost any range it will fire.

d. Rocket motor. The rocket motor (Figures 4 and 5) appears to be a close copy of that of a standard Russian aircraft projectile. The body of the motor is formed by a cylinder which is machined down slightly between the ends. The forward end of the cylinder is threaded internally to screw over the adapter plug which forms the junction with the warhead. Four studs in the body, two at each end, guide the projectile in the launcher. The base of the motor body is closed by the motor closing plate, which is in the form of a single venturi to which four stabilizing fins are spot welded.

The propellant consists of six sticks, of which two are slightly shorter than the other four. The four longer sticks are located by a supporting grid which is a push-fit in the venturi assembly. The other two sticks are supported on the two primary igniters attached internally to the walls of the rocket motor.

The ignition system consists of two ignition charges, one at each end of the propellant, and a primary igniter. The primary igniter is in the form of two copper tubes, each screwed internally over the end of one of the steel guiding studs which pass through the motor body at the rear end. A brass rod, insulated by a rubber sleeve, passes through the guiding stud and bears against a brass contact inside the copper tube. This contact passes through the tube into a small cardboard container holding a loose composition charge of gunpowder. Wires from the contact to the walls of the copper tube serve to ignite the charge. The circuit is presumably formed by two leads, one to the brass rod in each guiding stud, and is grounded (earthed) to the rocket body.

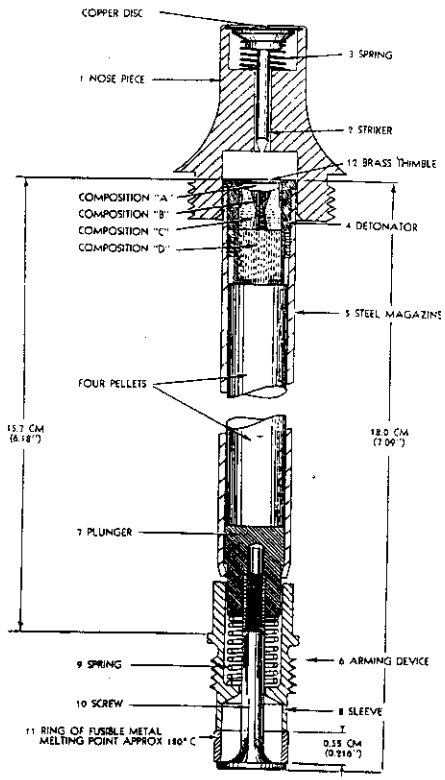

Figure 3.—Internal arrangement of fuzing system in 8-cm HE projectile.

Figure 4.—Rocket motor and tail assembly of 8-cm HE projectile.

2. *Technical Data.*

GENERAL	
Nature of projectile	Single axial-venting, non-rotating, fin-stabilized pusher rocket.
Caliber	78 mm.
Filled weight (complete round)	15 pounds 3 ounces.
Over-all length (complete round)	2 feet 4.5 inches.
Nature of fuze	Thermally armed nose percussion.
Nature of filling	Pressed flake TNT.

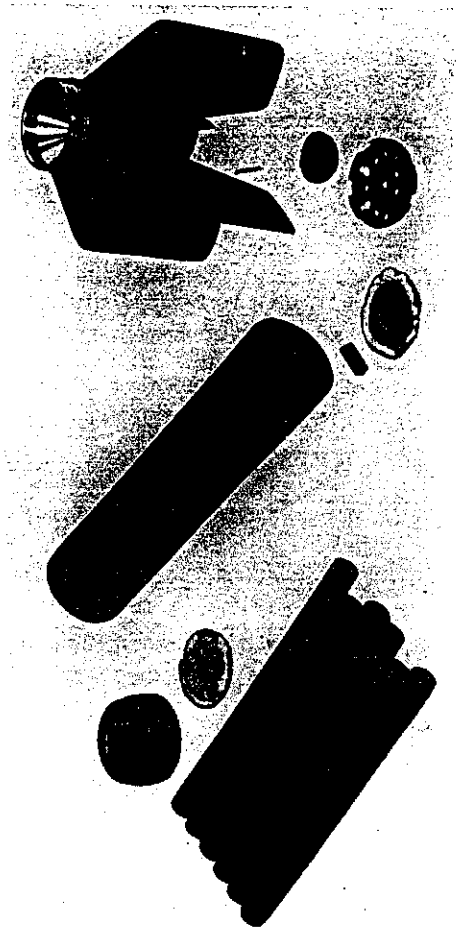

Figure 5.—Disassembled rocket motor and tail assembly of 8-cm HE projectile.

WARHEAD

General shape	Cylindrical with ogival nose terminating in cylindrical nose-fuze body.
Material	Steel.
Dimensions:	
Over-all length	8 inches.
Over-all diameter	3 inches.
Wall thickness	———

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Weights:	
Empty	———
Filling	1 pound 5.5 ounces.
Filling:	
Type	Pressed flake TNT.
Shape	Three pellets approximately equal in length.
Weight	1 pound 5.5 ounces.
Markings	None.

FUZE

Nature	Thermally armed nose percussion.
Weights:	
Complete fuze	5 ounces (approx.).
Detonator, composition (A)	0.08 gram.
Detonator, composition (B)	0.07 gram.
Detonator, composition (C)	0.30 gram.
Detonator, composition (D)	0.47 gram.
Pellets in exploder tube	12.6 grams (total).

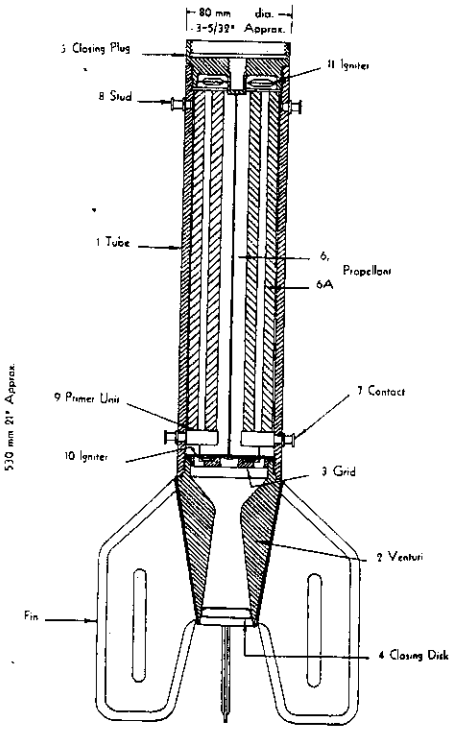

Figure 6.—Drawing of rocket motor for 8-cm HE projectile.

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Analysis of explosive contents:

Composition (A)	Mercury fulminate, 12 percent. Potassium chlorate, 52 percent. Antimony sulfide, 34 percent. Ground glass, 2 percent.
Composition (B)	Lead azide.
Composition (C)	PETN.
Composition (D)	PETN.
Pellets in exploder tube	TNT 58.6 percent. PETN 41.4 percent. Density 1.52 gm/cc.
Action	Fusible ring in base melts (melting point approximately 189 degrees C. or 356 degrees F.) under heat from propellant and allows exploder tube to go forward to the armed position. Fuze set off on impact by rearward movement of nose striker onto detonator in exploder tube.

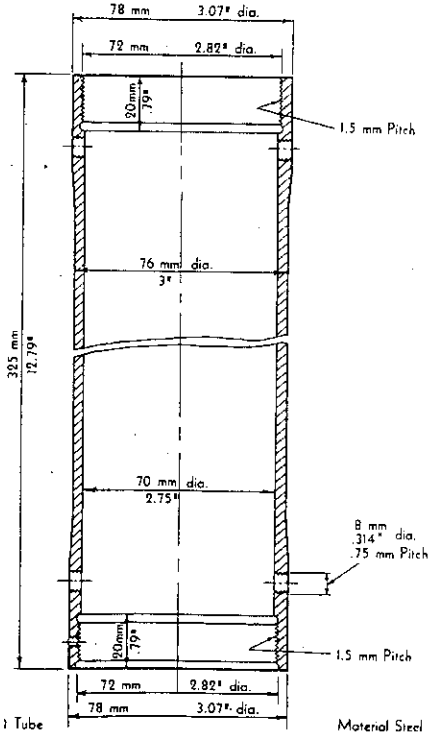

Figure 7.—Drawing of rocket motor tube for 8-cm HE projectile.

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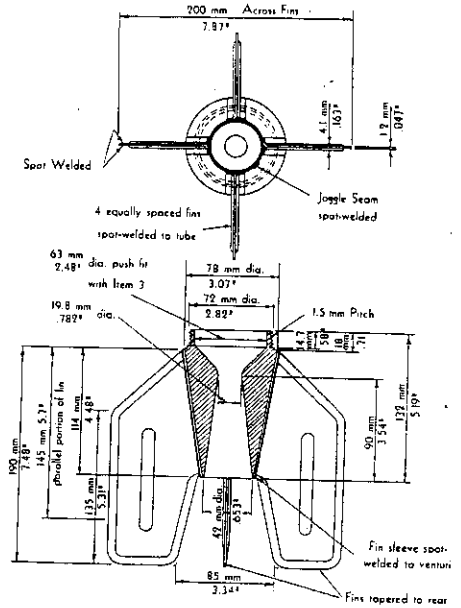

Figure 8.—Drawing of venturi assembly for 8-cm HE projectile.

Markings	———

ADAPTER

General shape	Circular plate recessed on both upper and lower surfaces. Upper flange female tapped and lower flange male threaded. Hollow central spigot extending downwards.
Dimensions:	
External diameter	3.07 inches.
Over-all length	1.57 inches.
Spigot diameter	0.78 inch.
Wall thickness, spigot	0.059 inch (1.5 mm).

ROCKET MOTOR

General	Single, central, convergent-divergent venturi; non-rotating, fin-stabilized pusher motor. Six mono-perforated propellant sticks supported at rear on multi-perforated grid.
Body tube:	
Material	Steel.
Diameter, center	3 inches.
Diameter, bearing surfaces	3.07 inches.
Internal diameter	2.75 inches.
Length	12.8 inches.
Weight	4 pounds, 5.25 ounces.
Markings	———

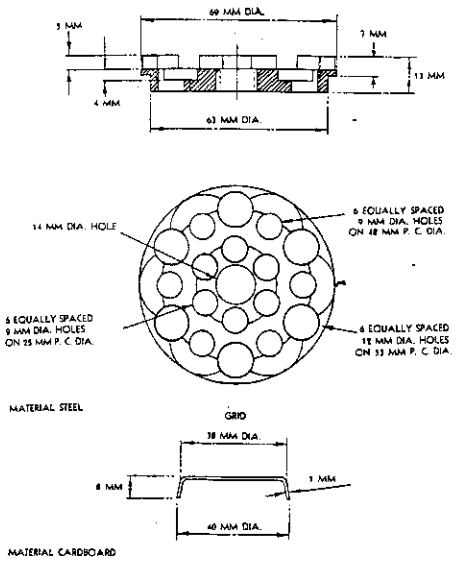

Figure 9.—Drawing of grid and closing disc for 8-cm HE projectile.

Venturi:
- Material ..... Steel.
- Length ..... 7.48 inches.
- Outside length of fins ..... 5.31 inches.
- Rear diameter across fins (external). ..... 7.87 inches.
- Rear diameter across fins (internal). ..... 3.34 inches.
- Weight ..... 2 pounds, 0.25 ounce.

Inlet:
- Maximum diameter ..... 2.48 inches.
- Minimum diameter ..... 0.782 inch.
- Length ..... 0.92 inch.

Throat:
- Diameter ..... 0.782 inch. (No length).

Outlet:
- Minimum diameter ..... 0.782 inch.
- Maximum diameter ..... 1.653 inches.
- Length ..... 3.54 inches.

Grid:
- Material ..... Steel.
- Diameter ..... 2.72 inches.
- Thickness ..... 0.51 inch.
- Weight ..... 3 ounces.

Propellant:
- Material ..... Double-base powder in monoperforated stick form.

- Number of sticks ..... Six.
- Total weight ..... 2 pounds, 3.75 ounces.
- Diameter ..... 0.87 inch.
- Diameter of perforation ..... 0.23 inch.
- Length (four long sticks) ..... 11.1 inches.
- Length (two short sticks) ..... 10.45 inches.
- Markings ..... ---------.
- Chemical analysis:
  - Nitrocellulose (12.4 percent N). ..... 63.05 percent.
  - Nitroglycerine ..... 28.04 percent.
  - Graphite ..... 0.1 percent.
  - Carbamite ..... 5 percent.
  - Diethylphthalate ..... 3.2 percent.
  - Ash ..... 0.25 percent.
  - Volatile material ..... 0.6 percent.
- Method of ignition:
  - Initiator ..... Two electrically fired gunpowder charges each weighing 0.75 gram, contained in copper tube and attached to guiding studs at rear of motor.
  - Firing current ..... ---------.
- Ignition charges:
  - Nature ..... Gunpowder.
  - Weight ..... Base: 10 grams. Head: 9 grams.
  - Container ..... Porous rough cloth bag.
  - Positioning ..... Base: attached to grid. Head: around spigot of adapter plug.

3. Performance. No details of the performance of this rocket are known at present.

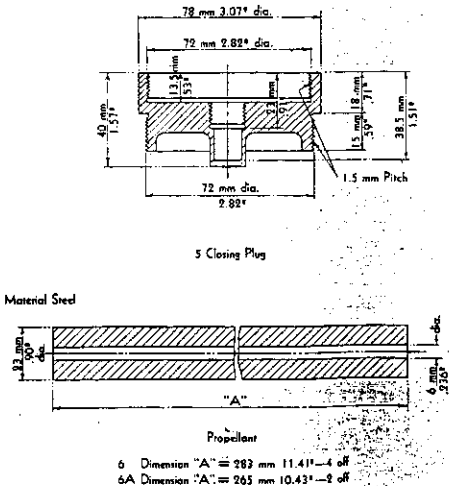

Figure 10.—Drawing of closing plug and propellant for 8-cm HE projectile.

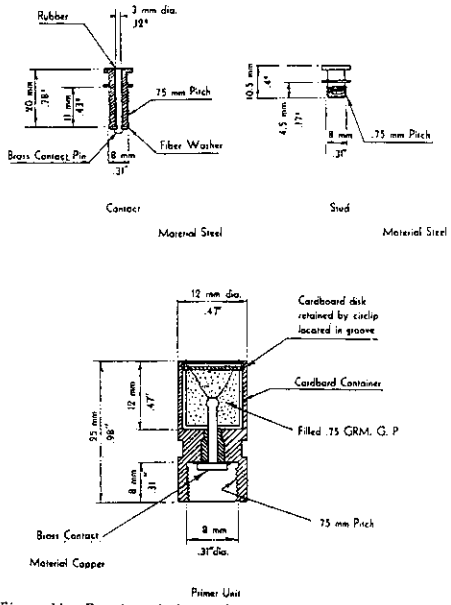

Figure 11.—Drawing of electrical contact, guiding stud, and electrical igniter for 8-cm HE projectile.

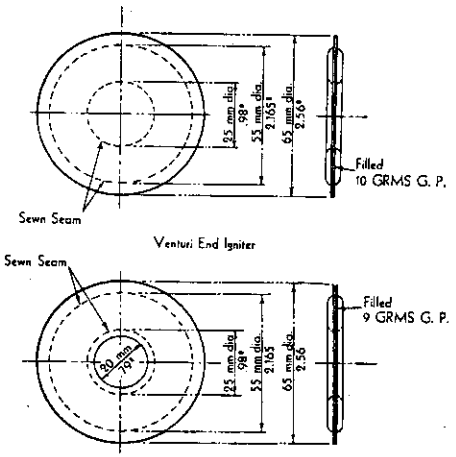

Figure 12.—Drawing of forward and rear ignition charges for 8-cm HE projectile.

8-cm Raketen Nebelgranate.

(8-cm Smoke Projectile.)

Fired from: *8-cm Raketen Vielfachwerfer* and possibly also from aircraft.

No specimen of this projectile has yet been received. Its existence has been assumed from a captured German document which brackets this rocket with the *8-cm Raketen Sprenggranate* (8-cm HE projectile) in an allotment of ammunition to the *8-cm Raketen Vielfachwerfer*. In the absence of confirmatory information, it is reasonable to assume that this projectile is similar in construction and appearance to the HE rocket, but with the HE charge replaced by a smoke filling and probably a small burster.

8.8-cm Raketen Panzerbüchse Granate 4322.

(8.8-cm Antitank Hollow-Charge Projectile.)
Fired from: *8.8-cm Raketen Panzerbüchse 54.*

1. Description. a. General. This antitank rocket projectile is fired from the *8.8-cm Raketen Panzerbüchse 54*, which is the German equivalent of the American "Bazooka." The projectile has been recovered in two forms; one of these is for normal temperature limits (−5 degrees to 140 degrees C.) and is fuzed with the dulled steel *A.Z. 5095/1* nose percussion fuze. The other is designed for winter use (temperature limits −40 degrees to 17 degrees C.) and has the Gothic letters "*arkt*" stenciled in white on the motor tube. This projectile takes the *A.Z. 5095* nose percussion fuze, which can be distinguished from the *A.Z. 5095/1* by its shape and its light blue color. Figure 2 shows the box label for the projectile designed for winter use. The projectile consists basically of the hollow-charge nose, the motor tube, and the tail-fin assembly.

b. Hollow-charge nose. The nose assembly comprises the nose fuze (either *A.Z. 5095* or *5095/1*), a spacing piece, and the cup holding the charge, which has a cavity about 2.875 inches in diameter. A booster charge is located at the rear of the main charge.

c. Motor tube. The motor tube is a metal cylinder sealed at the forward end where it is screwed into the tail of the cup holding the bursting charge. The propellent charge is held in place between the two grids. A stick of transparent fast-burning material through the central propellent stick transmits the ignition flame from the firing squib to the ignition charge at the forward end of the propellant.

A lead from the firing squib passes out through the venturi drilling and is connected to a plug which is inserted for firing into a socket on the launcher. The other electrical connection is formed by a spring-loaded contact on the inside of the launching tube which bears against a solder block on the side of the tail assembly.

d. Tail-fin assembly. The tail-fin assembly consists of a collar screwed over the rear of the motor tube. Six stabilizing fins are attached to the collar and strengthened by a supporting sleeve. The inside of the collar is shaped to form a simple convergent-divergent venturi drilling, and is sealed by a metal cap, which is blown out when the projectile is fired.

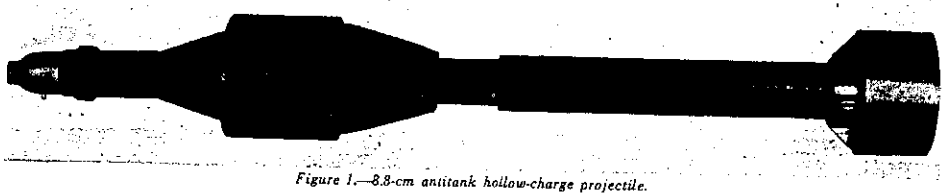

Figure 1.—8.8-cm antitank hollow-charge projectile.

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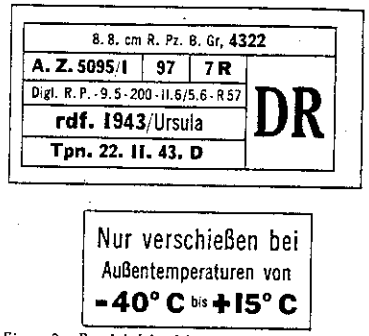

Figure 2.—Box label for 8.8-cm rocket for winter use.

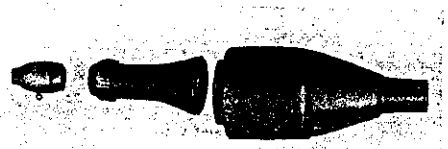

Figure 3.—Nose assembly of 8.8-cm antitank hollow-charge projectiles.

2. Technical Data.

GENERAL	
Nature of projectile	Single axial-venting, non-rotating pusher motor.
Caliber	8.8 cm.
Filled weight (complete round)	7.11 pounds.
Over-all length (complete round).	25.8 inches (fuze: *A. Z. 5095/1*). 25.75 inches (fuze: *A. Z. 5095*).
Nature of fuze	Nose percussion.
Nature of filling	RDX/TNT.
HOLLOW-CHARGE NOSE	
General shape	Cylinder conically reduced at each end to cylindrical tube.
Material	Steel.

I-B.104

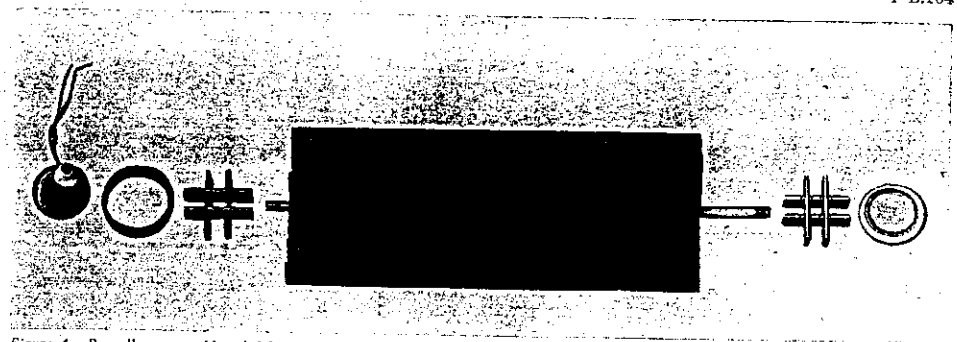

Figure 4.—Propellent assembly of 8.8-cm antitank hollow-charge projectile. Internal components of the motor tube (left to right) are: nozzle seal and electrical firing squib, rear grid supporting ring, rear grid, propellent charge (seven sticks), front grid, and ignition charge.

Dimensions:	
Over-all length	---------.
Length of main cylinder	2.35 inches.
Diameter of main cylinder	3.45 inches.
Weights:	
Empty	---------.
Filling	---------.
Filling	60/40 RDX/TNT.
Markings:	
Winter type	Black stencilling on main cylinder: *97 um s.11.43 D Lm 4322 elg 4.11.43* Exterior painted deep olive green.
Summer type	Black stencilling on main cylinder: *Tpn 10.6.44 97 Lm 4322* Exterior painted deep olive green.
FUZES	
Winter type	A. Z. 5095, instantaneous nose percussion.
Summer type	A. Z. 5095/1, instantaneous nose percussion.
MOTOR TUBE	
General shape	Tube threaded at ends.
Material	Steel.
Dimensions:	
Over-all length	11 inches (approx.).
Diameter	1.58 inches.
Weights:	
Empty	---------.
Propellant	0.28 pound.
Propellant:	
Number of sticks	Seven.
Length	---------.
Diameter	---------.
Diameter of perforation	---------.
Method of ignition:	
Initiator	Electrical squib grounded to motor tube and with one free lead connected to launcher. Transparent, fast-burning material along perforation of central propellent stick to ignition charge.
Ignition charge:	
Nature	---------.
Weight	---------.
Container	Ring.
Positioning	Metal grid.
Markings	---------.
TAIL-FIN ASSEMBLY	
Dimensions:	
Over-all length	---------.
Weight	---------.
Number of fins	Six.
Length of fins	---------.
Diameter across fins	3.45 inches.
Venturi:	
Inlet:	
Maximum diameter	---------.
Minimum diameter	---------.
Length	---------.
Throat:	
Diameter	---------.
Outlet:	
Minimum diameter	---------.
Maximum diameter	---------.
Length	---------.

3. Performance. a. Firing test procedure. Firing tests were conducted at Aberdeen (Maryland) Proving Ground with the winter-type 8.8-cm antitank hollow-charge projectile. Three rounds were used in this program. Two rounds were fired from the launcher against armor

plate. The third round was taken apart for examination and photography; after examination, the motor was fired on a static firing block and the head statically fired in contact with armor by a dynamite cap placed in the hole in the fuze firing button.

For the two rounds fired from the launcher, firing was done with a battery located in a concrete shelter. Two 16-mm motion picture cameras running at 128 frames per second recorded the firing of the launcher and the flight of the projectile. A high-speed (8,000 frames per second) camera recorded the collision and detonation of the round against the plate.

The trajectory of the two flight rounds formed an angle of about 10 degrees with the perpendicular to the plate. The first flight round was fired against 6-inch face-hardened armor. The second round was fired against the same 6-inch plate backed by two sheets of 2.25-inch class B homogeneous armor. The statically fired head was fired into the same 6-inch plate backed by two sheets of class B homogeneous armor plate.

b. Data. The following data were obtained from the tests:

(1) Statically fired rocket motor:

Weight of complete loaded round.	7.11 pounds.
Weight of propellant	0.28 pound.
Maximum pressure	6,910 pounds per square inch.
Maximum thrust	1,716 pounds.
Impulse	87 pounds per second.

(Figures on pressure, thrust, and impulse are doubtful because of possible gauge error.)

Propellent temperature 41 degrees F.

(2) Statically fired shaped-charge head:

Armor arrangement	6-inch face-hardened armor backed by two sheets of class B homogeneous armor each 2.25 inches thick.
Standoff	6.5 inches (approx.).
Hole diameters:	
6-inch plate	Front: 0.84 inch.
	Rear: 0.44 inch.
First 2.25-inch plate	Front: 0.70 inch.
	Rear: 0.25 inch.

The hole was smooth, symmetrical, and only gently tapered; very good performance. Hole came to end just at rear surface of first 2.25-inch plate. Second 2.25-inch plate only slightly pitted.

(3) First flight round:

Armor arrangement	6-inch sheet of face-hardened armor, unbacked.
Standoff	6 inches (approx.).
Hole diameters	Front: 1.13 inches.
	Rear: 0.70 inch.
Propellent temperature	55 degrees F.
Burning distance	7 feet (approx.).
Fuze functioning time (impact to detonation).	Less than 0.00014 second.

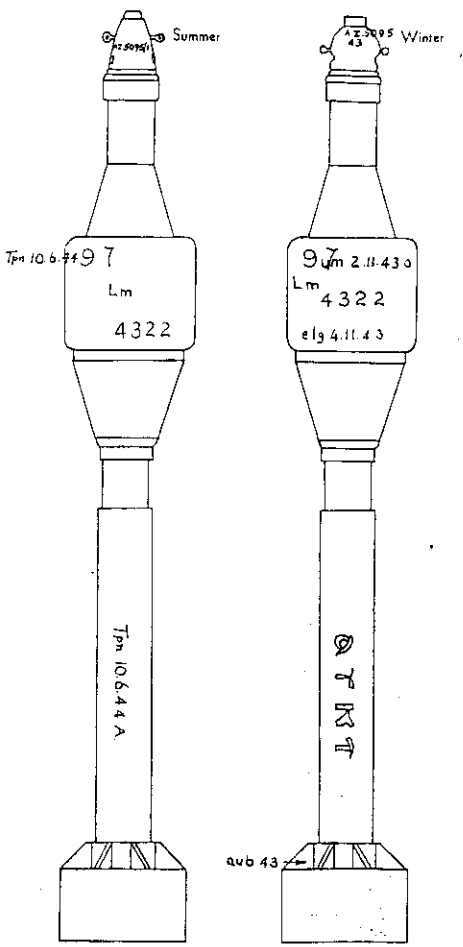

Figure 5.—Drawing showing difference in markings of summer (left) and winter (right) classes of 8.8-cm projectiles.

Velocity of round 340 feet per second (approx.).

The hole made by this round was symmetrical, smooth, and slightly tapered. The slug had passed with plenty of clearance to spare.

(4) Second flight round:

Armor arrangement	6-inch face-hardened armor backed by two sheets of class B homogeneous armor, each 2.25 inches thick.
Standoff	6 inches (approx.).
Hole diameters: 6-inch plate.	Front: 1.25 inches (minimum). 1.55 inches (maximum).
	Rear: 0.
	(One elliptical hole.)
Propellent temperature	55 degrees F. (approx.).
Burning distance	7 feet (approx.).
Fuze functioning time	Between 0.00014 second and 0.00023 second.
Velocity of round	340 feet per second (approx.).

This round produced a malformed hole.

8.8-cm Raketen Panzerbüchse Granate 4992.

(8.8-cm Antitank Hollow-Charge Projectile.)

Fired from: *8.8-cm Raketen Panzerbüchse 54* and *8.8-cm Raketen Panzerbüchse 54/1.*

No specimen of this projectile has been received to date, and evidence of its existence is purely documentary. The projectile apparently is basically similar to the *8.8-cm Raketen Panzerbüchse Granate 4322* but has a ring contact for the electrical firing connection. According to a German document, it can be fired from both the *8.8-cm Raketen Panzerbüchse 54* and from a newer type of launcher, the *8.8-cm Raketen Panzerbüchse 54/1.*

8.8-cm Raketen Panzerbüchse Granate 4312.

(8.8-cm Antitank Hollow-Charge Projectile.)
Fired from: *8.8-cm Raketenwerfer 43.*

1. Description. *a. General.* This projectile (Figure 1) is fired from the mobile antitank rocket launcher *8.8-cm Raketenwerfer* (I–F.103) and is similar in appearance to the *8.8-cm Raketen Panzerbüchse Granate 4322* (I–B.104). The projectile, which is fin-stabilized, consists basically of an HE head, a motor tube, and a tail-fin assembly.

b. HE head. The head of the projectile (Figure 2) consists of the body containing the cyclotol hollow-charge located by a cavity liner and an impact cap. The impact cap is flanged at the rear end to bear against the cavity liner and is fitted at the forward end with an adapter, threaded to receive either of two nose percussion fuzes, the *A. Z. 5095* or the *A. Z. 5095/1.*

Two pressed flanges at the forward end of the body secure the impact cap and the cavity liner. The rear end of the body is conical in shape and fits over a tail adapter which forms the junction with the motor tube. A reinforcing sleeve is pressed into position over the cylindrical portion of the body and provides the forward bearing surface of the projectile.

At the lower end of the cavity liner is a flash tube below which is located the gaine; this consists of an aluminum cup containing a charge of PETN and wax and a detonator. The gaine is separated from the motor tube by a wooden plug which acts as a buffer and which also provides the necessary thermal insulation between the motor and the gaine.

c. Motor tube. The forward end of the motor tube is sealed and threaded to screw into the tail adapter. The rear is screwed into the venturi block.

Figure 1.—8.8-cm antitank hollow-charge projectile (4312).

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I–B.106

I–B.106

I–B.106

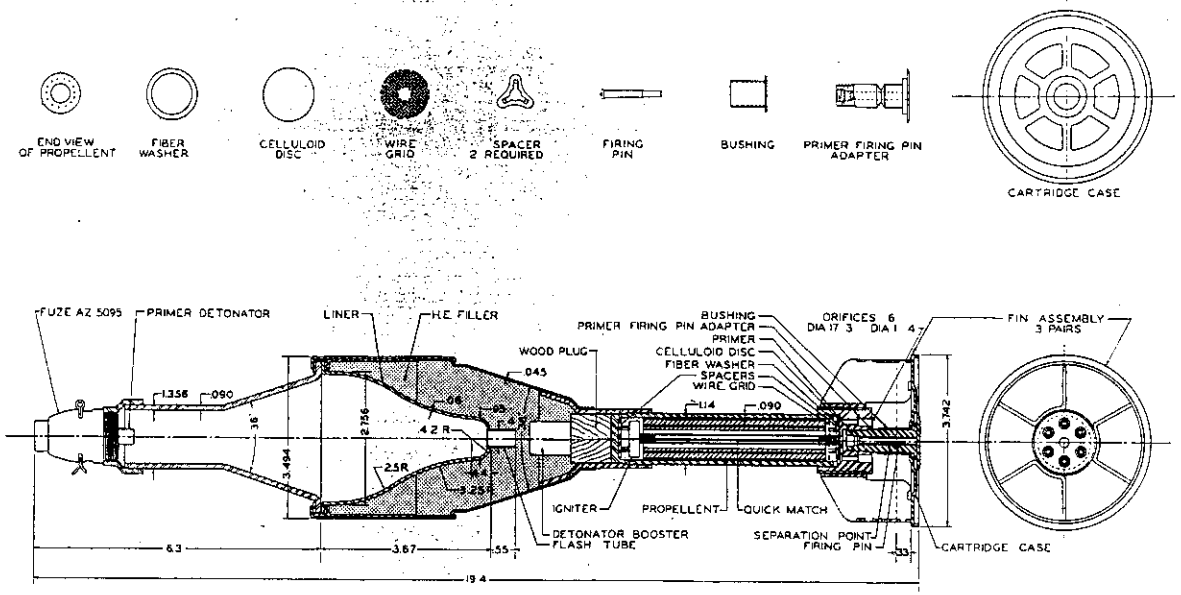


Figure 2.—Internal construction of 8.8-cm antitank hollow-charge projectile (4312). All dimensions are given in inches.

The propellant consists of a single stick with 14 small longitudinal perforations and a single axial drilling of larger diameter. Three lands around the outside of the stick keep the propellant from touching the inside of the tube and ensure an external burning surface. Two grids, one at each end, are used to support the propellant; each grid is a triangular metal platform on three legs. At the rear there is a wire mesh between the grid and the propellant to prevent any unburnt particles from blocking the venturi drillings.

Between the grid and the propellant at the forward end is an ignition charge mounted so that it is free to burn on both surfaces. A celluloid tube, containing a thin strip of what appears to be nitrocellulose powder, is located in the axial drilling of the propellant; both ends of the tube are capped with a block of black powder. This train serves to transmit the flash from the primer to the ignition charge at the forward end of the motor tube.

d. Tail-fin assembly. The tail-fin assembly consists of a venturi block, stabilizing fins, obturator, and percussion igniter.

The venturi block, which is screwed over the end of the motor tube, his six venturi drillings parallel to the axis of the projectile. These are each formed by two drillings of different diameter; instead of taper there is a sudden step from the smaller to the larger diameter. The block is drilled and tapped in the center to receive the firing-pin adapter. A collar on the rear of the firing-pin adapter holds the obturator in position around the rear of the fin assembly. A percussion cap is mounted in the forward end of the firing-pin adapter, immediately in rear of the quickmatch train. The adapter is machined down to a separation point near the rear end; when the projectile is fired, the adapter severs. and the rear portion remains in the breech together with the obturator.

The six stabilizing fins are mounted in three pairs around the venturi block and are strengthened by a sleeve fitted around the fins and under the forward lip of the obturator.

2. Technical Data.

GENERAL

Nature of projectile	Multiple-venting, non-rotating, fin-stabilized, pusher motor.
Caliber	8.87 cm.
Over-all length (complete round)	19.4 inches.
Total weight (complete round)	5 pounds, 13.6 ounces.
Nature of fuze	Instantaneous nose percussion.
Nature of filling	Cyclotol.

HE HEAD

General shape	Cylindrical main body; truncated, conical impact cap and rear section.
Dimensions:	
Over-all length	10.47 inches.
Diameter of bearing surface	3.494 inches.
Depth of cavity liner	3.67 inches.
Wall thickness, main body	0.045 inch.
Wall thickness, impact cap	0.090 inch.
Wall thickness, cavity liner	0.06 inch.
Forward diameter, impact cap	1.356 inches.
Weights:	
Empty	4 pounds, 0.75 ounce.
Filling	1 pound, 7.14 ounces.
Filling	Cyclotol.
Markings:	
Cylindrical portion of body	Stencilled in purple: *WaA 424* Stencilled in black: *Tpn 2. 3. 44D LM 4312*
Rear portion of body	Stencilled in white: *43 jcc 47*
Fuze	Either *A. Z. 5095* or *A. Z. 5095/1* instantaneous nose percussion fuzes.

GAINE

Weight	0.36 ounce.
Filling	PETN/wax.
Markings	---------
Method of assembly	Aluminum cup in lower end of flash tube below cavity liner.

ROCKET MOTOR

General	Multiple annular-venturi, nonrotating, fin-stabilized, pusher motor attached to rear of hollow-charge HE head. Single propellent stick located between forward and rear grids.
Motor tube:	
Over-all length	4.91 inches.
Internal length	4.75 inches.
External diameter	1.14 inches.
Internal diameter	0.96 inch.
Weight	---------
Markings	Stencilled in black on body: *WaAA37 Tpn 2 3. 44D*
Venturi block:	
Length	1.22 inches.
Diameter	1.42 inches.
Venturi:	
Number	Six.
Inlet, diameter	0.10 inch.
Inlet, length	0.39 inch.
Outlet, diameter	0.17 inch.
Outlet, length	0.30 inch.
Tail fins:	
Number	Six.
Length, internal	2 inches.
Length, external	1.3 inches.
Diameter across fins	3.51 inches.
Obturator:	
Diameter	3.74 inches.
Length extending forward over fins.	0.33 inch.
Propellant:	
Number of sticks	One.
Perforations	14 small, one central.
Diameter of central perforation	0.28 inch.
Diameter of stick	0.85 inch.
Length of stick	4.95 inches.
Method of ignition:	
Initiator	Percussion igniter mounted in center of venturi block. Igniter sleeve machined down to separation point for fracture on firing.
Length	1.57 inches.
Diameter	0.49 inch.
Ignition charge:	
Weight	0.06 ounce.
Location	Grid forward of propellant.

3. Performance. No figures on the performance of this projectile are available at present.

15-cm Wurfgranate 41 Spreng.

(15-cm HE Projectile.)

Fired from: *15-cm Nebelwerfer 41, 15-cm Panzerwerfer 42, 21-cm Nebelwerfer 42* fitted with guide rails, and *30-cm Raketenwerfer 56* fitted with guide rails.

1. Description. *a. General.* This projectile (Figure 1) consists of a ballistic cap, a forward compartment containing the propellent charge, and a rear compartment which holds the HE filling.

b. Ballistic cap. The ballistic cap, which is ogival and has no filling, fits over the forward end of the propellent compartment.

c. Propellent compartment. The propellent compartment is a plain steel cylinder, closed at the forward end, where it fits into the ballistic cap, and open at its lower end, where it fits in the rear explosive compartment.

The propellant consists of seven monoperforated sticks, six of which are arranged around a central identical stick. A length of quickmatch is enclosed in a celluloid tube in the drilling in the central stick and serves to connect two igniters, one situated above, the other below the propellent sticks. The upper igniter is an aluminum box of flash composition with a layer of initiating composition. The igniter, located over the venturi jets, is a celluloid ring containing gunpowder. Below the lower igniter is a sheet of metal foil which is perforated by the initiation of the primer.

d. Filling compartment. The lower compartment containing the explosive filling is in the form of a cylinder closed at the lower end. At the upper end it is joined by a sleeve to the propellent compartment. Around the lower periphery of the sleeve and outside the circumference of the lower compartment are 26 venturi jets through which the propelling gases are ejected.

The explosive charge is composed of TNT and weighs 4.4 pounds. It is initiated by means of a standard gaine and a base fuze screwed into the base of the compartment.

2. Technical Data.

GENERAL

Nature of projectile	Multiple, circumferential-venting tractor rocket.
Caliber	15 cm.
Filled weight (complete round)	76 pounds 13 ounces.
Over-all length (complete round)	36.4 inches.
Nature of fuze	Base fuze.
Nature of filling	TNT.
SHELL (filling compartment)	
General shape	Cylindrical with rounded base.
Material	Steel, painted green or khaki.

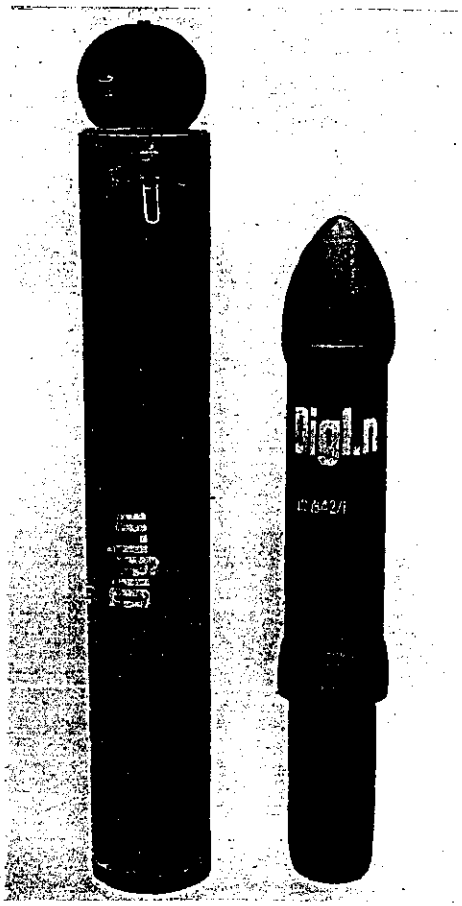


Figure 1.—15-cm HE projectile.

Dimensions:	
Over-all length (including venturi union assembly).	318 mm.
Over-all diameter (excluding venturi union assembly).	123 mm.
Wall thickness	---------
Weights:	
Empty	---------
Filling	4.4 pounds.
Filling	TNT.
Markings	*III 1 Ze 6.11.42 P Ze 10.11.42 O 42 (?) nr 83 S.KJ*

FUZE

Nature of fuze and ballistic cap, if any.	Base graze fuze *Zdlg.C/98 Np* type at rear of shell. Pressed steel ballistic cap at head of propellent compartment forward of shell.
Weights	---------
Action	The striker is freed by the action of centrifugal bolts in accordance with the normal German practice with this type of fuze.
Markings	*Bdz DOV.* Ballistic cap bears marking *42 aks 19*, and eagle surmounting encircled Swastika (ordnance inspection mark).

GAINE

Weight	---------
Filling	33.8 grams PETN/wax.
Markings	*Zdlg C/98 Np.*
Method of assembly	Received by rear of bursting-charge container and recessed at rear to receive fuze.

MOTOR

General	Multiple annular-venturi, circumferentially positioned in rear of the propellent compartment and forward of the filling compartment. Seven tubular, monoperforated sticks supported on cast-iron grid.
Body tube:	
Material	Mild steel.
Length	475 mm.
Diameter	137 mm.
Weight	24 pounds 12.5 ounces.
Markings	*Digl.n. ktz 1942/1*
Base:	
Over-all external diameter	157 mm.
Weight	10 pounds 13.75 ounces.
Method of assembly	Screwed to rear of body tube.
Venturi:	
Number and position	26 in annular ring in base of venturi union assembly which forms the attachment between the rocket motor and the filling compartment.
Angle of cant	14 degrees (approx.) to give right-hand spin viewed from rear.
Inlet:	
Maximum diameter	7 mm.
Minimum diameter	5.5 mm.
Length	5 mm.
Throat:	
Diameter	5.5 mm.
Length	5 mm.
Outlet:	
Maximum diameter	12.5 mm.
Minimum diameter	5.5 mm.
Length	20 mm.

Grid:
- General — Cast iron "wheel shape" with six "spokes" and central hole.
- Over-all diameter — 124 mm.
- Diameter outer ring — 112 mm.
- Depth — 22 mm.
- Weight — 1 pound, 3.25 ounces.

Igniter:
- Nature — Gunpowder.
- Weight — Base: 43.8 grams. Head: 85 grams.
- Container — Base: Celluloid ring. Head: Cardboard.
- Positioning — Base: On felt base on cast steel ring above grid. Head: Retained by metal cup held above split ring by a flange.
- Markings — None.

Chemical analysis of propellant:

Volatile matter (results calculated on V. M.-free material)	1.2 percent.
Nitrocellulose	61.1 percent.
Diethylene glycol dinitrate*	33.3 percent.
Stabilizers (probably akardite)	2.1 percent (approx.).
Graphite	0.24 percent.
Ash (carbonated)	0.75 percent.
Error and undetermined	2.51 percent.

*Calculated on theoretical N-content of 14.3 percent. The undetermined material probably arises from impurities in the original material.

PACKING

The complete projectile is housed base downwards in a cylindrical fiber container with metal end caps, of which the top cap is hinged and has one fastening catch. To the inside of the cap is attached a carton containing the electrical initiator.

3. Performance. a. British tests. (1) Conditions of firing: The 15-cm HE projectiles were fired in British tests with the rockets divided into three sections and fired at three quadrant elevations: section I, 6 degrees 30 minutes; section II, 30 degrees; and section III, 45 degrees. The mean temperature in the tent where the rockets were kept between 1300 and 1700 was 115 degrees to 120 degrees F. In this trial, section I was fired between 0930 and 1105; section II between 1330 and 1515, and section III between 1525 and 1600, the rounds being left exposed to the sun throughout the trial. It is clear, therefore, that the charge temperature, which was not known, increased during the trial. No corrections were made for meteorological conditions.

(2) Summary of observations: The number of rounds in each section were:

Section	*Fired*	*Observed*	*Included in means*
I	10	10	10
II	5	4	4
III	5	5	5

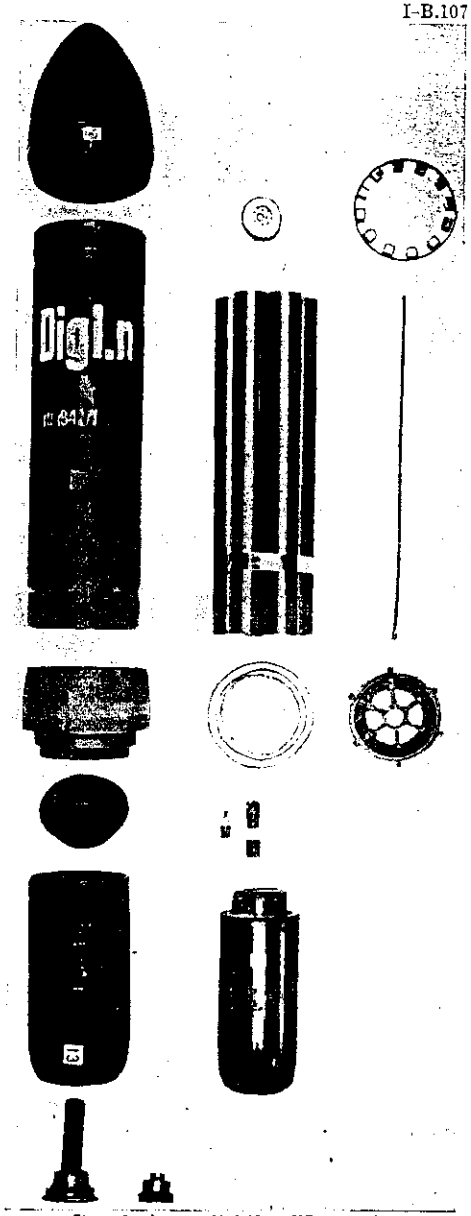


Figure 2.—Disassembled 15-cm HE projectile.

Position of mean point of fall:

Time of flight

Section	*Mean* (seconds)	*Mean deviation* (seconds)	*Range* (yards)
I	9.9	1.2	2,954
II	31.0	0.7	7,675
III	44.5	1.4	8,446

Dispersion (mean deviation from mean point of fall in horizontal plane):

Section	*In range* (yards)	*Laterally* (yards)
I	247	77
II	142	37
III	127	34

Time of burning:
- Section I — 0.9 second.
- Section II — 0.85 second.
- Section III — 0.55 second.

The decrease is probably due to increasing charge temperatures.

Remarks: The sound of projection is very similar to that of a British 3-inch rocket, whether heard from the firing point or near to graze. The burst is not impressive, and a crater about 6 inches deep and 3 feet in diameter is left in stony ground. A number of small high-speed fragments are probably produced, but the only fragments recovered weighed between ¼ ounce and 4 ounces. The tube splits into long knife-like portions which travel comparatively slowly for distances up to 150 yards from the burst. Numbers of larger pieces of the thicker machined portions were found. Evidence that spin persists to graze was provided by marks on the ballistic cap of one round which was recovered.

b. Tests at Aberdeen (Maryland) Proving Ground. (1) Firing tests: Twenty-four rockets were fired to determine range, velocity, and dispersion. In addition, data was obtained on burning time, burning distance, and revolutions per minute by means of the Hickman camera. Half of each rocket was painted white to obtain revolutions per minute. The average results obtained were as follows:

Quadrant elevation 20 degrees:
- Average range — 5,880 yards.
- Maximum deflection — 181 yards.
- Minimum deflection — 0.
- Average deflection — 72.6 yards.

Quadrant elevation 43 degrees:
- Maximum range — 7,625 yards.
- Average burning distance — 450 feet.
- Average over-all burning time — 0.577 second.
- Average velocity — 1,120 feet per second.

Figure 3.—Result of static firing at 140 degrees F.

Rounds 1 to 17 and 24 were fired singly from the same tube of the projector. Rounds 18 to 23 were fired by means of a ripple firing switch at intervals of ½ second. All rounds were ignited by means of a 110-volt AC field generator.

(2) Propellent powder test: To determine the pressure-temperature relationship of the propellent powder the HE charge was removed from 12 rounds. Two 3.8-inch holes were drilled and tapped into the rocket body to take copper-ball gauges. Rounds complete with gauges were allowed to soak at the desired temperature for at least 18 hours prior to firing. The maximum lapse of time between the removal of the rounds from the temperature control unit and firing was 3 minutes. The rounds were buried in the ground up to a point 6 inches below the venturi jets. Packing the earth tightly around the body prevented rotation when the rocket was ignited. An attempt was made to take electrical strain-gauge measurements, but the intense heat from the rocket caused this to be discontinued.

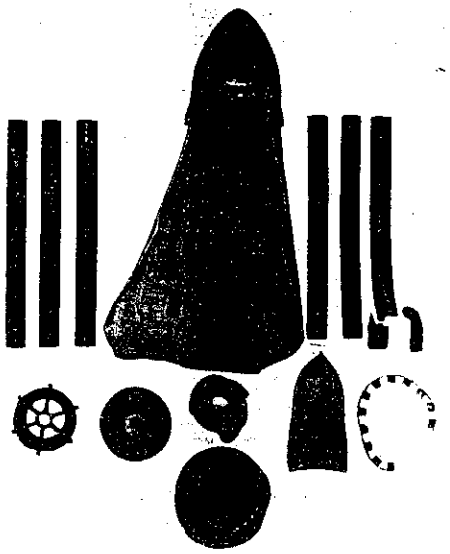


Figure 4.—Result of static firing at 140 degrees F.

Individual data by rounds:

Round	Temperature (degrees F.)	Average copper ball pressure (pounds per square inch)
1	70	2,475
2	80	2,650
3	100	3,424
4	100	2,975
5	20	2,150
6	20	2,025
7	120	3,725
8	120	4,500
9	140	4,975
10	140	5,575
11	6	2,000
12	−40	1,700

Insufficient rounds were fired to ascertain the exact separation (blow-up temperature) but it is probably between 120° F. and 140° F. as both rounds fired at 140° F. separated. The maximum pressures related to these temperatures, and consequently the maximum pressure the motor will stand, are between 4,000 and 5,000 pounds per square inch. There was no noticeable hangfire, chuffing, or after burning with the round fired at −40° F.

The following conclusions were drawn from these tests:

The maximum range is about 7,625 yards.
The average velocity is 1,120 feet per second.
The maximum deflection was 181 yards and the minimum deflection 0 yard (at 5,880 yards).
The average burning distance was 450 feet.
The over-all burning time was 0.577 second.
The rocket has a low temperature limit below −40° F.
The rocket has a high temperature limit between 120° and 140° F.

15-cm Wurfgranate 41 Nebel.

(15-cm Smoke Projectile.)

Fired from: *15-cm Nebelwerfer 41, 15-cm Panzerwerfer 42, 21-cm Nebelwerfer 42* fitted with guide rails, and *30-cm Raketenwerfer 56* fitted with guide rails.

1. General Description. This projectile is similar in appearance and construction to the HE projectile, *15-cm Wurfgranate 41 Spreng*, and consists of a ballistic head, a forward compartment containing the propellent charge, and a rear compartment containing the smoke composition filling.

2. Technical Data.

GENERAL

Nature of projectile	Multiple circumferential-venting tractor rocket.
Caliber	15 cm.
Filled weight (complete round)	78.1 pounds.
Over-all length (complete round)	39.8 inches.
Nature of fuze	Base fuze.
Nature of filling	30/70 pumice/sulphur trioxide.
Maximum range	———

SHELL (filling compartment)

General shape	Cylindrical with rounded base.
Material	Steel, painted green or khaki.
Dimensions:	
Over-all length (including venturi union assembly).	433 mm.
Over-all diameter (excluding venturi union assembly.	124 mm.
Weights:	
Empty	———
Filling	8.5 pounds.
Filling	30/70 pumice/sulphur trioxide.
Markings:	
Stencilled	*II II 38 Nb Orr. 10/41 Zc 15/9/42 41-ak.1.-22*
Stamped	*S.rr.10.41 Nb.*

FUZE

Nature of fuze and ballistic cap (if any).	Base graze fuze *Zdlg.C/98 Np* type at rear of shell. Pressed steel ballistic cap at head of propellent tube forward of shell.
Weights	———
Action	The striker is freed by the action of centrifugal bolts in accordance with the normal German practice with this type of fuze.
Markings	*Bds. DOV.* Ballistic cap bears marking *42 aks 19* and eagle surmounting encircled Swastika. (Ordnance inspection mark.)

CAINE

Weight	———
Filling	33.8 grams PETN/wax.
Markings	*Zdlg C/98 Np.*
Method of assembly	Received by rear of burster-charge assembly.

MOTOR

This projectile uses the same motor as that incorporated in the 15-cm HE rocket, *15-cm Wurfgranate 41 Spreng*. Multiple, annular venturi, circumferentially positioned in rear of the body tube and forward of the burster container; seven tubular 1.65-inch to 0.26-inch sticks supported on cast iron grid.

3. Performance. No details concerning the performance of this projectile are available at present.

15-cm Wurfgranate Gelbring.

(15-cm CW Projectile, Yellow Ring.)

Fired from: Same launchers as 15-cm HE projectile.

Complete information about this projectile is not available at present. The following data has been obtained from the examination of specimens consisting of the filling compartment and collar forming the junction with the rocket motor. It is believed, however, that, apart from the contents of the filling compartment, this projectile is almost identical with the 15-cm HE and smoke projectiles.

The filling compartment (Figure 1) contains approximately 3.5 liters (0.77 gallon) of H/MA and a burster charge of 70 grams of PETN/wax. The burster, which is formed of four short cylinders of PETN/wax packed end to end and surrounded by waxed paper, is located axially in the filling compartment. Below the burster is a small gaine, marked *Kl.Zdlg.34 Np* and embossed with *R* on the base, and a base graze fuze, *Bdz.DOV*.

The chemical filling is a dark brown liquid containing a ginger-colored sediment and smelling like mustard. On examination it gave positive SD and Gutzeit tests. On distillation in vacuum two fractions were obtained of roughly equal volume which boiled at 97 degrees to 104 degrees C/8-mm and 110 degrees to 130 degrees C/8-mm. From the first fraction, the sulphilimine derivative for H was obtained and from the second the pentamethylene-dithiocarbamate of MA.

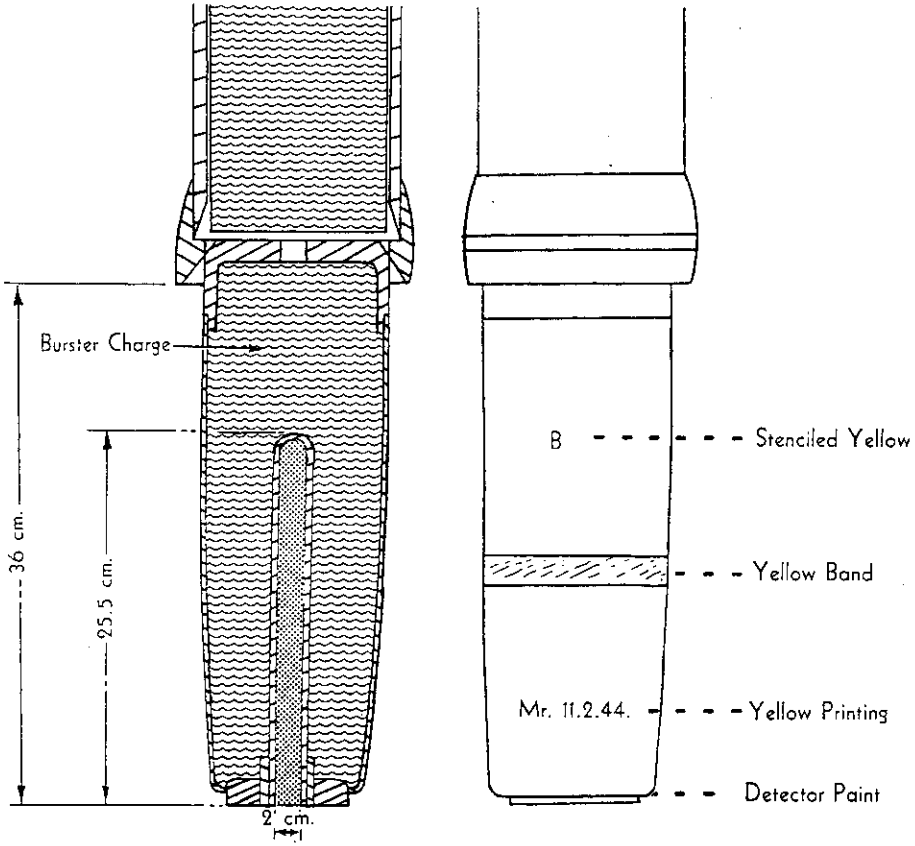


Figure 1.—15-cm chemical warfare projectile, yellow ring.

15-cm Wurfgranate Grünring.

(15-cm CW Projectile, Green Ring.)

Fired from: Same projectors as 15-cm HE projectile.

No detailed report on this projectile has yet been received, and the following data are therefore incomplete and tentative. The projectile is similar in appearance and basic construction to the 15-cm HE projectile and uses the same rocket motor. The filling compartment, which is also similar to that of the 15-cm HE projectile, contains approximately 2.5 liters (0.55 gallon) of HN–3 and a large burster of 1.4 kilograms (3.0856 pounds) of PETN/wax.

The burster charge, marked *Gr.Kh.Ldg.32.DOV*, consists of four cylinders of PETN/wax placed end to end and surrounded by waxed paper. The charge fits into a plastic reducing collar screwed into the tail of the projectile. A base graze fuze, *Bdz.DOV*, screws into the same collar and has a small gaine, *Kz.Zdlg.c/98 Np*, immediately above it, which fits into a recess in the lower cylinder of the burster.

The chemical filling consists of approximately 2.5 liters (0.55 gallon) of an almost colorless liquid with no appreciable odor. On examination it gave a permanent blue coloration to AIP paper and a red precipitate with Dragendorffs reagent thus indicating a nitrogen mustard. Formation of the picrate in benzene solution gave yellow plates (melting point, 135 degrees to 138 degrees C.). These were identical in appearance and melting point with an authentic picrate of HN–3. It is assumed therefore that the filling is HN–3.

In addition to the markings shown in Figure 1, the rocket had a green ring and the figures "38" on the ballistic cap.

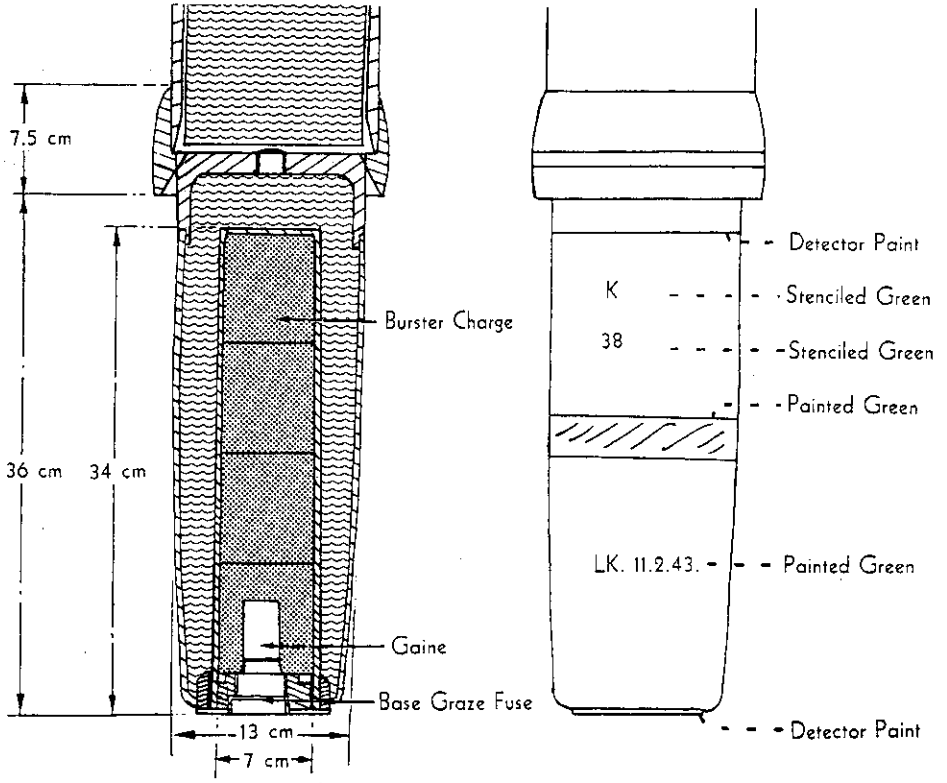


Figure 1.—15-cm CW projectile, green ring.

15-cm Wurfgranate Grünring-Gelb.

(15-cm CW Projectile, Green Ring Yellow.)

Fired from: Same projectors as 15-cm HE projectile.

Complete information on this projectile is not at present available. The following data have been obtained from the examination of specimens consisting of the filling compartment and the collar forming the junction with the rocket motor. It is believed, however, that apart from the contents of the filling compartment, this projectile is almost identical with the 15-cm HE and smoke projectiles.

The rocket tails were found stored in the open and bore no labels (possibly an experimental munition). The burster container was empty and closed with a plastic plug. The basic color of the round is gray-green and the markings are as shown in Figure 1. The dimensions of this container are the same as those of the container used in the "green ring" projectile, where the burster consisted of 1,400 grams of PETN/wax. The charge in this case will therefore be either identical with or at least very similar to that of the "green ring" rocket.

The charge consists of 2.6 liters (0.572 gallon) of a light brown, non-viscous liquid smelling of H. It gave a positive SD test and a negative Gutzeit test. On vacuum distillation, a small amount of low-boiling (20 degrees C/8-mm) material came over, after which the remainder boiled at 100 degrees to 104 degrees C/8-mm. The distillate was confirmed as H by the sulphilimine derivative.

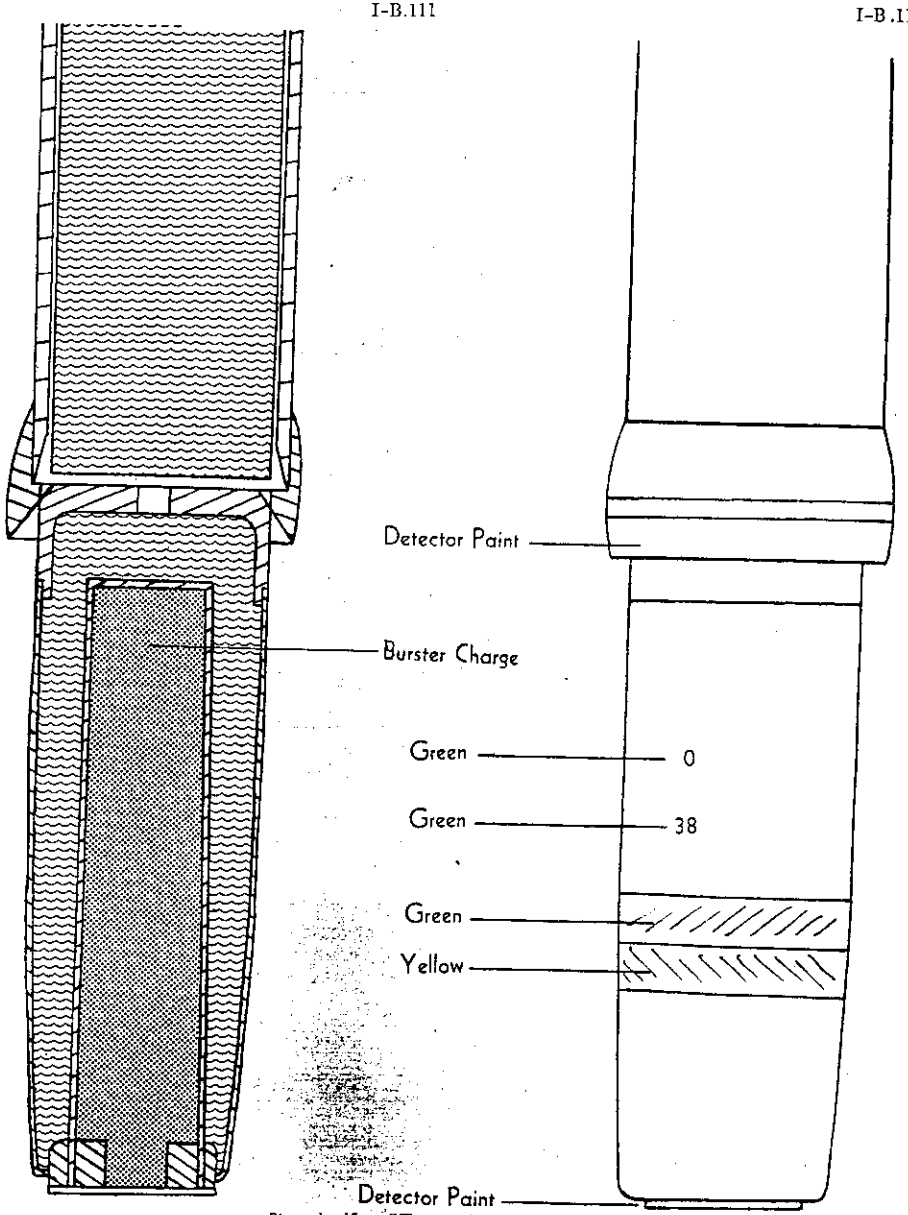


Figure 1.—15-cm CW projectile, green ring yellow.

21-cm Wurfgranate 42 Spreng.

(21-cm HE Projectile.)

Fired from: *21-cm Nebelwerfer 42* and aircraft (see I-B.302).

1. Description. *a. General.* This projectile (Figure 1) resembles an artillery projectile in appearance and consists of a forward filling compartment and a rear compartment containing the propellant. All metal components of the rocket are of mild steel, machined inside and out.

b. Filling compartment. The filling compartment has a mild steel body with fairly thick walls and is screwed into the forward end of the rocket body. A hollow ogival nose fits over the forward end of the body.

Figure 1.—Complete 21-cm HE projectile.

A point-detonating percussion fuze is fitted to the body below the ogival nose. This fuze may be set for either instantaneous action or for short delay by a setting screw which is reached through a drilling in the wall of the nose. A wooden actuating rod, extending from the top of the nose to the fuze, conveys the force of impact to the firing pin. An adapter in the forward end of the body locates the gaine immediately below the fuze.

c. Rocket motor. The body of the rocket motor is slightly reduced diametrically in the center and has a bourrelet surface at each end. The tail is closed by a motor closing plate in which there are 22 venturi drillings and a central drilling to receive an electrical igniter.

The propellant, which consists of seven monoperforated sticks, is located at the rear by a metal grid. The propellant is fired by two ignition charges, one at each end of the body.

2. *Technical Data.*

GENERAL

Nature of projectile	Multiple base-venting, rotating, pusher rocket.
Caliber	21.3 cm.
Filled weight (complete round)	242.7 pounds.
Over-all length (complete round).	1,225.5 mm (48 inches)
Nature of fuze	Optional delay action.
Nature of filling	Amatol.
Maximum range	About 10,000 yards.

SHELL (filling compartment)

General shape	Truncated ogival with solid base threaded into tail.
Material	Steel, painted olive green.
Dimensions:	
Over-all length (including threaded portions.)	402 mm.
Over-all diameter, nose	136.4 mm.
Over-all diameter, base	213 mm.
Diameter nose thread	112.4 mm.
Diameter base thread	190.3 mm.
Diameter (internal) fuze adapter thread.	89 mm.
Wall thickness	---------.
Weights:	
Empty	68.5 pounds.
Filling	21.5 pounds.
Filling	40/60 amatol.
Markings	None.

FUZE

Nature of fuze and ballistic cap	The fuze assembly (enclosed by ballistic cap) consists of a percussion fuze with optional delay of 0.15 second fitted with a wooden actuating rod from a special attachment in the nose of the ballistic cap. The fuze is attached to the shell by an adapter, which also receives the gaine holder.

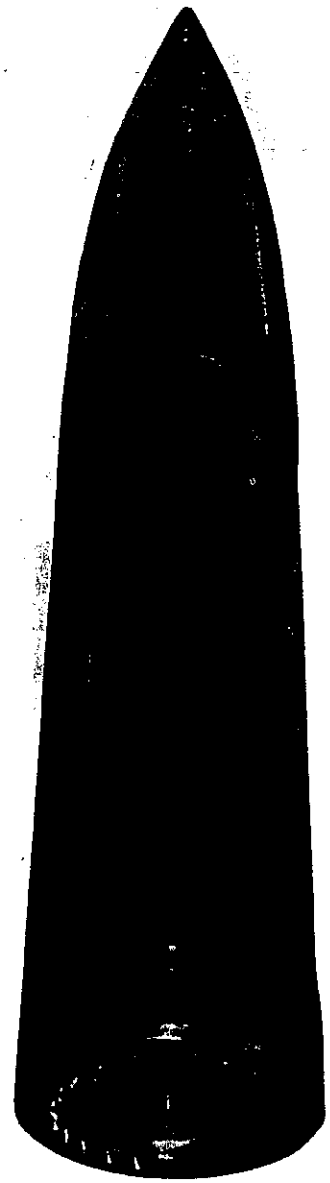


Figure 2.—Cut-away section of complete 21-cm HE projectile.

FUZE—Continued.

Weights:	
Fuze	14 ounces.
Adapter	2 pounds 1 ounce.
Ballistic cap	4 pounds 12 ounces.
Action	Delay action, if required, is selected by inserting a screwdriver through the hole in the side of the ballistic cap and turning the slot in the screw head from the position "O" to the position "M–V", thus giving 0.15-second delay. The fuze is armed as centrifugal force withdraws five segments from beneath a flange on the striker. Impact forces a nose plunger down on the wooden rod, which, in turn, forces down the striker.
Markings:	
Fuze assembly	*Hbgr. Z. 35 K.*
Fuze	*Dlgn Z 23 nA. 6 mv 43*

GAINE

Weight	5 ounces.
Filling	---------.
Markings	*Zdlg 36 nP.*
Method of assembly	---------.

The gaine is contained in a steel cylinder which is received by the base of the adapter.

MOTOR

General description	Multiple base-venting, annular venturi; seven tubular-sticks supported on grid; total weight 145 pounds.
Body:	
Over-all length	675 mm.
Length of propellent chamber	585 mm.
Main diameter	207 mm.
Bearing diameter	213 mm.
Weight unfilled	87 pounds 2 ounces.
Markings	None.
Base:	
Material	Steel.
Over-all length	50 mm.
Weight	16 pounds.
Method of assembly	Received by base of body.
Propellant:	
Material	Diglycol.
Number of sticks	Seven.
Total weight	5,925 grams.
Length	406 mm.
Internal diameter	6.4 mm.
External diameter	42 mm.
Markings	None.
Special features	Celluloid tube containing quick-match runs the full length of the central stick through the perforation.

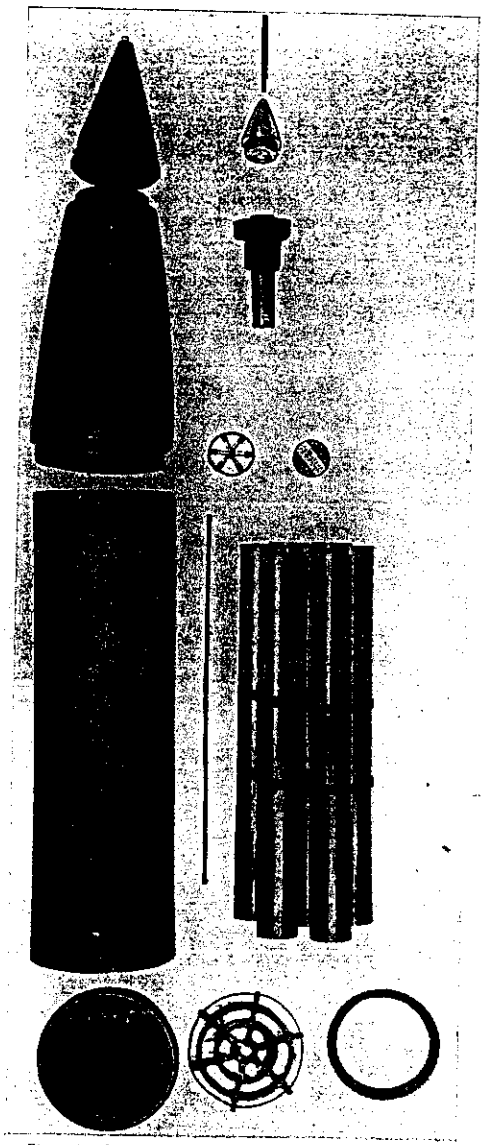


Figure 3.—Component parts of complete 21-cm HE projectile.

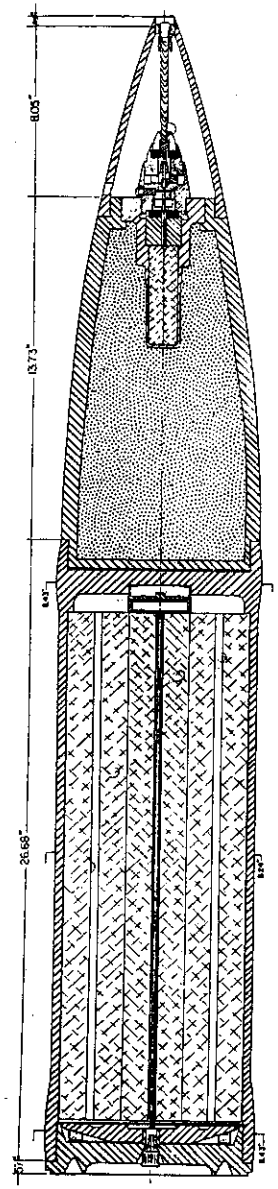


Figure 4.—Internal construction of 21-cm HE projectile.

Method of ignition:

Initiator	Electrical puffer (U. S.: plug) in plastic mounting with metal contacts. One contact is a metal band fitted around the conical portion of the mounting, which pushes into a venturi outlet. The second contact is cup-shaped, and located at the rear of the plastic mounting; it receives a firing lead bayonet.
Over-all length	35 mm.
Over-all diameter	15 mm.

Venturi:

Number and position	22 in annular ring at base.
Diameter of ring	153 mm.
Angle of cant	16 degrees to produce clockwise rotation viewed from rear.

Inlet:

Maximum diameter	11 mm.
Minimum diameter	8.5 mm.
Length	7.5 mm.

Throat:

Diameter	8.5 mm.
Length	3 mm.

Outlet:

Maximum diameter	20 mm.
Minimum diameter	8.5 mm.
Length	23.5 mm.

Grid:

General	Rough "gas-ring" casting, with six radial arms, central hole, and two concentric rings. Machined on propellent-supporting surface only.
Over-all diameter	184 mm.
Over-all thickness	19 mm.
Weight	1 pound 10 ounces.

Propellant:

Material	———
Number of sticks	Seven.
Total weight	40.25 pounds.

Each stick:

Length	550 mm.
Diameter	62 mm.
Diameter of perforation	7.75 mm.
Countersunk each end to	10 mm.
Markings	None.

Method of ignition:

Initiator	Electrical puffer (U. S.: plug) in plastic mounting with metal contacts. One contact is a metal band fitted around the conical portion of the mounting which pushes into a venturi drilling. The second is cup-shaped, and at the rear of the plastic mounting; it receives the firing lead bayonet.
Over-all length	35 mm.
Over-all diameter	15 mm.

Igniter:

Nature	Head: Compressed gunpowder. Base: Loose gunpowder.
Weight	Base: 2 ounces.
Container	Head: flat, circular aluminum, with open end toward propellant. Base: ring of transparent plastic.
Positioning	Head: supported by spring clip in recess at head end of propellant tube. Base: shaped to fit between venturi inlet and grid.
Markings	None.

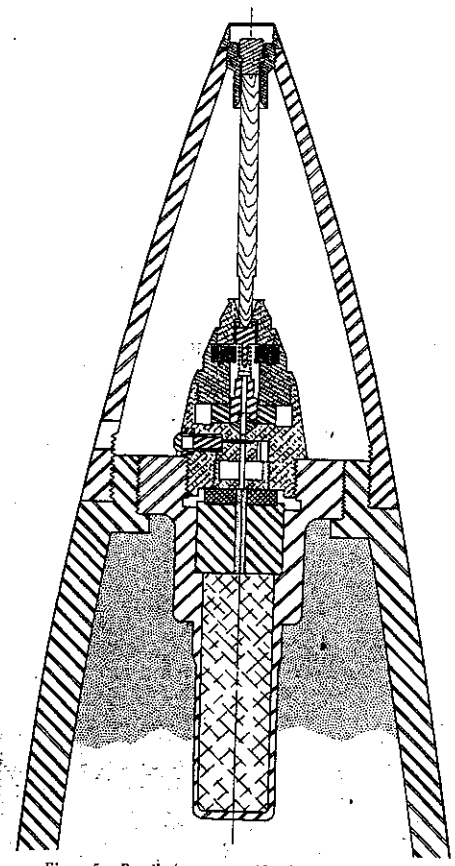


Figure 5.—Detail of nose assembly of 21-cm HE projectile.

Special features	Flash from base igniter is passed to head igniter via a length of quickmatch in celluloid tube, with flash pot at either end, and running the length of drilling in central stick.
Analysis of propellant	———

PACKING

The complete round, fuzed and with ballistic cap, is placed nose-first into a rolled paper cylinder, which has a fixed metal cap with metal supporting rings for the nose at one end, and a detachable metal cap with three clips at the other end, where a carton containing the electrical initiator is clipped. The base of the round and venturi are further protected by a metal cover which fits closely over the base. This cover has a central handle by which the round can be withdrawn. The container has four lifting handles.

Weights:

Filled	276.25 pounds.
Empty	31.25 pounds.
Markings	Painted in white on cylinder of container: *Luft. Mun. Beh. 4662.*

3. Performance. No data available.

28-cm Wurfkörper Spreng.

(28-cm HE Projectile.)

Fired from: *28/32-cm Schweres Wurfgerät 40* and *41*, *28/32-cm Schwerer Wurfrahmen 40* and *28/32-cm Nebelwerfer 41.*

1. Description. *a. General.* This is a spin-stabilized projectile consisting of a large warhead with a rocket motor of smaller diameter attached at the rear. The projectile is electrically fired from the wooden crate in which it is carried or from a multiple launcher consisting of a number of frames of similar dimensions. The layout of the complete projectile is shown in Figure 2.

b. Warhead. The warhead is a thin steel shell sealed at the rear, where it has a flange threaded to take the rocket motor. Two raised bearing surfaces on the body locate the projectile in the firing frame and also reduce lateral friction. An adapter in the nose of the warhead is threaded to take a nose percussion fuze and a gaine holder.

c. Rocket motor. The rocket motor is in the form of a cylinder screwed into the rear of the warhead and closed at the rear by a plug in which are a number of offset venturi drillings.

The propellant, which consists of a single stick, is located at the forward end by a flanged metal spacing ring which also contains the ignition charge, and at the rear by a metal grid holding the rear ignition charge. The base plug screws over the motor body and has a central drilling tapped to receive an adapter for the electrical igniter.

2. Technical Data.

GENERAL	
Nature of projectile	Multiple base-venting, spin-stabilized, pusher rocket.
Caliber	280 mm.
Filled weight (complete round)	83 kilograms (183 pounds).
Over-all length (complete round)	1,190 mm (46.41 inches).
Nature of fuze	Nose percussion delay action.
Nature of filling	HE.
Maximum range	2,339 yards.
WARHEAD	
General shape	Cylindrical canister with rounded ends, one of which receives the fuze and the other the tail unit.
Material	Sheet steel.
Dimensions:	
Over-all length	720 mm.
Diameter	280 mm.
Wall thickness	1 mm.
Weights:	
Empty	———
Filling	36 kilograms.
Filling	Amatol.
Marking:	
On nose	*28-cm Wk. Spr.*
On body	*13 Mr. 5.6.42. G.*
FUZE	
Nature	Delay action fuze received by a plastic adapter at the nose end of the warhead. No ballistic cap.
Weights	———

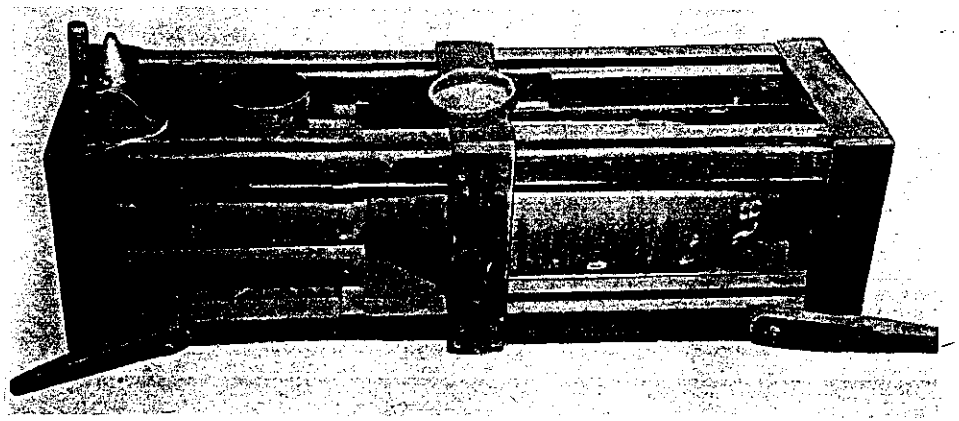


Figure 1.—28-cm HE projectile in wooden crate in which it is carried and from which it may be fired. On the left are the nose percussion fuze, gaine holder, and electric initiator used for firing the projectile.

Action	Before firing, a safety pin which passes through the head of the striker and protective cap is withdrawn by hand. The fuze is centrifugally armed during flight.
Markings	*Wgr Z 50+6 m 42 17 W. A. 732.*
GAINE	
Weights	———
Filling	Penthrite wax at the top of which is housed a thimble-shaped detonator. On top of the detonator are a paper washer, leather washer, and cork ring. The aluminum container is crimped down over the leather washer.
Markings	*dmz Np 10* (a standard German gaine for the 17-cm and 21-cm artillery shell).
Method of assembly	It is a push-fit in a gaine holder threaded at the top and received by threads in the nose of the warhead.
MOTOR	
General	Multiple, annular venturi at rear of tail; single stick of propellant of diglycol dinitrate, supported on a circular grid.
Body tube:	
Over-all length	475 mm.
Over-all diameter	140 mm.
Wall thickness	0.226 inch.
Weight	23 pounds 14 ounces.
Markings	*dbg 42/12 Nn 19. 10.42 M.*
Base:	
Over-all diameter	157 mm.
Over-all height	75 mm.
Weight	9 pounds 6.75 ounces.
Method of assembly	Screwed over rear of body tube.
Venturi:	
Number and position	26 in annual ring at base. In the tropical round, the venturi are sealed over the outlets by a flat tinned iron ring which is soldered on and which blows off on ignition.
Angle of cant	14 degrees.
Inlet:	
Maximum diameter	7 mm.
Minimum diameter	5.5 mm.
Length	5 mm.
Throat:	
Diameter	5.5 mm.
Length	5 mm.
Outlet:	
Minimum diameter	5.5 mm.
Maximum diameter	12.5 mm.
Length	20 mm.
Grid:	
Type	Annular ring supported above a base plate on six pillars.

Over-all diameter	120 mm.
Internal diameter	82 mm.
Depth	5 mm.
Height above venturi block.	18 mm.
Weight	1 pound 1 ounce.
Propellant:	
Material	Diglycol dinitrate.
Number of sticks	One.
Total weight	14 pounds 6.75 ounces.
Over-all length	413 mm.
Over-all diameter	124 mm.
Markings	*Dgp DOP 15 Wu (Digl. Ngl) Tp dbg 1942/2* or *DO WuP 15 (Digl) dbg 1942 12.*
Special features	In one example there was a recess 11 mm deep at one end of the charge. Six celluloid tubes nearly as long as the stick are housed in the longitudinal slottings around the circumference of the charge. Another celluloid tube, containing a length of quickmatch with a gunpowder pellet at each end, is housed in the central drilling of the stick.

Method of ignition:

Initiator:

A separate electrical initiator enclosed in an aluminum tube and bakelite container, and which may be fired from a 4-volt battery, is screwed into the central drilling in the base. For firing single rounds, initiators are provided, connected by 15 inches of two-strand insulated wire to a plug, and action is instantaneous on application of voltage. For firing from the *Wurfgerät* (four-frame stand), four initiators, externally similar in appearance, are provided, wired in series. One only (tagged "0") is instantaneous and the remaining three (tagged "2", "4", and "6") include powder pellets so as to fire after intervals of 2, 4, and 6 seconds respectively.

Ignition charge:

Nature	Head: compressed gunpowder. Base: nitrocellulose in powder in the form of six-pointed, star-shaped flakes.
Weight	Head: ——— Base: 10 grams.
Container	Head: flat, circular aluminum with open end towards propellant. Base: porous, rough-cloth bag.
Positioning	Head: in a pressed-steel housing supported by a flanged split ring. Base: in center of grid.
Markings	Head: none. Base: *Wx. Man. St. P (2.25/23) dt 1938/5 WO. 7.8.42 W.*

PACKING

Description of package and contents:

Projectile:

A wooden or metal open, rectangular crate contains four bearing rails for the projectile. (In the wooden crate these have metal facings.) A hinged and latched bar across the forward end retains the projectile in position in transit. The

wooden crate has four hinged lifting handles. The projectile is transported assembled.

Components:

Separate boxes each containing 12 fuzes in separate plastic containers, 15 gaines packed in a plastic container, cardboard box containing 16 single initiators, and four quadruple initiators.

Weights:

Filled (wooden)..... 243 pounds.
Empty (wooden)..... 60 pounds.

3. Performance. a. Firing trials. (1) Procedure: Firing trials were carried out in the United Kingdom at a quadrant elevation of 42 degrees 11 minutes (nominally 45 degrees). Charge temperatures were not known. The trials lasted from 0820 to 1230, and the rounds were exposed to the sun throughout. No corrections were made for meteorological conditions or for variation in quadrant elevation.

(2) Summary of observations:

Number of rounds:
Fired..... 12.
Observed..... 9.
Included in means..... 9.
Position of mean point of fall:
Mean..... 20.9 seconds.
Mean deviation..... 0.5 second.
Range..... 2,339 yards.
Dispersion (mean deviation from mean point of fall in horizontal plane):
In range..... 56 yards.
Laterally..... 62 yards.
Mean time of burning..... 4 seconds.

Remarks: The sound of detonation is similar to that of the British 3-inch rocket U. The detonation is thought to be imperfect in most cases. Only one burst came up to expectation, this being the tropical round. In stony ground the crater was about 1 foot deep and 6 feet in diameter. The HE case was broken up into fragments which were between 1 and 2 square centimeters in size and were found within 20 yards of the crater. Several larger pieces of the thicker machined portions of both warhead and rocket motor were also found. The base of the tube was blown off and the warhead end split and splayed out. Some fuzes were recovered intact.

b. Extract from official German range tables.

Range (meters)	*Elevation* (mils)	*Correction for Drift* (mils)	*Length* (meters)	*50 percent Zone Breadth* (meters)
300	68	+5	.....	.....
400	92	+7	.....	.....
500	116	+8	.....	.....
600	140	+10	160	20
700	165	+11	160	20
800	192	+13	150	20
900	219	+15	150	30
1,000	248	+17	150	30
1,100	278	+19	150	40
1,200	311	+21	150	40
1,300	344	+23	140	40
1,400	379	+26	130	50
1,500	417	+28	120	50
1,600	460	+31	110	60
1,700	509	+35	90	70
1,800	569	+39	80	80
1,900	659	+45	80	90
1,925	698	+48	80	90

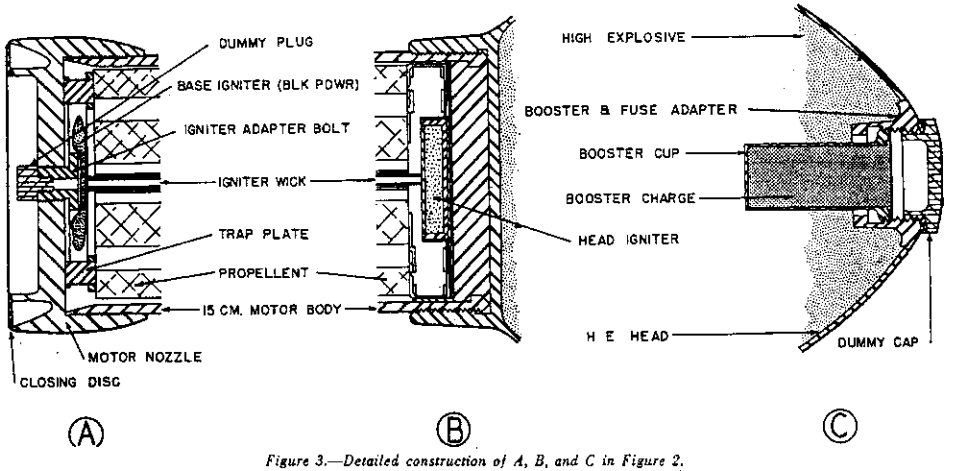


Figure 3.—Detailed construction of A, B, and C in Figure 2.

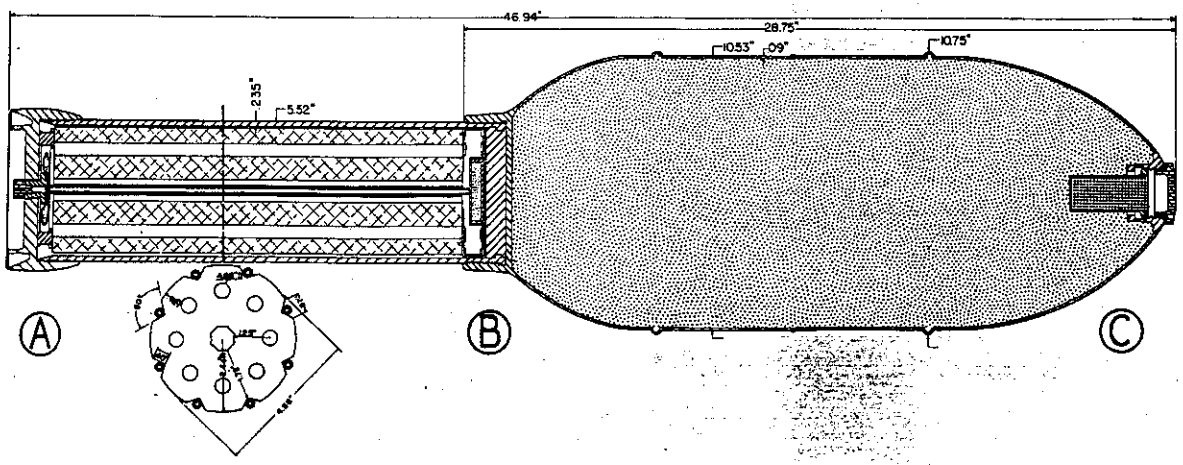


Figure 2.—Internal construction of 28-cm HE rocket.

30-cm Wurfkörper 42 Spreng.

(30-cm HE Projectile.)

Fired from: *30-cm Nebelwerfer 42* and *30-cm Raketenwerfer 56.*

1. Description. *a. General.* This projectile (Figure 1) is similar in design to the 28-cm and 32-cm rockets, being spin-stabilized and consisting of a forward warhead to the rear of which is attached a rocket motor of smaller diameter.

b. Warhead. The warhead is constructed of two sections of sheet steel, a nose piece and a tail, the four sections being joined together by circumferential welds. A single rib around the center of the projectile serves to reduce friction against the side of the launcher.

The nose piece is threaded to receive a nose fuze, *Wgr. Z.50+* and a gaine, and the tail internally threaded to screw onto the forward end of the rocket motor. The HE filling consists of 96 pounds of amatol.

c. Rocket motor. The rocket motor is of conventional design and consists basically of a cylindrical body and a base plug incorporating the venturi and igniter assemblies.

The body is machined internally and externally and is closed at the forward end, where it is threaded to screw on the tail of the warhead. This end section is not flat but is slightly concave internally to permit a more even distribution of pressure. The rear end of the body is threaded internally to receive the base plug which has 18 offset venturi drillings and a central drilling to take an electrical igniter.

The propellant, which consists of seven monoperforated sticks, is located by two grids, one at each end of the motor body. A celluloid tube containing a quickmatch train and plugged at each end by a gunpowder pellet, is located in the drilling in the central stick and transmits the flash from the igniter to the ignition charge at the forward end of the motor.

Figure 4 shows the layout of the complete projectile and Figures 5 to 13 show the individual component parts of the rocket motor.

2. Technical Data.

GENERAL	
Nature of projectile	Multiple base-venting, spin-stabilized, pusher rocket.
Caliber	30 cm.
Over-all length (complete projectile).	48.44 inches.
Over-all weight (complete projectile).	278 pounds.
Nature of fuze	Nose percussion.
Nature of filling	Amatol.
Maximum range	4,976 yards (range tables).

WARHEAD	
General shape	Elliptical with rounded forward end and truncated tail.
Material	Sheet steel.
Dimensions:	
Over-all length	29.5 inches.
Maximum diameter	12.125 inches (across rib).
Wall thickness	0.109 inch.
Diameter at tail, external	8.938 inches.
Diameter at tail, internal	8.625 inches.
Diameter at nose	4.563 inches.
Weights:	
Empty	49 pounds 12 ounces.
Weight of filling	98 pounds 6 ounces.

Figure 1.—Complete 30-cm HE projectile.

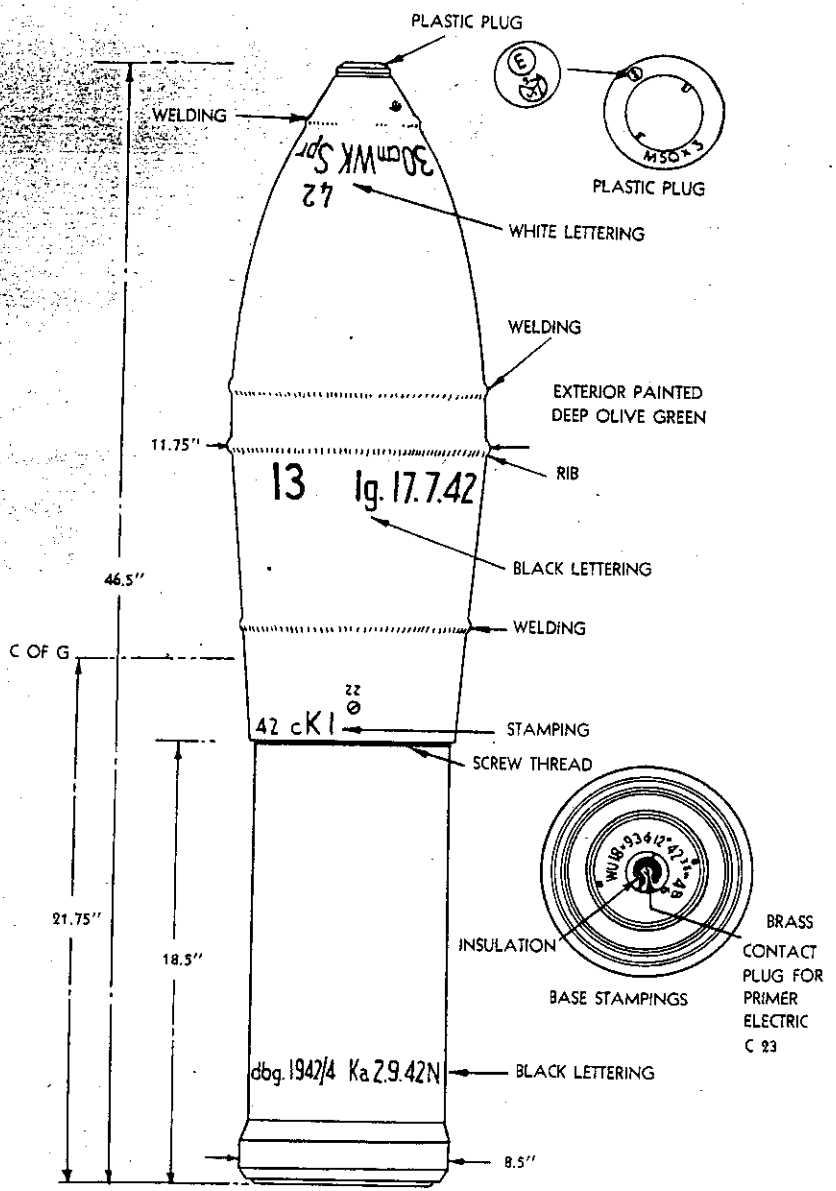


Figure 2.—30-cm rocket markings.

I-B.114

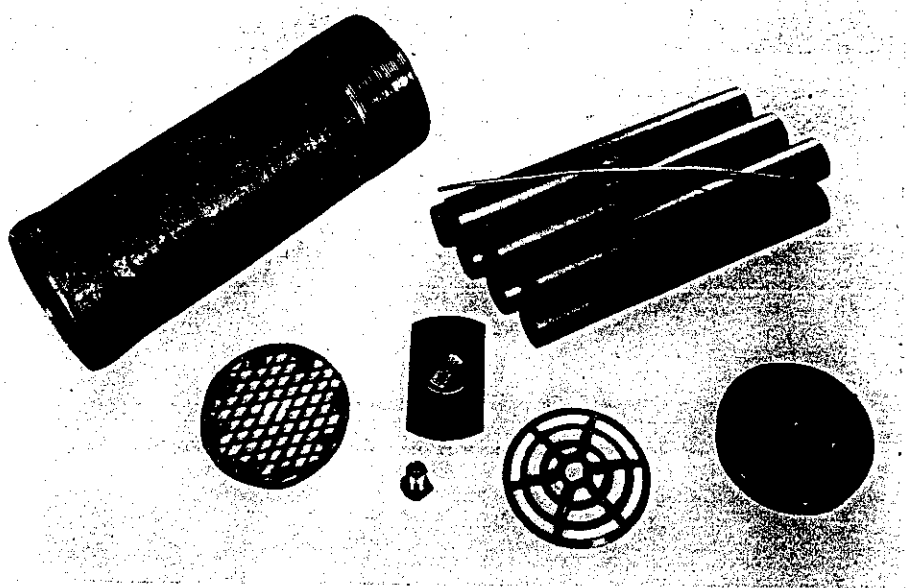


Figure 3.—Component parts of 30-cm rocket motor (left to right, top): motor tube, quickmatch train resting on pile of propellent sticks; (bottom): forward grid, ignition charge container with electrical primer below, rear grid, and base plate.

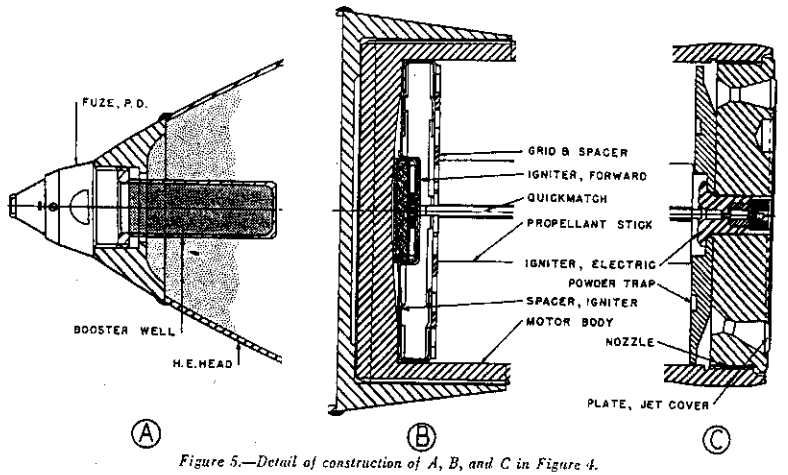


Figure 5.—Detail of construction of A, B, and C in Figure 4.

WARHEAD—Continued

Filling	60/40 amatol.
Markings:	
Stamped on nose of head	23.
Stencilled in white approximately 4 inches below fuze.	*30-cm WK 42 Sp.*
Stencilled on rear center	*13 Ig 29 9 42*
Stamped on lower end	*42, CKI.*

FUZE

Nature	Point detonating instantaneous nose fuze *Wgr. Z.50+*.
Weight with adapter	1 pound.
Action	The fuze is armed in two steps: by withdrawing a safety pin before firing and by centrifugal action after firing.
Markings:	
Stamped	*Wgr. Z.50+bmv 42.*

GAINE

Material	Aluminum.
Length	4.06 inches.
Diameter of body	1.38 inches.
Weights:	
Total weight	4.60 ounces.
Weight of detonator	0.04 ounce.
Weight of booster	3.93 ounces.
Filling:	
Detonator	Not analyzed, probably lead azide.
Booster	PETN and wax.
Markings	Stamped on base of well: *g. UZ.*
Method of assembly	Screwed into nose piece of warhead; immediately below fuze.

MOTOR

General	Cylindrical tube sealed at forward end and closed at rear end by base plug with 18 venturi drillings. Seven monoperforated propellent sticks supported between forward and after grids. Total weight 129 pounds 10 ounces.

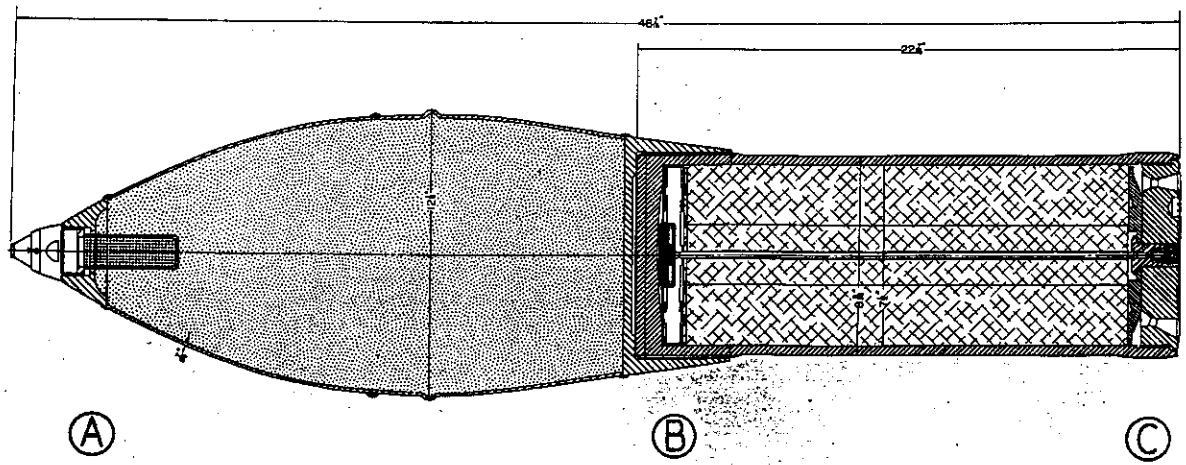


Figure 4.—Internal construction of complete 30-cm projectile.

I-B.114

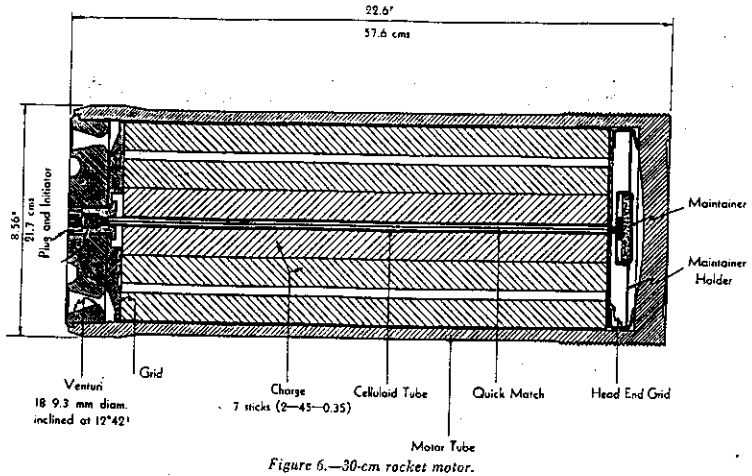


Figure 6.—30-cm rocket motor.

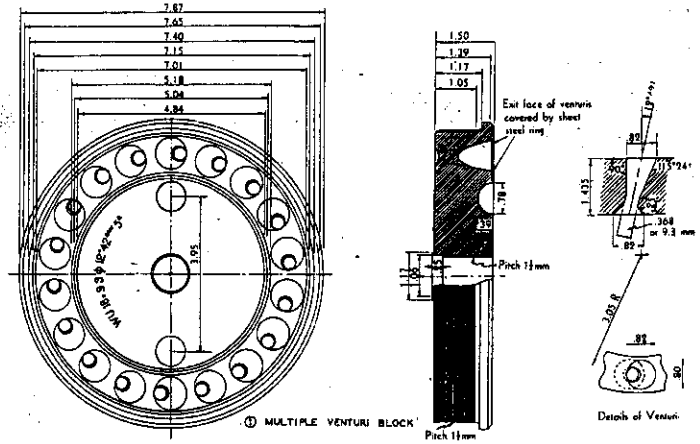


Figure 7.—Base plate of 30-cm rocket.

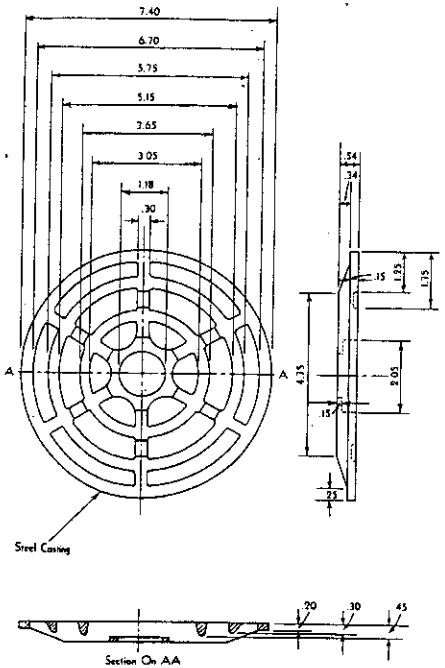


Figure 8.—Rear grid of 30-cm rocket.

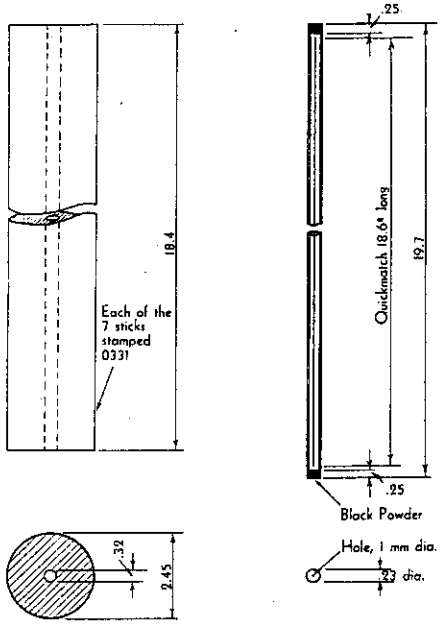


Figure 9.—Propellent charge of 30-cm rocket.

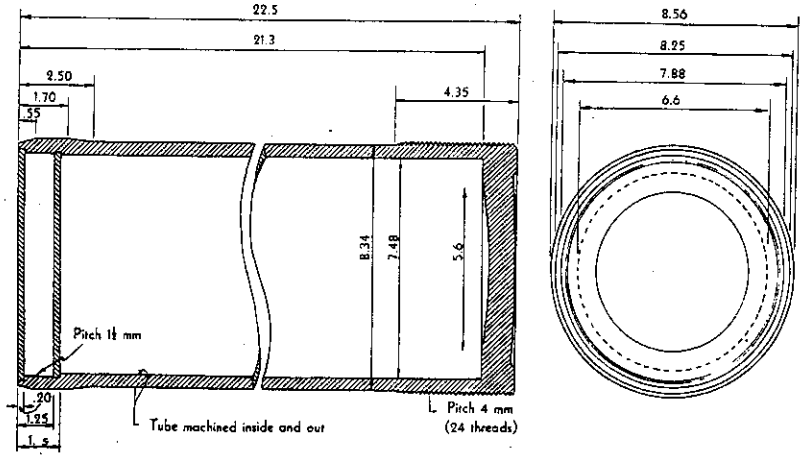


Figure 10.—Motor tube of 30-cm rocket.

I-B.114

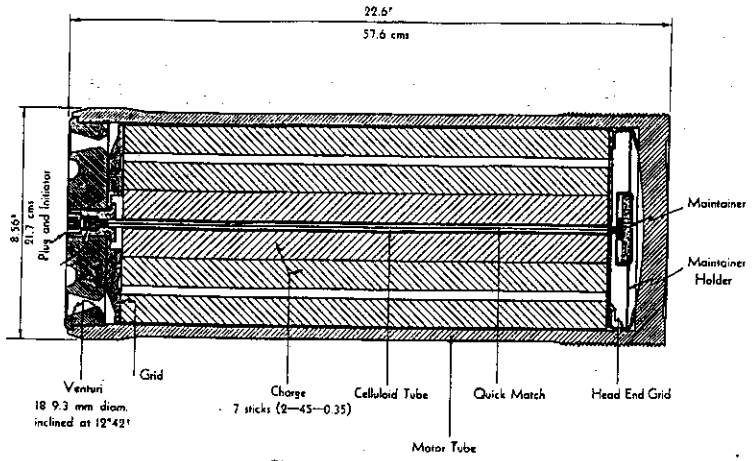


Figure 6.—30-cm rocket motor.

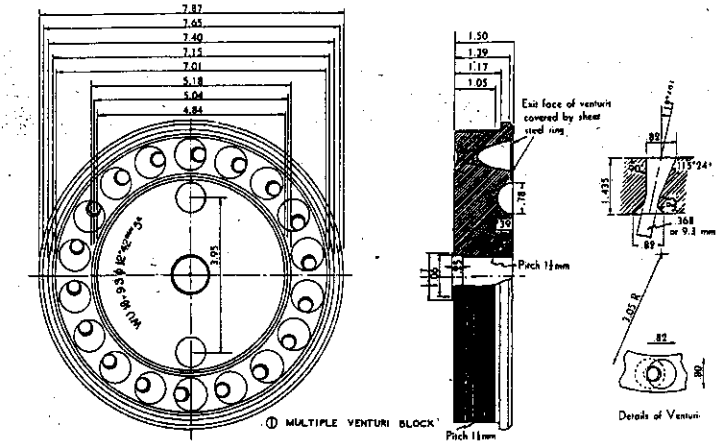


Figure 7.—Base plate of 30-cm rocket.

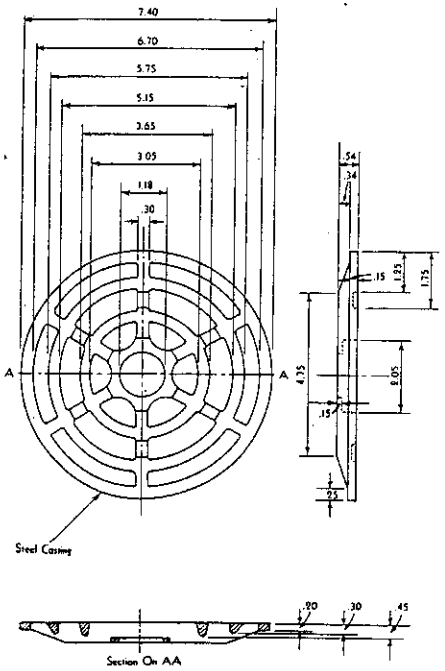


Figure 8.—Rear grid of 30-cm rocket.

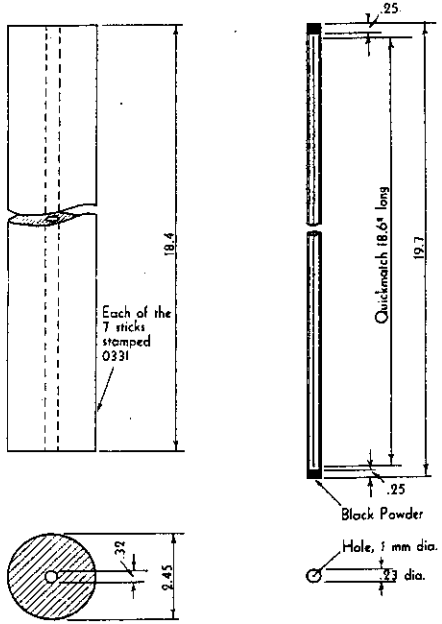


Figure 9.—Propellent charge of 30-cm rocket.

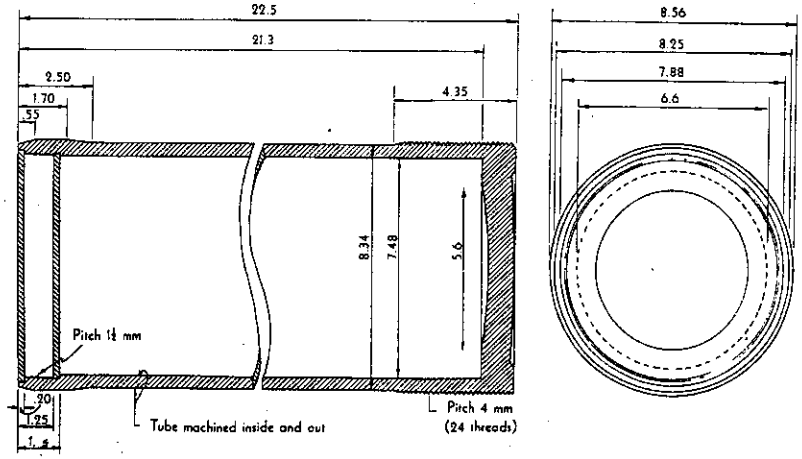
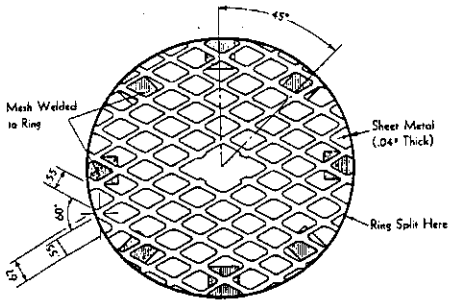


Figure 10.—Motor tube of 30-cm rocket.



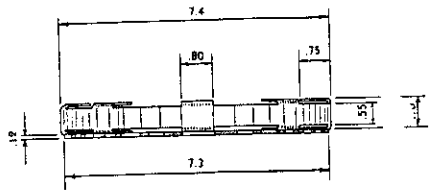


Figure 11.—Forward grid of 30-cm rocket.

Body:

Material	Steel.
Over-all length	22.50 inches.
Length of propellent chamber (internal).	19.81 inches.
External diameter, center	8.34 inches.
External diameter, rear	8.56 inches.
Internal diameter	7.48 inches.
Wall thickness, center	0.33 inch.
Weight, empty	76 pounds 13 ounces.
Markings: Stamped	abh 42 3156 Wda 94. 11

Base plug:

Over-all length	1.50 inches.
Material	Steel.
Over-all diameter	7.87 inches.
Diameter of threaded portion	7.40 inches.
Diameter of central drilling	1.06 inches.
Weight	16 pounds 6.5 ounces.
Markings	———

Venturi:

Number and position	18 in. annular ring.
Diameter of ring	6.10 inches.
Angle of cant	12 degrees 42 minutes.
Inlet:	
Maximum diameter	0.82 inch.
Minimum diameter	0.365 inch.
Length (axial)	0.96 inch.

Throat:

Diameter	0.365 inch.
Length (axial)	0.25 inch.

Outlet:

Minimum diameter	0.365 inch.
Maximum diameter	0.82 inch.
Length (axial)	0.21 inch.

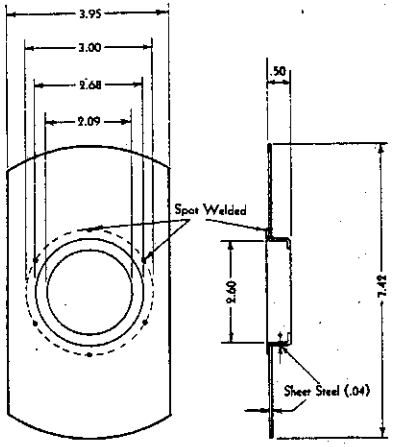
Supporting grids:

Forward:

General shape	Circular-metal-lattice work supported on inwardly turned lugs.
Diameter	7.4 inches.
Thickness	0.90 inch.
Weight	12.75 ounces.

Rear:

General shape	Concentric ring type.
Diameter	7.4 inches.
Thickness	0.54 inch.
Weight	1 pound 8 ounces.



HOLDER FOR MAINTAINER

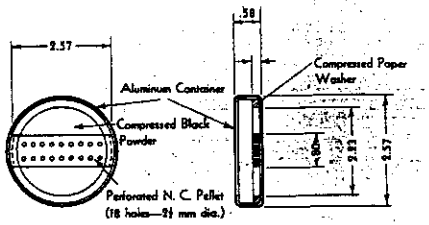
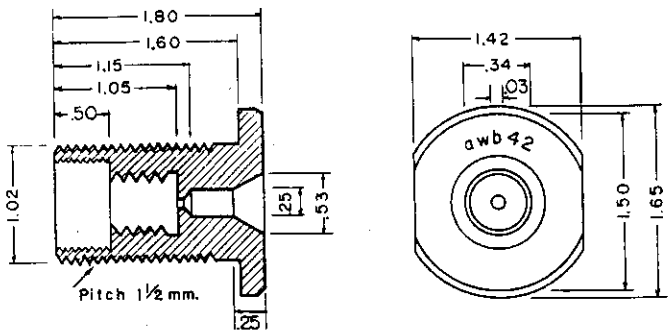
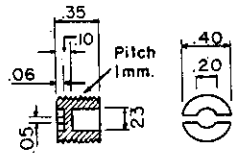


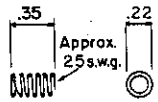
Figure 12.—Ignition charge and support of 30-cm rocket.



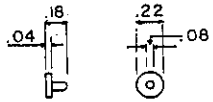
BODY OF PLUG (steel)



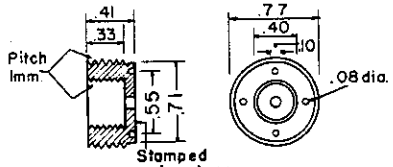
COVER CAP (brass)



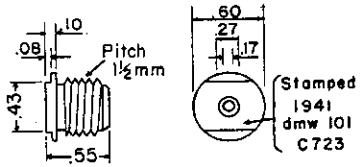
SPRING (steel)



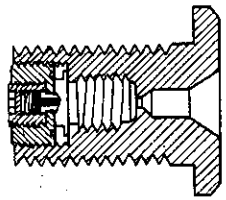
CONTACT PIN (steel)



PLASTIC BRUSH



PRIMER UNIT
(P.D. 675/1 revers)



PLUG ASSEMBLY

Figure 13.—Igniter of 30-cm rocket.

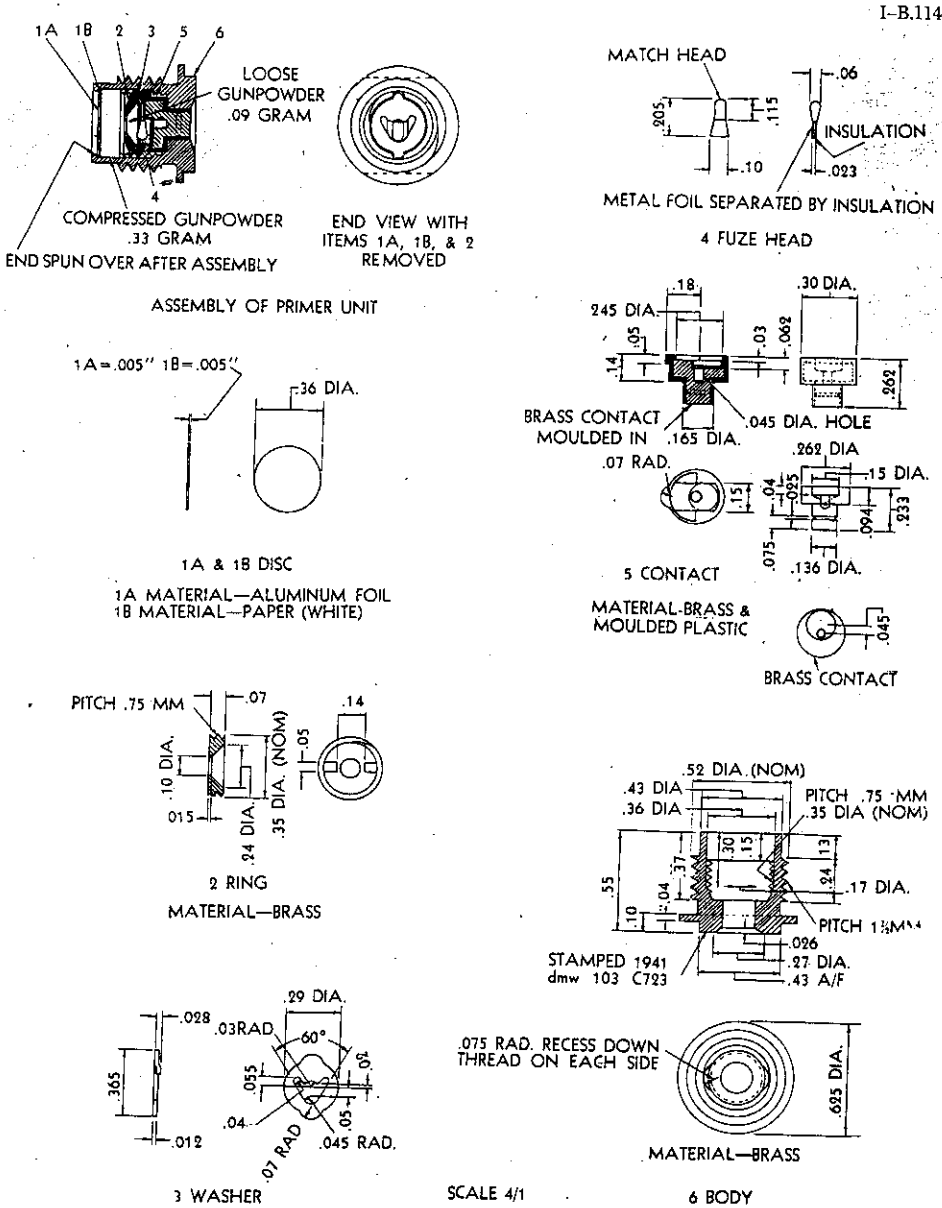


Figure 14.—Igniter assembly of 30-cm rocket.

Propellant:

Type	Monoperforated sticks.
Material	59.9 percent nitrocellulose. 35.4 percent diglycol dinitrate.
Number of sticks	Seven.
Total weight	33 pounds 3.75 ounces.
Weight per stick	4 pounds 12 ounces (approx.).
Each stick:	
Length	18.4 inches.
Diameter	2.45 inches.
Diameter of perforation	0.32 inch.
Markings	0331 stamped on side near end.
Special features	Celluloid tube, 19.7 inches long by 0.23 inch diameter, containing quickmatch train and sealed at each end with gunpowder plug, running along drilling in central stick.

Method of ignition:

Initiator	The initiator is in the form of a metal plug screwed into the central drilling in the base plug. The plug contains an electrically fired charge of 0.09 gram of loose gunpowder and 0.33 gram of compressed gunpowder. This charge ignites the gunpowder plug at the after end of the quickmatch train, and the flash is transmitted along the celluloid tube to the ignition charge at the forward end of the propellant.
Length	1.80 inches.
Diameter forward	1.65 inches.
Diameter of threaded portion.	1.02 inches.

Ignition charge:

Nature	Compressed gunpowder topped by perforated nitrocellulose pellet.
Weight complete	8 ounces.
Weight of charge	3 ounces.
Container	Shallow aluminum dish, 2.57 inches in diameter by 0.58 inch deep.
Positioning	Sheet-steel plate fitting across forward grid.
Markings	------

3. Performance. No details concerning the performance of this projectile are available at present.

30-cm Wurfkörper Spreng 4991.

(30-cm HE Projectile.)

Fired from: *30-cm Raketenwerfer 56* and probably also *30-cm Nebelwerfer 42.*

No description of this projectile has yet been received. Its existence is inferred from a report that HE projectiles found with the *30-cm Raketenwerfer 56* were marked *"30-cm W. K. Spr 4991"*. These were fitted with the *Jgr.Z.23 nA (0.15)* nose percussion fuze. It is presumed, pending further information, that this is a modification of the *30-cm Wurfkörper 42 Spreng* (standard 30-cm HE projectile) and that it may be fired also from the *30-cm Nebelwerfer 42.*

32-cm Wurfkörper m.F1.50.

(32-cm Incendiary Projectile.)

Fired from: *28/32-cm Schweres Wurfgerät 40* and *41*, *28/32-cm Schwerer Wurfrahmen 40*, and *28/32-cm Nebelwerfer 41*.

1. Description. *a. General.* The projectile (Figure 1) is basically the same as the *28-cm Wurfkörper Spreng* (28-cm HE projectile) but has, instead of the normal HE filling, a charge of gasoline and oil mixture in the warhead.

b. Warhead. The warhead is slightly larger than that of the 28-cm rocket but is similar in shape and construction. The filling consists of 11.25 gallons of gasoline and oil mixture, which is spread by a burster of penthrite-wax surrounding the gaine container. The incendiary igniter is contained in a soldered-tin-sheet cylinder located axially in the shell, with one end bearing against the base of the gaine container.

Figure 1.—32-cm incendiary rocket.

c. Rocket motor. The rocket motor used with this projectile is the same as that used with the 28-cm HE rocket.

2. Technical Data.

GENERAL	
Nature of projectile	Multiple base-venting, spin-stabilized, pusher rocket.
Caliber	32 cm.
Over-all length (complete projectile).	50 inches.
Total weight (complete projectile).	174 pounds.
Nature of fuze	Nose percussion.
Nature of filling	Incendiary.
Maximum range	2,224 yards.
WARHEAD	
General shape	A cylindrical canister with rounded ends, one of which receives the fuze and the other the tail unit.
Material	Sheet steel.
Dimensions:	
Over-all length	32.1 inches.
Diameter	12.6 inches.
Wall thickness	0.07 inch.
Weights:	
Empty	13 pounds 12.5 ounces.
Weight of filling	---------
Filling	11 gallons of gasoline and oil mixture.
Markings	*32-cm Fl.* (Tropical shells are also marked *Tp*).
FUZE	*Wgr.Z.50*+nose percussion fuze. This is the same as that used with the 28-cm HE projectile.
GAINE	Same as that used with the 28-cm HE projectile.
BURSTER CHARGE	
General	This consists of a cylinder of penthrite wax surrounding the gaine container.
Dimensions	---------
Weight	---------
Method of location	---------
INCENDIARY IGNITER	
General	A soldered-tin-sheet, cylindrical container placed axially in the warhead, bearing against the base of the gaine holder.
Length	24.1 inches.
Diameter	---------
Total weight	---------
Weight of charge	---------
ROCKET MOTOR	Since the same motor is used with the 28-cm projectile, technical data are not repeated here. Refer to I–B.113.

3. Performance. *a. Conditions of firing.* In firing tests conducted in the United Kingdom, 32-cm incendiary rockets were fired at a quadrant elevation of 42 degrees 8 minutes (mean nominally 45 degrees). No corrections were made for variation in quadrant elevation or meteorological conditions. The charge temperature was not known. The trial was fired between 1825 and 1935.

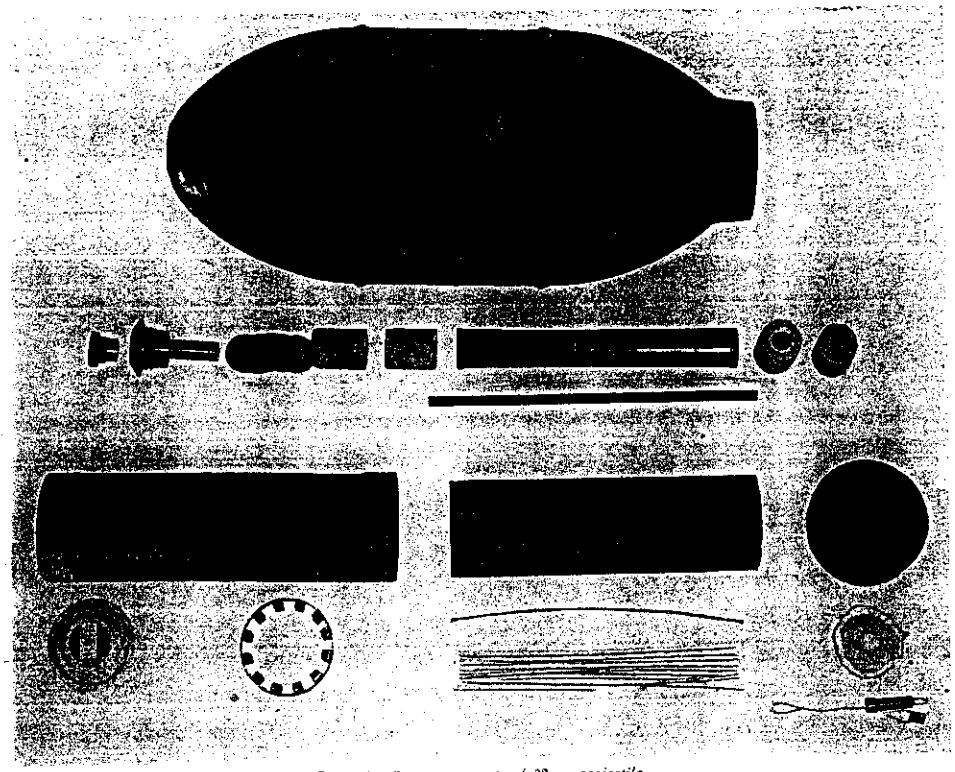


Figure 2.—Component parts of 32-cm projectile.

b. Summary of observations.

Number of rounds:	
Fired	10.
Observed	9.
Included in means	9.
Time of flight:	
Mean	19.8 seconds.
Mean deviation	0.8 second.
Range	2,224 yards.
Dispersion (mean deviation from mean point of fall):	
In range	127 yards.
Laterally	45 yards.
Mean time of burning	5.3 seconds.

The sound of projection is similar to that of the 28-cm rocket. All rounds were unfuzed and water filled, but one round functioned on graze, both its burster and igniter operating. In flight, the rocket shows yawing characteristic of liquid-filled projectiles.

38-cm Raketen Sprenggranate 4581.

(38-cm HE Projectile.)

Fired from: *38-cm Raketenwerfer 61.*

1. Description. a. General. This is a spin-stabilized projectile (Figure 1), basically of conventional design, consisting of a warhead, rocket motor, and base plug. The projectile is fired from the heavy launcher (*Raketenwerfer 61*) mounted on the Tiger Model E tank chassis. An unconventional feature of the projectile is the fitting of short splines on the rear of the rocket motor; these engage with the rifled liner in the launcher and give the rocket an initial stability which is continued during flight by the rotatory effect of the offset venturi.

b. Warhead. The warhead is of two-piece welded construction. An ogival nose piece is welded to the forward end of the cylindrical body. The gaine container and fuze-adapter assembly are welded into the nose of the warhead. The fuze used is a nose percussion fuze, *A.Z.KM 8,* which may be set for instantaneous or short-delay action.

The diameter of the body is increased at the ends to equal that of the rocket motor; the increase at the forward end forms a bourrelet just below the welded joint with the nose piece. The rear end of the body is threaded internally to receive the rocket motor.

c. Rocket motor. The rocket motor is a cylinder of uniform diameter screwed into the warhead and threaded internally at the rear end to receive the base plate. Both screw junctions are secured by two diametrically opposed set screws. The forward end of the motor is closed and is internally concave in shape.

The propellant consists of a central monoperforated stick with an intermediate stick, which is in the form of a sleeve fitting over the central stick, and 10 outer sticks, also of the monoperforated type. A spacer ring at the forward end of the propellent chamber serves to locate the ignition charge and also allows space for the proper ignition of the forward elements of the propellant.

The base plug has 32 offset venturi drillings and also a central drilling for an igniter. The shoulder of the plug bears against the end of the motor body and retains in position the nine short splines let into the rear of the body. A rear spacer ring is welded to the forward part of the base plug and serves to support the outer propellent sticks. The central and intermediate sticks are positioned by four radial arms inside the base plug.

Initiation of the propellent charge is accomplished by the base igniter which is set off by a flash from the firing mechanism in the breech of the projector. This flash is transmitted to the ignition charge at the forward end of the rocket motor by a powder train, consisting of three bags in the perforation of the central stick.

2. Technical Data.

GENERAL	
Nature of projectile	Multiple base-venting, spin-stabilized, pusher rocket.
Caliber	38-cm (19.4 inches).
Over-all length (complete projectile).	58.61 inches.
*Over-all weight (complete projectile).	761 pounds (subject to 12-pound variations).
Nature of fuze	Nose percussion, instantaneous or short delay.
Nature of filling	HE.
Maximum range	6,452 yards at 50 degrees C. (range tables).
WARHEAD	
General shape	Cylindrical with ogival nose piece welded to forward end.
Material	Steel.
Dimensions:	
Over-all length	37.19 inches.
Length of nose piece	13.25 inches.
Length of body	23.94 inches.
Length of bourrelet	2.07 inches.
Length of main body	19.71 inches.
Length of rear junction	2.16 inches.
Diameter of adapter	3.52 inches.
Diameter of bourrelet and rear junction portion.	14.94 inches.
External diameter of body	14.83 inches.
Internal diameter of body	14.23 inches.
Wall thickness	0.30 inch.
Weights:	
Total	---------
Filling	270 pounds.

*Weight of individual rockets vary considerably about the mean 761 pounds (345 kilograms), and each rocket is stencilled with its weight to the nearest 5 kilograms (12 pounds). A special weight-correction table is used in conjunction with the firing tables.

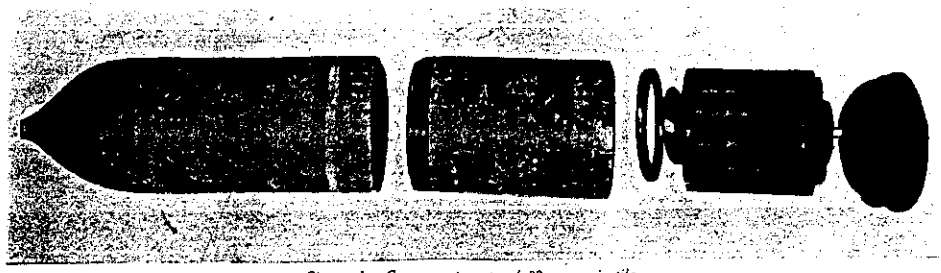


Figure 1.—Component parts of 38-cm projectile.

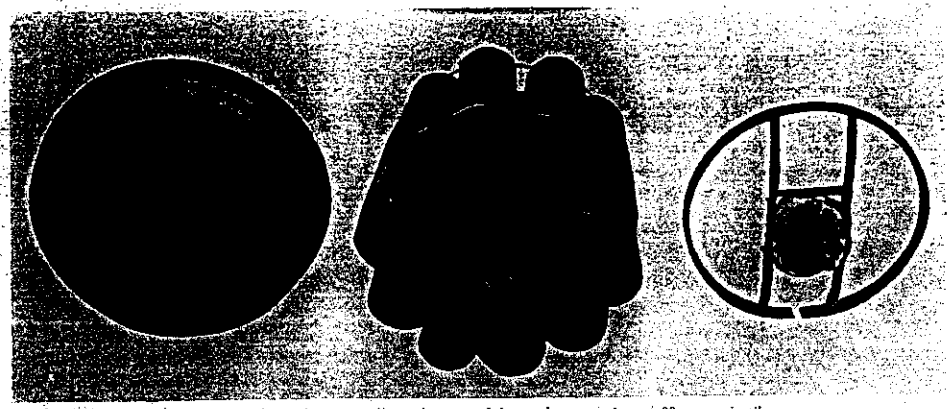


Figure 2.—Base plate, propellent charge, and forward spacer ring of 38-cm projectile.

Filling	50/50 amatol.
Markings	The projectile is painted olive green and has a white band 0.8 inch wide around the body at the center of gravity. Stencilled on the ogive is the inscription: *"Achtung! Feuchtigkeitsempfindlich. Vor Regen und Wasser Zu Schuetzen."* Translation: "Warning. Sensitive to damp. Protect from rain and water". The German explosive code number, 13A, is stencilled on the ogive in black.
FUZE	
Nature	Nose percussion (A. Z. KM. 8), either instantaneous or short-delay (0.12 second) action.
Weights	---------
Action	The fuze may be set at a safe position during transit by rotation of the fuze body. Before firing, the fuze body is rotated to the required setting. After being armed by rotation, the striker is held away from the primer cap by a creep spring.
Markings	---------
GAINE	
Weights	---------
Filling	The whole assembly consists of a standard PETN gaine and an exploder consisting of six PETN pellets 1.75 inches in diameter by $1\frac{1}{16}$ inch thick. In addition four PETN pellets are cast in the explosive below the exploder container.
Markings	---------
Method of assembly	The exploder container is welded into the nose of the warhead. The gaine container fits into the exploder container immediately below the fuze.
MOTOR	
General	Multiple annular venturi at rear of tail. Propellent charge supported on forward and after spacers.
Body tube:	
Over-all length	20.70 inches.
External diameter	14.94 inches.
Internal diameter	13.88 inches.
Wall thickness	0.53 inch.
Weight	---------

667462—45——4

Motor—Continued

Splines:

Number	Nine.
Type	Straight metal section let into rear of motor tube.
Length	1.60 inches.
Width	0.34 inch.
Height above motor surface	0.15 inch.
Markings	———

Base plug:

Over-all diameter	14.94 inches.
Diameter of threaded portion	13.88 inches.
Length	3.4 inches.
Diameter of igniter drilling	1.97 inches.
Weight	———
Method of assembly	Screwed into tail of motor tube. Junction locked by two diametrically opposed set screws.

Venturi:

Number and position	32 in annular ring at base.
Angle of cant	14 degrees.

Inlet:

Diameter	Stepped: 0.97 inch, 0.88 inch, 0.44 inch.
Length	0.18 inch.

Throat:

Diameter	0.44 inch.

Outlet:

Minimum diameter	0.44 inch.
Maximum diameter	0.80 inch.
Length	2.07 inches.

Spacers:

Forward:

Type	Metal ring with two crosspieces to which is attached the ignition charge.
Diameter	———
Total depth	2.37 inches.
Rear	Metal ring mounted on forward end of base plug. Supports rear ends of intermediate and outer sticks, central stick bearing directly against base plug.

Propellant:

Material	———
Number of sticks	12.

Weights:

Central stick	10.5 pounds.
Intermediate stick	20 pounds.
Each outer stick	5.6 pounds.
Total	86.5 pounds.

Central stick:

Length	16 inches.
Diameter	4.063 inches.
Diameter of perforation	1.375 inches.

Intermediate stick:

Length	15.313 inches.
Diameter	7.25 inches.
Diameter of perforation	4.75 inches.

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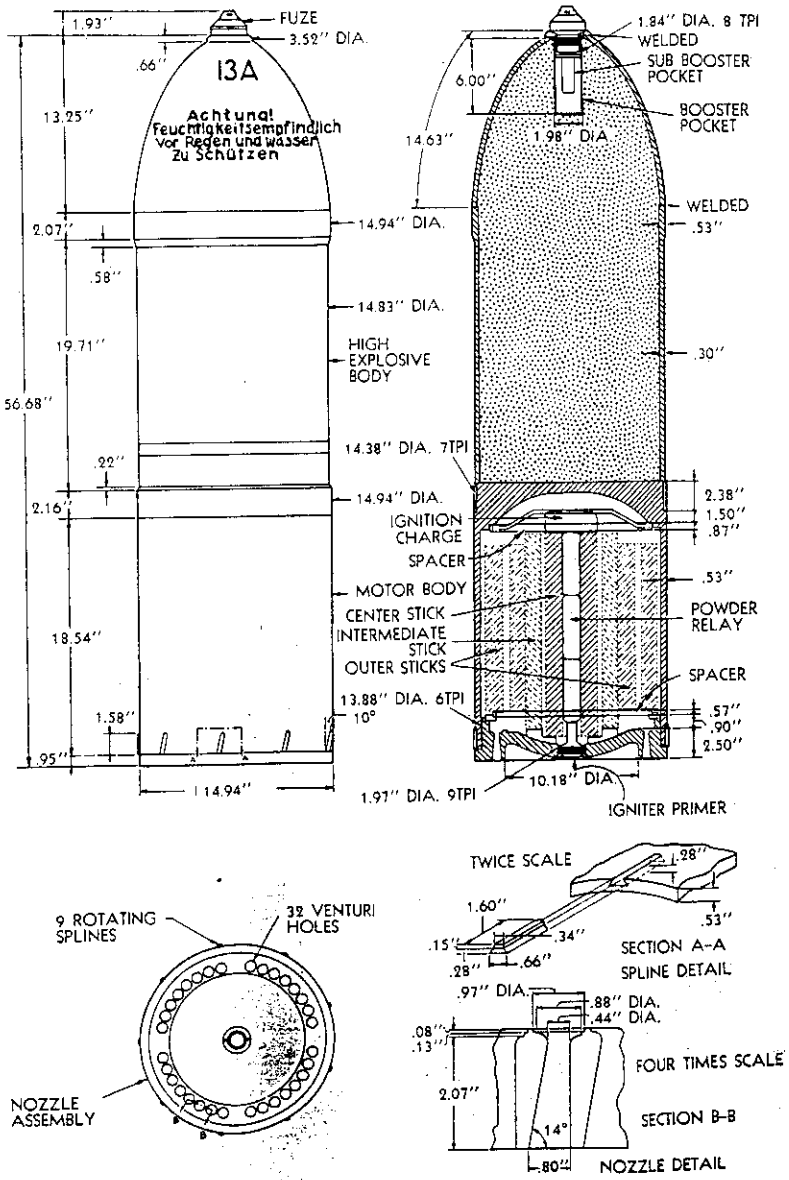

Figure 3.—Basic dimensions and internal layout of complete 38-cm projectile.

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Propellant—Continued

Outer stick:

Length	12.938 inches.
Diameter	3.188 inches.
Diameter of perforation	0.438 inch.
Markings	———
Analysis	———

Method of ignition:

Initiator	A powder igniter is located in the central drilling in the base plug. This is initiated by a flash from the firing mechanism in the breech of the launcher. The relay from this igniter to the ignition charge at the forward end consists of three bags of powder in the drilling of the central stick.
Nature	———
Dimensions	———
Weight	———

Ignition charge:

Nature	———
Weight	½ pound (approx.).
Container	Cylindrical.
Positioning	Tied to forward spacer.
Markings	———

3. Performance. *a. Firing trials.* No firing trials have yet been carried out with this projectile.

b. Firing tables. The following information is taken from a captured German firing table.

The projectile may be fired in both the upper and lower registers, and the firing table provides for a range of propellant temperatures from −40 degrees to +50 degrees C., a separate table being given for each 5-degree C. variation within these limits.

Weights of individual rockets vary considerably about the mean 345 kilograms (761 pounds), and each projectile is stencilled with its weight to the nearest 5 kilograms. A special weight-correction table is used in conjunction with the firing tables.

The following range limits are taken from firing tables:

−40 degrees C	4,200 meters (4,593 yards).
0 degrees C	5,150 meters (5,532 yards).
15 degrees C	5,650 meters (6,159 yards).
50 degrees C	5,900 meters (6,452 yards).

The same range limits apply to firing both in the lower and upper registers.

38-cm Hohlladungsgranate 4592.

(38-mm Hollow-Charge Projectile.)

Fired from: *38-cm Raketenwerfer 61.*

No specimen of this projectile has yet been recovered. Its existence is inferred from a captured German document in which it is bracketed with the 38-cm HE projectile. The projectile apparently uses the same rocket motor as the 38-cm HE rocket and is fuzed with an instantaneous nose percussion fuze, *A.Z.KM.10.*

ANTIAIRCRAFT PROJECTILES

7.3-cm Raketen Sprenggranate.

(7.3-cm HE Projectile.)

Fired from: *Föhn Gerät.*

1. Description. a. General. This is a spin-stabilized projectile (Figure 1) of conventional design, consisting of a warhead and a rock motor. The projectile is essentially the same as the 7.3-cm propaganda leaflet rocket (*7.3-cm Propagandagranate 41*, I-B.4011), except that a warhead provided with a percussion fuze and self-destroying delay has replaced the leaflet container of the propaganda rocket.

The projectile is fired from the *Föhn Gerät*, a 35-frame launcher with fast elevating and traversing gears. The launcher is capable of firing 35 rockets simultaneously. The self-destroying feature of the rocket plus the characteristics of the launcher suggest that the projectile is intended for use against low-flying aircraft in the form of barrage fire. Launching sites have been found along river fronts, however, indicating that the projectile can also be used against river crossings.

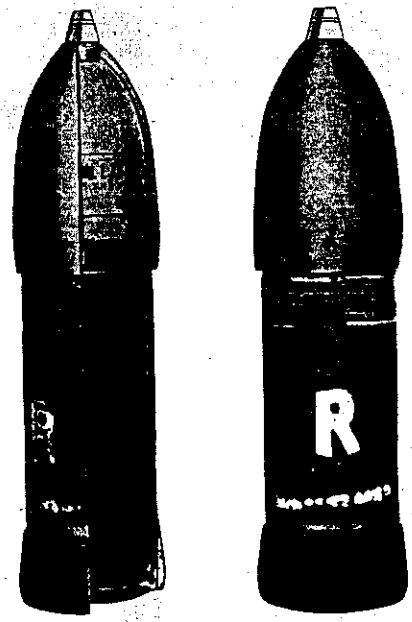

Figure 1.—7.3-cm HE projectile.

b. Warhead. The warhead (Figure 2) is ogival in shape and open at the rear where it is threaded internally to receive the rocket motor. The explosive filling is a pre-formed charge of 280 grams of RDX/TNT/wax pressed in a block and wrapped in wax paper.

The warhead is doubly fuzed, being fitted with a nose percussion fuze and a self-destroying base fuze. The nose fuze is the *R.A.Z.51* (*Raketen Aufschlagzünder 51*) which is screwed directly into the nose of the warhead; a cavity in the forward end of the explosive charge receives the primer detonator below the fuze.

In the base of the charge is a cavity which accommodates the self-destroying delay, located in a tube screwed into a metal plug in the forward end of the motor. The delay consists of a quick-fire igniter, initiated by the motor ignition charge, and what appears to be a tracer composition. When the tracer composition burns out, it flashes through an orifice into a primer-detonator which detonates the main charge.

c. Rocket motor. The rocket motor (Figure 3) consists of a plain cylindrical body and a cup-shaped base plate. The body is screwed into the warhead at the forward end and into the flange of the base plate at the rear.

The forward end of the rocket motor has a flange below which is located a metal closing plate which separates the warhead from the propellent compartment and also holds the rear end of the self-destroying assembly for the explosive charge. Below this plate is a stamped metal supporting ring containing the ignition charge for the propellant.

The base plate, which screws on the rear end of the body, has seven outer offset venturi, seven straight venturi, and a central drilling for a percussion primer.

The propellent charge consists of a single cylindrical stick with a central perforation and eight outer perforations. Raised ribs around the circumference of the propellant serve to keep it clear of the motor body and permit external burning. Two ⅛-inch blocks of powder, cemented to the base of the charge, act as spacers and keep the venturi free from obstruction.

The charge is ignited by the flash from the percussion primer. The flash is transmitted along a celluloid tube in the central drilling to the ignition charge at the forward end of the propellant. The celluloid tube is of conventional German design. It contains a quickmatch train and is closed at each end by a cylindrical block of gunpowder.

2. Technical Data.

Nature of projectile	Multiple base-venting, spin-stabilized, pusher rocket.
Caliber	7.29 cm.

Over-all length (complete projectile)	11.09 inches.
Over-all weight (complete projectile)	6 pounds.
Nature of filling	HE.
Nature of fuze	Nose percussion and base self-destroying.
Maximum range	———

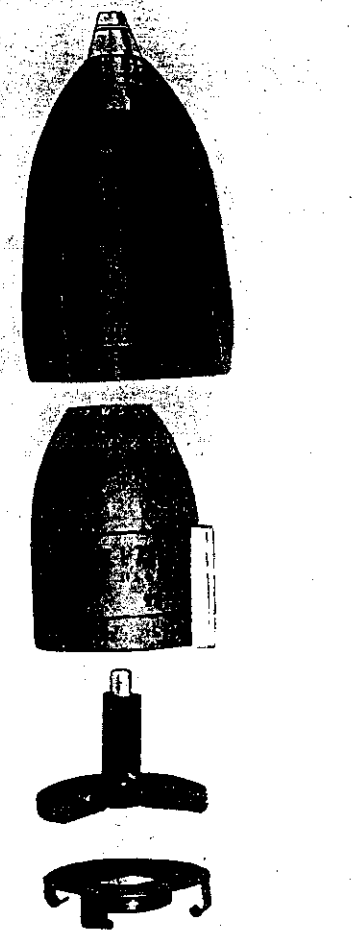

Figure 2.—Component parts of 7.3-cm projectile warhead.

WARHEAD

General shape	Ogival, open at rear end and fuze socket at front.
Material	Steel.
Dimensions:	
Over-all length	4.22 inches.
Maximum diameter	2.85 inches.
Diameter at nose	0.81 inch.
Wall thickness	Varies from 0.23 inch aft to 0.12 inch forward.
Weights:	
Empty	———
Weight of filling	0.62 pound.
Filling	The code number denoting shell filling marked on the charge is 95, which indicates RDX TNT 60/40. However, there also appears on the charge wrapper H5+Fp 02, which would introduce 5 percent wax to the mixture. Consequently, it is believed that the composition of the charge is as follows: RDX, 55 percent; TNT, 40 percent; Wax 5 percent.
Markings	The warhead has a rust-preventive coating varying in color from dull, dark gray to dull black. There are no markings.

FUZE (nose)

Nature of fuze	Nose-percussion, centrifugally armed *RAZ 51*.
Weights	———
Action	On impact, the firing pin sets off the primer-detonator which in turn detonates the main charge.
Markings	*RAZ 51*.

MOTOR

General	Multiple, annular venturi, both offset and straight at base. Single multi-perforated powder pellet stick.
Body tube:	
Over-all length	6.34 inches.
Over-all diameter	2.6 inches.
Wall thickness	0.1 inch.
Weight	———
Markings	Stencilled in white: *Hch 14.R13.44 So*. Yellow band approximately 1 inch wide immediately below bourrelet.
Base:	
Over-all diameter	2.86 inches.
Over-all height	1.29 inches.
Weight	———
Method of assembly	Screwed over rear of body.
Venturi:	
Number and position	14. 7 offset outer venturi. 7 straight inner venturi.

An aluminum foil disc is placed over the inner end of the venturi drillings to prevent moisture and dirt from entering the propellent chamber.

Outer set:	
Type	Divergent, offset.
Length	0.56 inch.
Minimum diameter	0.12 inch.
Maximum diameter	0.27 inch.
Angle of cant	45 degrees.
Radius of centers	1.14 inches.
Inner set:	
Type	Divergent, axial.
Length	0.40 inch.
Minimum diameter	0.12 inch.
Maximum diameter	0.25 inch.
Radius of centers	0.69 inch.

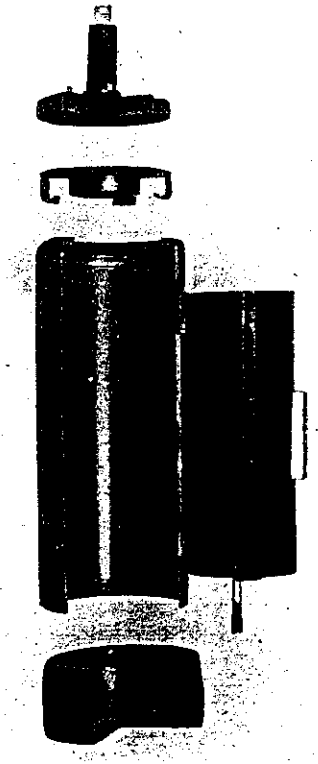

Figure 3.—Component parts of rocket motor for 7.3-cm HE projectile.

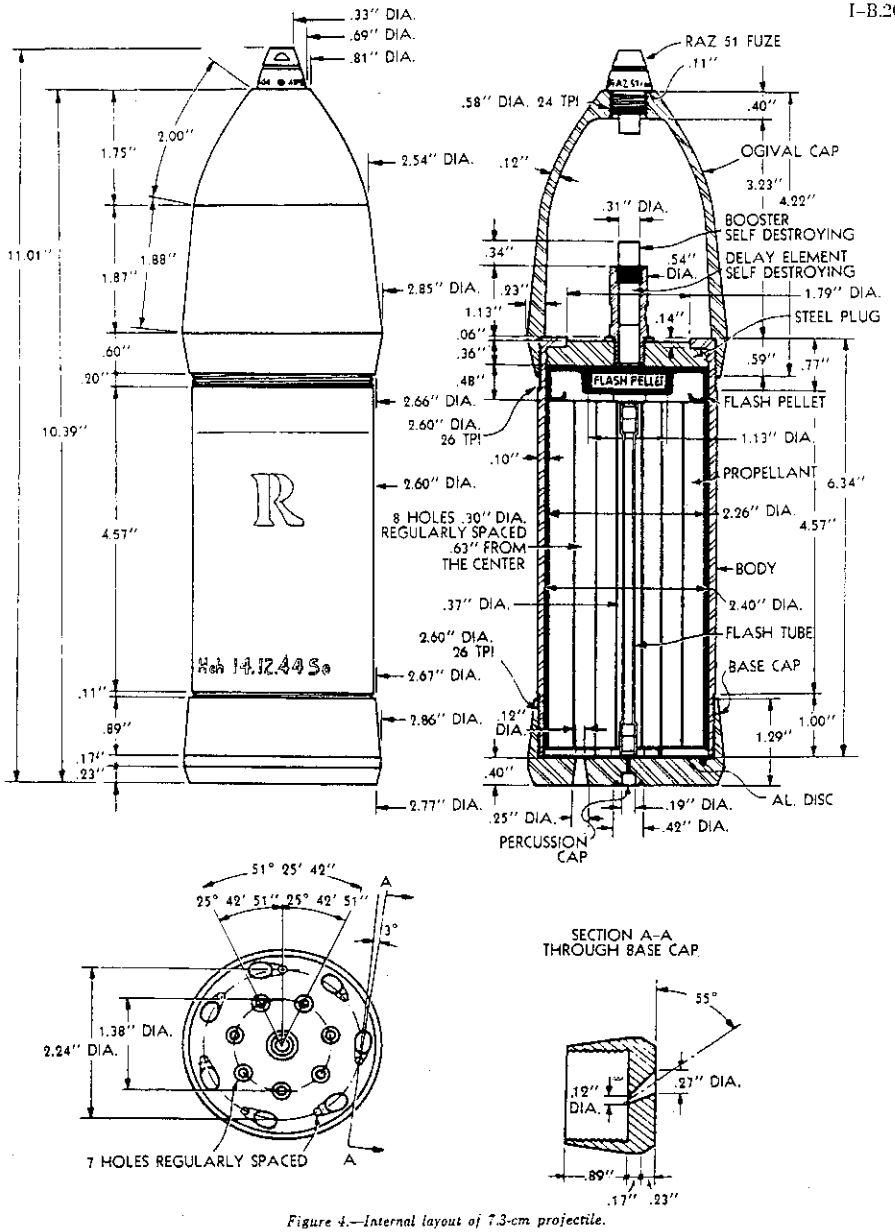

Figure 4.—Internal layout of 7.3-cm projectile.

Grid:

General	Metal disc supported on four turned-over lugs. Ignition charge in metal container in center of disc.
Over-all diameter	2.26 inches.
Over-all depth	0.48 inch.
Weight	--------.

Propellant:

Material	--------.
Number of sticks	One.
Weight	1.9 pounds.
Over-all length	5.28 inches.
Over-all diameter	2.31 inches.
Diameter, main body	2.25 inches.
Diameter, central perforation	0.38 inch.
Diameter, outer perforation	0.3 inch.
Markings	--------.

Method of ignition:

Initiator	A percussion primer is placed in central drilling in the base plug and is struck by a firing pin in the breech mechanism of the launcher. A relay train, consisting of a celluloid tube containing a quickmatch composition and sealed at the ends with gunpowder plugs, transmits the flash to the ignition charge at the forward end.

Ignition charge:

Diameter	--------.
Depth	--------.
Weight	--------.
Composition	--------.

3. Performance. No details of the performance of this projectile are available.

8.6-cm Parachute-and-Cable Projectile.

(German nomenclature not known.)

Fired from: 8.6-cm AA rocket launcher.

1. Description. *a. General.* This is a spin-stabilized, low-altitude antiaircraft projectile (Figure 1) intended for use in large numbers to form a parachute-and-cable barrage against low-flying aircraft. The projectile consists of a parachute container, projectile body (including a cable container), and a rocket motor.

b. Parachute container. The parachute container (14) is of light metal and is constructed in two halves, divided longitudinally, which fit into the projectile body (1) and which are retained in position by two strips of adhesive tape. The parachute is made of yellow silk with a bright red strip running down the center of each gore. When opened, it is 3 feet across and 20 inches deep.

c. Projectile body. The projectile body (1) is a cylinder of thin sheet steel 0.03 inch thick and open at each end. The lower end is slightly increased in diameter and is threaded internally to receive the rocket-motor body (3). Near the center of its length the body is pressed to form a bearing surface (2). The upper part of the body houses the cable container (12), which is made of steel and contains the coiled cable. One end of this cable is attached to the base of the container, and the other is attached to the parachute (13). Below the cable container is a wooden block (10), on the upper surface of which is an expulsion charge (11). A tube (4), screwed at its lower end into the rocket body, is located in a central drilling in the wooden block and contains a black-powder train.

d. Rocket motor. The rocket motor is of conventional design and consists of the rocket body and a base plate. The rocket body is closed at the forward end where it is screwed into the rear of the projectile body, and it is threaded externally at the rear end to receive the base plate. The base plate contains eight offset venturi drillings and a central drilling which takes a percussion cap. The propellent charge is a solid cylinder filling the whole of the propellent chamber. It is primed at the rear end by a block of gunpowder which is initiated by striking the percussion cap. The base of the motor is protected during transit by a pressed-on cover of thin sheet metal.

2. Technical Data.

GENERAL

Nature of projectile	Multiple base-venting, spin-stabilized, pusher rocket.
Caliber	8.6 cm.
Over-all length	16.5 inches.
Over-all weight	11 pounds.

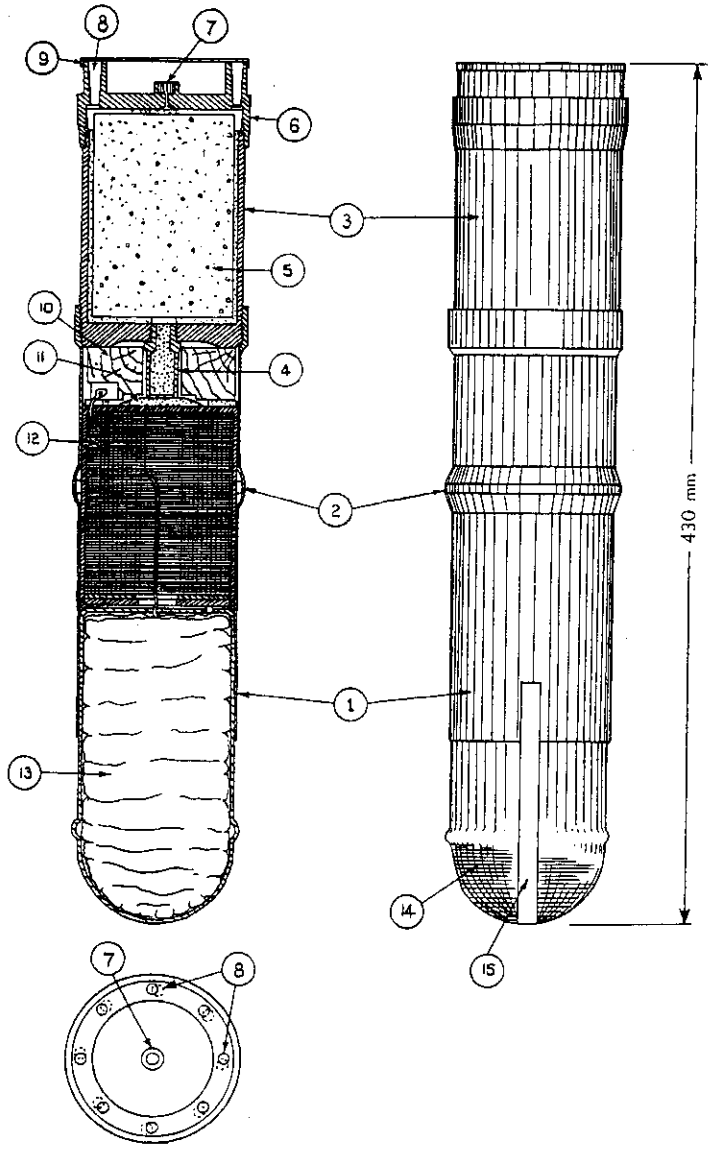

Figure 1.—Internal layout of 8.6-cm parachute-and-cable projectile.

CABLE CONTAINER

Length	4 inches.
Diameter	2.9 inches.
Weight complete	3.75 pounds.
Length of cable	310 feet.

PROPELLANT

Length	4 inches.
Diameter	2.75 inches.
Weight	1.75 pounds.
Composition	----------

3. Performance. No details of the performance of this projectile are at present available.

8.6-cm Raketen Sprenggranate 400.

(8.6-cm HE projectile.)
Fired from: 8.6-cm AA rocket launcher.

1. General Description. This is a spin-stabilized projectile (Figure 1) consisting of an HE-filled head and a rocket motor. The rocket motor is very similar to that of the 8.6-cm parachute-and-cable projectile but slightly longer. Since the venturi block is also similar, this motor must work at a somewhat higher pressure in view of the increased length of the propellant. The ignition system for the motor consists of a percussion primer let into the base and an ignition charge at the forward end of the propellant. The head of the projectile contains an HE filling which is actuated by a base fuze, screwed into the forward end of the rocket motor and initiated directly by the burning propellant.

2. Technical Data.

GENERAL

Nature of projectile	Multiple, base-venting, spin-stabilized, pusher rocket.
Caliber	8.6 cm.
Over-all length	16.25 inches.
Over-all weight	17 pounds 15 ounces.
Nature of filling	HE.
Nature of fuze	Base.
Range	----------

WARHEAD

Length	9.55 inches.
Diameter	3.35 inches.
Weight	----------
Weight of filling	----------
Type of filling	----------

ROCKET MOTOR

Length	6.7 inches.
Length of propellent chamber	6.08 inches.
External diameter	3.18 inches.
Internal diameter	2.94 inches.
Weight of filled motor	6 pounds 12.25 ounces.
Propellant:	
Length	5.90 inches.
Diameter	2.78 inches.
Weight	2 pounds 7.75 ounces.
Analysis:	
Potassium nitrate	75.5 percent.
Carbon	15.35 percent.
Sulphur	9.15 percent.
Volatile material	0.86 percent.

3. Performance. No details of the performance of this projectile are available at present, but it is estimated that it would reach a maximum height of 8,000 feet if fired at a quadrant elevation of 90 degrees.

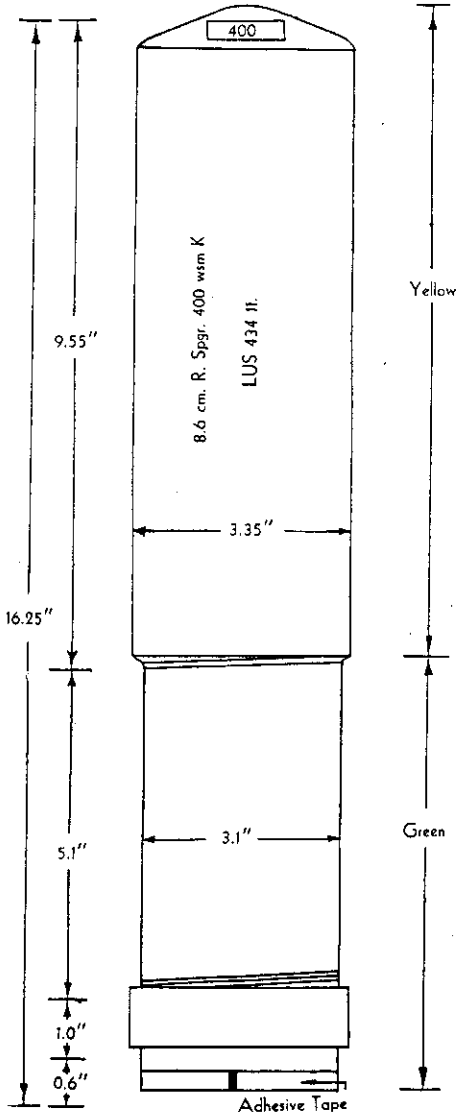

Figure 1.—8.6-cm HE Raketen Sprenggranate 400.

8.6-cm Raketen Leuchtgranate.

(8.6-cm Illuminating Rocket.)
Fired from: 8.6-cm AA rocket launcher.

1. General Description. This is a spin-stabilized projectile (Figure 1) consisting of a head, containing a star and parachute, and a rocket motor. The star and parachute are ejected by an expulsion charge initiated directly from the burning propellant. The motor is very similar to that used with the 8.6-cm parachute-and-cable rocket. No details of the internal construction of the projectile are available at present.

2. Technical Data.

GENERAL

Nature of projectile	Multiple, base-venting, spin-stabilized, pusher rocket.
Caliber	8.6 cm.
Over-all length	16.7 inches.
Over-all weight	11 pounds 7.25 ounces.

WARHEAD

Length	7.9 inches.
Diameter	-------
Weight	-------

ROCKET MOTOR

Length	8.8 inches.
Diameter, body	3.3 inches.
Weight	----------
Weight of propellant	1 pound 10.75 ounces.
Analysis of propellant:	
Potassium nitrate	76.1 percent.
Carbon	14.4 percent.
Sulphur	9.4 percent.
Volatile matter	0.87 percent.
Calculated on volatile matter free material.	

3. Performance. No details of the performance of this projectile are at present available, but it is estimated that it would reach a maximum height of about 8,000 feet if fired at a quadrant elevation of 90 degrees.

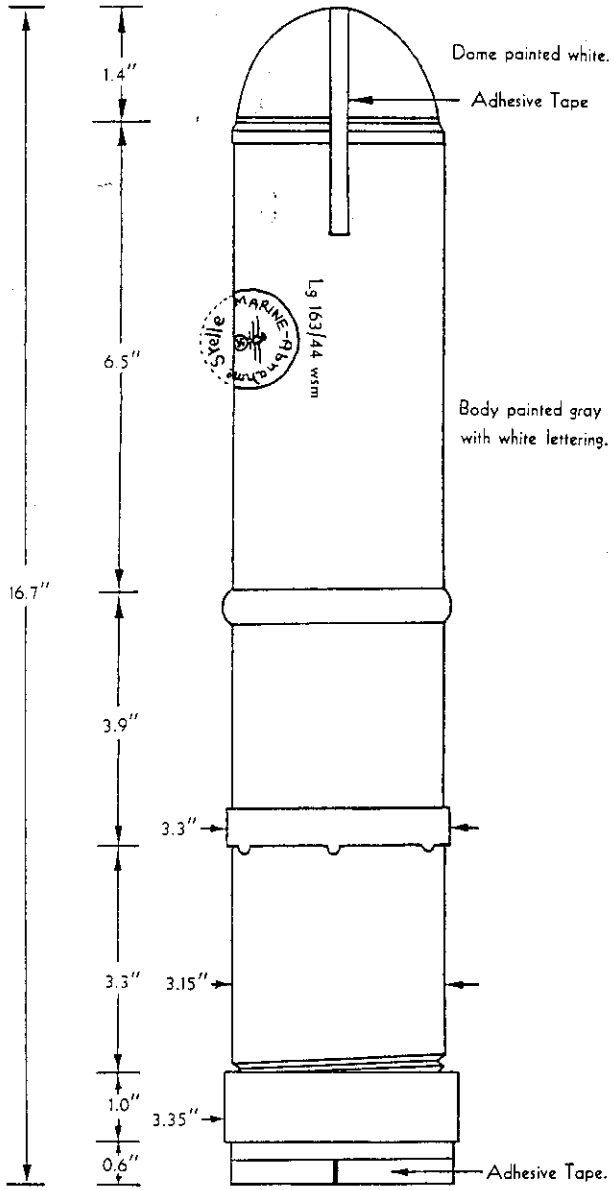

Figure 1.—8.6-cm Raketen Leuchtgranate.

15.2-cm Parachute-and-Cable Projectile.

(German nomenclature not known.)

Fired from: Special frame attached to lower half of cable housing (not yet recovered).

1. Description. *a. General.* This projectile (Figure 1) is of the "aerial-wire-barrage" type and is used to project a steel cable into the air by means of a rocket. One end of the cable is fixed to the ground and the other to a large support parachute and a smaller drag parachute. When the cable has paid out, the parachutes are pulled from their housing. The projectile is fin-stabilized and consists, from nose to tail, of the rocket motor, parachute housing, and upper and lower cable housing.

b. Rocket motor. The rocket motor (Figures 2 and 4) consists of a motor body, which is screwed into the parachute housing, and an ogival nose piece containing a TNT destruction charge. The motor body is a cylinder closed at the forward end and open at the rear. There is no base plate, but the propellent gases are allowed to escape through four venturi drillings in the forward end of the parachute housing (Figure 2). The propellant is a single, cylindrical, multiperforated stick and is ignited by means of an electrical base igniter, a train along the central drilling, and an ignition charge in a grid at the forward end. Leads to the electrical igniter pass through one of the venturi drillings. A delay fuze in the forward end of the motor body ignites the destruction charge in the nose piece.

c. Parachute housing. The parachute housing, which is a cylinder closed at the forward end, serves not only to house the large main support parachute and the smaller drag parachute, but also as a base plug for the rocket motor. The forward end has four venturi drilled obliquely in the sides of the body.

At the forward end of the parachute housing is a TNT destruction charge enclosed in asbestos. Although this has a primer, there is no means of initiation; it is assumed, therefore, that this charge is set off by sympathetic detonation from the charge in the nose of the projectile. Below this destruction charge is the main parachute wrapped in asbestos and below it the small drag parachute.

d. Cable housing. The cable housing is constructed in two separate halves. The upper half is attached to the base of the parachute housing and accompanies the projectile on its flight. The lower portion of the housing has a flanged base, which fits into the mounting and remains on the ground. The finned tail unit is spot welded to the upper half and fits over the lower portion. This maintains the projectile in position until it is fired. A slot is provided in two of the fins through which a wire is passed, holding the lower section in position; this wire should be removed before firing.

A continuous length of approximately 950 yards of ⅛-inch steel cable is coiled in equal lengths inside each portion of the cable housing. The end of the cable in the upper portion is attached to the parachute, and the other end passes through a hole in the bottom of the lower portion and terminates in an eyebolt secured to the launching frame.

e. Operation. The actual barrage consists of the support parachute, drag parachute, and cable (Figure 3). The projectile is evidently launched from some kind of frame (no specimen of this had yet been recovered), to which the lower portion of the cable housing is fixed. When the propellent charge is ignited, the projectile climbs until, theoretically, the whole of the cable has paid out. The drag parachute and the main support parachute are then withdrawn from the parachute hous-

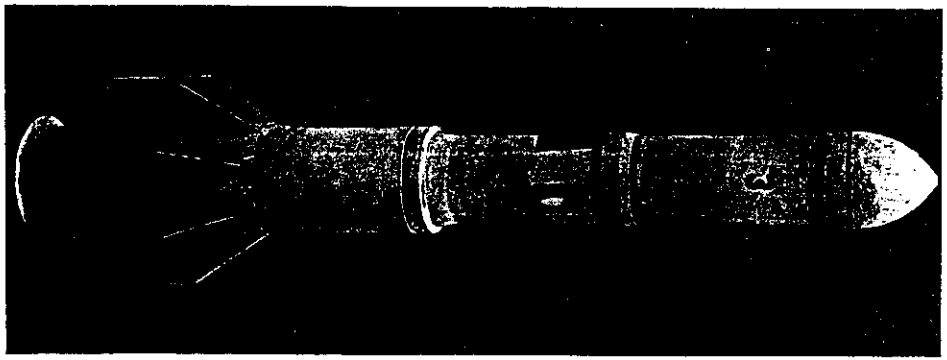

Figure 1.—15.2-cm parachute-and-cable projectile.

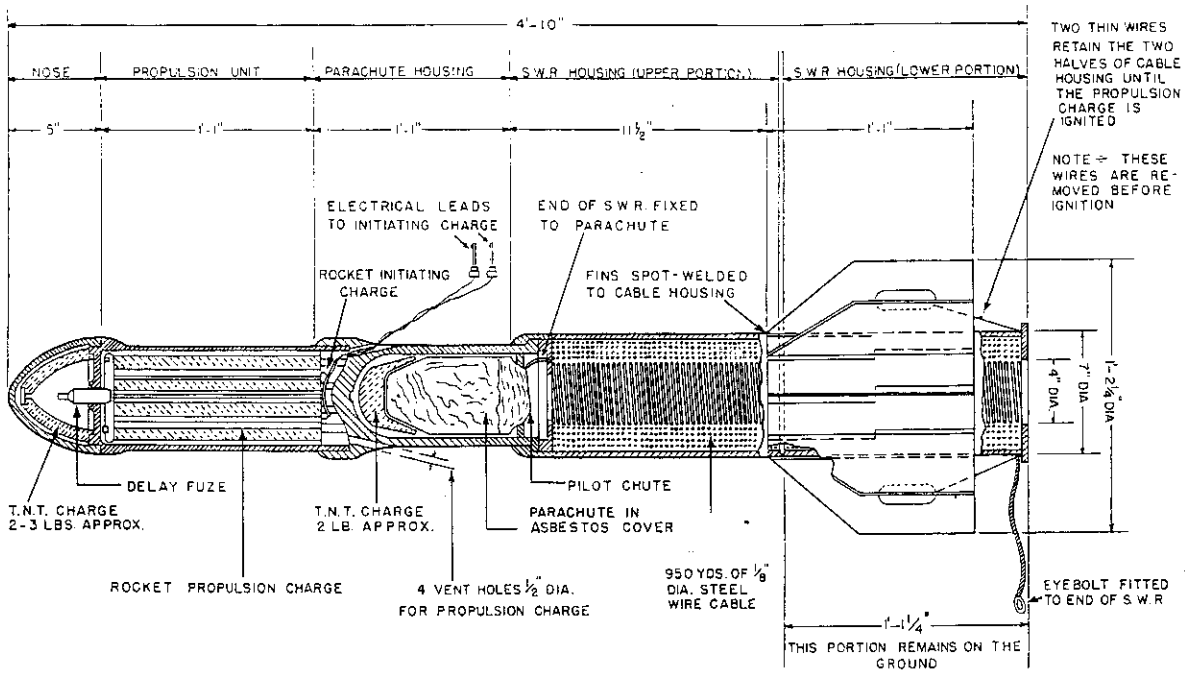

Figure 2.—Internal construction of 15.2-cm parachute-and-cable projectile.

ing, and the main unit continues on its course, leaving the cable suspended in the air.

When the propellant burns out, the destruction charge in the nose piece, actuated by the delay fuze, destroys the rocket motor and parachute housing. It is presumed that the charge in the forward end of the parachute housing is at this point set off by sympathetic detonation to assist in this destruction.

2. *Technical Data.*

GENERAL	
Nature of projectile	Multiple circumferential-venting, non-rotating, tractor rocket.
Caliber	15.2 cm (ballistic head).
Over-all length (complete projectile)	58.2 inches.
Weight (complete projectile)	150 pounds.
Nature of filling	Parachutes and cables.
Range (vertical)	Theoretical maximum of 2,850 feet (length of cable).
ROCKET MOTOR (including nose piece)	
Nose piece:	
Length	5 inches.
Diameter	6 inches.
Weight	4 pounds 12 ounces.
Weight of filling	2.3 pounds.
Type of filling	TNT.
Body tube:	
Length	———
External diameter	5.51 inches.
Internal diameter	5.2 inches.
Weight	27 pounds 11 ounces.
Propellant:	
Shape	Cylindrical with four longitudinal spacing ribs on outside.
Perforations	Nine, one central and eight outer.
Length	11.7 inches.
Diameter	———
Weight	11 pounds 10 ounces.
Propellant—Continued	
Analysis:	
Nitrocellulose	57.7 percent.
Diglycol dinitrate	38.1 percent.
Dibutyl phthalate	2.7 percent.
Akardite	0.4 percent.
Ash	0.6 percent.
Graphite	0.3 percent.
Volatile matter	0.85 percent.
PARACHUTE HOUSING	
Length	———
Diameter	———
Weight	28 pounds 1 ounce.
Venturi:	
Number	Four.
Diameter	———
Main suppport parachute	Silk, diameter approximately 11 feet. Colored green, white, or blue. Eight shrouds.
Drag parachute	Linen, diameter 6 inches.
Destruction charge	2 pounds TNT.

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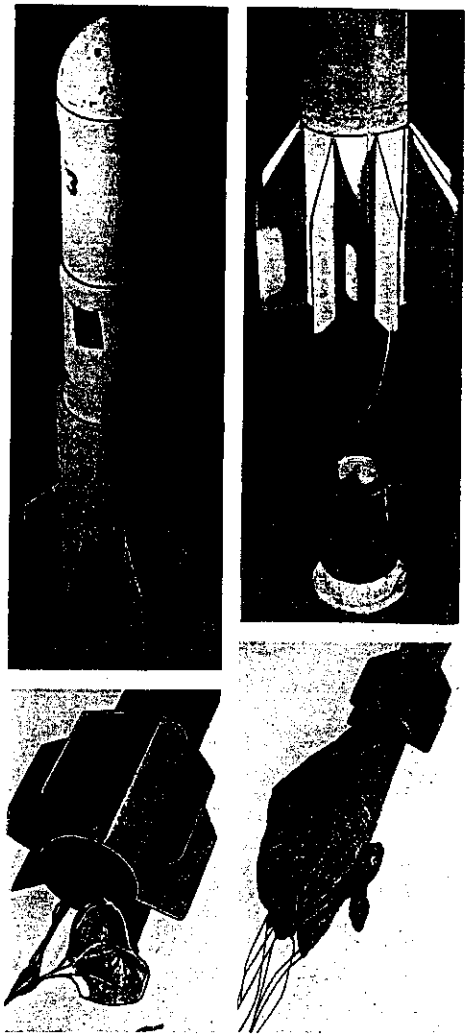
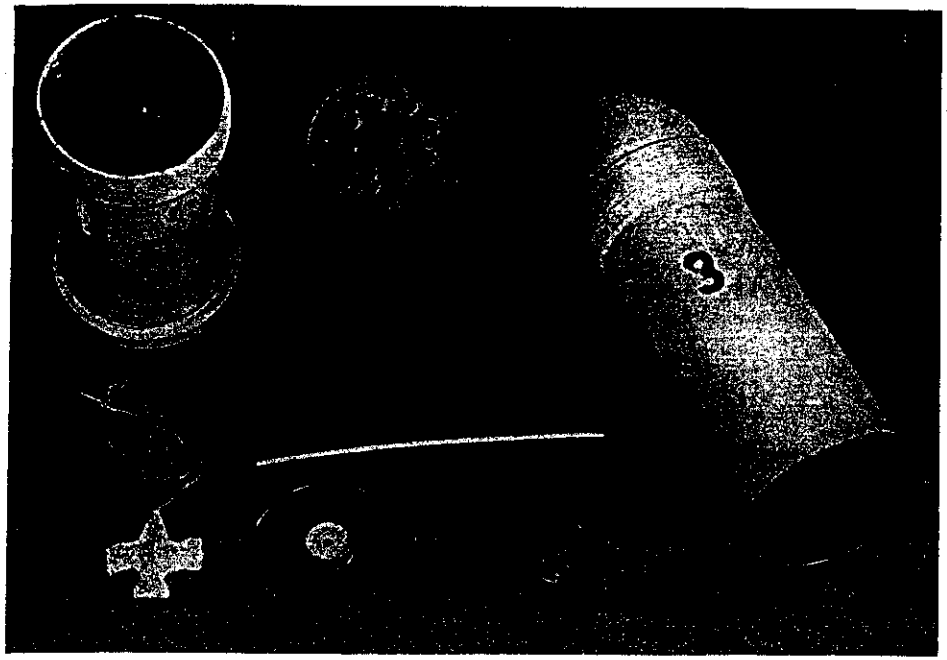


Figure 3.—Sequence of operation of 15.2-cm AA rocket: (left to right, top) ready for firing, the cable unwinds; (bottom) drag parachute emerges, and finally support parachute emerges.



Motor body. *Propellant.* *Delay train.* *Complete motor.*
Electrical igniter. *Forward ignition charge and grid.* *Delay fuze.*

Figure 4.—Component parts of rocket motor.

CABLE HOUSING

Length of upper portion	11.5 inches.
Length of lower portion	13.25 inches.
Length of finned unit	13 inches.
Diameter of housing	7 inches.
Diameter of fins	14.25 inches.
Weight, including fins	90 pounds 4 ounces.
Cable	The cable consists of five layers wound on a fiber core, each consisting of four strands of steel. Each strand is 0.017 inch in diameter and has a breaking tension of 80 pounds weight. The cable as a whole has a diameter of 0.118 inch and a breaking tension of 1,500 pounds weight.

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20-cm Parachute-and-Cable Projectile.

(German nomenclature not known.)

Fired from: Some type of frame which has not yet been recovered.

1. Description. *a. General.* This projectile (Figure 1), for which no projector has yet been recovered, is an AA wire-barrage device whereby a cable can be projected vertically and suspended from a parachute. The round consists of a rocket motor at the forward end; a center compartment containing the parachute; and a cable housing, surrounded by a finned sleeve, at the rear. The design is similar to that of the 15.2-cm parachute-and-cable projectile but is crude by comparison.

b. Operation. On firing, the cable housing remains attached to the ground while the motor, parachute container, and finned sleeve are projected vertically, towing the cable, which uncoils from its housing. When the cable has completely uncoiled, the parachute is pulled out through the finned sleeve. The separation of the parachute and motor operates a pull igniter which initiates a demolition charge contained in the central tube of the motor. The motor is of special interest in that it contains an HE charge surrounded by the propellant.

2. Technical Data.

Over-all length	64.3 inches.
Length of rocket motor	18.1 inches.
Diameter of rocket motor	8 inches.
Diameter across tail fins	10 inches.
Diameter of tail unit	5.6 inches.
Total weight	159 pounds 3 ounces.
Weight of propellant	11 pounds 9.5 ounces.
Type of propellant	NC/DGDN.
Preliminary analysis	Ether soluble (NC and inorganic constituents) 58.5 percent, DGDN 38.2 percent.
Rocket motor	Fin-stabilized; 12 annular venturi; concentric, cylindrical charges supported on a grid; electrically initiated.
Cable, thickness	0.092 inch.
Breaking stress	760 pounds weight.

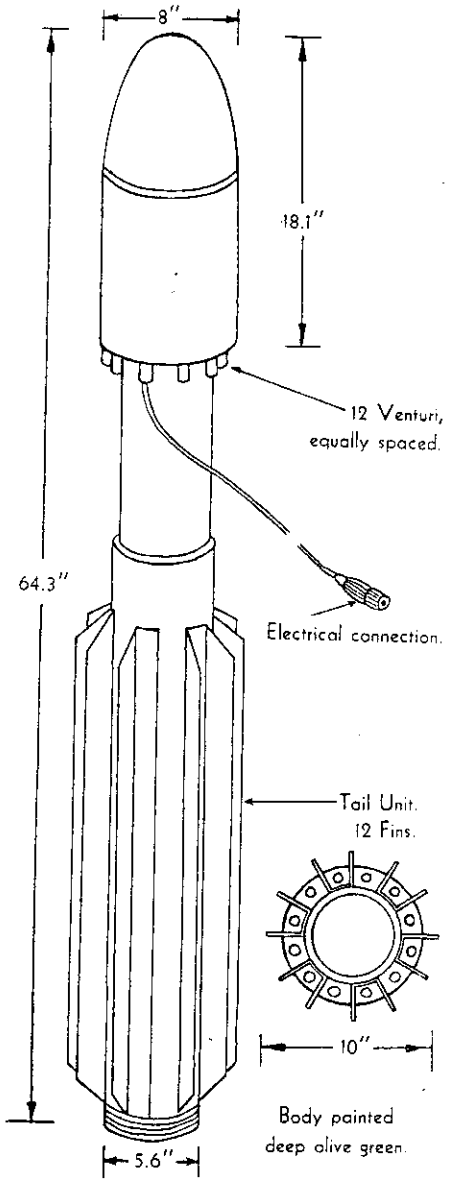


Figure 1.—20-cm parachute-and-cable rocket.

AIRCRAFT PROJECTILES

8-cm Raketen Sprenggranate.

Fired from: Aircraft and *3-cm Raketen Vielfachwerfer.*

This is a fin-stabilized projectile with an appearance typical of that of small caliber aircraft rockets. The projectile is described in detail under I–B.102, but is included in this section since it is an air-to-ground as well as a ground-to-ground weapon. When used on aircraft, the projectile is launched from rails under the wings.

21-cm Wurfgranate 42 Spreng.

(21-cm HE Projectile.)

Fired from: Aircraft and *21-cm Nebelwerfer 42.*

Although this projectile is basically a ground-to-ground rocket (described under I–B.112), mention of it is made in this section since it is believed to have been used as an air-to-ground weapon. Apart from the fact that it was launched from some kind of framework suspended from the wings of the aircraft, no details of the launching mechanism are available.

NON-STANDARD AND UNCONFIRMED PROJECTILES

7.3-cm Propagandagranate 41.

(7.3-cm Leaflet Rocket.)

Fired from: *7.3-cm Propagandawerfer.*

1. Description. *a. General.* The projectile (Figure 2) consists of two steel tubes, screwed into a central joint. The lower tube contains the rocket motor and the upper tube serves as a container for the leaflets. The projectile is spin-stabilized and is fired from the *Propagandawerfer*, which is a single launching tube.

b. Rocket motor. The rocket motor is formed by the lower tube and a screwed-on base plug. The base plug has 12 venturi set in two rings; those in the inner ring are straight and those in the outer ring are offset. A copper percussion cap is located centrally in the base of the plug.

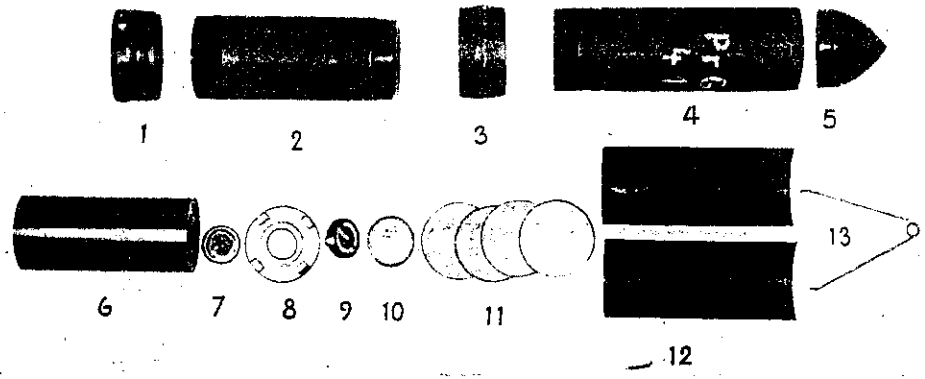
The propellant consists of a cylindrical stick with nine longitudinal drillings. One of these is central, and the other eight are in a ring around the central drilling. An ignition charge is located in a holder at the forward end of the propellant. This is fired by the flash from the percussion cap passing up the central hole of the propellant.

c. Leaflet container. The upper tube is closed by a bakelite ballistic cap. The leaflets are contained within a cylinder split longitudinally and are wrapped around a steel spring which is kept under compression. Below the leaflets and two cardboard and one bakelite washers is the bursting charge, incorporating a delay train which is fired by the heat from the ignition charge for the propellant.

d. Operation. The operation of this projectile is very simple. When the heat from the ignition charge ignites the bursting charge, the contents of the upper tube are ejected; as the split cylinder emerges, it falls apart and allows the compressed spring to scatter the leaflets packed around it.

2. Technical Data.

Weight (without leaflets)	7 pounds 3 ounces.
Length over-all	16.1 inches.
Weight of propellant	1 pound 1 ounce.
Weight of propellent unit	3 pounds (approx.).
Maximum diameter (at central joint)	2.85 inches.



1. Base plate.
2. Motor body.
3. Junction piece.
4. Forward tube.
5. Plastic cap.
6. Propellant.
7. Ignition charge.
8. Supporting grid.
9. Delay train.
10. Bursting charge.
11. Washers.
12. Split cylinder.
13. Spring.

Figure 1.—Component parts of leaflet rocket.

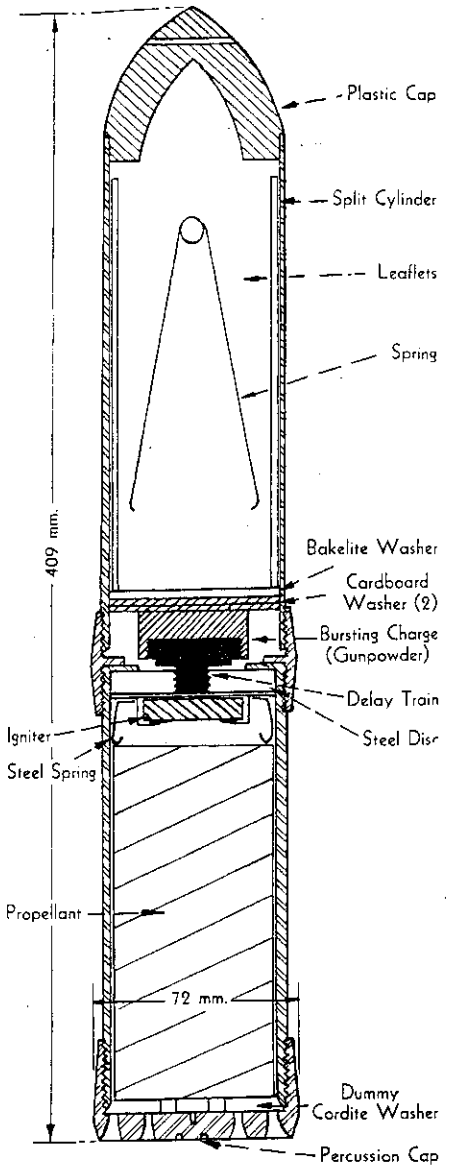


Figure 2.—Internal construction of 7.3-cm leaflet rocket.

15-cm Raketen Scheinsignal Geschoss.

(15-cm Pyrotechnic Rocket.)

Fired from: Special single launching frame.

This projectile, launched vertically from the wooden crate shown in Figure 1, is used to project a flare into the air to simulate target-marking flares dropped by attacking aircraft. No full report on the internal arrangement of the projectile has been received, but it is known to consist basically of a forward compartment containing a colored candle and a rocket motor and finned tail unit. The rockets, which use white, yellow, red, or green candles, are usually used collectively in an installation consisting of 16 launching crates. They are fired from a remote control room.

The following are brief characteristics of the projectile:

Over-all length	76 inches.
Total weight	94.5 pounds.
Weight of candle section	36.375 pounds.

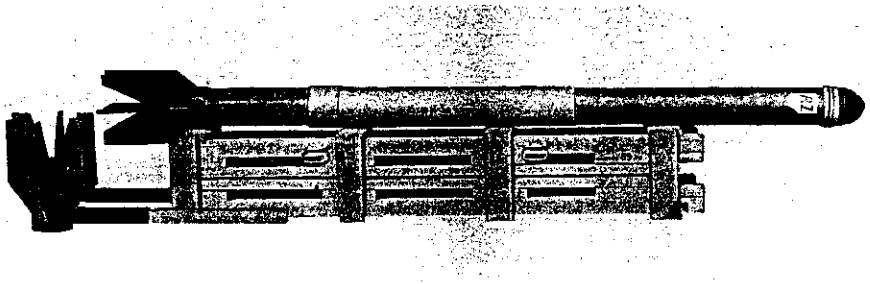


Figure 1.—15-cm pyrotechnic rocket resting on frame from which it is launched.

High-Altitude Antiaircraft Projectile.

(Unconfirmed.)

The first tangible substantiation of the numerous aircrew observations of rockets at high altitudes has now been provided by a reliable report of an HE rocket of about 20-cm caliber. It is thought that this projectile may have a warhead of about 50 pounds, of which about a quarter would be HE content, giving a lethal radius of burst of about 85 feet. Its ceiling may be in the region of 25,000 feet. Also, there may possibly be a multi-barreled version.

It is open to question whether many of these weapons were ever brought into service, but they may well have been deployed experimentally, which would account for some of the aircrew observations in the past.

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Section III

FUZES

CONTENTS

Introduction.

With the exception of certain special fuzing systems, such as the thermally armed fuze in the *8-cm Raketen Sprenggranate* (I-B.102) and the expulsion and demolition charges in the parachute-and-cable projectiles which are initiated by delay trains from the propellant, the fuzes used in German rockets are restricted to nine types. Three of these are types used on standard artillery projectiles. Apart from the *Bdz.DOV.*, a base graze fuze used on the 15-cm projectiles, all fuzes are of the nose percussion variety. These fuzes are of conventional design and do not exhibit any features of special interest. Although a great deal of time was devoted to experimental work with proximity fuzes, particularly for ground-air projectiles, these were intended for use on guided missiles, and as such do not fall within the scope of this publication.

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List of Fuzing Systems.

The following table shows the types of fuzing systems used on all rocket projectiles included in Part I.

Projectile	*Fuzing System*
Ground projectiles:	
7.5-cm HE projectile	Not known.
8-cm Raketen Sprenggranate	Special thermal fuzing system; described under projectile.
8-cm Raketen Nebelgranate	Not known.
8.8-cm Raketen Panzerbüchse Granate 4322.	*A.Z. 5095* or *A.Z. 5095/1.*

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8.8-cm Raketen Panzerbüchse Granate 4992.	Not known; probably as above.
8.8-cm Raketen Panzerbüchse Granate 4312.	*A.Z. 5095* or *A.Z. 5095/1.*
15-cm Wurfgranate 41 Spreng.	*BdZ.DOV.*; base graze fuze.
15-cm Wurfgranate 41 Nebel	*BdZ.DOV.*
15-cm Wurfgranate Gelbring	*BdZ.DOV.*
15-cm Wurfgranate Grünring	*BdZ.DOV.*
15-cm Wurfgranate Grünring-Gelb.	*BdZ.DOV.*
21-cm Wurfgranate 42 Spreng.	*Hbgr.Z.35.K.*
28-cm Wurfkörper Spreng.	*Wgr.Z.50+.*
30-cm Wurfkörper 42 Spreng.	*Wgr.Z.50+.*
30-cm Wurfkörper Spreng 4991.	*Igr.Z.23.nA.*
32-cm Wurfkörper m.Fl.50	*Wgr.Z.50+.*
38-cm Raketen Sprenggranate 4581.	*A.Z.KM.8.*
38-cm Hohlladungsgranate 4592.	*A.Z.KM.10.*
Antiaircraft projectiles:	
7.3-cm Raketen Sprenggranate	*R.A.Z.51.*
8.6-cm parachute-and-cable projectile.	Explosion charge ignited by delay train.
8.6-cm Raketen Sprenggranate 400.	Base fuze, initiated by burning propellant.
8.6-cm Raketen Leuchtgranate	Expulsion charge ignited by delay train.
15.2-cm parachute-and-cable projectile.	Destruction charge ignited by delay train.
20-cm parachute-and-cable projectile.	Destruction charge initiated by pull igniter attached to parachute.

I-C.002

A.Z. 5095.

(Instantaneous Nose Percussion Fuze.)

Used on: *8.8-cm Raketen Panzerbüchse Granate 4322*, *8.8-cm Raketen Panzerbüchse Granate 4312*, and probably *8.8-cm Raketen Panzerbüchse Granate 4992*.

1. General Description. A drawing of this fuze is shown in Figure 2. The action is very simple. The safety cotter pin is withdrawn before the round is loaded. When the round is fired, the force of setback causes the setback ring to move to the rear, bending the two prongs of the stirrup spring which then rise and engage in the inside groove of the ring, preventing it from returning forward.

The striker needle has so far been held away from the primer-detonator by a flat coiled clock spring held inside the setback ring. As the setback ring moves to the rear, the clock spring unwinds and expands against the inside of the fuze body. This movement, which arms the fuze, also provides a short delay in the arming process. On impact, the striker needle moves directly to the rear and actuates the primer-detonator in the base of the fuze.

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The fuze has two safety features. The first is the safety cotter pin which secures the setback ring in position and which is withdrawn before the projectile is loaded. The second is the slight delay in the clock-spring arming of the fuze.

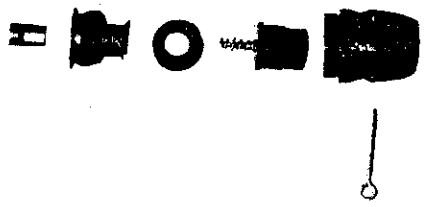

Figure 1.—Component parts of fuze, A.Z. 5095, showing (left to right) primer-detonator, screwed-in base piece with setback spring, setback ring and clock spring, fuze body, and (below) safety cotter pin.

I-C.002

2. Technical Data.

Over-all length	1.79 inches.
Over-all diameter	1.182 inches.
Weight	3.5 ounces.
Fuze functioning time	Between 0.00014 and 0.00023 second.
Color	Painted light blue.

I-C.003

A.Z. 5095/1.

(Instantaneous Nose Percussion Fuze.)

Used on: Same projectiles as *A.Z. 5095*.

This fuze is almost identical with the *A.Z. 5095* and is used on the same projectiles. The unpainted steel fuze may be distinguished by its oval shape and dull color. In addition, it does not have the deep neck of the *A.Z. 5095*. Since the *A.Z. 5095/1* is used on projectiles intended for use within normal temperature limits, and the *A.Z. 5095* is designed for use at low temperature, it seems probable that the former will have a slightly longer functioning time.

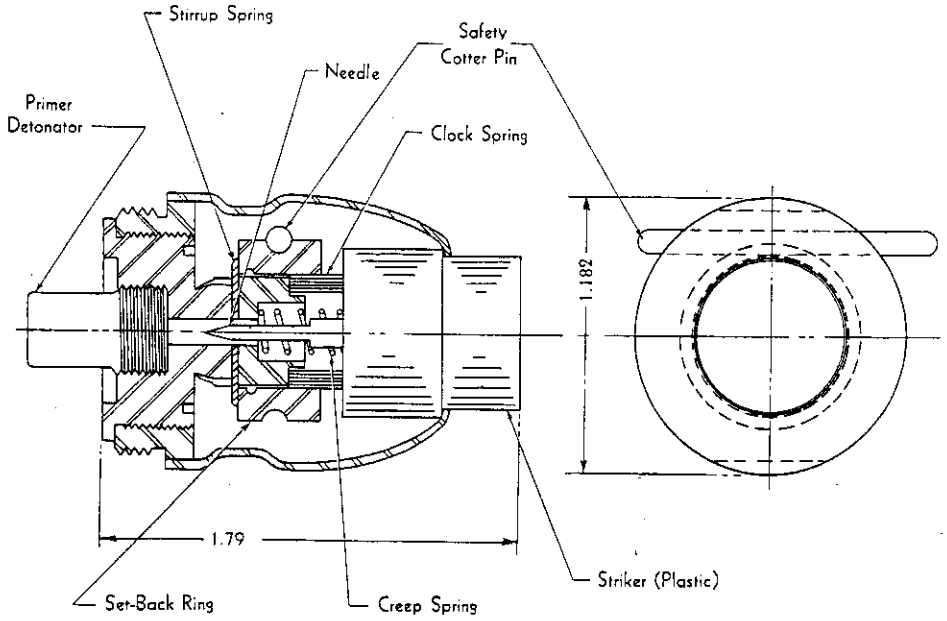

Figure 2.—Cross section of fuze, A.Z. 5095.

Hbgr.Z.35.K.

(Nose Percussion Fuze.)

Used on: *21-cm Wurfgranate 42 Spreng* (HE projectile).

This is a centrifugally armed, nose percussion fuze which may be set for an optional delay of 0.10 second. The fuze is designed for use under a ballistic cap and is used in the 21-cm HE rocket. Basically, the fuze is of normal design and consists of a striker and inertia pellet which are held away from the detonator by centrifugal segments which bear against a shoulder on the inertia pellet. A delay element is located in the lower half of the fuze body and is included in the train when a centrifugal bolt is locked in position; for instantaneous action this bolt is free to swing outwards and leaves a clear passage for the flash from the detonator.

The primary feature of this fuze is the use of a rod which connects the fuze to the point of the ballistic cap under which the fuze is located. This rod serves to transmit the force of impact from the nose of the projectile to the end of the striker and so fire the detonator. The layout of the fuze is shown in a drawing of the complete projectile under I–B.112.

Wurfgranatzünder 50+ (Wgr.Z.50+).

Used on: *28-cm Wurfkörper Spreng, 30-cm Wurfkörper 42 Spreng,* and *32-cm Wurfkörper m.Fl.50.*

1. General. Two types of this fuze have been encountered. They are similar in principle and appearance but differ in detail. They have been designated Type A and Type B for the sake of comparison. The arming mechanism consists of centrifugal bolts which unlock an inertia pellet and striker at an estimated rotational speed of 1,800 revolutions per minute for Type A and 1,500 revolutions per minute for Type B. The fuzes have adapters which fit the standard German 5-cm fuze hole. The adapter for the Type A is zinc alloy, and that for the Type B is plastic.

2. Type A. The action of this fuze is as follows: The safety pin and cap are removed before firing. In the unarmed position, the striker and inertia pellet are locked together by two centrifugal bolts, which are held in position by two spiral springs. During acceleration, the setback of the striker is sufficient to hold the centrifugal bolts in their original positions. When the centrifugal force is sufficient to overcome the friction between the bolts and the striker, as well as the resistance of the springs, the bolts move outwards, leaving a clear path for the striker which is held forward by the creep spring.

Upon impact, the striker and inertia pellet move toward one another, and the striker needle contacts the igniferous

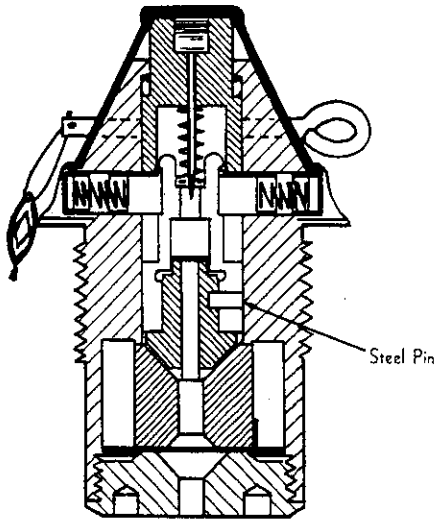

Figure 1.—Internal construction of Wgr.Z.50 + Type A.

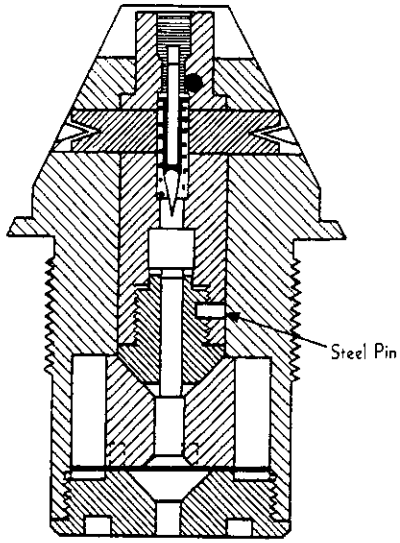

Figure 2.—Internal construction of Wgr.Z.50 + Type B.

detonator. If the impact is oblique, the conical inner surface of the inertia ring bears against the base of the inertia pellet and drives it forward.

The following are the brief technical characteristics of this fuze:

Weight of fuze	6 ounces 13 grams.
Weight of adapter	11 ounces 13 grams.
Length of fuze	2.37 inches.
Length of fuze and adapter	3.03 inches.

3. Type B. This fuze differs from Type A chiefly in that the centrifugal bolt spring is a circular-wire type which allows the fuze to arm at a much lower rate of spin. The action of the fuze is otherwise identical with that of the Type A.

Technical characteristics:

Weight of fuze	7 ounces.
Weight of adapter	2 ounces 4 grams.
Length of fuze	2.87 inches.
Length of fuze and adapter	3.03 inches.

Jgr.Z.23.nA. I–C.006

(Nose Percussion Fuze.)

Used on: *30-cm Wurfkörper Spreng 4991.*

This is an instantaneous or delay-action, centrifugally armed fuze, which is generally issued set for delay action. It consists of a striker and spring, a detonator and detonator holder, and two centrifugal bolts which hold the striker and detonator apart. Centrifugal force causes the bolts to move outwards, leaving the striker and detonator free to move toward each other on impact.

The delay mechanism consists of another centrifugal bolt to which is attached a shutter. When set for delay, the bolt is held rigid and the shutter causes the flash from the detonator to be diverted through a delay composition before entering the magazine. By manipulating a small screw near the base of the fuze, the centrifugal bolt is released and is free to swing outwards, taking the shutter with it. This leaves a channel direct from the detonator to the magazine, and the action is instantaneous.

A.Z.KM.8. I–C.007

(Nose Percussion Fuze.)

Used on: *38-cm Raketen Sprenggranate 4581* (HE projectile).

No complete report on this fuze has been received. It is a centrifugally armed, nose percussion fuze with an optional delay of 0.12 second. The fuze is carried in the "safe" position and set to either instantaneous or delay action before firing. Certain of these fuzes are painted

with a red ring; this is reported to indicate that the fuze is "travel safe" in the bore (U. S.: bore safe). Details of the internal construction of the fuze are not known but it is known to be of the normal design in which the fuze is armed centrifugally, and thereafter the striker is kept away from the detonator by means of a creep spring. It is reported that when using this fuze, ricochets may occur if the angle of impact is less than 14 degrees, and that the projectile may break up in such instances when the ground is hard. For this reason, the fuze is set for instantaneous action when firing at low elevations (less than 8 degrees 26 minutes) or against buildings.

A.Z.KM.10. I–C.008

(Nose Percussion Fuze.)

Used on: *38-cm Hohlladungsgranate 4592* (hollow-charge projectile).

Neither this fuze nor the projectile for which it is designed has been received. Its use is known only from captured documents. The fuze is believed to be of the usual centrifugally armed type, probably similar to the *A.Z.KM.8*, but without the optional delay.

R.A.Z.51. I–C.009

(Nose Percussion Fuze.)

Used on: *7.3-cm Raketen Sprenggranate* (HE projectile).

This fuze is of conventional design, being centrifugally armed and having an instantaneous action upon impact. The fuze presents no features of special interest and warrants no further comment.

Bdz.DOV. I–C.010

(Base Graze Fuze.)

Used on: All 15-cm projectiles.

This is a base fuze of extremely simple design. The fuze consists of a base piece, which screws into the rear end of the projectile, and the fuze body. A recess in the center of the base piece houses the inertia pellet and needle which are cast in one piece. Five pivot pins on the upper surface of the base piece serve to locate five centrifugal segments which are retained in the inner position by an expanding spring ring and which bear against a shoulder on the inertia pellet. Above the striker is an igniferous detonator in a recess at the forward end of the fuze body which is screwed over the base piece. The striker is held away from the detonator by a creep spring. The fuze is centrifugally armed by the five segments which move outwards and leave the striker free to move forwards onto the detonator on impact.

Section IV

PROPELLANTS AND FILLINGS

CONTENTS

PROPELLANTS

Conventional (Extruded) Propellants.

This section consists merely of notes of a general nature on standard German propellants. Detailed information, such as size, weight, and chemical composition of the propellants used in individual projectiles, are given in an analysis included in I–G.000 (Tabulation of Technical and Ballistic Data).

All propellants used in standard German rockets take the form of cylindrical sticks extending the length of the rocket motor and usually bearing against metal supporting grids at each end. In most cases several sticks of propellant are used, one in the center and the others equally disposed around this central stick. While a single stick is sometimes used in fin-stabilized rockets, spin-stabilized projectiles generally employ a number of sticks; this is probably due to the fact that several sticks of comparatively small diameter are less likely to break during rotation than a single stick of larger diameter.

These propellent sticks are all either mono- or multiperforated and generally consist of a double-base powder; the two forms of powder most used are nitrocellulose/diglycol dinitrate and nitrocellulose/nitroglycerine. The standard means of igniting the propellant is by two ignition charges, attached to the rear and forward supporting grids, and connected by a celluloid tube containing a quickmatch train located in the drilling in the central propellent stick. During the sequence of firing, the rear ignition charge is initiated by the igniter, which may be either electrical or mechanical, and the flash is transmitted along the quickmatch train to the forward ignition charge.

Experiments with Cast Rocket Propellants.

1. General. It has been known for some time that the Germans were interested in the development of a cast propellant. The following information was obtained during the examination of a powder plant (Wolff and Company, Bomlitz) in Germany. It may be expected that further information on this subject will be forthcoming when other experimental plants in Germany have been thoroughly processed.

As early as January 1941 experiments were begun in the development of a cast rocket propellant which could be used to conserve the consumption of DGN (diethylene glycol dinitrate). After the production and testing of many variants, a standard composition (Giessling Pulver) was evolved in 1943, and it was decided at the end of that year to erect a plant for the large-scale manufacture of this propellant. The present composition of Giessling Pulver is:

Trinitrotoluene, pure (melting point: 80.6 degrees C.)	53 percent.
DGN	17 to 18 percent.
Nitrocellulose (N content: 12.2 percent) lacquer grade.	28 to 29 percent.
Diphenylamine (DPA)	---------
Centralite I. (Carbamite)	---------

The method of manufacture consists briefly in slowly adding moist crumbled NC/DGN paste to stirred molten TNT; water and air are removed by vacuum, and the molten charge is then injected into steel molds from which it can be removed after cooling under controlled conditions for 24 hours.

2. Mixing Trials. The early mixing trials were with batch weights of 2 to 3 kilograms (4.4 to 6.6 pounds), later scaled up to 30 kilograms (66 pounds), and finally, in two specially adapted pots, to 160 (353 pounds) and 200 kilograms (441 pounds) respectively. A considerable number of molds capable of producing cast charges up to 26 cm in diameter and 150 cm long have been recovered. These molds appear to be about 10 percent longer than the final charge. The charges were trimmed to length by means of a rotary cutter (wet) and in the case of sticks up to 130 mm in diameter were inspected for flaws by means of visual X-ray apparatus.

3. Large Scale Production. Ten thousand charges for the 15-cm rockets were produced for testing. All the charges were inspected by X-rays. They were 120 mm in diameter and had nine perforations: eight outer (7.5 mm in diameter) and one central (25 mm in diameter). Field trials were carried out with these charges; it was reported that they produced too much smoke, and that about 1.5

to 2 percent of the 600 rounds fired at 20 degrees C. gave "bursts." The 15-cm charge was rejected, and no further work was done on it. Some earlier trials had given 25 to 30 percent "bursts" at −25 degrees C. and at 40 degrees C. The charge was clearly too brittle at low temperatures and too soft at high temperatures and broke up in rotating rockets. The Germans intended to try the charges in fin-stabilized rockets.

In spite of these apparent failures, a considerable amount of serious development work proceeded with ATO (assisted take-off) charges and with ultra-large charges which, it is assumed, might have been used in V-weapons. During January and February of 1945, many ATO charges were made. The dimensions of two of these are as follows:

Diameter	550 mm	550 mm.
Perforation diameter	230 mm	130 mm.
Length	1,000 mm	1,000 mm.
Weight	243 kilograms	272 kilograms.

There is obvious potential hazard in the method of manufacture, since the charge in the melting pot is maintained at 70 to 90 degrees C. for periods up to 6½ to 7 hours. Scientists responsible for this work are divided concerning the danger of this process.

4. General Properties. The performance of the cast propellant is only slightly lower than that of the normal solventless diglycol rocket propellant. Its density is 1.58 gm/cc and its calorimetric value 740 to 750 cals/gm. Measurements have been made of the hardness and impact strength of the material. At 30 degrees C. the impact strength is about the same as that of the diglycol propellant, but at 10 degrees C. it is only about 0.5 and at −20 degrees C. about 0.25 of the value for the normal propellant. Below 10 degrees C. the cast propellant is harder, but above, softer than the diglycol propellant. The rates of burning of the two propellants were said to be very similar.

5. Alternative Compositions. A number of attempts were made to reduce the smoke from the propellant by the inclusion of a proportion of potassium nitrate or perchlorate. The results were unsatisfactory, and the propellants were too sensitive to small-arms fire. The inclusion of flake aluminum or 10 to 20 percent of nitroguanidine was tried, but ease of manufacture was reduced, and the propellant was less stable than the standard composition.

6. Improved Physical Properties. Attempts were made to reduce brittleness at low temperatures by the inclusion of polyvinyl acetate; a less brittle propellant resulted, but the performance was lower.

FILLINGS

HE Fillings.

The HE fillings used in standard German rocket projectiles are fairly consistent. Smaller caliber projectiles generally have an RDX, TNT, pressed TNT, or cyclotol charge, while larger rockets use amatol, either 40/60 or 50/50. The only use of shaped charges has been in the 8.8-cm hollow-charge antitank rockets and in a 38-cm anti-concrete projectile; no specimen of the anti-concrete rocket has been received, and details of the charge are not known.

Details of the weights and size of the charges used in the individual projectiles are given in a filling analysis included in I–G.000 (Tabulation of Ballistic and Technical Data).

Chemical Warfare Fillings.

Only three projectiles with chemical warfare fillings have been identified. These are the three 15-cm rockets which have the following markings, indicating the chemical composition of the filling:

Yellow ring	H/MA.
Green ring	HN-3.
Green Ring Yellow	H.

Other Fillings.

Apart from the three parachute-and-cable rockets and the one leaflet-filled projectile, the only rockets having fillings other than HE or war gases are the 15-cm smoke and the 32-cm incendiary projectiles. The smoke composition used consists of 30/70 pumice/sulfur trioxide. The incendiary filling is a gasoline and oil mixture.

Section V

FIRING SYSTEMS

GENERAL

As is the usual practice with rockets, German projectiles generally employ electrical firing systems which lend themselves readily to firing from a remote control position to the flank of the launcher. The electrical firing systems used on the 15-cm, 21-cm, 28-cm, 30-cm, and 32-cm rockets are described in detail under I–E.101. No other method of firing is used which warrants description.

ELECTRICAL FIRING SYSTEMS

This section is a collation of information concerning the firing mechanisms of the following standard German ground projectiles, all of which are fired electrically: *15-cm Wurfgranate 41 Spreng, 15-cm Wurfgranate 41 Nebel,* 15-cm chemical warfare projectiles, *21-cm Wurfgranate 42 Spreng, 28-cm Wurfkörper Spreng, 30-cm Wurfkörper 42 Spreng,* and *32-cm Wurfkörper m.Fl.50.*

General.

In all cases the firing current is supplied by a hand-operated magneto-generator in a remote control position, connected to the projector by a cable. The rockets are fired either singly as ordered or singly in succession for barrage fire, but never simultaneously from one projector. Figure 1 shows the sequence of firing and the type of initiator used with each projector.

It will be noted that, although the *28/32-cm Schweres Wurfgerät* and the *28/32-cm Schwerer Wurfrahmen* fire the same projectiles, different types of initiators are used for each projector.

Circuit.

Rockets launched from the *28/32-cm Schweres Wurfgerät 40* and *28–32-cm Schweres Wurfgerät 41* frames are fired individually at 2-second intervals, the time lag between adjacent rounds being controlled by delay elements in the electrical initiators. Four initiators which flash after delays of 0, 2, 4, and 6 seconds respectively are connected in series and operated by a single impulse.

With five other projectors—*15-cm Nebelwerfer 41, 15-cm Panzerwerfer 42, 21-cm Nebelwerfer 42, 30-cm Nebelwerfer 42, 28/32-cm Nebelwerfer 41,* and *28/32-cm Schwerer Wurfrahmen 40*—the magneto-generator is connected by a multilead cable to the junction box on the

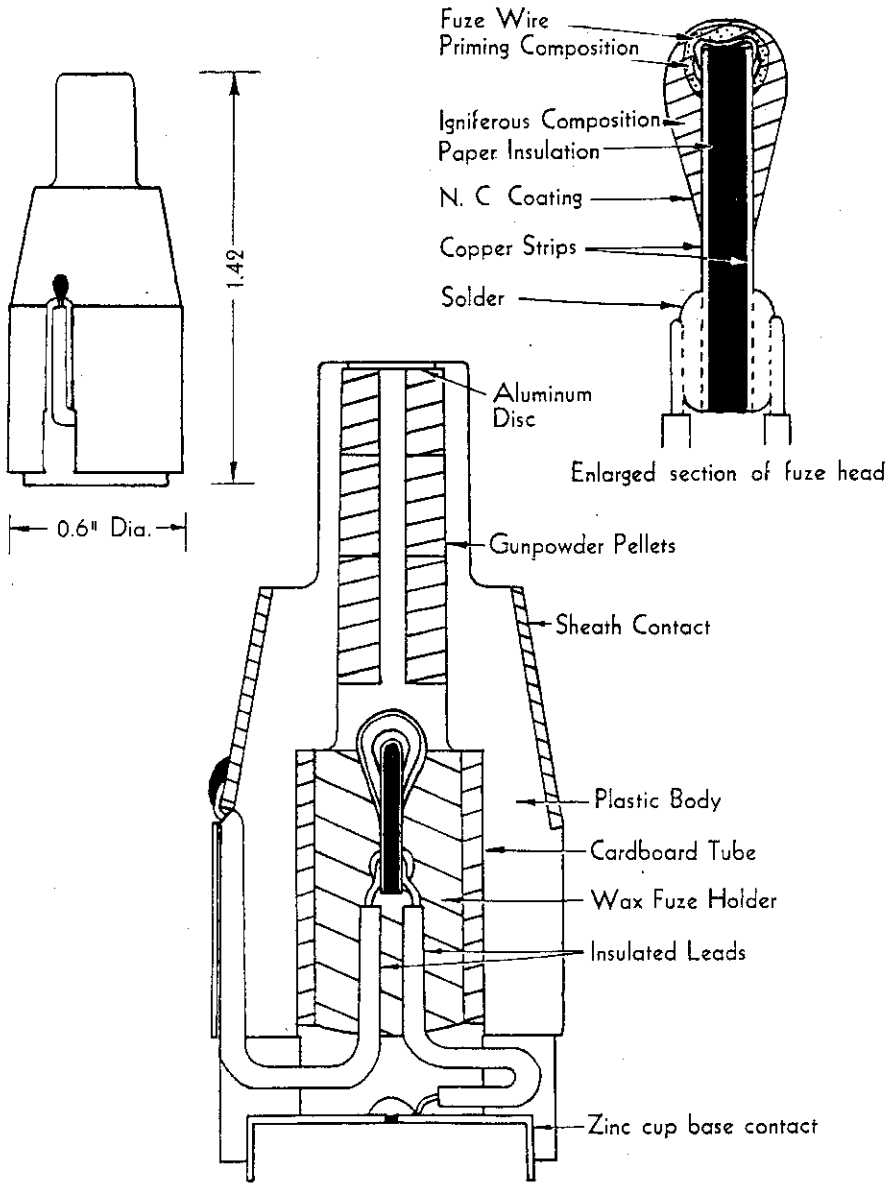

Figure 1.—15-cm and 21-cm rocket initiator 39 (E.R.Z. 39).

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projector. This cable contains one lead for each rocket and one common return lead. With the standard generator, one round is fired each time the handle is turned. The 2-second interval is left to the judgment of the firer.

Ignition System.

The train by which the propellant in the rocket motor is ignited may be divided as follows: electrical initiator, internal primary igniter, quickmatch train, and maintainer.

1. Electrical Initiator. The 15-cm, 21-cm, 28-cm, and 32-cm projectiles all use separate external initiators. (These are described on pages 39 and 40.) On the 15-cm and 21-cm rockets the initiator is inserted into one of the annular venturi. On the 28-cm and 32-cm rockets the initiator is inserted into the central hole in the venturi block. The 30-cm projectile is issued with an initiator already screwed into the center of the venturi block at the base of the rocket.

All initiators consist basically of a low-tension fuze fired electrically. This fuze produces a flame which is transmitted to a perforated pellet of gunpowder, either directly across a gap or through a delay unit (*Schweres Wurfgerät 40* and *41*).

2. Internal Primary Igniter. The primary igniter, used in all except the 30-cm rocket, is placed above the venturi block where it can be ignited by the flash of the initiator. In the 15-cm and 21-cm projectiles this consists of a celluloid ring containing gunpowder, resting on the venturi block above the annular venturi. In the 28-cm and 32-cm projectiles it is a cloth bag of nitrocellulose flake, resting on the venturi block above the central hole.

3. Central Quickmatch Train. This is similar in all rockets. It consists of a celluloid tube filled with quickmatch and has a gunpowder plug at each end. It extends the length of the rocket motor at the center. It is ignited by the internal primary igniter, except in the 30-cm rocket where it is ignited directly from the gunpowder pellet of the fixed initiator.

4. Maintainer. The maintainer is present in all rockets. It is situated at the forward end of the motor unit and consists of a flat metal container holding a flash composition with a surface layer of priming composition.

Initiators.

1. 15-cm and 21-cm Projectiles. These projectiles use the standard external electrical initiator, *Elektrische Randdüsen Zünder* (*E.R.Z. 39*). The initiator is inserted

into one of the annular venturi on the rocket. An insulated spring-loaded hook at the rear of the projectile barrel rests on the zinc base cup of the initiator, and the circuit is completed by an earth (U. S.: ground) return from the zinc body ring on the initiator to the venturi block. Each ammunition box, containing one round, has one initiator in a waxed cardboard cylindrical container clipped inside the box.

The *E.R.Z. 39* has a plastic body, and a zinc body ring and base cup. Above the electrical fuze are three perforated gunpowder pellets, each weighing 0.15 gram. The initiator appears to function reliably with a current of 0.3 ampere. The zinc contacts are liable to corrode but can be cleaned easily; the initiator as a whole, however, is not sealed against moisture and will deteriorate on exposure.

2. 30-cm Projectile. This projectile is issued with the electrical initiator contained in the primer unit screwed into the center of the venturi block. In the event of a misfire this primer was unscrewed from the rocket and replaced with a new one, so that boxes of spares were found with the 30-cm rocket equipment.

3. 28-cm and 32-cm Projectiles. These rockets also use external initiators. The initiator itself is the same for all projectors but is issued in three ways, which differ only in the external electrical connections and the incorporation of delay units in one case.

a. Steckzünder 40. This is a single initiator with a simple plug at the end of two insulated leads 13 inches long. It is used with these projectiles when they are fired from the *38/32-cm Nebelwerfer 41* or the *Schwerer Wurfrahmen 40* (Type A) projectors.

b. Glühzündkette 40 m.V. This consists of four initiators connected in series at distances of 24 inches along an insulated lead, and with 12 inches of lead at each end (ending with one inch of bare wire). Three of these initiators incorporate varying lengths of delay composition between the electric fuze and the gunpowder pellet. Thus, the fuzes in all four initiators are set off when the current passes through the circuit but the rockets are fired at intervals of 0, 2, 4, and 6 seconds. Four metal tags embossed 4, 0, 2, and 6 respectively are attached to the insulated lead, one above each initiator, indicating their delay. These are used on *Warfgerat 40* and *41* projectors.

c. Drückknopfzünder 42. This is a single initiator, with a metal press stud at the end of each lead, which is 28 inches long and insulated. This is used on the *Wurfrahmen 40* (Type B). The *Glühzündkette* and *Drückknopfzünder* merely incorporate different methods of attachment to the ends of the initiator leads. The initiator used is the same.

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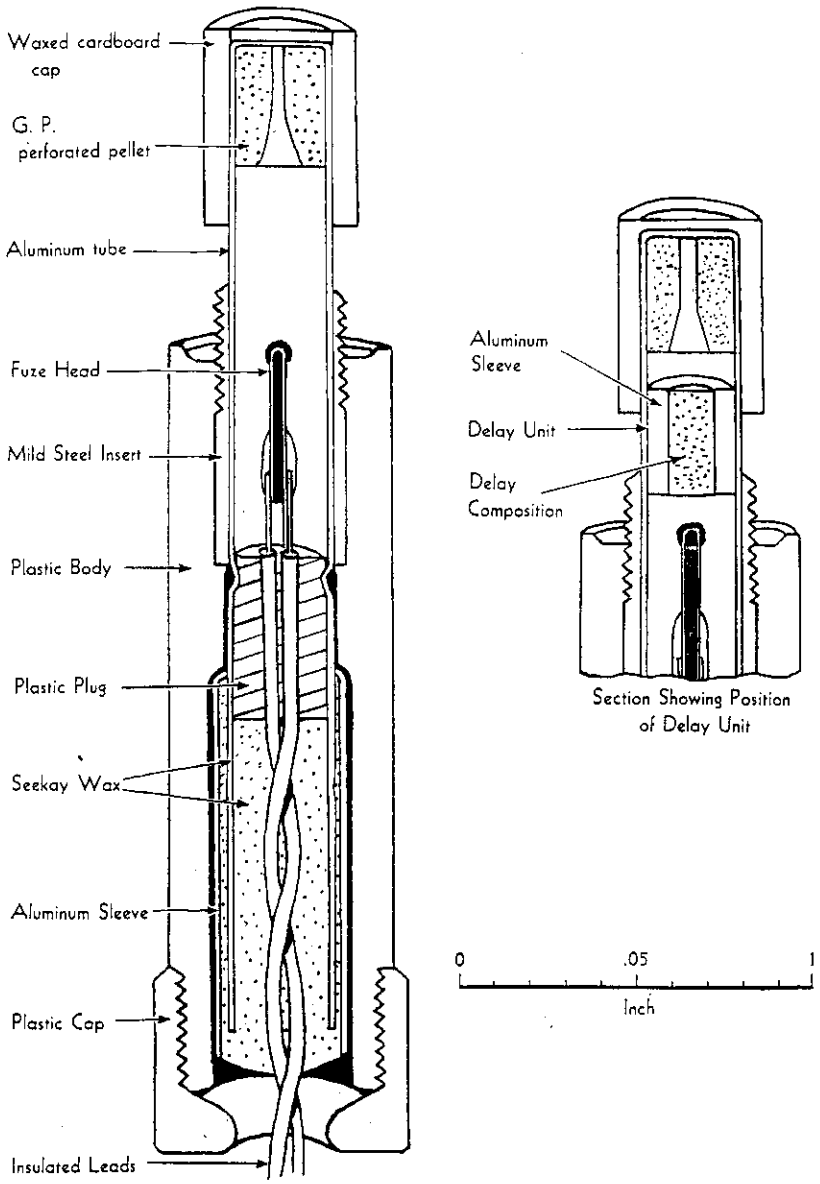

Figure 2.—28/32-cm rocket initiator.

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4. Initiator 28/32-cm. The body of this initiator is plastic. A steel insert projects at the front and is threaded externally so that the initiator may be screwed into the rocket. The exposed end of the initiator is covered by a heavily waxed cardboard cap which has to be removed before use. Earlier models had a plastic cap which screwed on the projecting steel insert in the body.

An aluminum tube containing the electric fuze and gunpowder pellet is held in the body and extends 1½ inches beyond the steel insert. The electrical fuze is similar in design to that used in the *E.R.Z. 39* although different igniferous compositions are used. There is a space between the electrical fuze and the 0.68-gram perforated gunpowder pellet at the top of the aluminum tube. This space is empty in the initiators intended for instantaneous functioning, and contains one of three lengths of delay units, manufactured for 2-, 4-, and 6-second burning time, in the initiators for delayed functioning. The end of the delay unit nearest the gunpowder pellet is a red and brown composition of lead oxides and nitrocellulose.

The whole initiator is well protected against damp and should stand up well under exposure. It is probably designed to function with a minimum current of 0.1 ampere.

Section VI

LAUNCHERS

CONTENTS

GROUND TUBE-TYPE LAUNCHERS

8.8-cm Raketenpanzerbüchse 54.

(8.8-cm Antitank Rocket Launcher.)

Projectiles fired: *Raketen Panzerbüchse Granate 4322*, and *Raketen Panzerbüchse Granate 4992* (hollow-charge antitank projectiles).

1. General Description. *a. Construction.* This weapon is similar to the U. S. launcher M9A1 and fires two types of hollow-charge antitank rocket projectiles. The launcher (Figures 1 and 2) consists of a steel tube into which are pressed three shallow longitudinal grooves forming guide ribs extending the length of the tube. The backsight is fixed and is welded to the left-hand side of the tube, just forward of the cocking lever and trigger mechanism. The foresight frame is also welded to the tube, but the foresight itself is adjustable for elevation. Two bolts retain the foresight at the required setting, and a screwdriver is required to make any alteration in the setting for elevation. There is no lateral adjustment, and the ranges are not inscribed on the sight.

At the rear end of the tube is a circular protecting guard, and just forward of the trigger and firing mechanism is a shield fitting around the tube. Three types of shield have been issued; all are rectangular in shape and have a circular clamp for attaching to the tube. In each shield there is an observation window on the left of the firer. One of the shields examined was fitted with a clear, colorless, plastic window.

A projectile-retaining catch is located at the rear end of the tube to prevent slip-back, and a spring-loaded plunger, which projects into the interior of the tube, is positioned to engage the front end of the tail unit and so prevent the projectile from slipping forward before it is fired.

A housing is located on the left-hand side of the tube, at the rear. This carries a socket, and approximately below the housing, projecting into the interior of the tube, is a spring-loaded contact.

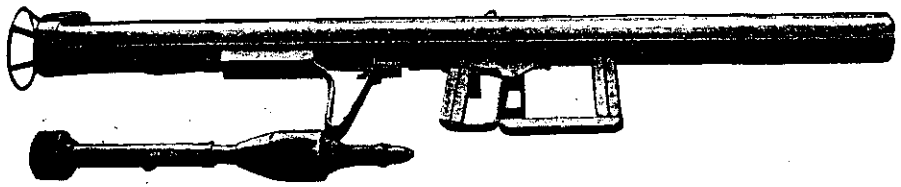

Figure 1.—8.8-cm antitank rocket launcher and projectile.

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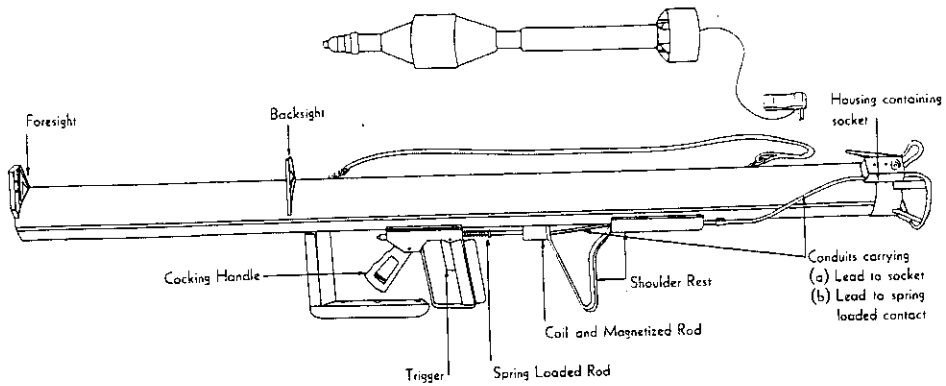

Figure 2.—Layout of 8.8-cm rocket launcher.

The firing mechanism is located underneath the tube. Connected to the cocking lever is a spring-loaded rod, which is drawn forward when the cocking lever is operated, compressing the spring and finally being held in position by a hook at the top of the trigger.

Immediately to the rear of and in line with the spring-loaded rod is a cylindrical component, about 2½ inches long and 1¼ inches in diameter. This houses a coil through which a small magnetized rod travels freely. Two thin insulated wires lead from the rear of this component to the housing containing the spring-loaded contact. One wire is connected to the socket and the other to the spring-loaded contact.

b. Loading. The projectile is inserted in the rear of the tube and is maintained in the correct position by the projectile-retaining catch and the spring-loaded plunger.

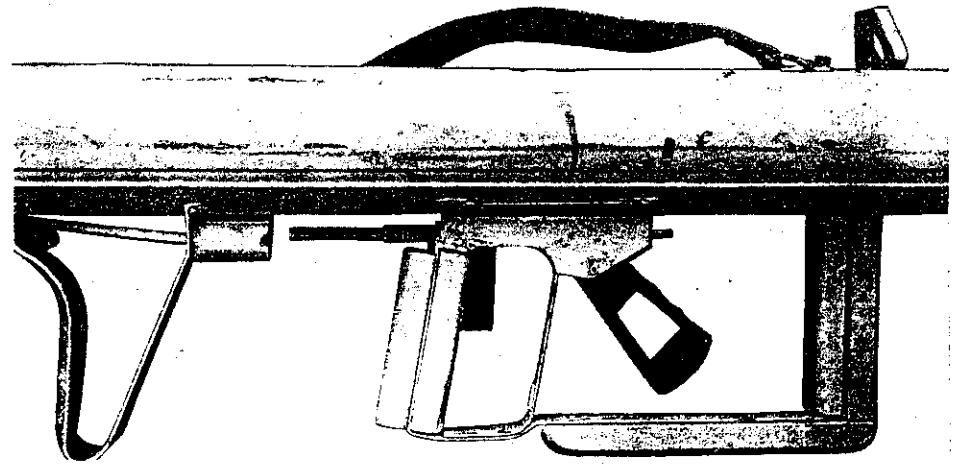

Figure 3.—Cocking and firing mechanism of the 8.8-cm launcher.

When it is so positioned, the tail unit is connected by a spring-loaded contact and the wandering lead is inserted into the spring socket in the housing.

c. Cocking and firing. When the cocking lever (Figure 3) is pressed, the spring-loaded rod is drawn forward and away from the cylindrical component. During travel, the spring is compressed, and the hook at the top of the trigger retains the rod in the forward position.

When the trigger is pressed, the rod, under the influence of the spring, flies to the rear and strikes a stud located in the center of the cylindrical component. This causes the magnetized rod to pass quickly through the coil, generating a current which is passed to the tail tube and ignites the propellent charge.

2. Technical Data.

Over-all length of complete weapon	5 feet 4.5 inches.
Over-all length of tube only	5 feet 2.5 inches.
External diameter of tube	3.7 inches.
Internal diameter of tube	3.5 inches.
Length of rear guard	1.7 inches.
Size of protective shield	14 by 16 inches (approx.).
Weight	20.5 pounds.

8.8-cm Raketenpanzerbüchse 54/1.

(8.8-cm Antitank Rocket Launcher.)

Projectiles fired: *Raketen Panzerbüchse Granate 4992* (hollow-charge antitank rocket projectile).

This launcher is basically similar to the original antitank rocket launcher, *8.8-cm Raketenpanzerbüchse 54*, described in I-F.101. Figure 1 shows the two launchers together. The two fundamental differences between this launcher and the Model 54 are the reduction in length and the use of a slightly different electrical contact at the rear of the tube. The Model 54/1 is designed for firing the hollow-charge projectile, *Raketen Panzerbüchse Granate 4992*, which has a ring contact for the firing connection. The reduction in length is about 11.3 inches and the launcher is about 2.5 pounds lighter than the Model 54.

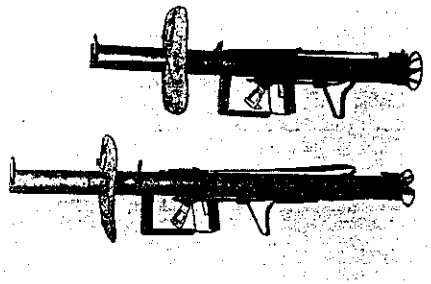

Figure 1.—Raketenpanzerbüchse 54/1 (top), and Raketenpanzerbüchse 54 (bottom).

8.8-cm Raketenwerfer 43.

(8.8-cm Antitank Rocket Launcher.)

Projectiles fired: *8.8-cm Raketen Panzerbüchse Granate 4312* (hollow-charge antitank projectile).

1. General Description. *a. Tactical use.* This is a front-line infantry antitank projector (Figure 1), consisting of a smooth-bore barrel and breech mechanism mounted with free traverse on a two-wheeled carriage with a single box trail and spade. It is ordinarily fired with wheels removed and resting on two skids, but it may be fired from its wheels if necessary. The German instructional pamphlet emphasizes that the weapon is designed for positional warfare, and that positional changes during battle are possible only under very favorable visibility and cover conditions. The weapon, not sufficiently robust to be towed by motor transport, is usually towed behind small horse carts or hauled on a truck. The maximum effective range is stated to be 220 yards, and all types of tanks may be engaged. The launcher may be broken down into seven pieces.

b. Construction. The monobloc is 63 inches long and 5 mm thick at the muzzle end. It is secured to the breech ring by a type of interrupted thread, and is held in position by a spring plunger located on the forward bracket of the cradle. A clip secures the flash hider to the muzzle.

The breech ring is bolted to the cradle and is prepared to receive a square breechblock operated by a conventional type of breech lever. The block, which is only 15 mm thick, slides to the left, freeing itself from six locking lugs, and then opens to the left and backwards, like a screw-type block. The firing mechanism is the percussion type, and cocking is accomplished in the last movement of the opening block, or by hand. There are two safety devices. A tripping piece cannot be rotated to release the hammer until the breech is fully closed, and a milled knob on the rear of the breechblock may be set at safe by hand. The trigger is on the right handgrip to the left rear of the breechblock. An extractor operates on the last movement of opening the breech.

The cradle consists of a flat rectangular sheet of metal on which are mounted the handgrips at the left rear, the breech ring, and, at the forward end, a bracket on which the trunnions are located. On top of the bracket is the barrel-retaining plunger.

The saddle (U. S.: upper carriage) consists of a simple U-bracket pivoted on the axle tree. Lugs for carrying the shield are located on the forward cheeks.

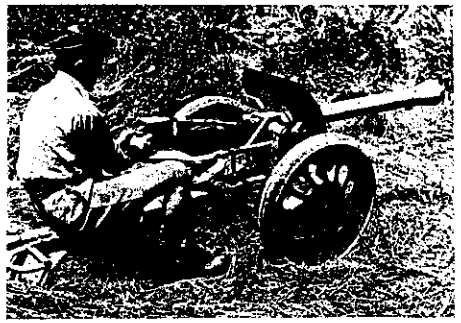

Figure 1.—8.8-cm Raketenwerfer 43 in position for firing.

c. Elevation and traverse. Elevation and traverse are free, the weapon being controlled by the handgrips. An elevation damper, consisting of a small hydraulic cylinder, is mounted on the left-hand side of the weapon. The cylinder is attached to the saddle, and the piston rod is secured to a lug on the breech ring. By depressing a spring-loaded plunger on the top of the piston rod, the rod may be lifted upward and freed from the breech ring.

d. Trail. The single-leg trail is integral with the axle tree. At the rear are a spade, two hand grips, and a detachable trail arm with traversing handle and trail eye. A clamp for locking the piece in traveling position is mounted on the trail leg. Underneath the axle tree at each end is an oval skid. At each extremity is a spring-loaded plunger to retain the wheel. The wheels are metal throughout, except for a rubber band on the inner side of the metal tire.

e. Sights. The sights consist of a U backsight mounted on the front part of the spade grip and a foresight secured to the cradle bracket. The backsight is a vertical blade graduated from 180 meters to 700 meters (197 to 765 yards).

2. Technical Data.

Total weight	334 pounds.
Length over-all	9 feet 10 inches.
Length of tube	5 feet 9 inches.
Width of carriage	3 feet 4 inches.
Diameter of wheels	2 feet 3 inches.

15-cm Nebelwerfer 41.

(15-cm Multi-Barreled Launcher.)

Projectiles fired: *15-cm Wurfgranate 41 Spreng* (HE projectile), *15-cm Wurfgranate 41 Nebel* (smoke projectile), *15-cm Wurfgranate Gelbring, 15-cm Wurfgranate Grünring,* and *15-cm Wurfgranate Grünring-Gelb* (three types of chemical warfare projectiles).

1. General Description. Since this launcher is the best known of the German tube-type launchers, a complete description of the whole equipment is included. The details of the tube construction and firing mechanism will apply equally well to the two other 15-cm multi-barrelled launchers, the *15-cm Panzerwerfer 42* and the *15-cm Nebelwerfer Zehnling 42*, and to the *21-cm Nebelwerfer*.

a. Projector. The projector (Figure 1) consists of six tubular barrels set with their center lines equally spaced on a pitch circle 41.4 cm in diameter. The barrels are steel tubes 3 mm thick, 18.35 cm in mean internal diameter, and 130 cm long.

Each barrel has three internal rails to support the round, the rails consisting of 3-mm angles with unequal flanges. One flange, 20 mm wide, is attached to the barrel by 10 rivets, and the free flanges appear to have been machined after assembly, so that the bearing surface for the round is very true. The rails are equally spaced around the circumference, one being at the top. The barrels are assembled into two tube plates, 7 mm thick, spaced 61 cm and 123.5 cm from the muzzle, and each tube plate is relieved by a central hole, 16.3 cm in diameter, to save weight and reduce blast reaction. Steel collars, 2 mm thick, are welded on to reinforce the barrels at the points of attachment to the tube plates. The forward band is 4 cm wide, and the rear band which extends to the breech end of the barrel is 7 cm wide. The attachment to the

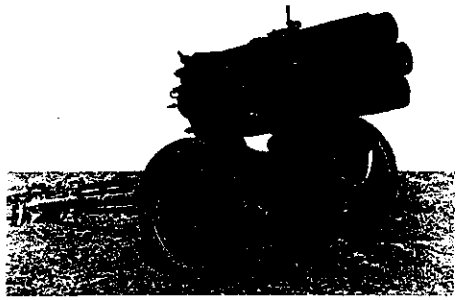

Figure 1.—15-cm multi-barreled launcher with front leg raised and trails closed.

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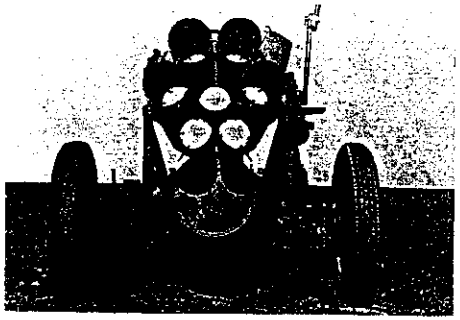

Figure 2.—Front view of 15-cm multi-barreled launcher.

tube plate is made by three 8-mm bolts on each barrel, fitting in small angle brackets welded to the plates. At the muzzle end, adjacent barrels are bolted together by single 8-mm bolts and tubular spacers.

Stout back stops are fitted to the barrels, spring controlled so that they swing forward clear of the rounds for breech loading, and swing back against rigid stops under the weight of the rounds. They have extensions outward so that they can be released by hand if it is necessary to unload a round. Barrels are numbered from 1 to 6 clockwise when viewed from the breech end, No. 1 being at 1 o'clock. On the top of the projector between Nos. 1 and 6 barrels a bracket is welded to the front tube plate, having a machined and scraped face for use as a clinometer plane. This surface is protected by a cover plate held on by two bolts.

The complete projector assembly is pivoted on trunnions 42 cm from the breech end, and 7 cm below the center line of the assembly. Connecting straps are attached on one side to Nos. 2 and 3 barrels, and on the other side to Nos. 4 and 5 barrels, and the trunnion pins are mounted on these straps. The barrels are reinforced with collars at the points of attachment of the straps. The trunnions are held in split bearings, with hinged caps and single-bolt fastenings for quick removal. The trunnion bearings are supported by a saddle fabricated from pressings and mounted on a bearing for traverse.

Elevation from −5 degrees to about 45 degrees is carried out by a pinion-and-tooth quadrant, supported at one end on a bracket attached to the front tube plate and at the other end by a strap between barrels 3 and 4. The arc of traverse is 27 degrees.

A few degrees of traverse on each side of the center line are provided by a tangent screw, and this movement is locked by a quick-action, ratchet-operated clamp on the bearing plate. Elevating and traversing handles are

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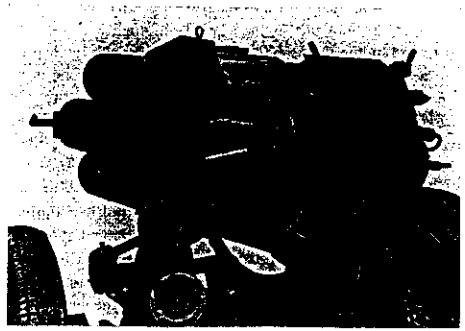

Figure 3.—Rear of 15-cm launcher barrel assembly, showing spring-loaded plungers which make contact with the rocket igniter.

grouped on the left-hand side of the saddle for convenient operation by one man.

b. Electrical circuit. The projector is fired, one barrel at a time, from a remote control point by means of a hand-operated magneto. From this a seven-core cable runs to a junction box mounted just behind the front tube plate between barrels 1 and 2. A quick-action hinged lock secures the cable in the box. From this junction box, conductors in heavy conduits are led to the breech ends of the barrels, where they terminate in spring-loaded plungers with hooked ends, which make contact with the rocket igniters (Figure 3). The plungers lie axially along the barrels. To make contact they have only to be pulled out until the hooked ends clear the breech faces of the barrels, and swung around until the pointed ends will register in the puffers (U. S.: plugs) which are inserted, one in each round, into the exit cones of the venturi. The circuit is completed by a ground return through the projector to the junction box.

The magneto is a low-tension instrument. As the handle was missing from the one examined it was not possible to form any estimate of the voltage which it will give. It is possible that special precautions may be necessary to ensure a good electrical contact between the body of the round and the projector rails. One turn of the magneto handle fires one round, the location of which on the projector is indicated by a moving disc on the magneto apparatus.

Provision is made for circuit testing by inserting puffers (U. S.: plugs) into conical holes bored in the back tube plate near each barrel and engaging the hooked contacts in them. Tests were made on some spare puffers included in the equipment, and their characteristics were found to be closely similar to those of the British fuze electric F. 53: resistance 1.3 ohms, minimum firing current about 0.30

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ampere. For the F. 53 fuze the corresponding figures are 1.3 ohms and 0.35 ampere.

One of the great advantages of magneto firing is that no safety switches of any sort are necessary, and, in fact, none are fitted on this projector.

c. Sighting mechanism. The projector is equipped with open sights, consisting of a plain, blade foresight on a folding bar attached to the muzzle end of barrel No. 5, and a V backsight in the plane of the trunnions. The backsight slides on a vertical pillar, the lower end of which fits into a groove machined in a block forming an extension of the left-hand trunnion pin. The pillar is graduated from 200 to 2,000 (presumably meters); the graduations are about 11 mm apart. The total height of the pillar is 18 cm, and the distance between backsight and foresight is 85 cm.

Besides the pillar carrying the backsight, there is an extension piece, 39.5 cm long, fitting at its lower end into the groove on the base block, and having at its upper end a similar groove into which the backsight pillar can be fitted.

As the full movement of the backsight on the graduated pillar is only 11 cm for a change of range from 200 to 2,000 meters, it seems clear that the graduations cannot be valid for the same projectile when the extension piece is in use. With the graduated pillar alone, the marked ranges are consistent with a burnt velocity of some 900 feet per second, assuming a short burning time. With the extension piece in place, this burnt velocity would correspond to a range of 6,000 meters (6,580 yards) with the backsight on the 200-meter mark.

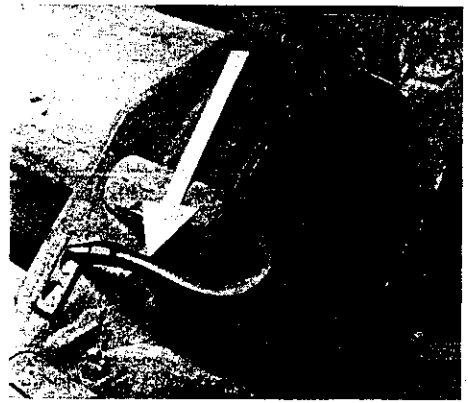

Figure 4.—Close-up of contact arm on 15-cm launcher.

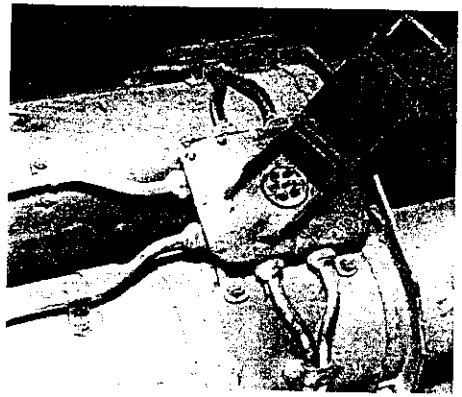

Figure 5.—Firing junction box for 15-cm launcher.

Beneath the backsight bracket is a milled head operating a worm which tilts the sight transversely through about 5 degrees on each side of the vertical. There are no graduations for this movement, but the zero is indicated by a notch.

A sighting board is included in the equipment, but its use is not clear. It consists of a graduated scale, 1 meter long, divided into ten parts lettered from A to L, each part being subdivided into five.

d. Carriage. The bearing plate, upon which the projector is mounted, is carried on a cross tube, 10.8 cm in diameter, through which pass torsion bars for the suspension of the road wheels. These are carried on trailing cantilever arms which have extensions to the rear (muzzle) end fitting in a tubular lifting bar. The carriage is fitted with a support foot under the muzzles, hinged to the bearing plate by a V bracket of 76-mm tube, and locked in either the up or down position by spring-loaded bolts operated from either side by a cross camshaft and hand levers.

The split trail consists of two 76-mm tubes hinged to the ends of the cross tube and connected together at the towing ends by a register peg and hinged latch which is locked by a swinging catch; the catch is in turn locked by a spring-loaded bolt, and the latch can be locked in its open position by a similar bolt. In the same way the trail arms are latched to the cross tube in either the split or the towing position by spring-loaded bolts on the trail arms.

To go into action, the sequence of operations is as follows: The trail is split, and the support foot dropped. The carriage is then lifted onto the foot by pushing the lifting bar onto each of the extension pieces of the suspension

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cantilevers in turn, and pressing down the free end. After latching the foot in the down position, each wheel in turn is raised by the lifting bar and retained clear of the ground by a cam-operated bolt on the carriage. These bolts are one of the few features of the equipment which are definitely unsatisfactory, for should one of them be inadvertently left extended while towing, it would very likely be damaged by the movement of the suspension cantilever.

The ends of the trail arms are fitted with spades which are considerably lighter than gun spades, but it is thought that on all but the hardest ground the equipment should be reasonably stable. For traveling, the elevation is locked by latching the barrel assembly to the raised support foot. Rubber buffers are fitted as limit stops for the suspension.

e. Conclusions. This appears to be a well-designed and soundly constructed rocket launcher, with simple and efficient fastenings and controls. The ease with which the barrel assembly can be removed for replacement or repair is especially noteworthy. The electrical installation is particularly simple and robust, and provided no troubles arise with the ground return circuit, it is difficult to see how there can be any risk of misfire due to the electrical circuit.

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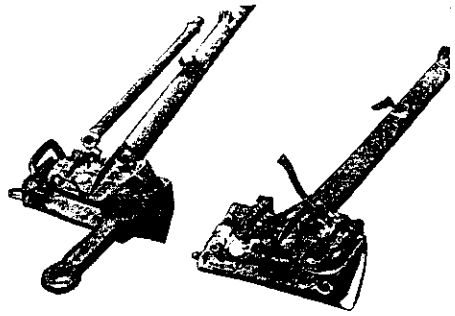

Figure 7.—Trails of 15-cm launcher in unlocked position. Locking piece can be seen on right trail.

2. Technical Data.

Over-all weight	1,232 pounds.
Over-all length	11 feet 8 inches.
Over-all height in traveling position	4 feet 6 inches.
Over-all height in firing position with maximum elevation.	6 feet.
Over-all width	5 feet 5 inches.

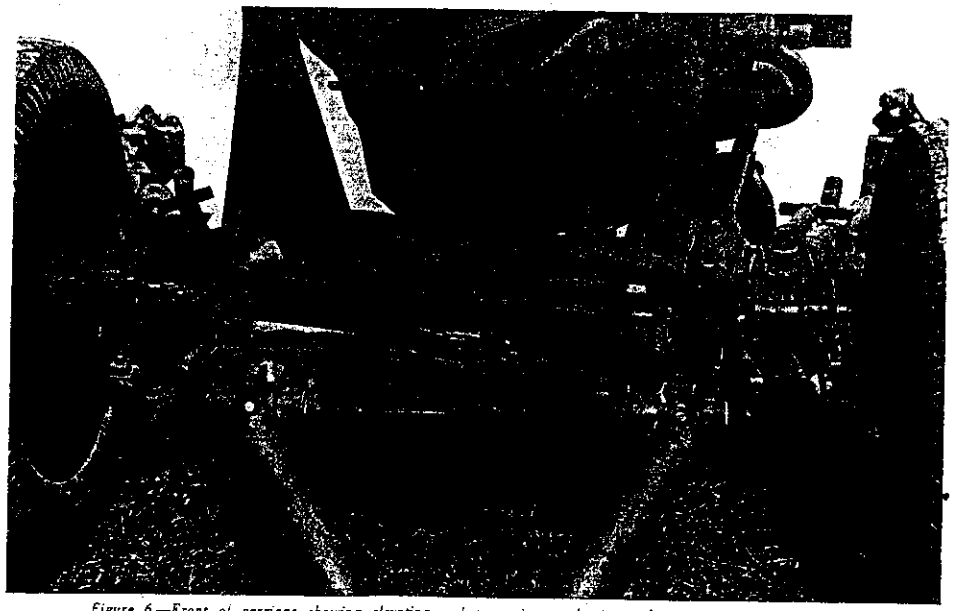

Figure 6.—Front of carriage showing elevating and traversing mechanism and suspension of 15-cm launcher.

15-cm Panzerwerfer 42.

(Self-Propelled 15-cm Multi-Barreled Rocket Launcher.)
Projectiles fired: Same as the *15-cm Nebelwerfer 41*.

1. General Description. This is a development of the *15-cm Nebelwerfer 41* and fires the same projectiles. The ten tubes (Figure 1) are mounted in two banks, each of five, and trunnioned to the two vertical arms of a U-shaped bracket pivoted on the rear of the vehicle. The tubes and firing mechanism are identical with those used for the *15-cm Nebelwerfer 41*; firing is accomplished from inside the cab of the vehicle, which is the Opel 2-ton Maultier half-track vehicle. The tube assembly is of normal design, and, apart from the fact that it is mounted on a vehicle instead of on the original two-wheeled carriage, this launcher is of no particular interest. It represents merely a logical development from the more static *15-cm Nebelwerfer 41*. The launching assembly is known as the *15-cm Nebelwerfer Zehnling* and the term *Panzerwerfer* covers both the launcher and its mounting.

2. Alternative Mounting. This 10-barreled launcher has been found mounted on the armored *Schwerer Wehrmacht Schlepper* shown in Figure 2. The launching assembly is almost identical with that of the *Panzerwerfer* and is mounted on a revolving turret below which the gunner sits. The rockets are fired singly from inside the turret, where the number fired is indicated on a window on a control box. The vehicle is armored with 7/32-inch plate and is of the same general design as the standard German armored half-track vehicles.

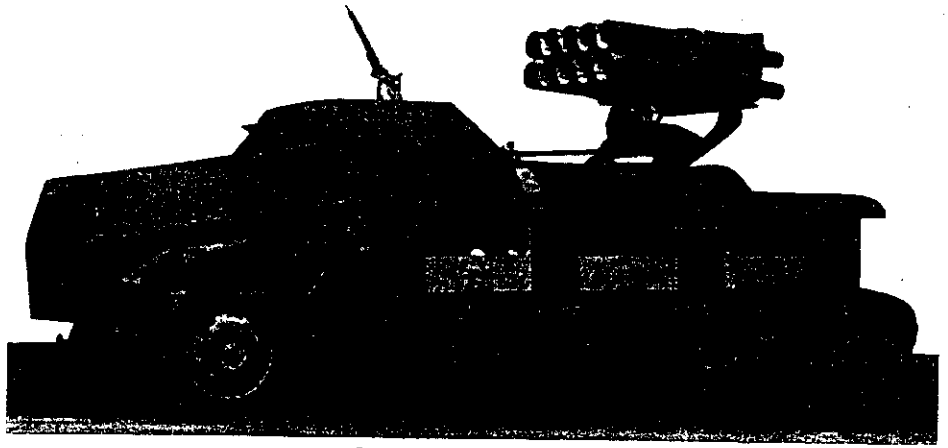

Figure 1.—15-cm Panzerwerfer 42.

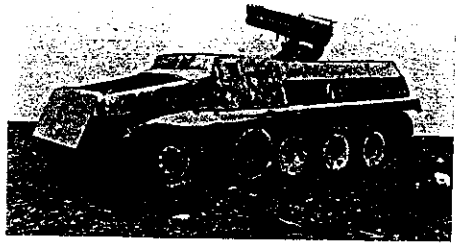

Figure 2.—15-cm launcher on alternative mounting.

21-cm Nebelwerfer (No Model Number).

(21-cm Rocket Launcher.)
Projectiles fired: *21-cm Wurfgranate 42 Spreng* (HE projectile).

This launcher is included for interest value only. It was a scaled-up version of the six-barreled *15-cm Nebelwerfer 41*. It was produced in 1942 but never appeared in large numbers. It was soon abandoned in favor of the *21-cm Nebelwerfer 42*, which has only five barrels. It is presumed that this launcher was found unstable and was scrapped for this reason.

21-cm Nebelwerfer 42.

(21-cm Rocket Launcher.)
Projectiles fired: *21-cm Wurfgranate 42 Spreng* (HE projectile).

1. Description. *a. General.* This is a five-barreled, field rocket launcher on a two-wheeled carriage with a split trail (Figure 1). The Germans used this weapon for attacking area targets; instructions for its tactical employment included a warning that the attack of point targets was not in accordance with the characteristics of the weapon, except in the case of close-range defense. The Germans also said that, to be effective, a fixed minimum number of rounds must be fired from the launcher, and every effort must be made to get into action quickly and achieve the highest possible rate of fire.

b. Launcher tubes. The equipment consists of the five-tube assembly on a mobile carriage. The tubes are arranged in a circle like the chambers of a revolver and are located by two transverse plates, one at the breech end, the other approximately midway between breech and muzzle. The plates are formed with a ring of circular openings to receive the tubes and a further central opening for lightness. Spring-loaded retaining catches are fitted at the breech end of each tube to maintain the loaded round in position at all angles of elevation. The tube assembly is provided with trunnions which rest in phosphor bronze bearings under quickly detachable cap squares each side of the saddle (U. S.: upper carriage).

c. Carriage. The carriage is constructed almost entirely of steel tubes and light metal pressings welded together to form a light yet robust equipment. The axletree consists of a large hollow tube through which torsion bars pass to give independent springing to the two 6.00-by-20 pneumatic-tired wheels.

Two tubular split trail legs are pivoted to the rear of the axletree while a pressed steel platform is welded to the front. The platform supports a saddle which has a bearing about a center pin. Tilt of pivot is prevented by three clip plates engaging in a prepared surface on the platform. Additional stability during firing is provided by a foot pivoted to the front of the platform which may be locked resting on the ground or in a traveling position.

Traversing and elevating are carried out from two pressed steel handwheels on the left of the saddle. The elevating arrangements consist of a simple shaft drive through a worm and wormwheel to an arc and pinion underneath the projector tubes. The traversing mechanism is even simpler. A worm on a short, obliquely set shaft engages with a wormwheel provided with a pinion for engagement with a rack.

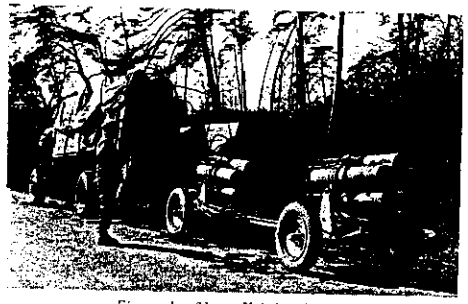

Figure 1.—21-cm Nebelwerfer 42.

d. Electrical circuit. The electrical circuit is extremely simple and robust. The rounds are launched singly from a remote-control point, the firing current being provided by a hand-operated magneto-generator. The generator is connected to a junction box on the right of the tube assembly by means of a 20-meter multi-core cable. From the junction box, conductors, protected by heavy conduits, are led to the rear of the tubes where they terminate in insulated spring-loaded plungers with hooked ends. The circuit is completed by merely drawing these hooks to the rear and engaging them in the appropriate igniter or puffer (U. S.: plug). Ground return to the junction box is used. One turn of the generator handle fires one round, the location of which on the projector is indicated by a moving disc on the generator.

2. Technical Data.

Weight in action	605 kilograms (1,334 pounds).
Caliber of each tube	21.15 cm (8.45 inches).
Length of each tube	4 feet 3.5 inches.
Elevation	−5 degrees to 45 degrees.
Traverse	12 degrees right and left.
Maximum range (from German range tables)	7,850 meters (8,530 yards).

A maximum range of nearly 10,000 yards was obtained during trials in North Africa.

I–F.108

I–F.108

38-cm Raketenwerfer 61.

(Self-Propelled 38-cm Rocket Launcher.)

Projectiles fired: *38-cm Raketen Sprenggranate 4531* (HE projectile) and *38-cm Hohlladungs-granate 4592* (hollow-charge projectile).

1. Description. *a. General.* This is a new type of weapon and consists of a launcher mounted on a modified Tiger Model E chassis (Figure 1). The following details are based on an examination of one specimen in fair condition.

The projector is a completely new type, embodying many interesting features made necessary by the fact that a pure rocket of large caliber is breech loaded and launched from within the fighting compartment of an armored vehicle. Apart from loading the heavy projectiles, the main difficulties to be overcome were the exclusion from the fighting compartment of the rearward flow of propellent gases normally associated with a rocket projector; and ensuring that the propellent gases have an outlet on firing, in order to reduce recoil stresses to a minimum in the absence of a recoil mechanism. The first difficulty was overcome by using the initial propelling gases to actuate a flat steel obturator band fitted to the front face of the breechblock, while the gases were given an escape channel by forming an expansion chamber 1.5 inches in depth all the way around between the rifled liner and the jacket with an outlet at the muzzle.

b. Construction of projector tube. This consists of a ½-inch rifled steel liner and a full-length jacket. The liner is rifled with nine grooves having a right-hand twist with a pitch of approximately one turn in 17.6 calibers. To facilitate engagement of the driving segments of the projectile, a considerable lead is provided on the non-driving edge of the groove. In order to provide a space between the liner and the jacket, the liner is supported at the rear on four equally spaced steel blocks, and at the front on a bearing ring bored with 31 holes and inserted between liner and jacket.

The jacket appears to be constructed of two parts, secured together and locked by a key at the top. At the muzzle end are four projections integral with the jacket. Two are square-shaped, one above and one below the piece, and are 9.5 cm deep, 11 cm wide, and 7 cm thick. The other two are cylindrical, 3 cm in length, and are placed one on each side (Figure 2). The purpose of these projections is not known, but a prisoner of war declared that similar self-propelled rocket launchers with a much longer projector exist. It is quite possible that if an extension tube is fitted these projections are machined to serve as anchorage.

A large mantlet curving rearwards is formed on the front portion of the jacket. The rear portion of the jacket extends into the fighting compartment, where it forms the breech end. It is suitably slotted to carry the thin sliding block and is faced to provide a bearing surface for the obturator.

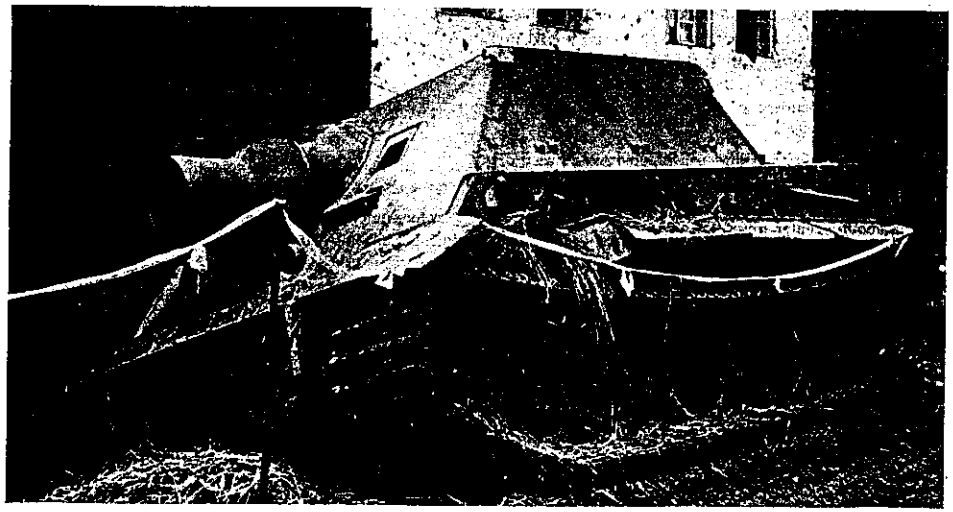

Figure 1.—38-cm Raketenwerfer 61.

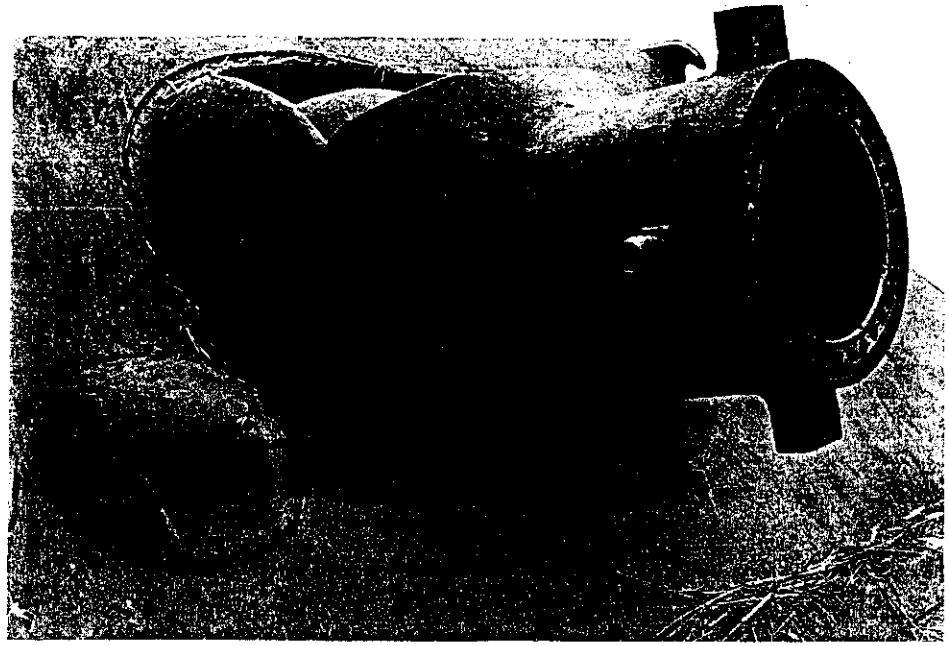

Figure 2.—Muzzle of projector on self-propelled 38-cm rocket launcher.

c. Breech mechanism. This is a horizontal-sliding block, rack-and-pinion operated, and is fitted with a trip-action, percussion firing mechanism. The block, which is really a large steel plate, slides to the right on opening in grooves machined in the rear of the jacket. The operating mechanism consists of a simple rack and pinion, the rack being screwed to the lower edge of the sliding block while the crank-handle-operated pinion is carried in a bearing on the lower side of the breech end.

The firing mechanism consists mainly of a striker, mainspring, and lanyard-operated firing lever contained in a block which slides vertically in a slideway built up by screwing undercut bars to the rear face of the breechblock. This "sliding-block" firing mechanism is provided to enable the block to be lifted while the breech is open for the insertion of a percussion tube into a chamber bored in the rear of the firing-hole bushing. The rocket is fired by a flash directed at its igniter situated centrally in the base plate.

The obturator deserves special mention. It fits into a circular recess in the front face of the breechblock and consists of a flat ring, accurately machined to bear against a corresponding surface in the breech end; an inner ring; and an adjusting ring. The obturator ring is L-shaped in cross section and is fitted with an inner ring bored with 80 half-inch holes communicating with the inside face of the obturator ring in order that the gases may force the ring against its seating to give a seal. The obturator ring is a very close fit on a flange of the inner ring. An examination of the breech spare-parts box reveals that six adjusting rings are provided, varying slightly in thickness. One of these is fitted behind the obturator ring, adjustment being necessary to compensate for wear on ring or seating, sliding surfaces of breechblock or jacket, or slight irregularities in manufacture.

d. Safety arrangements. The firing lever cannot be operated until the breech is fully closed, when a projection on the lever may enter a recess in the breech face. Applied safety is present in the form of a thumb catch which locks the firing lever when turned.

e. Round retaining plunger. A plunger, bevelled on its front edge, is fitted into the top of the bore at the breech end. Its function is to drop behind the round to prevent slip back at angles of elevation and maintain the rocket at the correct distance for firing (approximately 5 inches from face of the breechblock). A bracket, cut with a cam groove and bolted to the top of the breechblock, forces a locking plunger over the retaining plunger as the breech closes.

f. Elevation. This is carried out by means of an arc bolted to the left of the rear bracket (see supporting arrangements) driven by a pinion through worm and wormwheel gearing. The handwheel is on the left. Elevation is from 0 degree to approximately 85 degrees.

g. Traverse. Traverse is 10 degrees to left and right and is carried out by a similar gearing with the pinion, worm, and wormwheel bolted above the breech opening to the top of the jacket. A short arc is fixed to the top of the rear bracket. A pointer and scale plate graduated from 0 to 200 mils (10 degrees) on each side are provided.

The center of gravity is apparently unaffected by the loading of the rocket, as ease of elevation and traverse remains the same. The handwheel is above the breech opening.

h. Sighting arrangements. The optical portions of the sight were missing. The sight bracket is bolted to the inside of the superstructure front plate and is operated by an adjustable motion link from the left trunnion. It is presumed that a rocking mechanism and range scale have been removed, or that they were incorporated in the optical portions. The sight bracket at the top is provided with a deflection mechanism, consisting of a worm and segment, which gives a deflection of 10 degrees on either side. It is operated by a milled handscrew on the worm spindle, and the deflection is recorded on a drum in front of the handscrew, graduated from 0 to 100 mils and used in conjunction with another scale engraved from 0 to 2 (on both sides of a zero line in hundreds of mils).

i. Projector supporting arrangements. The projector is mounted in a large cast bracket secured to the inside of the front superstructure plate by six wedges welded in position. The supporting bracket is hollowed out to receive a spherical casting, which forms the cradle, and is provided with trunnions which ride in bearings placed on each side of the supporting bracket to give elevation. For traverse, the projector is given two vertical bearings in its spherical cradle.

Another rearward directed bracket is bolted to the rear of the spherical cradle. This carries various fittings, including elevating and traversing arcs, and traveling, traverse, and elevation locks. It appears to be enlarged to give balance.

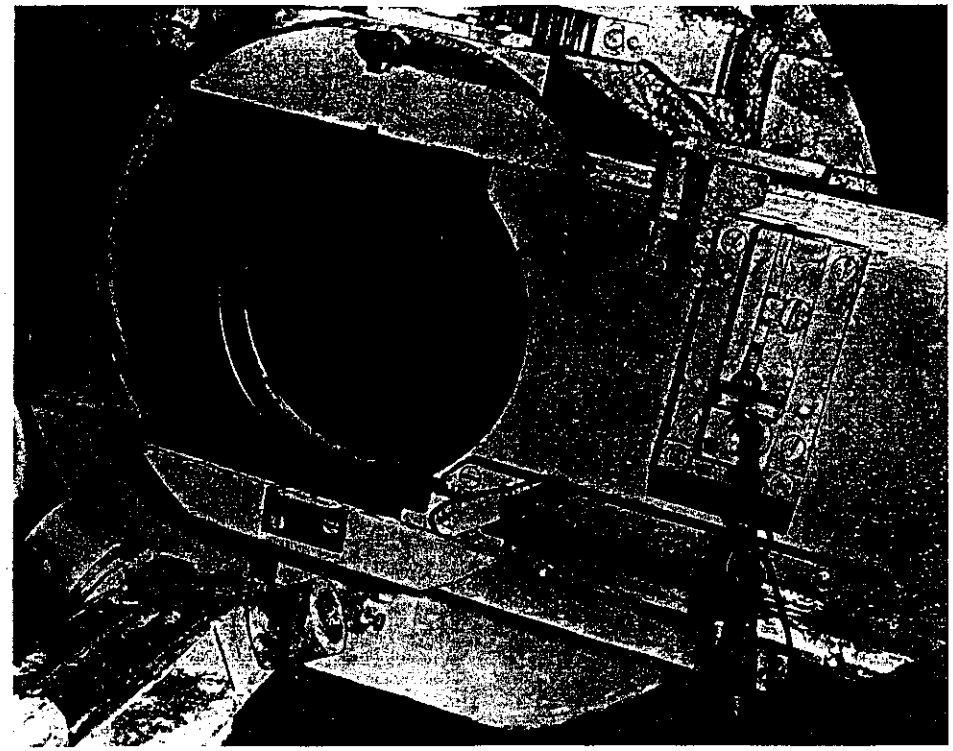

Figure 3.—Breech mechanism of self-propelled 38-cm rocket launcher.

j. Dimensions (approximate):

Caliber	38 cm (15 inches).
Thickness of liner	13 mm (0.5 inch).
Length of liner	188 cm (74.25 inches).
Length of projector	206 cm (81.12 inches).
Distance from liner to inside of breech face.	47.5 mm (1.87 inches).
Thickness of breechblock	59 mm (2.31 inches).
Depth of rifled groove	5 mm (0.2 inch).
Width of rifled groove	10 mm (0.4 inch).
Width of lead to rifling	27 mm (1.06 inches).

k. Loading arrangements. The rocket is loaded by hand with the projector at 0 degrees elevation from a loading tray mounted on tubular supports from the floor. The tray is fitted with six steel rollers and folds into the floor of the fighting compartment when not in use.

The roof of the fighting compartment is fitted with a set of overhead rails to carry a hand-operated winch which may be run from side to side to place rockets on the loading tray and assist in stowage.

l. Ammunition stowage. There are stowage arrangements for 12 rockets in the vehicle, six on each side of the fighting compartment. It is probable that in action a 13th rocket was carried in the projector. The rockets are stowed horizontally and held in position by collapsible cradles.

A hand-operated ammunition-stowage crane is supported in brackets welded to the offside of the superstructure rear plate. It enables rockets to be lifted from a supply vehicle and lowered through the roof ammunition hatch into the fighting compartment.

GROUND FRAME-TYPE LAUNCHERS

7.5-cm Multiple Fortress Rocket Projector.
Projectiles fired: 7.3-cm rocket.

1. Description. a. General. The projector (Figure 1) consists of 28 projector rails mounted in four rows of seven rails each at the forward end of a long and low carriage. The German nomenclature, type of ammunition, and role are not known, but from the general arrangement and the low minimum elevation it would appear that the equipment has a dual purpose.

b. Projectors. The projectors are constructed of welded T-section steel bars, the bearing surfaces of the guide rails being formed from the stems of three bars equally spaced. Each row of seven projectors is a separate assembly and is bolted to an inclined, welded-steel superstructure built above the carriage.

c. Carriage. The carriage consists of a framework of U-section steel extended well to the rear, where it terminates in a protected control point containing the elevation handwheel, the firing cable, and two handgrips for the free traverse. The shield covering this point is 1 cm thick (0.39 inch) and has a front plate 19.5 inches by 16 inches with additional side and top plates giving a total coverage of 34 inches by 20 inches.

A U-section axletree is fitted and carries two metal-rimmed, rubber-sprung detachable wheels (similar to *Püppchen* wheels) 27 inches in diameter. No other springing is provided, and the wheels are evidently only to be used for manhandling the equipment and for transporting it short distances.

A small shield, 3 mm thick, designed to protect the layer from blast, is fixed to the carriage at a point 35 inches in front of the control point. The shield is 28.5 by 19.75 inches.

d. Firing arrangements. Firing is by percussion. Each row of seven projectors carries a bar which extends underneath the whole length of the row. This bar holds a firing hammer and striker for each projector. Each striker bar has a cocking lever on the right which, when rotated to the rear against a spring, cocks all seven strikers. Any number of rows may be cocked, but all strikers are released by one pull of the firing cable from the control point. The cocking mechanism of each row is extremely simple, consisting of a bar which, during the cocking motion, moves upwards over a spring-loaded plunger, to engage the plunger in a hole at the cocked position. On firing, this plunger is withdrawn, thus allowing the bar and the strikers to move forward under the action of a spring.

e. Traversing arrangements. It appears that the equipment can be traversed about a fixed center pivot or about

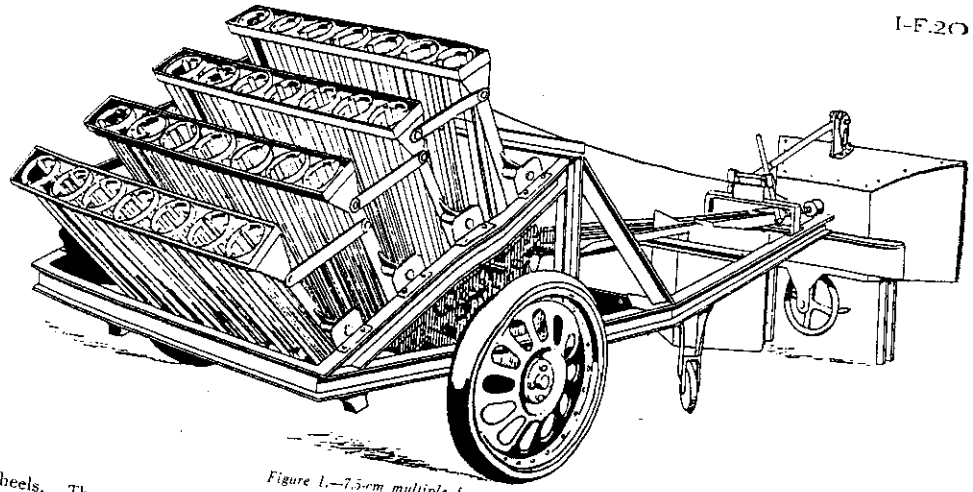

Figure 1.—7.5-cm multiple fortress rocket projector.

its wheels. The center pivot is locked into a bracket welded to the center of the axletree, a rear support being taken on two steel rollers welded at a suitable angle on the underside of the carriage. When traversed on its road wheels, the rear support consists of two legs bolted one on each side of the control point shield. The traverse is free, two handgrips being provided for rotating the carriage from the rear.

f. Elevating arrangements. Each row of projectors is independently trunnioned to the superstructure, and all four are elevated together by means of a linkage which is connected to a nut and screw mechanism in front of the control post. The screw, which is operated by a chain drive from the handwheel, is carried in bearings while the nut moves along the screw, carrying the linkage with it.

g. Sighting arrangements. The sight was missing from the launcher examined. The sight bracket, apparently designed to receive a tangent sight, is operated by a motion link from the elevating nut. The projectors are displaced from the center both for line and elevation to give dispersion of fire.

h. Ammunition. No ammunition was found, but from an examination of the tubular steel containers the complete rocket would appear to be about 58 inches long with a caliber of 7.5 cm (2.95 inches).

2. *Technical Data.*

Over-all length	14 feet (approx.).
Over-all width	5 feet 11 inches.
Track	5 feet 7.87 inches (wheel center to center).
Width of each projector frame	49 inches.
Depth of each projector frame	5.75 inches.
Maximum height (above center-pivot platform).	3 feet 4 inches.
Maximum height (on road wheels)	4 feet 5 inches.
Elevation	4 degrees to 55 degrees (approx.).

8-cm Raketen Vielfachwerfer.

(8-cm Multiple Rocket Launcher.)

Projectiles fired: *8-cm Raketen Sprenggranate* (HE projectile) and *8-cm Raketen Nebelgranate* (smoke projectile).

No specimen of this launcher has been recovered and the following information has been obtained from documents.

Nomenclature	*8-cm R-Vielfachwerfer.*
Weight in action:	
Without ammunition	6,200 kilograms (13,669 pounds).
With two salvos	6,853 kilograms (15,108 pounds).
Actual caliber	78 mm.
Elevation	Up to 37 degrees 7 minutes (660 mils).
Traverse	360 degrees.
Maximum range	5,300 meters (5,796 yards).
Ammunition allotment	*8-cm R. Sprenggranate:* 232 rounds. *8-cm R. Nebelgranate:* 56 rounds.

From this information the following deductions may be made: By reason of its weight and the fact that it has a 360-degree traverse, the launcher is probably self-propelled. The name shows it to be a multiple projector. The weight of a single salvo of ammunition is 326.5 kilograms (719.6 pounds). Since the weight of a single round is known to be 6.9 kilograms (15.2 pounds), this gives some indication of the number of rounds in each salvo, although the uncertainty as to whether the weight given includes ammunition containers makes it impossible to give an accurate estimate.

The following estimates are possible:

Salvo of 32 rounds (Nine salvos in ammunition allotment).	Packing weight 32.4 percent of round and packing.
Salvo of 40 rounds (Seven salvos and eight spare rounds in ammunition allotment).	Packing weight 14.5 percent of round and packing.

The second estimate appears to be the more probable.

The construction of the projectile indicates that it is launched from guide rails and not from barrels.

28/32-cm Schweres Wurfgerät 40.

(28/32-cm Rocket Launcher.)

Projectiles fired: *28-cm Wurfkörper Spreng* (HE projectile) and *32-cm Wurfkörper m.Fl.50* (incendiary projectile).

This launcher (Figure 1) consists of a wooden framework from which the 28-cm HE and 32-cm incendiary projectiles are fired. The rockets are fired from the crates in which they are carried, the crates being laid on the framework of the launcher. This launcher soon gave way to the *28/32-cm Schweres Wurfgerät 41*, which is exactly the same but is constructed of metal instead of wood.

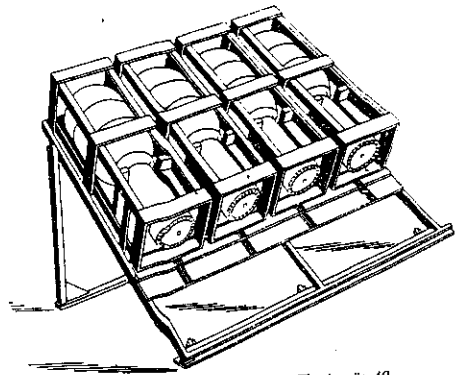

Figure 1.—28/32-cm Schweres Wurfgerät 40.

28/32-cm Schweres Wurfgerät 41.

(28/32-cm Rocket Launcher.)

Projectiles fired: *28-cm Wurfkörper Spreng* (HE projectile) and *32-cm Wurfkörper m.Fl.50* (incendiary projectile).

This launcher is identical with the *28/32-cm Schweres Wurfgerät 40* described in I–F.203 except that it is constructed of metal instead of wood. Like the Model 40, this launcher soon gave way to a more mobile model, the *28/32-cm Schwerer Wurfrahmen* and later to the *28/32-cm Nebelwerfer 41* (I–F.206).

28/32-cm Schwerer Wurfrahmen.

(Self-Propelled 28/32-cm Rocket Launcher.)

Projectiles fired: *28-cm Wurfkörper Spreng* (HE projectile) and *32-cm Wurfkörper m.Fl.50* (incendiary projectile).

This launcher represents a logical development of the *28/32-cm Schweres Wurfgerät* Models 40 and 41, both of which were found to be too static for use other than in fixed defenses. In this case, the crates from which the projectiles are fired are hung on launchers mounted on the sides of a half-track armored vehicle. Three launchers are mounted on each side.

Each launcher consists of two parts: the carrier plate bolted to the side of the vehicle, and a bracket to take the crate in which the projectile is carried and from which it is launched. The bracket is provided with a clamp and an elevating scale to enable the launcher to be laid at the correct elevation. This launcher has the obvious advantage over earlier models of increased mobility and was the first fully mobile rocket launcher to appear.

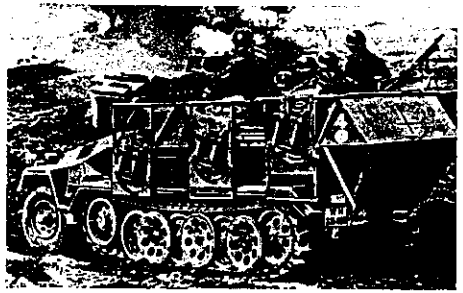

Figure 1.—28/32-cm Schwerer Wurfrahmen, showing carrier plates.

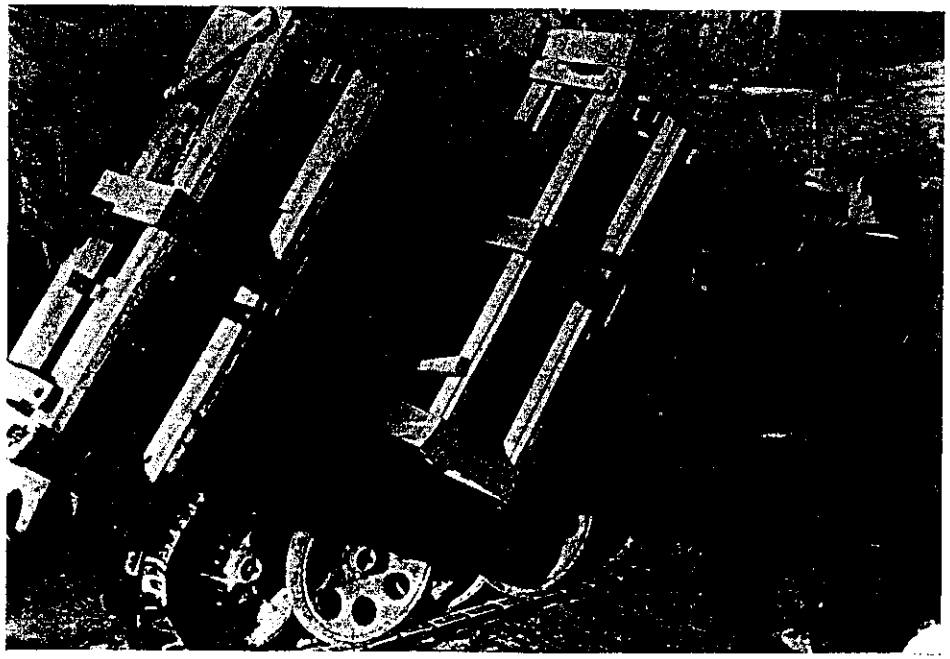

Figure 2.—Crates mounted on carrier plates of 28/32-cm Schwerer Wurfrahmen.

28/32-cm Nebelwerfer 41.

(28/32-cm Rocket Launcher.)

Projectiles fired: *28-cm Wurfkörper Spreng* (HE projectile) and *32-cm Wurfkörper m.Fl.50* (incendiary projectile).

This launcher (Figure 1) is a mobile version of the *Schweres Wurfgerät* and consists of a framework designed to hold six projectiles mounted on a two-wheeled carriage. The carriage is provided with a trail and is towed into position where it is detached from the vehicle and laid in the same way as an artillery piece. The launcher is usually towed by a half-track vehicle, which also serves as an ammunition carrier.

Elevating and traversing gears of normal design are included as is also the standard electrical firing mechanism. In this case the projectiles are not fired from the crates in which they are carried but are removed from the crates and loaded into the launcher from the forward end. In addition to firing the 28-cm HE and 32-cm incendiary projectiles, this launcher will also fire the 15-cm rockets: to enable these to be fired, a liner, shown in Figure 1, is inserted into the launching frames before loading.

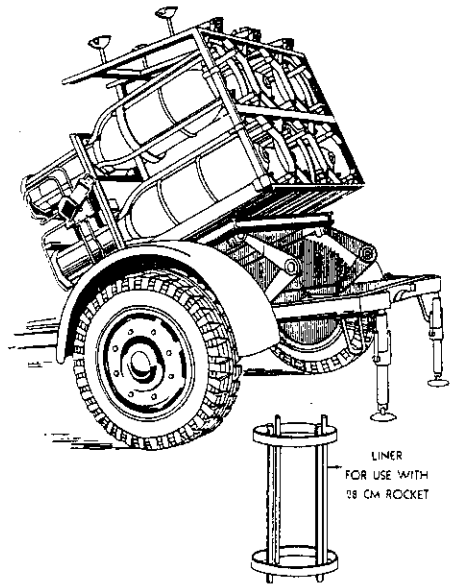

Figure 1.—28/32-cm Nebelwerfer 41.

30-cm Nebelwerfer 42.

(30-cm Rocket Launcher.)

Projectiles fired: *30-cm Wurfkörper 42 Spreng* (HE projectile) and *30-cm Wurfkörper Spreng 4991* (HE projectile).

This launcher is almost identical with the *28/32-cm Nebelwerfer 41* but with slightly smaller launching frames designed to fire the 30-cm projectiles. Like the *28/32-cm Nebelwerfer*, this launcher also consists of six metal frames mounted on a two-wheeled carriage. The launcher possesses no features of particular interest.

30-cm Raketenwerfer 56.

(30-cm Rocket Launcher.)

Projectiles fired: *30-cm Wurfkörper Spreng 4991* (HE projectile) and probably also *30-cm Wurfkörper 42 Spreng* (HE projectile).

This launcher is similar in construction to the *28/32-cm Nebelwerfer 41* and, particularly, to the *30-cm Nebelwerfer 42*. The main difference between the *Raketenwerfer 56* and the *30-cm Nebelwerfer 42* lies in the carriage. The *Raketenwerfer* carriage appears to be a copy of the mount for the German standard 5-cm antitank gun. The trail is of the normal split design and has a towing eye at the end. A second towing eye at the rear of the launcher suggests that an ammunition limber or another launcher can be attached.

ANTIAIRCRAFT ROCKET LAUNCHERS

7.3-cm Föhn Gerät.

(7.3-cm Multiple Antiaircraft Rocket Launcher.)

Projectiles fired: *7.3-cm Raketen Sprenggranate* (HE projectile).

1. Tactical Use. This is the only type of multiple antiaircraft rocket launcher recovered from the Germans. It was intended primarily for use in large numbers to form a rocket barrage against low-flying aircraft, yet several launchers observed on river banks and sited to give defensive fire indicated that the weapon could have been used in a ground role. The use of a combined ground and antiaircraft sight confirms this belief.

The launcher consists basically of a framework carrying the launcher racks; a pedestal mount; a shield protecting the firer; and elevating, traversing, and firing mechanisms.

The various specimens examined were either emplaced statically, with the pedestal bolted to a prepared foundation, or were mounted on a circular folding platform carried on a two-wheeled trailer. The projector can be fired from the trailer, but in this case the traverse is limited, and to achieve the full 360-degree traverse it is necessary to remove the launcher from the trailer, support it on the jacks provided, and fold down the circular metal platform.

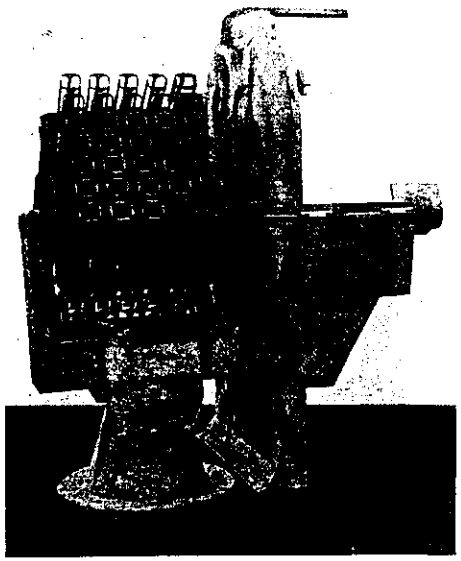

Figure 1.—7.3-cm Föhn Gerät.

2. General Description. *a. Launching racks.* The 35 launching racks are supported on pipes which run horizontally and vertically and which are fitted to a metal framework trunnioned to vertical arms extending upwards from the pedestal base. Each launching rack is provided with a percussion-type firing pin mounted on a horizontal pipe, each pipe having five pins so mounted. All 35 firing pins are actuated by a single trigger, and there is no provision for firing single racks or rows. A single cocking handle on the left-rear side cocks all firing pins at the same time. The launching racks are 31 inches long and approximately 3 inches square.

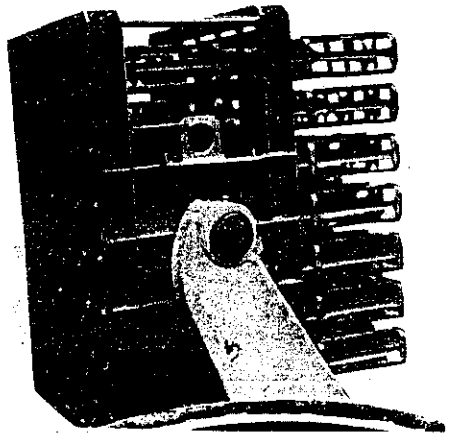

Figure 2.—Launching racks of the 7.3-cm Föhn Gerät.

b. Elevation and traverse. Free traverse through 360 degrees is provided, with a lock to secure the framework in any desired position. The elevation scale is marked from —10 degrees to 90 degrees; the projector frames examined, however, could not be depressed below 0 degrees or elevated above 30 degrees. The elevating handwheel (Figure 3) has 30 holes around the circumference into which a locking plunger can be fitted to lock the projector in elevation.

c. Sighting. The sight bracket is mounted on an arm which is attached to the projector frame so that the sight is elevated or depressed in coincidence with the launching racks. There is an open sight with rear V notch and triangular front post sight. A main sight of the pivoting-ring type is also provided; this is graduated for both ground and antiaircraft targets. The range limits are 500 and 1,200 meters (546.5 and 1,311.6 yards), of which

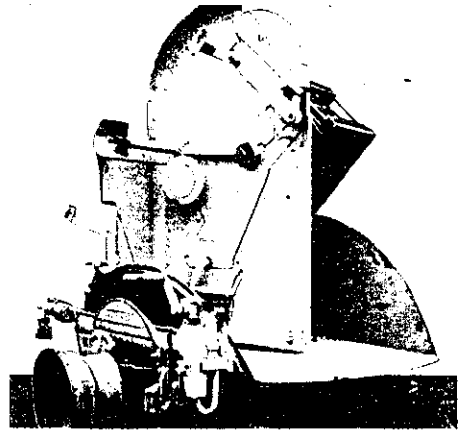

Figure 3.—Left-hand side of protective shield, showing sighting gear and elevating mechanism of 7.3-cm Föhn Gerät.

500 to 750 meters is indicated as covering the ground-fire limitations of the launcher.

d. Safety. Two positive safety devices are provided. There is a plunger button located on the trigger handle which must be released before trigger linkage can be completed. There is also a safety lever on the rear of the racks which, when set at safe, causes a metal surface to block the trigger linkage.

8.6-cm Antiaircraft Rocket Launcher.

(German nomenclature not known.)

Projectiles fired: 8.6-cm parachute-and-cable projectile, *8.6-cm Raketen Sprenggranate 400* (HE projectile), and *8.6-cm Raketen Leuchtgranate* (illuminating rocket).

1. General Description. *a. Launcher.* This launcher (Figure 1) consists of a covered frame incorporating sighting gear and elevating and traversing mechanism and a tubular mounting. The weapon is simply and sturdily constructed and appears to be intended for static use. The launcher is constructed of four guide rails of V-angle iron welded to form a square, the bearing surface for the rocket being formed by the bases of the four rails. The top and sides of the launcher are covered by thin steel plate bolted into position, probably to protect the ammunition, when loaded, from rain and the direct rays of the sun. Blast and flash protection is afforded by a large, octagonal eliminator welded to the front.

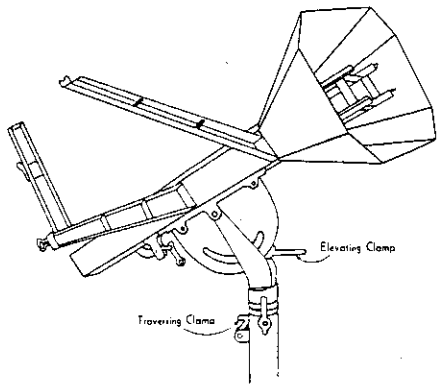

Figure 1.—8.6-cm antiaircraft rocket launcher.

b. Sighting arrangements. Two light pressed-steel arms are bolted to the left of the launcher. The forward arm carries a fixed foresight in the form of a notched plate. The rear arm carries, at the end, a frame which folds along the arm when not in use, and which is raised to a vertical position for firing. The frame carries a sliding backsight which is locked in position by a spring clip. The frame is graduated from 1 to 8, presumably in hundreds of meters, giving a maximum sighted ceiling of 2,625 feet. For transporting, the sights are unbolted from the launcher and carried separately.

c. Elevating and traversing mechanism. A rotatable spigot, which rests on the top of the mounting tube, gives the launcher a 360-degree traverse. This traverse may be limited to a confined angle by a fixed bar on the mounting tube and two circular collars on the spigot which may be locked in any desired position. A traversing clamp at the top of the mounting tube serves the dual purpose of reducing the diameter of the tube (which is split at the top) and locking the traverse.

The launcher can be elevated about an axis pin on the top of the traverse fork and may be locked in any position by a screw clamp bearing against an arc attached to the lower side of the launcher. The elevating arc is graduated from −10 degrees to 90 degrees in steps of five.

d. Firing mechanism. A hammer is pivoted at the base of the lower end of the launcher. This is brought forward by pulling a lanyard attached to the lower end. The hammer normally rests in its rearward position due to gravity and can be secured in the forward position for transportation by means of a clamp. The robust nature of this clamp suggests that when the striker is clamped in the forward position, rapid fire, as for a mortar, is possible, but no evidence of this has been found.

15.2-cm Antiaircraft Rocket Launcher.

Projectiles fired: 15-cm parachute-and-cable rocket.

No specimen of this launcher has been recovered. It probably consists of some kind of metal or wooden framework in which the rocket is placed in a vertical position and from which it is launched.

20-cm Antiaircraft Rocket Launcher.

Projectiles fired: 20-cm parachute-and-cable rocket.

No specimen of this launcher has been recovered. It probably consists of some kind of metal or wooden frame from which the rocket is launched. The frame will require some method by which the cable housing, which remains on the ground, may be attached and also some method of securing the ground end of the cable.

NON-STANDARD AND UNCONFIRMED LAUNCHERS

7.3-cm Propagandawerfer.

(7.3-cm Leaflet Rocket Launcher.)

Projectiles fired: *7.3-cm Propagandagranate* (leaflet rocket).

This launcher is simple in the extreme and consists of a launching rack and a base piece. The launching frame is constructed of a length of angle iron, which forms the lower guide, and a metal bar which forms an upper guide rail for the projectile. These two guides are held in position by four circular iron supporting bands, spaced at equal intervals along the length of the launching rack. The striker pin is fixed to a metal plate at the lower end of the rack, and a catch on the lower guide rail prevents the projectile from slipping down onto the firing pin until it is to be fired. The launching rack is supported near the forward end by a tubular monopod attached to the base. The base piece is a tubular metal framework with three spades attached underneath. The length of the launching rack is about 30 inches, and the weight of the whole launcher is 27 pounds.

Section VII

TABULATION OF TECHNICAL AND BALLISTIC DATA

Type of Projectiles	STANDARD GROUND PROJECTILES																	ANTIAIRCRAFT PROJECTILES					
	7.5 cm HE Projectile	8 cm Raketen Sprenggranate	8 cm Raketen Nebelgranate	8.8 cm Raketen Panzerbüchse Granate 4322	8.8 cm Raketen Panzerbüchse Granate 4992	8.8 cm Raketen Panzerbüchse Granate 4312	15 cm Wurfgranate 41 Spreng	15 cm Wurfgranate 41 Nebel	15 cm Wurfgranate Gelbring	15 cm Wurfgranate Grünring	15 cm Wurfgranate Grünring—Gelb	21 cm Wurfgranate 42 Spreng	28 cm Wurfkörper Spreng	30 cm Wurfkörper 42 Spreng	30 cm Wurfkörper Spreng 4991	32 cm Wurfkörper m. Fl. 50	38 cm Raketen Sprengranate 4581	38 cm Hohlladungsgranate 4592	7.5 cm Raketen Sprenggranate	8.6 cm Parachute and Cable Projectile	8.6 cm HE Projectile	8.6 cm HE Illuminating Projectile	15.2 cm Parachute and Cable Projectile	20 cm Parachute and Cable Projectile
GENERAL ANALYSIS	I-B.101	I-B.102	I-B.103	I-B.104	I-B.105	I-B.106	I-B.107	I-B.108	I-B.109	I-B.110	I-B.111	I-B.112	I-B.113	I-B.114	I-B.115	I-B.116	I-B.117	I-B.118	I-B.201	I-B.202	I-B.203	I-B.204	I-B.205	I-B.206
1. Caliber (cm)	7.5	8.0	8.0	8.8	8.8	8.8	15	15	15	15	15	21	28	30	30	32	38	38	7.5	8.6	8.6	8.6	15.2	20
2. Stabilization		Fin	Fin	Fin	Fin	Fin	Spin	Spin	Spin	Spin	Spin	Spin	Spin	Spin	Spin	Spin	Spin	Spin	Spin	Spin	Spin	Spin	Fin	Fin
3. Filling	HE	HE	Smoke	Hollow Charge	Hollow Charge	Hollow Charge	HE	Smoke	CW	CW	CW	HE	HE	HE	HE	Incendiary	HE	Hollow Charge	HE	Cable and parachute	HE	Star	Cable and parachute	Cable and parachute
4. Fuzing		PD		PD	PD	PD	Base	Base	Base	Base	Base	PD	PD	PD	PD	PD	PD		PD and SD base		Base			
5. Igniter		Electrical		Electrical	Electrical	Electrical	Electrical	Electrical	Electrical	Electrical	Electrical	Electrical	Electrical	Electrical	Electrical	Electrical	Flash	Flash	Percussion	Percussion	Percussion	Percussion	Electrical	Electrical
6. Total length (cm)	About 148	92.55		65.53		39.28	92.16	101.11				122.55	119.0	123.04		127.0	148.87		28.169	41.91	41.27	42.42	147.83	163.32
7. Total weight (kg)		6.897		3.228		2.653	34.872	35.457				110.186	83.0	126.12		79.0	345.49		2.724	4.994	8.145	5.198	68.10	
8. Maximum range (m)							7745					9500	2145	4563		2039	5916		750 ground 1,200 air	Probably about 2400 vertical			Theoretical maximum 087	
9. Weapons from which fired	7.5 cm Multiple Fortress Projector, Frame Type (Multiple launcher)	(a) Aircraft. (b) 8-cm Raketenvielfachwerfer.		8.8-cm Raketen Panzerbüchse 54. Antitank rocket launcher.		8.8-cm Raketenwerfer. Mobile antitank launcher.	(a) 15-cm Nebelwerfer 41.—Tube-type multiple launcher. (b) 15-cm Panzerwerfer 42.—SP multiple launcher. (c) 21-cm Nebelwerfer 42.—Fitted with guide rails. (d) 30-cm Raketenwerfer 56.—Fitted with guide rails.					(a) 21-cm Nebelwerfer 42.—Tube-type multiple launcher. (b) Aircraft.	28/32-cm frame-type launchers. Single, multiple and SP.	(a) 30-cm Nebelwerfer 42. (b) 30-cm Raketenwerfer 56. Frame types.	30-cm Raketenwerfer 56.	As for 28-cm HE rocket.	Raketenwerfer 56. SP tube-type launcher.		Führ Gerät Multiple-frame launcher	8.6-cm Antiaircraft rocket launcher. (Frame type).					
WEIGHT ANALYSIS																								
1. Weight of filling (kg)		0.5961				0.653	1.998	3.859				9.761	36.0	44.662			122.58		0.281			14.852		
2. Weight of propellant (kg)		1.014		0.427			5.925	5.925	5.925	5.925	5.925	18.274	6.547	15.088		6.547	39.271		0.863	0.795	1.128	0.759	5.278	5.264
3. Motor weight (kg)		2.880					16.788	16.788	16.788	16.788	16.788	47.536	15.616	58.852		15.616	154.07							
4. Weight of empty projectile (kg)		4.1149					26.821	25.673				82.151	40.453	66.46			183.639		1.580				47.67	
5. Total weight (kg)		6.897		3.228		2.653	34.872	35.457				110.186	83.0	126.12		79.0	345.49		2.724	4.994	8.145	5.198	68.10	
6. Ratio: Charge/Total weight		1/11.57				1/4.06	1/17.45	1/9.19				1/11.29	1/2.31	1/2.83			1/2.82		1/9.69				1/4.59	
7. Ratio: Propellant/Total weight		1/6.80		1/25.42			1/5.89	1/5.98				1/6.03	1/12.68	1/8.36		1/12.07	1/8.80		1/3.16	1/6.28	1/7.22	1/6.85	1/12.90	
8. Ratio: Propellant/Motor weight		1/2.84					1/2.83	1/2.83	1/2.83	1/2.83	1/2.83	1/2.60	1/2.39	1/3.90		1/2.39	1/3.92						2.81/1	
9. Ratio: Charge/Propellant		1/1.70					1/2.97	1/1.54				1/1.87	5.5/1	2.96/1			3.12/1		1/3.07					

Tabulation of Technical and Ballistic Data—Continued

	STANDARD GROUND PROJECTILES																	ANTIAIRCRAFT PROJECTILES					
	7.5 cm HE Projectile	8 cm Raketen Sprenggranate	8 cm Raketen Nebelgranate	8.8 cm Raketen Panzerbüchse Granate 4322	8.8 cm Raketen Panzerbüchse Granate 4992	8.8 cm Raketen Panzerbüchse Granate 4312	15 cm Wurfgranate 42 Spreng	15 cm Wurfgranate 41 Nebel	15 cm Wurfgranate Gelbring	15 cm Wurfgranate Grünring	15 cm Wurfgranate Grünring—Gelb	21 cm Wurfgranate 42 Spreng	28 cm Wurfkörper Spreng	30 cm Wurfkörper 42 Spreng	30 cm Wurfkörper Spreng 4991	32 cm Wurfkörper m. Fl. 50	38 cm Raketen Sprenggranate 4581	38 cm Hohlladungsgranate 1592	7.5 cm Raketen Sprenggranate	8.6 cm Parachute and Cable Projectile	8.6 cm HE Projectile	8.6 cm HE Illuminating Projectile	15.2 cm Parachute and Cable Projectile	20 cm Parachute and Cable Projectile
PROPELLANT ANALYSIS	I-B.101	I-B.102	I-B.103	I-B.104	I-B.105	I-B.106	I-B.107	I-B.108	I-B.109	I-B.110	I-B.111	I-B.112	I-B.113	I-B.114	I-B.115	I-B.116	I-B.117	I-B.118	I-B.201	I-B.202	I-B.203	I-B.204	I-B.205	I-B.206
1. Number of sticks		6: 4 long, 2 short		7		1	7	7	7	7	7	7	1	7		1	12		1	1	1	1	1	
2. Shape and perforations		Monoperforated				Multiperforated, 1 central, 14 outer	Monoperforated	Monoperforated	Monoperforated	Monoperforated	Monoperforated	Monoperforated	Multiperforated, 1 central, 8 outer	Monoperforated			(a) Central monoperforated. (b) Intermediate sleeve. (c) 10 outer monoperforated		Multiperforated, 1 central, 8 outer	Solid cylinder	Solid cylinder	Solid cylinder	Multiperforated, 1 central, 8 outer	
3. Length (cm)		(1) 28.194 (2) 26.543				12.573	40.60	40.60	40.60	40.60	40.60	55.0	41.3	46.736		11.3	(a) 40.64 (b) 38.895 (c) 32.863		13.411	10.16	14.986		29.718	
4. Outer Diameter (cm)		2.210				2.159	4.2	4.2	4.2	4.2	4.2	6.2	12.4	6.223		12.4	(a) 10.320 (b) 18.415 (c) 8.098		5.715	6.985	7.061			
5. Inner diameter (cm)		0.584				0.711	0.64	0.64	0.64	0.64	0.64	0.775	1.67	0.813		1.67	(a) 3.493 (b) 12.065 (c) 1.113		0.965	Nil	Nil	Nil		
6. Web (cm)		0.813				0.724	1.78	1.78	1.78	1.78	1.78	2.713	5.365	2.705		5.365	(a) 3.414 (b) 3.175 (c) 3.493		2.375	Nil	Nil	Nil		
7. Diameter of other perforations (cm)		Nil					Nil	Nil	Nil	Nil	Nil	Nil	1.24	Nil		1.24	Nil		0.762	Nil	Nil	Nil		
8. Total weight (kg)		1.014		0.127			5.925	5.925	5.925	5.925	5.925	18.274	6.547	15.088		6.547	39.271		0.863	0.795	1.128	0.759	5.278	5.264
9. Surface area (square cm)		1456					4382	4382	4382	4382	4382	8852	3322	6723		3322	6992							
10. Volume (cubic cm)		592					3846	3846	3846	3846	3846	11445	4496	9781		4496	25528		290	389	587			
11. Density (grams per cubic cm)		1.713					1.541	1.541	1.541	1.541	1.541	1.597	1.456	1.543		1.456	1.538		2.97	2.04	1.92			
12. Composition		Percent N. C. 63.05 N. G. 28.4 Graphite 0.1 Carbamite 5.0 Diethylphthalate 3.2 Ash 0.25 V. M. 0.6 (N. G. 12.4N)					Diglycol	Diglycol	Diglycol	Diglycol	Diglycol			N. C. 59.9% diglycol-dinitrate 35.4%							Potassium nitrate 75.5% Carbon 15.33% Sulfur 9.15% V. M. 0.86%				
MOTOR DESIGN ANALYSIS																					1.94		1.11	
A. Motor body: 1. Weight of motor (kg)		2.88					16.188	16.188	16.188	16.188	16.188	16.82	15.116	42.31		15.116								
2. Wall thickness (mm)		3.0				2.31	c. 6	c. 6	c. 6	c. 6	c. 6	8.72	5.74	8.38		5.74	13.46		2.54					
3. External length (cm)		32.51	27.94			12.471	47.5	47.5	47.5	47.5	47.5	67.5	47.5	57.2		47.5	52.58		16.10		17.02			
4. External diameter (cm)		7.6	4.01			2.9	13.7	13.7	13.7	13.7	13.7	20.7	13.97	21.18		13.97	37.95		6.60		8.08			
5. Cubic capacity (cubic cm)		1096				56.3	c. 5829	c. 5829	c. 5829	c. 5829	c. 5829	16786	5833	15039		5833	45556		470		745			
6. Density of loading (percent)		54.01				c. 70	65.98	65.98	65.98	65.98	65.98	68.18	77.07	65.04		77.07	56.04		61.7		78.7			
B. Venturi: 1. Number		1	1	1	1	6	26	26	26	26	26	22	26	18		26	32		14	8	8		4	12
2. Type		Central Convergent, divergent	Axial	Axial	Axial	Axial	Annular offset	Annular offset	Annular offset	Annular offset	Annular offset	Annular offset	Annular offset	Annular offset		Annular offset	Annular offset		7 axial, 7 offset	Annular offset	Annular offset		Axial	Axial
3. Final diameter D_f (mm)		41.99				4.32	12.5	12.5	12.5	12.5	12.5	20	12.5	20.8		12.5	20.32		6.35 axial 6.86 offset					
4. Throat diameter D_t		19.86				2.54	5.5	5.5	5.5	5.5	5.5	8.5	5.5	9.27		5.5	11.18		3.05					
5. Expansion ratio		4.47				2.89	5.17	5.17	5.17	5.17	5.17	5.54	5.17	5.03		5.17	3.30		4.70					
6. Angle of cant		Nil				Nil	14°	14°	14°	14°	14°	16°	14°	12°12′		14°	14°		15°					

PART II. JAPANESE ROCKET WEAPONS*

Section I

REVIEW OF DEVELOPMENT

GENERAL

To appreciate fully the existing stage of development of Japanese rocket weapons it should be borne in mind that Japan started the production of this class of weapons comparatively recently and has hardly had time to produce anything comparable to those used either by the Germans or by the Allies. Consequently, Japanese rocket weapons are still in the early stages of development and are only now beginning to pass through the transitional stage from extreme infancy to the production of proven models. This statement is made, not in an attempt to prove that the Japanese are capable of producing or will produce anything revolutionary in this field, but as a reminder of the fact that, with very few exceptions, the specimens so far encountered represent experimental and not production models of rocket weapons.

It should be remembered, also, that the Japanese have recently had at their disposal the results of German experimentation in this field. Although the extent to which the Germans have assisted the Japanese is not known, Japanese rockets are already beginning to exhibit definite signs of German influence. It may be expected, therefore, that provided the war continues for a sufficient length of time, the Japanese will continue their experimentation and will produce projectiles analogous to, if not identical with, those developed by the Germans.

GROUND PROJECTILES

The earlier types of Japanese ground projectiles were very crudely designed and consisted mainly of improvisations. Typical of these makeshift designs were the 19-cm rocket motors—Type 10 and Type 3—which are used to propel a 60-kilogram (132-pound) aircraft bomb out of a launching ramp and so give it the initial impulse necessary for its flight. Both these motors are fin stabilized and consist of a rocket motor body to which is attached a crude divergent venturi tube. The firing system is equally crude, consisting of two leads from an exploder to a small powder charge in the nose of the motor.

A further development of this weapon, and representative of the improvisation stage, is the 30-cm rocket, which consists of a 250-kilogram (550-pound) bomb with the tail assembly replaced by a rocket motor. This projectile, which employs an electrical firing system similar to that used with the smaller rockets, is also fired from a crude trough-shaped metal launcher, supported at the forward end by a bipod.

The first indication of a Japanese attempt to produce a projectile having any degree of accuracy and, incidentally, the first evidence of the influence of German design, was the appearance of the Navy 20-cm spin-stabilized rocket. Although an improvisation, consisting of a cut-down Navy shell with rocket motor attached, this projectile showed that the Japanese were beginning to consider the use of spin stabilization as a possible preference to the fin stabilization of the earlier projectiles. The propellent layout and the method of ignition (percussion igniter and charge attached to the forward supporting grid) also showed that greater attention was being paid to the design of the rocket motor. Further influence of German design is shown by the appearance of the first Japanese tube-type launcher, which replaced the original frame-type launchers used with the Navy 20-cm projectile. Although this launcher is crudely constructed, it shows that the Japanese appreciate the advantages of a tube, as compared to a frame-type launcher, for securing initial control over the flight of the rocket.

The first projectile that appears to have been standardized is the Army 20-cm rocket which is fired from the Type 4 launcher. This is the first launcher to which a type number has been given and presumably, therefore, the first production model. It is now believed that both the Navy 20-cm projectile and its launcher were experiments in the production and development of the Army rocket. The Army rocket, with a range of just over 3,200 yards and an accuracy comparable to that of a mortar, has proven a most satisfactory weapon and will probably render unnecessary the production of another rocket of this caliber.

Only one heavy Japanese rocket projectile has so far appeared. This is the 45-cm Navy spin-stabilized rocket. Although the accuracy of this projectile is limited by its frame-type launcher, the motor is well designed and the rocket functions reasonably well, considering its weight and the consequent difficulties of stabilization. One feature of interest in this rocket is the use of convergent-divergent venturi, typical of almost all German spin-stabilized rockets. The earlier Japanese spin-stabilized projectiles (20-cm Navy and Army rockets) were fitted with convergent-parallel venturi.

In addition to the above projectiles, which represent the series of ground rockets so far recovered, the Japanese have developed two other types of projectiles. One of these is the 12-cm incendiary shrapnel rocket, a spin-stabilized projectile having a warhead filled with white phosphorus incendiary pellets which is ignited by a delay train from the propellent chamber. Although this projectile was developed originally for use on suicide craft, it apparently is also fired from a multiple launcher to form a barrage against low-flying aircraft. The other projectile, no specimen of which has yet been recovered, is an antitank rocket. Early this year, the Japanese broadcast that an individual weapon of this class was being produced at a rate of one million per month. Although doubtless a gross exaggeration, this demonstrates that they have been showing an interest in a projectile of this type. It is believed that this weapon, when it appears, will prove to be an adaptation of either the American "Bazooka" or the German equivalent.

It seems problematical whether the Japanese will produce multiple ground launchers similar to those used by the Germans. A recently captured document includes an illustration of a multiple antiaircraft launcher for use on ships. It seems more likely than not, however, that the launchers used for the lower caliber ground projectiles will be confined to the single-tube type, which can be broken down and pack loaded. This type probably lends itself better to the generally rough nature of the terrain upon which they are to be used. At the same time, it would appear equally probable that the heavier class of projectile, such as the 45-cm Navy rocket, may be fired from static multiple launchers incorporated in beach defenses to supplement mortar fire.

ANTIAIRCRAFT AND AIRCRAFT PROJECTILES

Although numerous and conflicting reports have been received from air crews of the use of air-to-air rockets, no specimens have been found as yet. Initial experiments indicate that aircraft rockets will probably prove to be of the conventional fin-stabilized type launched from under the wings of fighter aircraft.

Apart from the use of the 12-cm incendiary shrapnel rocket as an antiaircraft projectile, no direct evidence exists as to the nature of other types of rockets employed in this role. If German influence is extended from the field of ground rockets to that of antiaircraft projectiles, then some form of parachute-and-cable projectile may appear.

CONCLUSION

The stage of development of Japanese rocket weapons may be summed up by the statement that they are only on the brink of large-scale production and, given a sufficient extension of the war, the future can be expected to reveal considerable Japanese progress in this field of armament.

*This study was written before the surrender of Japan.

Section II

DESCRIPTIONS OF INDIVIDUAL PROJECTILES

CONTENTS

STANDARD GROUND PROJECTILES

19-cm Type 10 Rocket Motor.

(Used for launching 60-kilogram Type 97 land bomb.)
Fired from: Metal trough-shaped launcher.

1. Description. a. General. This rocket motor constitutes the first attempt by the Japanese to produce a rocket weapon and may be considered as obsolescent if not already obsolete. The rocket motor differs from those used in standard projectiles in that it does not form an integral part of the projectile. There is no permanent connection between the rocket motor and the bomb and the motor serves merely to propel the bomb out of the launching trough and impart the initial impulse. After the rocket motor and bomb have traveled a short distance, the motor generally drops off, leaving the bomb to complete its trajectory. Figure 2 shows the rocket motor with the 60-kilogram (132-pound) bomb and the metal trough from which it is launched.

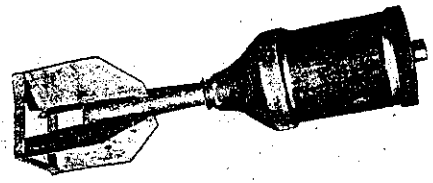

Figure 1.—19-cm Type 10 rocket motor.

Although the original bomb with which this rocket motor was used is the 60-kilogram Type 97 land bomb, a later version of the motor, the Type 3, is used with both this bomb and the 63-kilogram ordinary bomb. Therefore, it would appear reasonable to assume that any conveniently sized bomb weighing about 130 pounds could be used.

b. Construction. The rocket motor is of the single axial-venting, fin-stabilized type and consists basically of the propellent chamber, closing plate, and a tail assembly incorporating a single venturi tube. The propellent chamber is closed at the forward end by a nose cap, drilled centrally to receive the electrical igniter. Fitting over the igniter is a wooden spacer with four longitudinal grooves which engage in the tail of the bomb. A forward supporting plate behind the nose cap serves to locate the propellent and also contains the ignition charge. The motor closing plate fits over the rear end of the propellent chamber and forms the junction with the tail assembly. A rear supporting plate is located between the end of the chamber and the inside of the closing plate. The tail assembly is a single venturi tube with four fins welded to it. It fits into a collar inside the motor closing plate and is apparently spot welded in position. The propellant consists of three monoperforated sticks located by the forward and rear supporting plates.

c. Firing mechanism. A silk bag containing an ignition charge of approximately 47 grams of black powder is attached to the inside of the forward supporting plate. This bag is sewn in five sections, consisting of a central section and four outer quarters, and is attached so that the center section is opposite the inner end of the igniter. The igniter consists of an electrical bridge surrounded by approximately 4 grams of black powder and encased in a heavy metal cylinder. It ignites with a minimum current of 250 milliamperes, supplied by a small exploder connected to the igniter leads.

2. Technical Data.

GENERAL	
Nature of projectile	Single axial-venting, fin-stabilized rocket motor, separate from warhead.
Caliber	19 cm.
Total weight (complete round)	
Total length (complete round)	
Filling	HE.

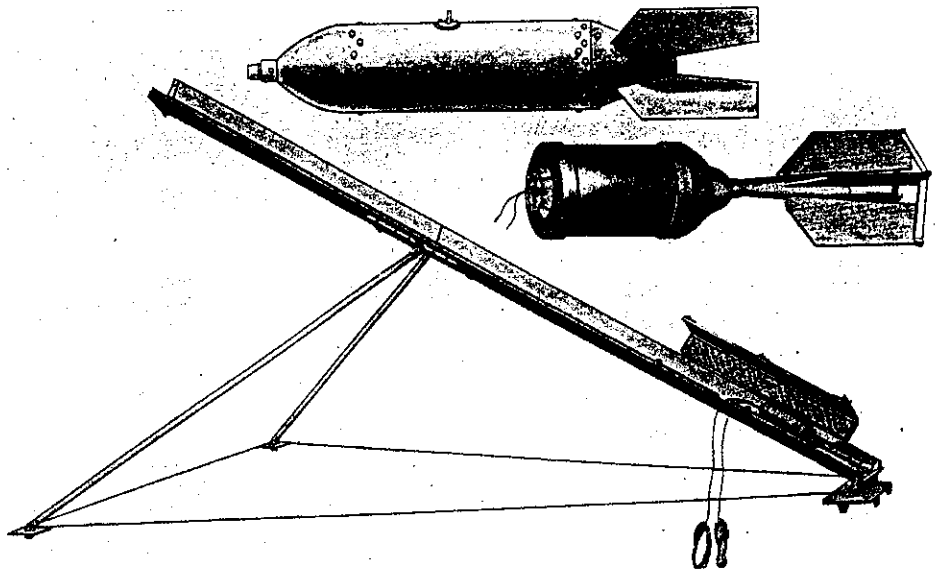

Figure 2.—Type 10 rocket motor with launcher and 60-kilogram bomb.

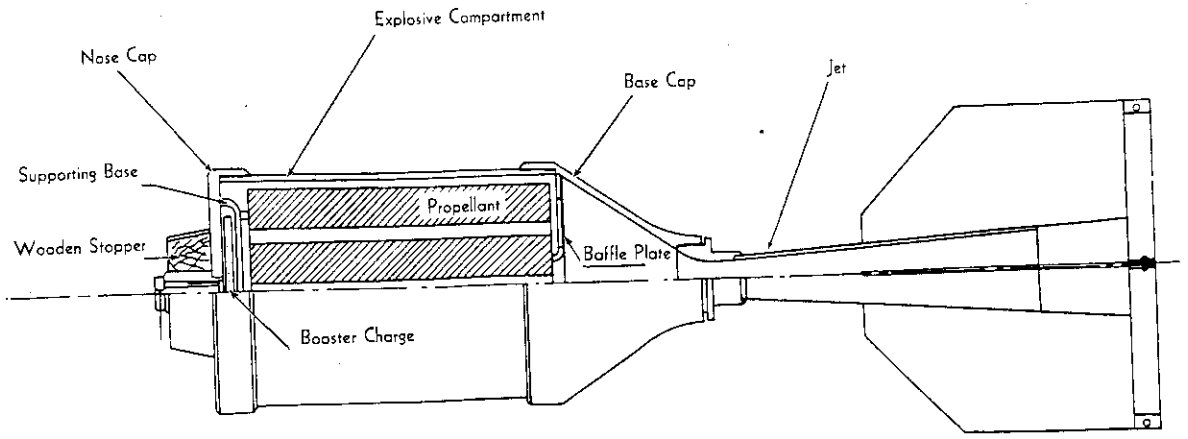

Figure 3.—Internal layout of Type 10 rocket motor.

Rocket Motor	
Over-all length	85 cm.
Propellent chamber:	
Length	29.2 cm.
Internal diameter	17.8 cm.
External diameter	18.9 cm.
Diameter of nose cap	20 cm.
Venturi:	
Throat diameter	2.95 cm.
Final diameter	3.82 cm.
Tail fin:	
Length	29.8 cm.
Diameter	30.3 cm.
Propellant:	
Total weight	5.88 kilograms.
Single stick:	
Weight	1.96 kilograms.
Length	26 cm.
Diameter	7.95 cm.
Diameter of perforation	1.08 cm.
Composition:	
Nitroglycerine	43.3 percent.
Nitrocellulose	56.7 percent.
Igniter:	
Length	5.7 cm.
External diameter	2.86 cm.
Internal diameter	0.95 cm.

3. Performance. The only available data on the performance of this rocket is the following range table taken from a Japanese document.

Angle of Elevation (degrees)	*Range* (meters)	*Drift*
30	700 to 850	----------
35	750 to 900	----------
40	800 to 950	Less than 10 degrees.
45	850 to 1,100	----------
50	1,000 to 1,200	----------

19-cm Type 3 Rocket Motor.

(Used for launching 60-kilogram bombs.)
Fired from: Wooden trough-shaped launcher.

1. Description. *a. General.* This rocket motor is a later version of the 19-cm Type 10 rocket motor to which it is basically similar in construction. Like the Type 10, this rocket motor does not form an integral part of the complete projectile and is also used merely to propel the bombs out of the launching trough, after which it falls to the ground. The two types of bombs with which this motor is used are the 60 kilogram Type 97 land bomb and the 63-kilogram ordinary bomb. The main difference between this rocket motor and the Type 10 lies in the increased length of the propellent chamber. This motor also may be considered obsolescent if not already obsolete.

b. Construction. The motor has the appearance of a flat-nosed bomb and consists basically of the propellent chamber, motor closing plate, and tail assembly. The propellent chamber is a cylindrical steel tube closed at the forward end by a nose plate in the center of which is a drilling tapped to receive an electrical igniter. No wooden spacer was found with the single specimen recovered; however, the spacer used with the Type 10 motor will fit this rocket also. Behind the nose plate is a perforated supporting plate which contains the ignition charge, consisting of a silk bag filled with black powder and an igniting squib.

The rear end of the propellent chamber is threaded externally to receive the motor closing plate. A rear supporting plate, located between the end of the propellent chamber and a shoulder on the inside of the closing plate, locates the propellant at the rear end. The propellent charge consists of three monoperforated sticks of a double-base powder, tied together fore and aft with strips of silk cloth. The single venturi tube screws into the end of the motor closing plate. Four tail fins are spot welded to the tube and braced by four struts. A cardboard disc, secured

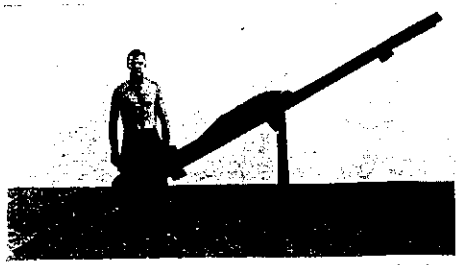

Figure 1.—19-cm Type 3 rocket motor and 60-kilogram bomb on launching ramp ready for firing.

in the after end of the venturi tube, serves to exclude moisture from the rear end of the propellent chamber.

c. Firing mechanism. The igniter body contains no charge but serves merely to close the igniter well and act as a guide for the igniter leads which run through the igniter body to the squib in the ignition charge. The leads are connected to an exploder and the rocket fired from a flank position.

d. Markings. The motor is painted blue-gray and has a red band around the after end of the motor closing plate. A label on the propellent chamber reads "Type 3 rocket launcher (for No. 6 land bomb)."

2. Technical Data.

General	
Nature of projectile	Single axial-venting, fin-stabilized rocket motor, separate from warhead.
Caliber	19 cm.
Total weight (complete round)	102 kilograms (approx.).
Total length (complete round)	----------
Filling	HE.
Rocket Motor	
Over-all length	103 cm.
Maximum diameter	20.2 cm.
Propellent chamber:	
Length	54.6 cm.
Diameter	19.1 cm.
Wall thickness	0.71 cm.
Motor closing plate:	
Maximum diameter	20.2 cm.
Length	18 cm.
Venturi and tail assembly:	
Length of tail assembly	40.7 cm.
Length of venturi tube	35.6 cm.
Final diameter of venturi tube	5.97 cm.
After thickness of venturi tube	0.28 cm.
Width of tail fins	27.6 cm.
Length of struts	19.1 cm.
Width of struts	2.54 cm.

Figure 2.—Disassembled Type 3 rocket motor and 60-kilogram bomb.

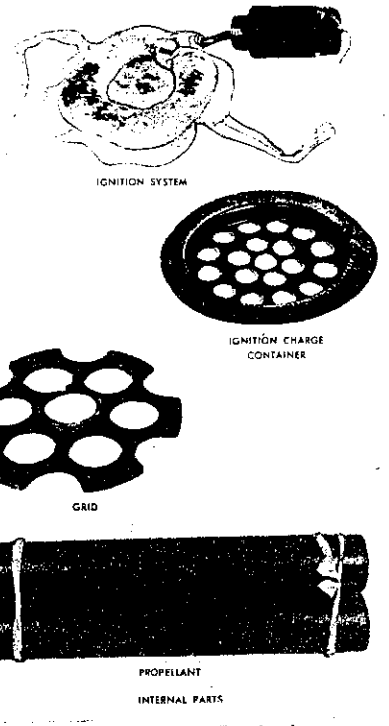

Figure 3.—Internal components of Type 3 rocket motor.

Weights:	
Rocket motor empty	29.936 kilograms.
Propellant	11.7 kilograms.
Ignition charge	0.064 kilogram.
Total weight	41.70 kilograms.
Propellant:	
Number of sticks	Three.
Single stick:	
Length	51 cm.
Diameter	7.75 cm.
Diameter of perforation	1.12 cm.
Ignition charge container:	
Diameter	17.3 cm.
Number of perforations	19.
Diameter of perforations	1.83 cm.

3. Performance. Nothing is known concerning the performance of this rocket motor, but the increased length of the propellent chamber should give a corresponding increase in range over that of the Type 10 motor. The range can be expected to be in the region of 1,300 meters (1,960 yards).

20-cm Navy Projectile.

Fired from: Metal trough-shaped launcher, wooden single and triple launchers, and tube-type launcher.

1. Description. a. General. This rocket, the first spin-stabilized projectile to be produced by the Japanese, appears to consist of a cut-down 8-inch naval shell with a rocket motor attached to its base. Although it seems to be an improvisation, the projectile exhibits the basic design features of conventional German spin-stabilized rockets and represents the first German influence on Japanese rocket design. This influence is further demonstrated by the replacement of the original wooden and metal trough-shaped launchers for this projectile by a tube-type launcher, the first of its type to be used by the Japanese.

The projectile consists basically of the warhead and the rocket motor. The thin wall of the warhead and the scale on the launcher suggest that this projectile was designed as a short-range weapon (maximum range about 1,900 yards), relying for effect upon blast rather than upon fragmentation. Also, it seems probable that the rocket was intended to serve as an experiment in the development of the 20-cm Army rocket.

b. Warhead. The warhead appears to be a cut-down 8-inch naval shell, but has a thinner case and a higher charge-weight ratio than is usual with naval ammunition. The body has parallel sides and an ogival nose with a socket threaded to receive a point-detonating fuze. The base of the body is closed by a male screw plug which is flanged to give it the same diameter as the warhead and threaded below the flange to receive the forward end of the rocket motor. A shipping plug with a dummy wooden gaine is screwed into the fuze socket in transit; the fuze is carried separately.

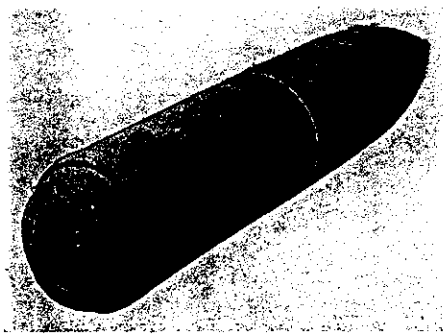

Figure 1.—20-cm Navy projectile.

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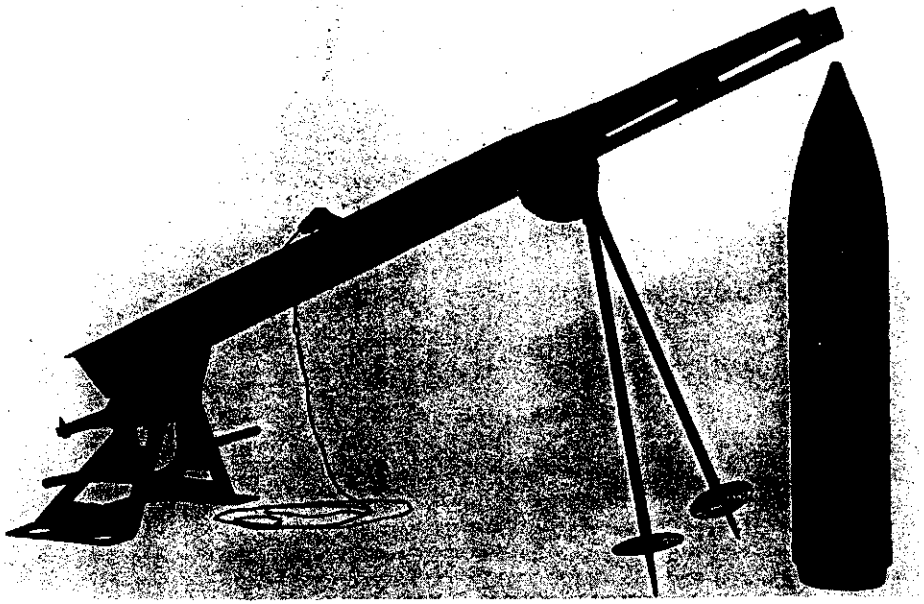

Figure 2.—20-cm Navy rocket projectile and trough-shaped launcher.

The base plug is locked in the warhead body by a single set-screw. The filling is Type 91 explosive (trinitroanisol) which is cast directly into the lacquered interior of the warhead. Figure 5 shows the warhead with the base plug removed and the cast filling visible.

c. Rocket motor. The rocket motor is in the form of a parallel cylinder with raised forward and after bearing surfaces. It is threaded internally at the forward end for screwing onto the lower half of the warhead base plug (Figures 3 and 4). A motor closing plate threads inside the forward end below the warhead base plug and separates the base plug from the combustion chamber. Below the motor closing plate is a perforated cup containing a black-powder ignition charge in a silk bag. The cup has 19 evenly spaced perforations.

At the lower end the rocket motor body is threaded internally to receive the motor base plug. A metal grid, screwed to the upper surface of the motor base plug, reduces the space inside the body to the length of the propellent sticks so that they fit closely.

The propellent charge is made up of six sticks located around an identical seventh stick (Figure 5). The seven sticks form a reasonably tight fit inside the body and are positioned at the forward end by the perforated plate holding the ignition charge and at the rear by the metal grid above the motor base plug.

The motor base plug is made of hardened steel and has six offset venturi and a central drilling threaded to receive an igniter. The forward end of each venturi is splayed out toward what is the leading edge of the opening as the rocket spins. The outlet is parallel.

Ignition is accomplished through the percussion igniter in the motor base plug and the powder ignition charge in the perforated cup at the forward end of the propellant. The perforation in the central stick serves as a flash tube.

2. Technical Data

General	
Nature of projectile	Multiple base-venting, spin-stabilized, pusher rocket.
Caliber	21.05 cm.
Over-all length (complete round)	107.1 cm.
Total weight (complete round)	90.7 kilograms.
Nature of fuze	Nose percussion.
Nature of filling	Trinitroanisol.
Maximum range	1,800 meters (1,968 yards).

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Warhead	
General shape	Cylindrical with ogival nose.
Material	Steel.
Dimensions:	
Over-all length (less fuze)	58.80 cm.
Diameter	21.05 cm.
Wall thickness	1.2 cm.
Radius of ogive	4 calibers.
Weights:	
Body (less fuze)	26.0 kilograms.
Base plug	6.4 kilograms.
Filling	17.5 kilograms.
Total weight (less fuze)	49.9 kilograms.
Filling	Trinitroanisol.
Markings	Painted maroon with 54-mm green band at the nose and a 9-mm yellow band at the junction of the warhead and the rocket motor. Label on nose fuze socket: Type of explosive.. Type 91. Lot ..... 933. Cast ..... June 44 at Kure.
Fuze	
Nature	Type 4 impact rocket fuze (centrifugally armed, nose percussion) screwed into fuze pocket in nose of warhead.
Weight	807.2 grams.
Action	The striker is freed by the action of centrifugal force in accordance with normal practice in centrifugally armed fuzes.
Gaine	Metal cup screwed into base of fuze body and containing initiating charge and booster. Described together with fuze under II-C.002.

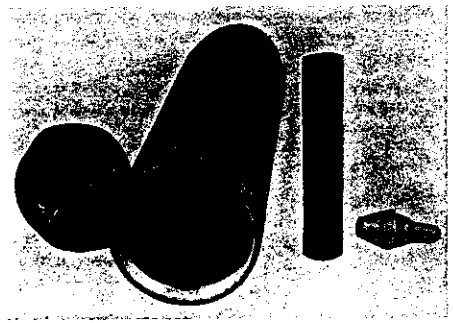

Figure 3.—Base plate, motor body, propellent sticks, and nose fuze of 20-cm Navy rocket.

Motor	
General	Multiple base-venting annular venturi. Seven monoperforated propellent sticks. Total weight 40 kilograms.
Motor body:	
Over-all length	46 cm.
Length of propellent chamber	39.5 cm.
Main diameter	----------
Diameter of bearing surface	21.05 cm.
Wall thickness	1 cm.
Weight	9.1 kilograms.
Motor base plate:	
Diameter	18.1 cm.
Length	8 cm.
Weight	9.1 kilograms.
Venturi:	
Number and position	Six in annular ring at base.
Angle of cant	25 degrees.
Type	Convergent-parallel.
Inlet:	
Maximum diameter	----------
Minimum diameter	15 mm.
Length	----------
Outlet:	
Diameter	15 mm.
Length	----------
Grid:	
General	Two annular rings supported above motor base plate on three arms.
Diameter of outer ring	130 mm.
Diameter of inner ring	45 mm.
Forward projection from motor base plate.	35 mm.
Weight	526 grams.
Perforated cup:	
Diameter	175 mm.
Number of perforations	19.
Diameter of perforations	25 mm.
Weight	452.1 grams.
Propellant:	
Type	240 DT 2.
Number of sticks	Seven, monoperforated.
Length	290 mm.
Diameter	58 mm.
Diameter of perforation	11 mm.
Weight of each stick (varies slightly).	1.162 kilograms.
Total weight	8.3 kilograms.
Composition:	
Nitrocellulose	65 percent.
Nitroglycerine	30 percent.
Sodium chloride	2 percent.
Centralite	3 percent.
Method of ignition:	
General	The propellant is ignited by the percussion igniter in the center of the motor base plate and the ignition charge at the forward end of the rocket motor. The perforation in the central stick serves as a flash tube.

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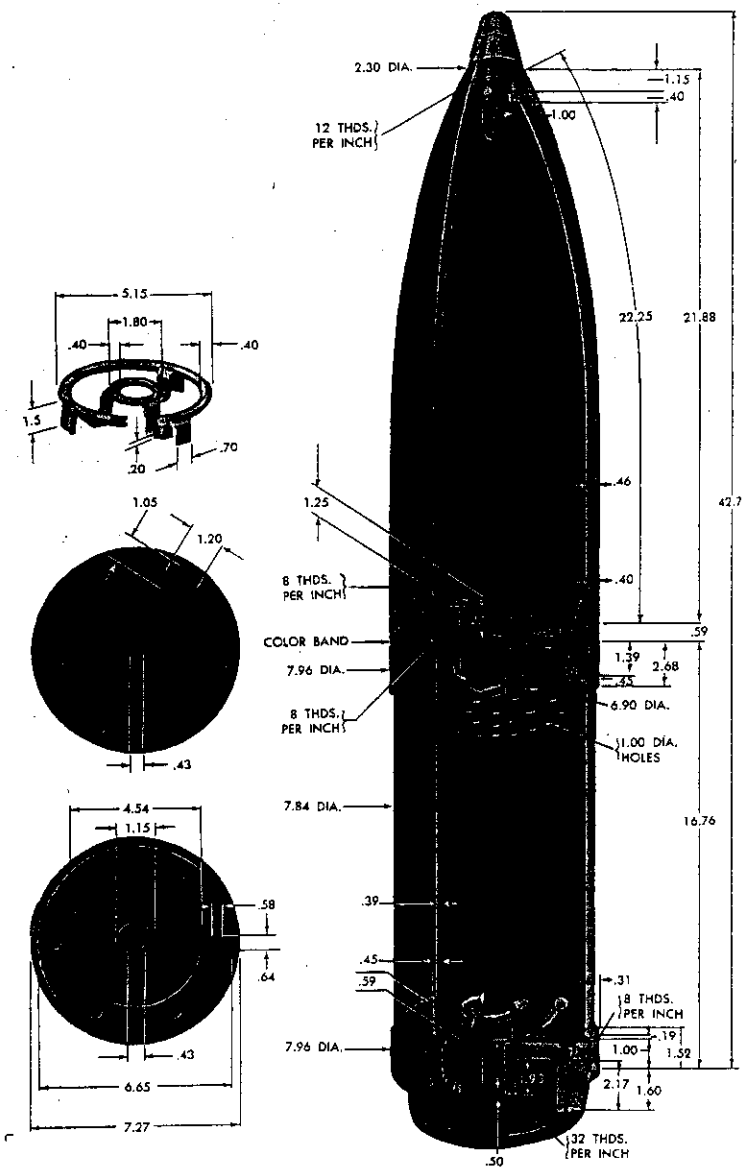

ALL DIMENSIONS IN INCHES

Figure 4.—Interior layout of 20-cm Navy projectile.

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Method of ignition—Continued.	
Ignition charge:	
Weight	50.6 grams.
Material	Black powder.
Composition	----------
Markings:	
The rocket motor is painted maroon over-all and has no other color markings. A label attached to the forward end of the motor base plate gives the following information concerning the propellant:	
Common propelling charge:	
Type	240 DT 2.
Lot	39 grade (illegible).
Powder weight	8.5 kilograms.
Powder manufactured	March 1944.
Loaded	24 June 44 at Kure "A."
The black-powder ignition bag had no marking except a Kure anchor.	

3. Performance. *a. Firing tests.* No test figures are available for the performance of this projectile.

b. Range scale. The markings on the arc of the pendulum scale of the trough launcher are as follows:

Elevation (degrees)	*Range* (meters)
10	450
20	1,000
30	1,450
40	1,650
50	1,800
60	1,600

This gives a maximum range of 1,800 meters, any further elevation above 50 degrees serving to decrease the range.

c. Range table. The following data have been taken from a captured Japanese document dealing with Navy rockets. Although the figures supplied do not agree with the range scale calibrations on the trough launcher, it is believed that they apply to this projectile for the following reasons: The weight and length of the projectile agree to within 1 percent. The weight of the propellent charge agrees to within 2 percent. The type of filling agrees and is not the same as that used in the Army rocket of the same caliber; nor does the weight vary considerably. The type of fuze specified is used only with the 20-cm and 45-cm Navy projectiles. The terminal velocity is considerably lower than that calculated for the Army rocket. The ranges definitely do not agree with those obtained during firing tests with the Army rocket.

The Japanese document is headed "Type 4 (1944) 20-cm Rocket Gun Model I." This heading is confusing and would not appear to support the conclusion that the range table applies to the Navy rocket. However, it seems probable that both the Navy projectile and its tube-type launcher were steps in the development of the Army rocket and the Type 4 (1944) launcher. The "Model I"

is probably a mistranslation of "Mark I," indicating the initial launcher of this type. The Type 4 (1944) launcher is not equipped with the necessary firing mechanism (striker hammer) to fire the Navy rocket, and an entirely different set of range tables has been captured which almost certainly apply to the Army rocket.

The Japanese document gives the following information concerning the rocket (believed to be the Navy 20-cm projectile):

Projectile	20-cm ordinary rocket.
Weight	90 kilograms.
Length	1,085 mm.
Fuze	Type 4 impact rocket fuze.
Bursting charge	Type 91 explosive (Trinitroanisol), 15.7 kilograms.
Propelling charge	240 Special DT6, 8.15 kilograms.
Burning time	2.5 seconds.
Terminal velocity	125 meters per second.

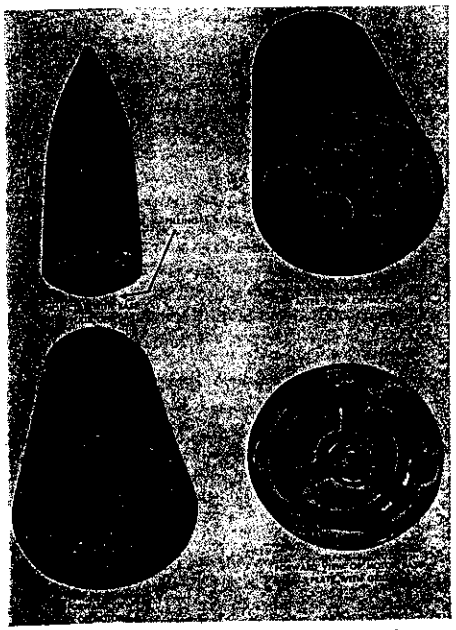

Figure 5.—Component parts of 20-cm Navy projectile.

Range Table

[This chart is based on elevation for floating targets]

Elevation (degrees)	Range (meters)	Time of Flight (seconds)	Deviation (meters)
5	39	0.5	−2
6	76	0.9	−4
7	115	1.3	−5
8	156	1.7	−7
9	198	2.2	−8
10	242	2.6	−10
11	288	3.0	−12
12	336	3.5	−14
13	386	4.0	−15
14	438	4.4	−17
15	491	4.9	−18
16	545	5.4	−20
17	600	5.9	−21
18	655	6.3	−22
19	711	6.8	−22
20	766	7.3	−23
21	821	7.8	−23
22	876	8.3	−23
23	930	8.8	−23
24	982	9.2	−22
25	1,032	9.7	−22
26	1,081	10.2	−21
27	1,128	10.6	−20
28	1,173	11.1	−19
29	1,216	11.5	−17
30	1,257	12.0	−15
31	1,296	12.4	−13
32	1,333	12.9	−10
33	1,368	13.3	−7
34	1,398	13.7	−4
35	1,426	14.1	−1
36	1,452	14.5	3
37	1,475	15.0	6
38	1,495	15.4	10
39	1,512	15.8	14
40	1,527	16.2	18
41	1,540	16.5	22
42	1,551	16.9	26
43	1,559	17.3	30
44	1,565	17.6	34
45	1,568	18.0	38
46	1,568	18.3	41
47	1,566	18.7	44
48	1,562	19.0	47
49	1,555	19.3	50
50	1,545	19.6	53
51	1,533	19.9	55
52	1,519	20.2	57
53	1,502	20.5	59
54	1,482	20.8	61
55	1,460	21.1	62
56	1,436	21.3	63
57	1,409	21.6	63
58	1,380	21.8	64
59	1,349	22.0	64
60	1,316	22.3	64

20-cm Army Projectile, Older Type.

(Straight-Sided Rocket Motor.)

Fired from: Type 4 (1944) launcher.

1. Description. *a. General.* Two types of Army 20-cm spin-stabilized projectiles have been recovered; since the correct nomenclature is not yet known, these have been designated the older type, straight-sided rocket motor, and the newer type, bourrelet rocket motor, since the most apparent external distinction is the shape of the rocket motors. These projectiles are similar in many respects, and both are fired from the Type 4 (1944) launcher.

The rocket is a conventional spin-stabilized design and consists basically of explosive head and rocket motor. It apparently has been developed from the Navy spin-stabilized projectile of the same caliber; however, the relative size of the rocket motor in the Army projectile has been increased to give the projectile greater range.

b. Warhead. The warhead is a thin-walled cylinder with an ogival nose terminating in a fuze-adapter socket. The rear end of the warhead body is closed by a male base plate, internally concave to permit a maximum explosive filling of cast TNT. The warhead is transported separately, and the exterior threads of the base plate are protected by wax paper.

c. Rocket motor. The rocket motor consists of the motor body, base plate, and forward and rear supporting grids. The motor body is a parallel steel cylinder threaded internally at the forward end to fit onto the warhead base plate and similarly threaded at the rear end to receive the motor base plate.

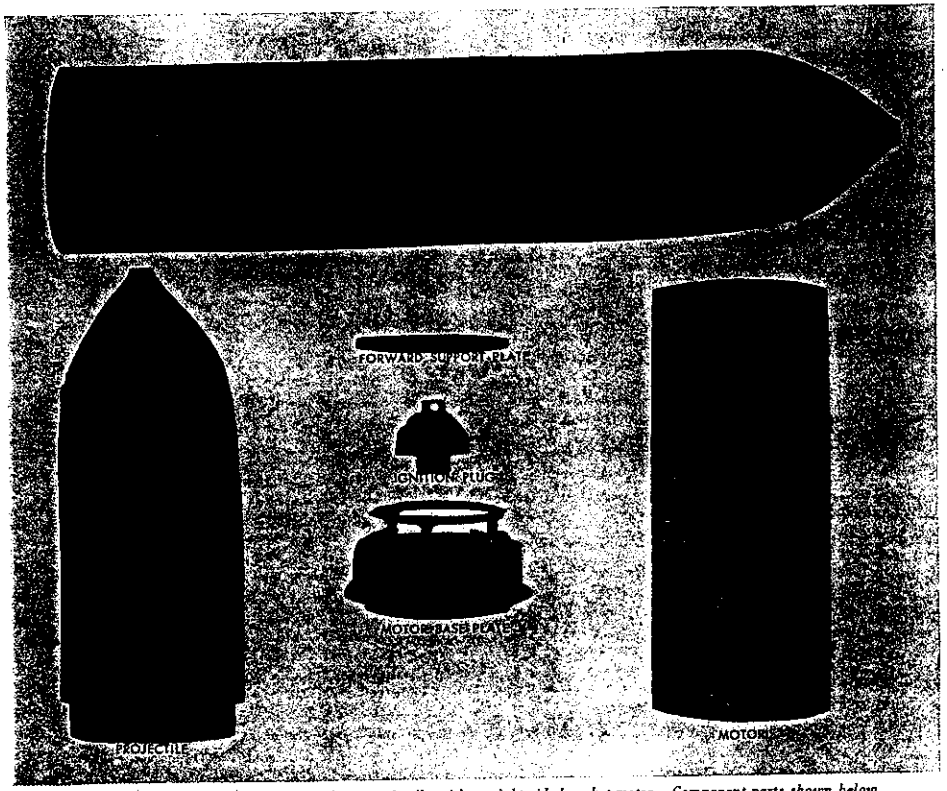

Figure 1.—The early model 20-cm Army projectile with straight-sided rocket motor. Component parts shown below.

Venturi—Continued
Outlet:
Diameter ..... 15 mm.
Length .....
Supporting grids:
Forward:
Thickness .....
Diameter ..... 17.8 cm (approx.).
Weight ..... 2.05 kilograms.

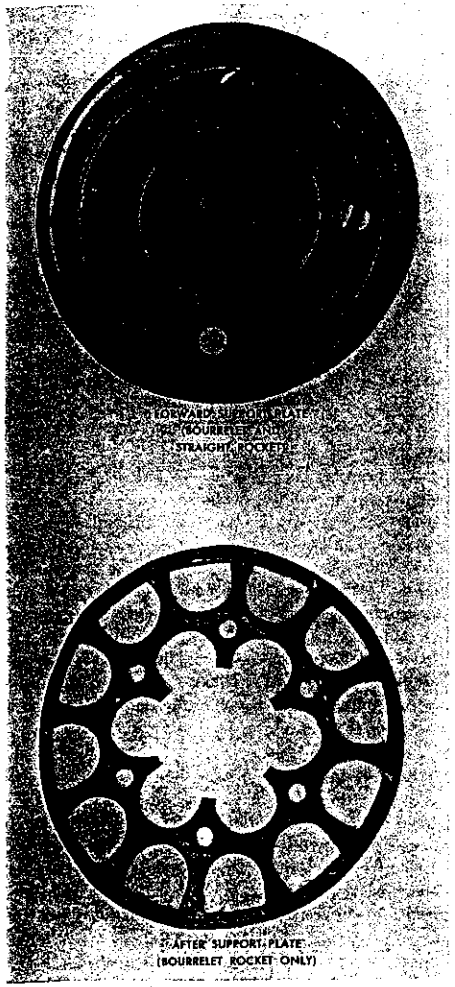

Figure 5.—Forward and rear supporting grids of newer type 20-cm rocket motor.

Supporting grids—Continued
Rear:
Thickness .....
Diameter ..... 17.5 cm (approx.).
Weight ..... 1.36 kilograms.
Propellant ..... The propellant used in this rocket motor is the same as that used in the older type. (See II–B.104.)
Method of ignition ..... Ignition plug, screwed into base plate and containing ignition charge, and pull igniter. The charge and igniter are the same as those used in the older type rocket and are described under II–B.104.
Markings ..... The following is a translation of the stenciling on a recovered rocket motor:
42 K 630 "Su" (Weight: 42.63 kilograms).
Loaded October 44 at Osaka Army Ordnance Branch Depot. "Experimental."

3. Performance. *a. Test firing.* (1) Procedure: Firing tests were carried out on Luzon with six 20-cm Army rockets, including both old and new types. The tests were performed using the standard Japanese Type 4 (1944) launcher, which was laid with the aid of the regulation sight used with the Japanese 81-mm and 90-mm mortars. The projectiles were fired using the standard ammunition components.

The weights (in kilograms) of the projectiles fired were as follows:

Round Number	*Type*	*Motor*	*Warhead*	*Complete Rocket*
1	Old	45.010	38.575	83.585
2	Old	45.460	38.800	84.260
3	Old	45.010	38.650	83.660
4	.....	42.190	39.560	81.750
5	New	43.020	39.120	82.140
6	Old	45.245	38.800	84.075

(2) Results of firing test:

Round Number	*Elevation (mils)*	*Range (yards)*	*Time of Flight (seconds)*
1*	800	2,660	24.0
2	800	3,040	24.5
3	800	3,075	25.5
4	800	Dud	.....
5	800	3,290	25.5
6	800	3,130	25.5

*The first rocket was fired with one-half of the center propellent stick removed from the motor. This apparently shortened the range approximately 400 yards. All other rounds were fired with full propellent charge.

It was noted that there was excessive moisture condensation, due to improper field storage conditions, in some of the motors, which probably caused range differences. The maximum range differences, however, on the same (old) type of rocket at the same elevation was

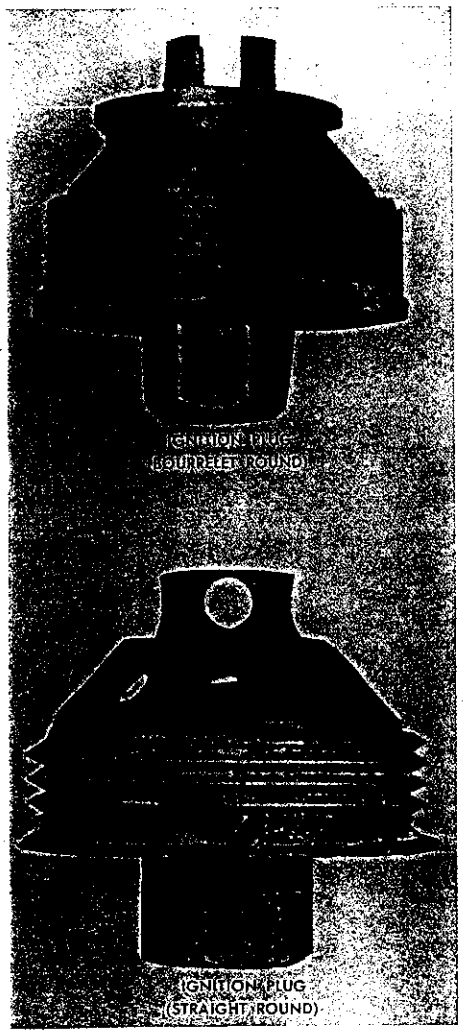

Figure 6.—Comparison of ignition plugs used on the two types of 20-cm Army rockets.

90 yards. On rounds 1, 2, 3, and 6 there was a very noticeable hangfire which is characteristic of the old type rounds. The range of round 4, a dud, was not determined because the evidence of a hit and the point of entry could not be located.

Rounds 2, 3, and 6, all old type rockets, fired with full charge at the same elevation and azimuth, hit within an area 100 yards in width (lateral dispersion) by 90 yards long. The new type rocket, No. 5, had a 160-yard greater range than No. 6, which had the longest range reading of the old type rockets. The lateral dispersion of rounds 1, 3, and 5 was almost nil, the rounds being line shots. Regarding lateral dispersion, no aiming stake was used, and the launcher was not checked for movement in azimuth between rounds. Therefore it is probable that less lateral dispersion would have been observed if the azimuth had been checked. No range corrections were made for the type or weight of round fired during the range firing tests.

The 20-cm rocket craters had the usual daisy cutter appearance, the short grass being cut or blasted in an area 75 to 100 yards in diameter. The average crater was 1.8 feet deep by 7 feet in diameter. Fires were started up to 50 yards from the bursts.

(3) Recent test. The following is taken from a preliminary report of a firing test conducted recently:

Rounds fired ..... Four older type.
Two newer type.
Ballistic data:
Burnt velocity ..... 570 feet per second.
Time of burning ..... 1.9 seconds.
Burning distance ..... 540 feet.
Range ..... 4,600 feet at 310 mils elevation.

The above results represent an average for all six projectiles.

b. Fire missions. A U. S. unit used the Japanese Type 4 launcher, firing 20-cm rockets, on tactical fire missions. This rocket fire was quite accurate. On one mission 20 rounds were fired at a Japanese concentration point; it was noted that all rounds fell in an area approximately 100 yards wide by 150 yards long, starting several fires. A careful analysis of all tactical fire missions failed to disclose any erratic rounds. The propellant of the motors was generally checked prior to firing, and if any excessive condensation of moisture appeared, it was removed. If this moisture was not removed, the rounds fell slightly short. Examination of a large number of rounds disclosed that several of the rocket motors contain 14 half sticks of propellant of the type normally used only as the center stick or increment. It is believed that this would not cause any appreciable range difference. During tactical firing missions it was necessary to use U. S. "Ba-

zooka" shell squibs for igniters due to the shortage of the Japanese pull-type friction igniters for use in igniting the propelling charge of the rockets.

c. Range tables. The following range tables and table of characteristics were taken from a Japanese document and are believed to be intended for use with the 20-cm Army rocket. Although the upper range limit is considerably less than that obtained during test firing, the table is included here to illustrate the extent to which the Japanese recommend corrections should be made when firing the 20-cm rocket.

Table of characteristics of rocket gun (Type 4 launcher?)

Gun barrel:	
Caliber	203 mm.
Firing mechanism	Lanyard percussion hammer type.
Sight	Collimator type.
Projectile characteristics:	
Maximum range	2,500 meters.
Main charge	16.5 kilograms (approx.).
Charge I propellent weight	9.6 kilograms (approx.).
Charge II propellent weight	8.9 kilograms (approx.).
Charge III propellent weight	8.2 kilograms (approx.).
Gun in position:	
Elevation	40 to 65 degrees.
Traverse (elevation 45 degrees).	150 mils right and left (approx.).
Total weight	228.3 kilograms.

Experimental 20-cm Rocket Shell

CHARGE I

(Six long sticks, two short)

Range (meters)	Angle of Elevation (mils)	Drift (mils)	Time of Flight (seconds)	Correction for 1 Meter per Second Cross Wind: Range (meters)	Correction for 1 Meter per Second Cross Wind: Angle of Elevation (mils)	Deflection Correction for 1 Meter per Second Range Wind (mils)	Range Correction for 1 Degree Increase of Propellent Temperature (mils)
2,000	486	16	14.8	22.8	7.6	1.0	−19.2
2,100	520	19	15.9	21.7	8.3	1.1	−19.9
2,200	562	23	17.1	19.8	9.0	1.3	−20.6
2,300	613	29	18.4	16.7	9.6	1.5	−21.3
2,400	681	37	20.2	12.1	10.0	1.7	−21.9
2,450	728	43	21.5	9.1	10.1	1.9	−22.1
2,450	901	75	25.6	−7.7	9.8	2.6	−21.1
2,400	952	93	26.8	−11.0	9.6	2.8	−20.2
2,300	1,022	131	28.4	−15.3	9.3	3.1	−18.4
2,200	1,076	162	29.7	−18.3	9.0	3.4	−16.7
2,100	1,121	95	30.7	−20.6	8.7	3.6	−15.1
2,000	1,162	23	31.6	−22.5	8.5	3.7	−13.5

CHARGE II

(Six long sticks, one short)

Range (meters)	Angle of Elevation (mils)	Drift (mils)	Time of Flight (seconds)	Correction for 1 Meter per Second Cross Wind: Range (meters)	Correction for 1 Meter per Second Cross Wind: Angle of Elevation (mils)	Deflection Correction for 1 Meter per Second Range Wind (mils)	Range Correction for 1 Degree Increase of Propellent Temperature (mils)
1,600	469	12	12.9	26.4	8.8	1.2	−17.2
1,700	504	15	13.9	25.0	9.6	1.4	−17.9
1,800	547	20	15.1	22.7	10.3	1.6	−18.6
1,900	599	26	16.4	19.1	10.9	1.8	−19.3
2,000	667	35	18.2	13.2	11.2	2.0	−19.9
2,000	982	94	25.4	−9.5	8.7	3.2	−17.8
1,900	1,058	137	26.9	−11.8	7.4	3.5	−15.8
1,800	1,113	78	28.0	−12.4	6.4	3.6	−14.0
1,700	1,162	27	29.0	−11.9	5.4	3.7	−12.2

CHARGE III

(Six long sticks)

Range (meters)	Angle of Elevation (mils)	Drift (mils)	Time of Flight (seconds)	Correction for 1 Meter per Second Cross Wind: Range (meters)	Correction for 1 Meter per Second Cross Wind: Angle of Elevation (mils)	Deflection Correction for 1 Meter per Second Range Wind (mils)	Range Correction for 1 Degree Increase of Propellent Temperature (mils)
1,300	489	14	11.7	28.1	10.8	1.8	−15.9
1,400	531	18	13.0	25.5	11.6	1.9	−16.6
1,500	584	24	14.4	20.9	12.2	2.2	−17.2
1,600	654	33	16.2	13.6	12.5	2.5	−17.8
1,600	1,023	91	23.8	−6.5	6.7	3.6	−14.8
1,500	1,106	56	25.3	−6.0	4.2	3.8	−12.6
1,400	1,166	104	26.4	−3.8	2.1	3.9	−10.6

30-cm Special Mark I Rocket Motor.

Fired from: Metal trough-shaped launcher.

1. Description. *a. General.* This is a fin-stabilized motor of simple design used for launching either of two types of 250-kilogram bombs. This rocket motor is in many respects a scaled-up version of the 19-cm motors, Types 10 and 3, but in this case the rocket motor is directly attached to and not just resting behind the bomb.

Only one specimen of the projectile has been captured; this comprised the rocket motor and the Navy 250-kilogram Type 98 land bomb. According to a Japanese manual, the rocket motor used in conjunction with this bomb is known as Type 21, and when used with the 250-kilogram Type 99 ordinary bomb, it is designated Type 22. Since the actual rocket motor appears to be identical, this variation in nomenclature can be accounted for only by the different method of attaching the motor to the bombs. The projectile is launched from a trough-shaped metal launcher.

b. Warhead. The warhead is either the Type 98 land bomb or the Type 99 ordinary bomb, in both cases with the tail assembly removed. The basic difference between the two lies in the adapter assembly which attaches the warhead to the rocket motor. The exact nature of these assemblies is not clear but the following brief descriptions, taken from a rough sketch in a captured document, give some idea of the basic layout.

(1) Type 98 land bomb: An internal base plate is slipped into the tail end of the bomb and is held in place against the explosive by the motor adapter, which is in the form of a sleeve fitting inside the bomb and riveted around the circumference. A cylindrical spacing ring, welded to the base plate, separates the base plate from the nose of the rocket motor. In Figure 1 this has been buckled by the force of impact; it is believed, however, that normally the attachment is flush with the warhead and the rocket motor. Drillings in the spacing ring and the adapter sleeve enable the leads from the igniter to be connected to the exploder used to fire the projectile.

(2) Type 99 ordinary bomb: The sketch found in a captured document shows that the type of adapter used to connect this bomb to the rocket motor consists of a sleeve fitting inside the bomb and over the end of the motor. No spacing ring is used, but a circular disc is welded inside the sleeve, approximately in the center, to strengthen the adapter. The rear half of the adapter is drilled for connecting the igniter leads to the exploder.

c. Rocket motor. The rocket motor is of simple construction and consists of the motor body, the motor closing plate, and a tail-fin assembly incorporating a single venturi. The body is closed at the forward end by a nose

cap which fits into the rear end of the adapter sleeve. A central drilling is provided in the nose cap to receive the electrical igniter. It is not known whether a forward supporting grid is used to locate the propellant, although a rear grid is used to maintain the propellant in position at the opposite end. Screwed into the body behind the rear supporting grid is the motor closing plate; this is in the form of a hollow truncated cone threaded internally at the rear to receive the tail assembly.

The tail assembly consists of a single venturi screwed onto the closing plate and has four fins spot welded around the circumference. These are strengthened by thin strips at the end of the fins.

d. Fuzing and firing mechanism. The projectile recovered, incorporating the Type 98 land bomb, was fuzed with the A–3 (a) impact fuze with a green tipped A–3 gaine (0.025-second delay). An electrical igniter was screwed into the forward end of the rocket motor. The leads from the igniter were passed through the drillings in the adapter assembly and connected to a small exploder. According to the Japanese manual, the igniter contains an ignition charge of black powder weighing 150 (grams?). Assuming this figure to be in grams, it is estimated that it would fire with a minimum current of 250 milliamperes.

e. Markings. The projectile recovered was painted blue-gray over-all, although an illustration in the Japanese manual shows that the rocket motor is of a much lighter color, possibly yellow or white.

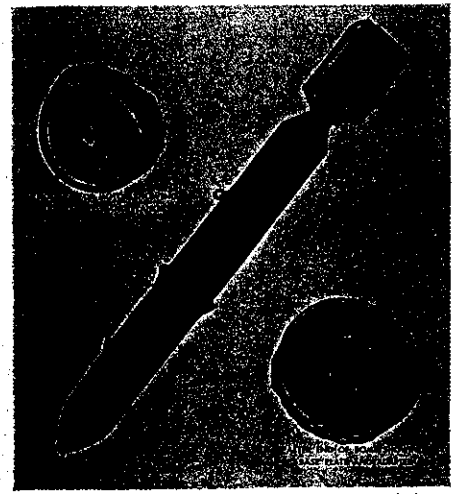

Figure 1.—30-cm Special Mark 1 rocket motor attached to 250-kilogram bomb.

667462—45——9

2. Technical Data.

GENERAL	
Nature of projectile	Single axial-venting, fin-stabilized, pusher rocket.
Caliber:	
Recovered specimen	30.3 cm.
Japanese manual	30 cm.
Over-all length:	
Recovered specimen	300 cm.
Japanese manual	309.5 cm.
Total weight	392.5 kilograms (approx.).
Nature of fuze	Nose percussion.
Nature of filling	H.E.
Maximum range	6,850 meters.
WARHEAD	
General	The only figures available for the warhead are those obtained from the captured projectile and apply to the Navy Type 98 land bomb. Those for the Type 99 ordinary bomb will presumably be the figures applying to the complete projectile, with the equivalent reductions.
Over-all length	100.8 cm.
Maximum diameter	30.3 cm.
Wall thickness	1.27 cm.
Diameter of base plate	28 cm.
Thickness of base plate	0.97 cm.
Diameter of spacing ring	11.65 cm.
Weight of filled bomb, adapter, and base plate.	197.5 kilograms.
Weight of filling	96.5 kilograms.
ROCKET MOTOR	
Over-all length:	
Recovered specimen	198 cm.
Japanese manual	195 cm.
Diameter:	
Recovered specimen	30.3 cm.
Japanese manual	30 cm.
Wall thickness (recovered specimen).	0.95 cm.
Length of tail assembly (recovered specimen).	63 cm.
Length of venturi tube (recovered specimen).	63 cm.
Length of tail fins (recovered specimen).	55.8 cm.
Diameter across fins (both sources).	45.8 cm.
Weight less propellant (recovered specimen).	114 kilograms.
Weight of propellant (Japanese manual).	81 kilograms.
Total weight (Japanese manual)	190 kilograms.

3. Performance. Although the Japanese credit this rocket with a maximum range of 10,000 meters, the maximum recorded range is only 6,850 meters (7,480 yards),

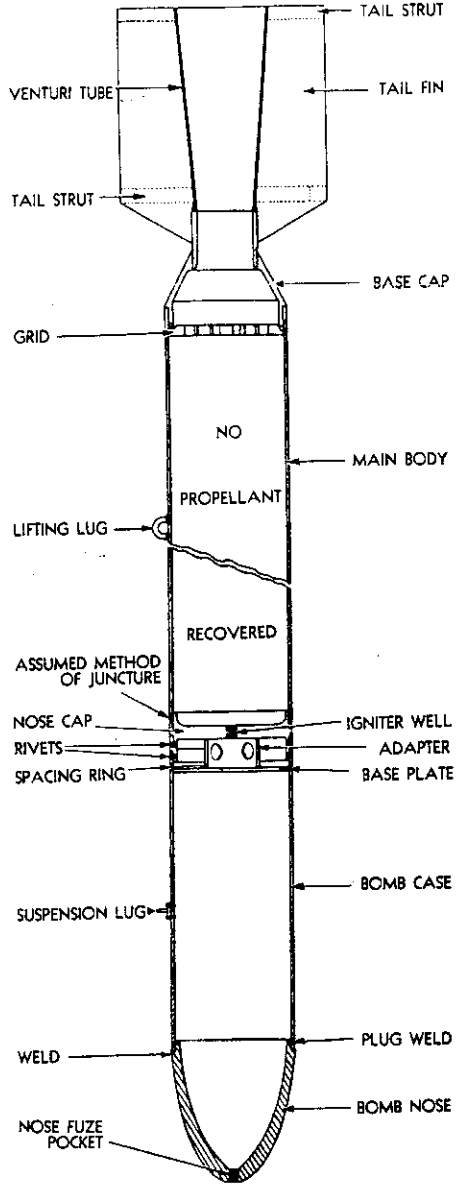

Figure 2.—Internal layout of 30-cm projectile (diagrammatic only).

at which accuracy is very poor. The flight of the bomb is erratic, being affected by wind currents. The rocket has a distinctive "bubble-whistle" sound in flight, making recognition easy.

II–B.107

45-cm Navy Projectile.

Fired from: Wooden ramp mounted on wheeled carriage.

1. Description. *a. General.* This is the second of two types of Navy rockets to be captured; the first was the 20-cm projectile described under II–B.103. The 45-cm rocket is basically a scaled-up version of the 20-cm projectile and has the same conventional layout (HE filling forward and rocket motor to the rear) and a percussion igniter in the center of the motor base plate. Like the 20-cm rocket this projectile is nose fuzed.

Only one type of launcher has been recovered. This is a heavy wooden ramp, mounted on wheels and provided with a firing hammer at the rear. Although based on the 20-cm projectile, this rocket is of cruder construction. This fact, together with the rough nature of the launcher, tends to reduce its ballistic stability. The weight of the rocket makes it unlikely that a tube-type launcher will be developed.

Figure 1.—45-cm Navy rockets.

b. Warhead. The warhead consists of a cylindrical body welded into a conical nose piece. Both the body and the nose piece are of sheet steel, rolled and welded. The junction between the warhead and the rocket motor is formed by a sleeve coupling fitting into the body of the warhead and secured by internal and external welds. The rear end of the sleeve is threaded externally to receive the rocket motor body and internally to take a wooden disc and a metal warhead base plate which is sealed with a gas check (Figure 2).

The forward end of the nose piece is drilled and tapped to receive either of two types of nose fuze. The Navy rocket nose fuze used with the 20-cm Navy rocket may be used, threaded directly into the fuze socket, or an adapter may be inserted for the Army Type 100 mortar fuze. When the adapter is used, the Navy gaine well in the charge is fitted with a picric pellet recessed for an Army gaine.

c. Rocket motor. The rocket motor is of conventional design and consists of the motor body, base plate, and forward and rear supporting grids. The body of the motor is a steel cylinder threaded internally at the forward end where it is screwed onto the sleeve attached to the rear of the warhead body. The rear end of the body is closed by the motor base plate (Figure 5) into which six offset venturi tubes are welded. These are of the convergent-divergent type and are the first of their kind to be encountered in a Japanese rocket projectile. A central drilling in the base plate is tapped to take an igniter carrier containing a percussion igniter.

The forward supporting grid is a square metal plate having 19 peripheral perforations. The edges of the plate are turned over and serve to hold the plate clear of the gas check to the warhead base plate. The ignition charge is contained in a cloth bag attached to the plate. The rear supporting grid is formed by three annular rings and a central boss mounted above the motor base plate.

The propellant comprises 39 monoperforated sticks, which are either dark red or dark green. In earlier specimens of this projectile there were 30 red and 9 green sticks and they were arranged in a definite order. Later rockets, however, do not appear to conform to this order. A label attached to the base of the rocket states that this propellant is known as "240 Special DT6," but it is not clear to which color of stick this designation refers, since the two types differ in composition.

d. Fuzing and firing mechanisms. Two types of fuze may be used, either the Type 4 impact rocket fuze, which is used with the 20-cm Navy projectile, or the Army Type 100 mortar fuze.

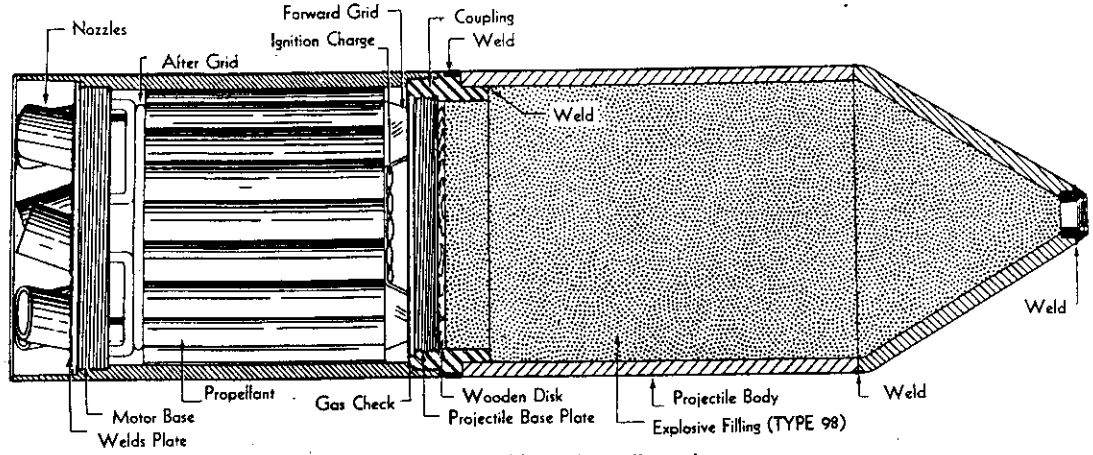

Figure 2.—Internal layout of 45-cm Navy rocket.

The method of ignition is similar to that used on the 20-cm Navy projectile. A percussion igniter in the igniter carrier in the base of the rocket is struck by a hammer pivoted at the base of the launcher. This action causes a flash to pass along the perforation in the central propellent stick to the ignition charge at the forward end of the propellant.

2. Technical Data.

GENERAL	
Nature of projectile	Multiple base-venting, spin-stabilized, pusher rocket.
Caliber	45.085 cm.
Over-all length (complete round)	171.45 cm.
Total weight (complete round)	682.29 kilograms.
Nature of fuze	Nose percussion.
Nature of filling	Type 98 explosive.
Maximum range	2,000 meters (approx.).
WARHEAD	
General shape	Cylindrical with conical nose piece terminating in fuze socket. Closed at rear by base plate.
Material	Rolled sheet steel.
Over-all length	101.87 cm.
Maximum diameter	45.085 cm.
Distance from maximum diameter to nose.	35.81 cm.
Wall thickness	1.97 cm (approx.).
Nose fuze socket:	
Outside diameter	2.39 cm.
Length of threaded portion	1.27 cm.
Threads per inch (U. S. Std.)	12.
WARHEAD—Continued	
Adapter pocket:	
Outside diameter	4.78 cm.
Length of threaded portion	1.27 cm.
Threads per inch (U. S. Std.)	12.
Base plate:	
Outside diameter	37.95 cm.
Length of threaded portion	3.86 cm.
Threads per inch (U. S. Std)	Six.
Weights:	
Empty with coupling	199.58 kilograms.
Base plate	44.19 kilograms.
Filling	180.45 kilograms.
Total	424.22 kilograms.
Filling	180.45 kilograms of Type 98 explosive.
Markings	Maroon over-all with nose painted green/ An arabic numeral is stenciled in white on the nose.
FUZE	Either Navy Type 4 impact rocket fuze or Army Type 100 mortar fuze. See II–C.001 and II–C.002.
GAINE	Incorporated in fuze assemblies. See II–C.001 and II–C.002.
ROCKET MOTOR	
General	Multiple annular venturi at base; 39 monoperforated propellent sticks located between forward and rear supporting grids. Total weight 258.073 kilograms.

II–B.107

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ROCKET MOTOR—Continued

Motor body:

Length	68.58 cm.
Length of propellent chamber	47 cm (approx.).
External diameter	45.09 cm.
Internal diameter	40.89 cm.
Wall thickness	2.1 cm.
Weight	121.05 kilograms.

Motor base plate:

Length, including venturi and grid.	18.7 cm (approx.).
Length, excluding venturi and grid.	5.6 cm (approx.).
Diameter	42.4 cm (approx.).
Weight, including grid	73.36 kilograms.

Threads of base plate:

Outside diameter	41.91 cm.
Length of threaded portion	5.08 cm.
Threads per inch (U. S. Std.)	Six.

Venturi:

Number and position	Six in annular ring at base.
Type	Convergent-divergent.
Angle of cant	18 degrees 30 minutes.

Inlet:

Maximum diameter	67.34 mm (approx.).
Minimum diameter	41.15 mm (approx.).
Length	22.45 mm (approx.).

Throat:

Diameter	41.15 mm (approx.).
Length	Nil.

Outlet:

Minimum diameter	41.15 mm (approx.).
Maximum diameter	52.37 mm (approx.).
Length	104.75 mm (approx.).

Supporting grids:

Forward:

Type	Square steel plate with corners turned over.

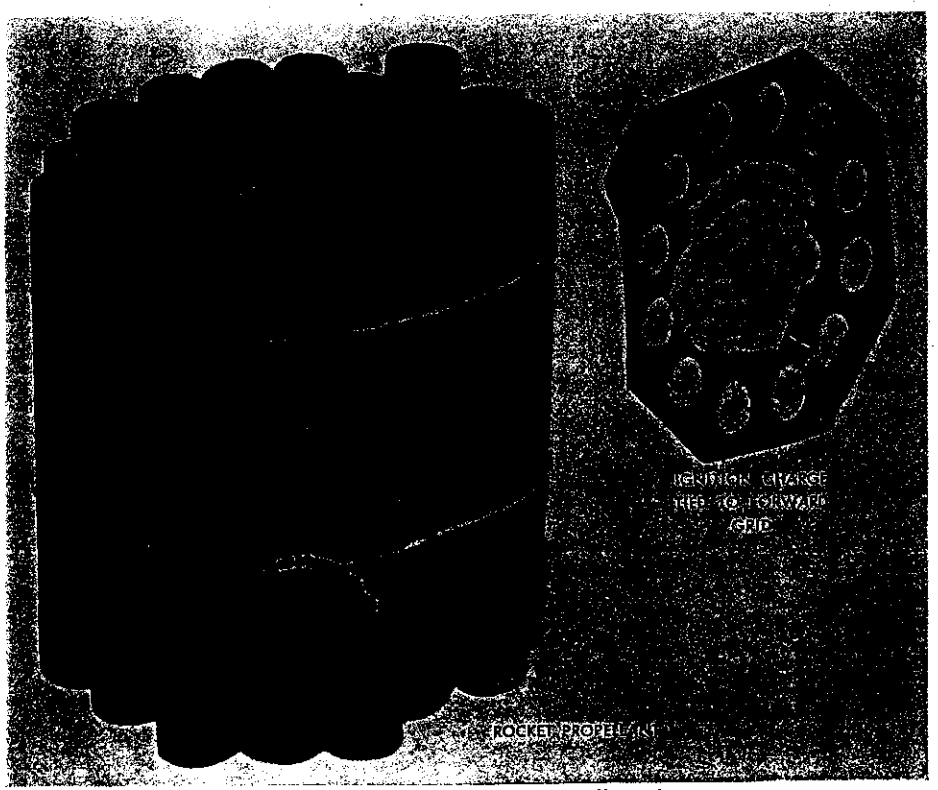


Figure 3.—Propellant and ignition charge of 45-cm Navy rocket.

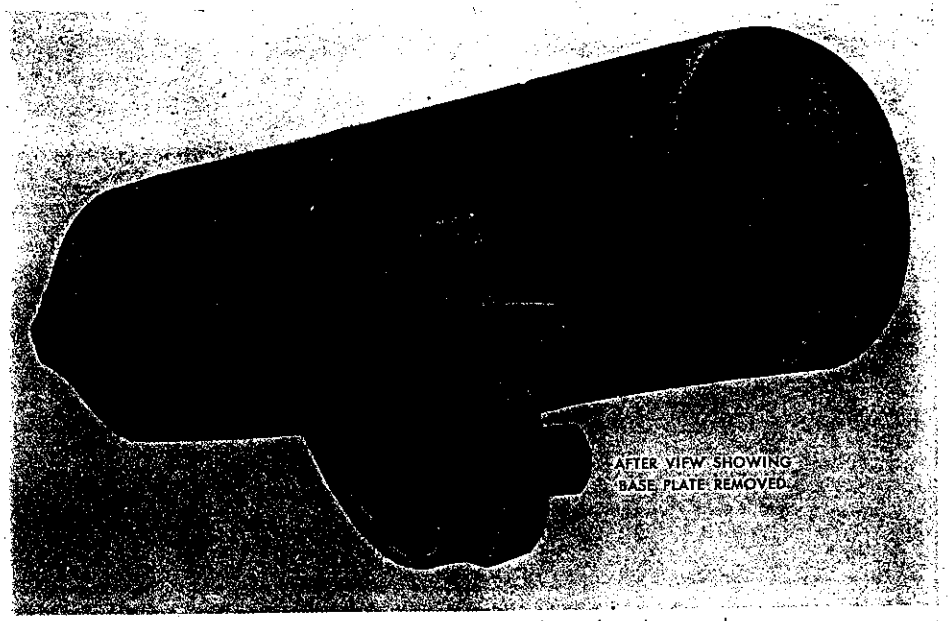


Figure 4.—Rear view of 45-cm Navy rocket showing base plate removed.

Supporting grids—Continued

Depth	3.63 cm (approx.).
Size	37.3 cm by 37.3 cm (approx.).
Weight	4.42 kilograms.

Rear:

Mean diameter, outer ring	35.16 cm (approx.).
Mean diameter, intermediate ring.	26.07 cm (approx.).
Mean diameter, inner ring	17.38 cm (approx.).
Diameter of section of all three rings.	1.58 cm (approx.).
Central boss, outer diameter	10.25 cm (approx.).
Central boss, inner diameter	7.11 cm (approx.).
Maximum height above base plate.	5.45 cm (approx.).

Propellant:

Type:

According to label on base of rocket motor.	240 Special DT 6.
According to range table believed to refer to this rocket.	240 Special DT 6. 240 Special DT 2.
Number of sticks	39 (30 red and nine green in earlier projectiles).
Length	38.735 cm.
Diameter	5.867 cm.
Diameter of perforation	1.041 cm.

Propellant—Continued

Weight of each stick	1.517 kilograms.
Total weight	59.18 kilograms.

Composition:

Red	Believed to be 240 Special DT6: Nitroglycerine, 37 percent; nitrocellulose, 60 percent; stabilizer, 5.8 percent.
Green	Believed to be 240 Special DT2: Nitroglycerine, 29.1 percent; nitrocellulose, 65.1 percent; stabilizer, 5.8 percent.

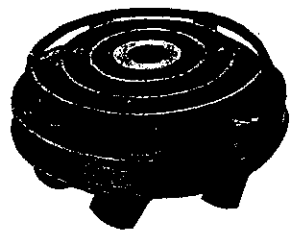
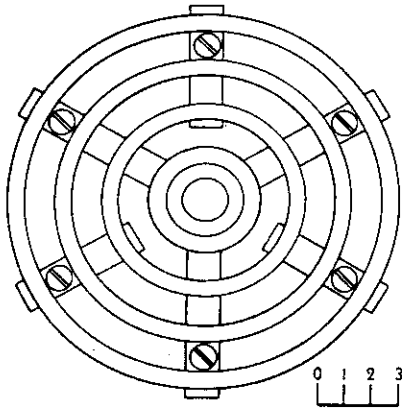
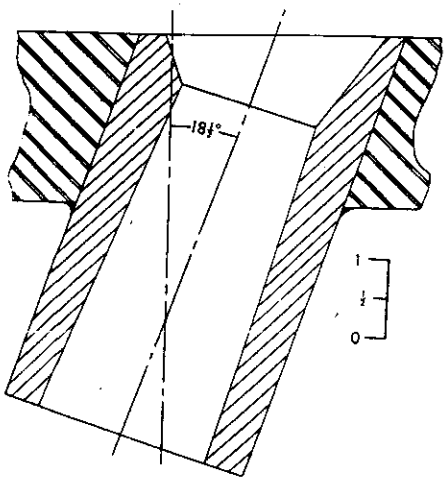


Figure 5.—Base plate, showing venturi and rear supporting grid of 45-cm Navy rocket.



Forward View of After Grid



Cross Secton of Nozzle

Figure 6.—Venturi and rear supporting grid of 45-cm Navy rocket.

Method of ignition:

General	Percussion igniter located in igniter carrier in center of motor base plate and ignition charge at forward end of rocket motor.
Igniter carrier:	
Over-all length	9.6 cm (approx.).
Diameter	3.9 cm (approx.).
Diameter of flash channel	1.02 cm (approx.).
Percussion igniter	Type not known; believed to be a cap fitting over the threaded end of the igniter carrier.
Ignition charge, weight	0.083 kilogram.
Markings	The rocket motor, like the remainder of the projectile, is painted maroon. A label attached to the base of the motor gives the following data on the propellant:
	Common propellant
	Kind 240 Special DT6.
	Lot number 9 P.
	Manufactured September 1944.
	Loaded November 20, 1944.
	Lot Kure A.

3. Performance. *a. Firing Tests.* (1) Pacific: One rocket was test fired from the standard launcher in Manila. The projectile was fired at an elevation of 43 degrees, took off well and flew well until the latter part of the downward trajectory where it seemed to lack sufficient spin and wobbled badly. The impact of the projectile could not be observed but the range was estimated at about 2,000 yards. On the basis of a vacuum trajectory, this gives a final velocity of 440.6 feet per second (the same as the 20-cm projectile) and an effective gas velocity of 4,896 feet per second. The nozzle constant is 443.

(2) Aberdeen (Maryland) Proving Ground: The following is taken from a preliminary report on a firing test conducted recently.

Rounds fired	Four.
Ballistic data:	
Burnt velocity	460 feet per second.
Time of burning	3 seconds.
Burning distance	650 feet.
Range	5,000 feet at 440 mils elevation.

b. Range table. The following range table was taken from a Japanese document and is believed to refer to this projectile for the following reasons: The document deals specifically with Navy rockets and other range and trajectory tables have been captured which almost certainly refer to the 20-cm Navy rocket. The Type 98 explosive mentioned in the trajectory table which accompanied the range table is used in the 45-cm rocket and not in the 20-cm projectile. The characteristics agree with those obtained in recent laboratory tests. The date of issue of the tables agrees with the date of manufacture of all rockets of this type captured to date.

Japanese Range Table for 45-cm Navy Rocket

Elevation (degrees)	Firing Range (meters)	Time of Flight (seconds)	Deviation (meters)
5	205	3.4	−5
6	263	3.8	−6
7	321	4.2	−7
8	379	4.7	−8
9	437	5.1	−9
10	495	5.5	−10
11	553	5.9	−11
12	611	6.3	−12
13	668	6.8	−14
14	725	7.2	−15
15	781	7.7	−16
16	836	8.1	−17
17	891	8.6	−18
18	945	9.0	−19
19	998	9.5	−20
20	1,050	9.9	−21
21	1,100	10.4	−22
22	1,148	10.9	−23
23	1,194	11.4	−24
24	1,238	11.9	−25
25	1,280	12.4	−26
26	1,319	12.9	−27
27	1,356	13.4	−28
28	1,390	13.9	−30
29	1,422	14.4	−31
30	1,452	14.9	−32
31	1,480	15.4	−34
32	1,505	15.9	−35
33	1,528	16.4	−37
34	1,549	17.0	−38
35	1,568	17.5	−40
36	1,585	18.0	−42
37	1,600	18.6	−44
38	1,612	19.1	−46
39	1,622	19.6	−48
40	1,631	20.2	−50
41	1,638	20.8	−52
42	1,643	21.3	−54
43	1,646	21.9	−56
44	1,648	22.4	−58
45	1,648	23.0	−60
46	1,646	23.6	−62
47	1,642	24.1	−64
48	1,637	24.7	−66
49	1,630	25.2	−68
50	1,621	25.8	−71

ANTIAIRCRAFT PROJECTILES

Although numerous reports have been received from aircrews of the use of antiaircraft rockets, no specimen of this type of projectile has yet been captured.

A recently captured document gives brief details of a shipborne multiple antiaircraft launcher (see II-F.301). The 12-cm antiaircraft incendiary shrapnel rocket which this launcher fires appears to be identical with that described under II-B.402. According to the document, this is intended for use against torpedo planes and dive bombers. If German influence is felt in this field, the Japanese can be expected to produce a type of projectile similar to the German parachute-and-cable rockets, intended for use in large numbers to form a parachute-and-cable barrage against low-flying aircraft. Therefore, for low-altitude antiaircraft fire, we may reasonably expect to encounter this 12-cm incendiary shrapnel rocket with an airburst fuze and possibly a parachute-and-cable rocket similar to those used by the Germans. It should, of course, be remembered that the parachute filling of this type of rocket can be replaced by a high-explosive charge, as was the case with the German 8.6-cm parachute-and-cable rocket. The Japanese may develop a similar projectile.

In high-altitude fire, a guided projectile fitted with a proximity fuze is probably most effective. While it is known that the Japanese have for some time shown interest in acoustic and sonic fuzes, it is not considered probable that this type of projectile will make an appearance for a considerable time, if at all.

AIRCRAFT PROJECTILES

Aircraft Rocket Projectiles.

Although it is known that the Japanese are employing air-to-air and air-to-ground rocket projectiles, no specimens have been found. The following is typical of the reports received of the use of such projectiles:

"The rockets . . . from fighter aircraft . . . originated from 1, 5, and 11 o'clock and were usually released in pairs. The trajectory was relatively flat and the projectiles had a fire trail. . . . It is estimated that the projectiles were released from a range of about 1,000 to 1,200 yards."

Aircraft Rocket-Assisted Bombs.

According to the documentary evidence available, a certain amount of experimental work has been carried out with various types of rocket-assisted bombs, though it is not believed that any standard weapon of this type has yet appeared. A Japanese document, which is a series of lecture notes on aerial armament, refers to four types of aerial bomb under the heading "Air Technical Branch—Bomb Section."

1. Rocket-Type Bomb, Mark 4. It is not certain whether this is an actual type of rocket bomb or whether it refers to both the #25 Mark 4 and the #50 Mark 4 bomb, but it is believed to be a type of its own. The extract from the Japanese document is as follows:

Propellant for Mark 4 bomb:

Liquid rocket	Can be adjusted by means of a valve. Duration long. Requires an oxygen bottle—steel.
Solid fuel rocket	Has oxygen but does not use a bottle. Short duration.

This seems to be a general note on the theoretical side of rocket propulsion. References are made to pressure and explosive temperatures. It seems possible that the designation "Mark 4" refers to rocket-assisted bombs as a class of projectiles and not as a specific bomb.

2. #25 Mark 4 Bomb. Tests have been carried out with this bomb, a 15-cm AP projectile designed for use against shipping. Tests showed that the bomb penetrated 120 mm at a range of 800 meters, diving at an angle of 60 degrees.

Extract from Japanese document:

NVNC 150-mm AP bomb:	
Impact speed	3,200 m. s.

Altitude	1,000 meters.
Air speed	120 m. s.
Propellant	2 tons required (TN: Thrust??).
Operating time	2 seconds.
Capacity of propellent case	V=14.9 l.
Uses a propellant DC pressure.	
Internal pressure	100 kilograms per square centimeter or less.
Propellant	t 2.13 seconds—combustion time. v 305 m. s.

3. #50 Mark 4 Bomb. This is a 24-cm AP bomb designed for use against battleships. It apparently requires 50-kilograms of propellant. It is of interest to note that the production of an Army rocket of this caliber has been mentioned in recently captured documents.

Extract from Japanese document:

NVNC 240-mm AP bomb:	
Impact speed (required)	380 m. s.
Operating time	1 second.
Delay period	3 seconds.
Air speed	100–120 m. s.
Propellant necessary	11.3 tons (TN: thrust??).
Amount of propellant	50 kilograms required.
Uses a propellant 37–176 DT.	
Dm	110 mm x nozzle D.
Pi	90 kilograms per square cm.
P	11.5 tons (thrust).

4. Mark 19. A Japanese document makes the following comment concerning this rocket: "Amount of main charge of rockets under tests is 500 gr" (?). A bombing velocity of 500 meters per second is quoted. This may be a small caliber rocket launched from aircraft against ground targets.

NON-STANDARD AND UNCONFIRMED PROJECTILES

68-mm Projectile.

Fired from: Metal launching frame mounted on tripod.

1. Description. *a. General.* An incomplete specimen of this projectile has been recovered, together with a launcher consisting of a metal framework mounted on a tripod. The absence of any explosive compartment suggests that this rocket may possibly be used as a line throwing device.

b. Rocket motor. The incomplete rocket motor which was captured consisted of three parts: the ogival nose piece, the propellent chamber, and the motor closing plate.

The ogival nose is hollow and fits over the forward end of the propellent chamber, where it is located by three screws with large heads which serve to guide the rocket in the three rails of the launcher.

The propellent chamber is a steel cylinder, very slightly conical in shape, into the rear of which is screwed the motor closing plate. The entire body of the propellent chamber is filled with the propellant of which no analysis is available at present.

The motor closing plate is a truncated cone screwed into the rear of the propellent chamber. Through the conical face of the closing plate are four venturi openings. These are drilled so that they are focused on a cone-shaped recess in the center of the propellant. The venturi are not canted and, therefore, the projectile is not spin-stabilized.

There is a central drilling in the rear of the closing plate; it is presumed that either a fin assembly or a line adapter of some kind is fitted into this recess.

c. Fuzing and firing mechanism. No fuze is fitted to the rocket and there is no indication of the method of ignition either on the launcher or on the projectile.

2. Technical Data.

Over-all length, as received	26.6 cm.
Forward diameter	6.6 cm.
After diameter	6.8 cm.
Length of nose piece	8.1 cm.
Length of propellent chamber	13.5 cm.
Length of motor closing plate	5 cm.
Venturi, diameter	0.79 cm.
Diameter of drilling in closing plate	0.95 cm.

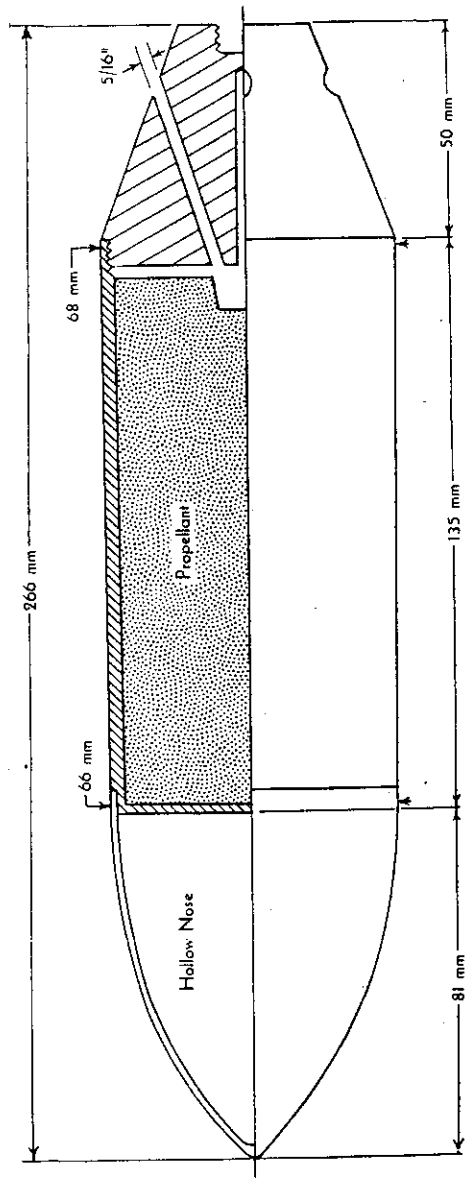


Figure 1.—Sketch of rocket motor for 68-mm projectile.

12-cm Navy Incendiary Shrapnel Projectile.

Fired from: Launcher on suicide boat.

1. Description. a. General. This is a spin-stabilized projectile fired from the Japanese suicide craft. The rocket consists basically of a warhead filled with a number of incendiary pellets, a warhead adapter containing an explosive charge, and a rocket motor of conventional design.

b. Warhead. The body of the warhead is formed by a steel cylindrical tube with a steel ogival nose piece welded at the forward end. The cavity under the nose piece is filled with a wooden plug.

The rear end of the body is threaded internally to receive the forward end of the warhead adapter. Inside the warhead body is a metal canister containing 62 metal-encased, incendiary (WP) pellets. Running the length of the cylinder and centrally located is a small burster tube containing five picric acid cylinders. The lower end of the canister is centrally perforated to form a connection between the booster in the warhead adapter and the burster charge in the canister.

c. Warhead adapter. The warhead adapter is in the form of a steel cup threaded externally fore and aft to screw into the warhead and rocket motor respectively. Between the two threaded portions the adapter is flanged to the same diameter as the two components. Inside the adapter cup is an explosive charge consisting of a cylindrical block of picric acid with a central drilling in which is located a tetryl booster. This booster surrounds the gaine of the base fuze screwed into the base of the cup. The cup is closed at the forward end by a metal plate having a central perforation containing a picric acid pellet.

d. Rocket motor. The rocket motor is of conventional design with a motor body, base plate, and forward and rear supporting grids. The motor body is a parallel cylinder threaded internally at both ends to screw over the warhead adapter and motor base plate.

The motor base plate (Figure 3) is a cylindrical steel block in which are drilled six convergent-divergent venturi, offset at an angle of approximately 21 degrees. On the forward surface of the base plate are three equally spaced studs which support the rear grid. At the end of one of these studs is a button which fits into a recess in the grid and positions the internally threaded boss of the grid in line with the central drilling in the baseplate. This central drilling receives the igniter sleeve. The outlets of the venturi are covered by a celluloid disc which fits over the rear end of the igniter sleeve.

The rear supporting grid is a circular metal plate with six peripheral holes and a central boss threaded to receive the forward end of the igniter sleeve. The grid is supported on three studs in the forward face of the motor base plate.

The forward supporting grid is a square metal plate the four corners of which are bent over to keep the plate clear of the warhead adapter. The grid has one central and six outer drillings. A silk bag, containing the ignition charge, is attached to the forward side of the grid. The bag has a hole in the center to correspond with the central drilling in the grid. The base fuze for the warhead passes through these drillings and is screwed into the warhead adapter.

The propellant consists of one short and seven long monoperforated sticks located between the forward and rear supporting grids.

e. Fuzing and firing mechanism. The fuze threads into the rear end of the warhead adapter and is, in effect, a powder train. Into the forward end of the fuze is threaded a small gaine containing a high explosive, which is actuated by a delay train housed in the body of the fuze. There are no moving parts in the fuze.

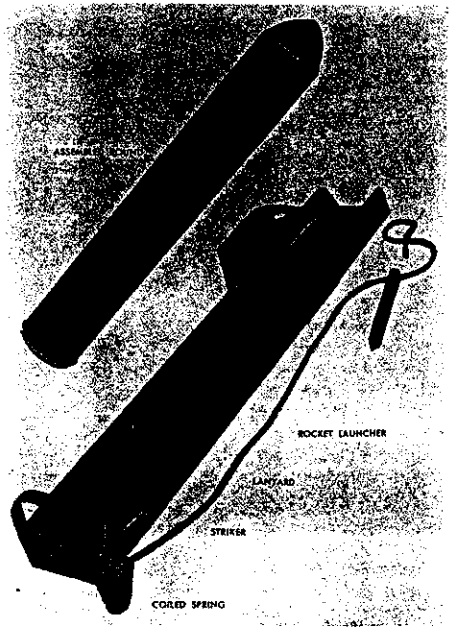


Figure 1.—12-cm incendiary shrapnel rocket and launcher.

The powder delay element is initiated by a small black powder bag, which is crimped to the rear end of the fuze and is in turn initiated by the primer. Field reports indicate that the delay train allows the rocket to travel 2,000 to 3,000 yards before the main charge is detonated.

The firing mechanism consists of the percussion igniter in the igniter sleeve in the motor base plate and the ignition charge attached to the forward grid. Since the central propellent stick bears against the rear of the base fuze for the warhead, the flash from the percussion igniter presumably passes along one or more of the outer sticks and through the corresponding drilling in the forward grid to the ignition charge. This would not appear to be as satisfactory as the normal procedure whereby the perforation in the central propellent stick serves as the flash tube.

2. Technical Data.

Nature of projectile	Multiple base-venting, spin-stabilized, pusher rocket.
Caliber	12.06 cm.
Over-all length (complete projectile).	75.08 cm.
Total weight	22.8 kilograms.
Nature of filling	Incendiary pellets and explosive charge.
Nature of fuze	Delay train from propellant.
Maximum range	2,000 to 3,000 yards.
WARHEAD	
Shape	Cylindrical with ogival nose piece; contains incendiary canister.
Material	Steel.
Dimensions:	
Over-all length	25.4 cm.
Length of cylindrical body	18.09 cm.
External diameter	12.06 cm.
Internal diameter	11.11 cm.
Wall thickness	0.476 cm.
Thread at base:	
Outside diameter	10.63 cm.
Length of threaded portion	1.90 cm.
Threads per inch (right-hand)	Eight.
Wooden nose plug:	
Length	4.76 cm.
Diameter	8.89 cm.
Canister:	
Length	18.89 cm.
Diameter	9.68 cm.
Diameter of burster tube hole	1.59 cm.
Incendiary pellets:	
Number	62.
Diameter	----------
Burster tube:	
Length	17.94 cm.
Diameter	1.11 cm.
Weights:	
Empty	2.86 kilograms.
Wooden nose plug	0.076 kilogram.

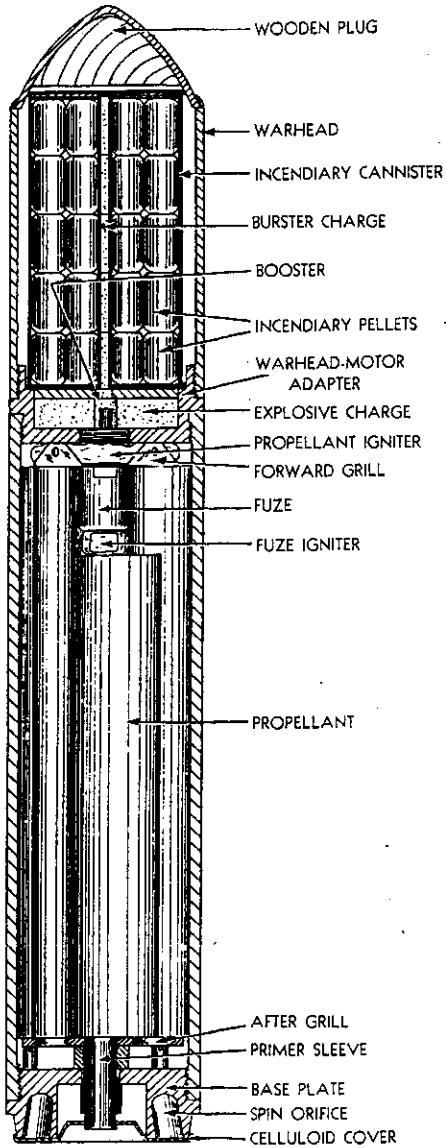


Figure 2.—Internal construction of 12-cm incendiary shrapnel rocket.

Weights—Continued

Canister (complete)	4.83 kilograms.
Incendiary pellets	----------
Burster tube	0.031 kilogram.
Total	7.77 kilograms.
Markings	Painted black over-all with one ½-inch yellow band 3½ inches aft of the junction of the body and the nose piece.

WARHEAD ADAPTER

Dimensions:

Length	5.55 cm.
Diameter	12.06 cm.

Threads fore and aft:

Outside diameter	10.63 cm.
Length of threaded portion	1.90 cm.
Threads per inch (right-hand)	Eight.

Fuze socket threads:

Outside diameter	2.86 cm.
Length of threaded portion	1.59 cm.
Threads per inch (left hand)	15.

Metal plate:

Diameter	9.63 cm.
Diameter of central drilling	0.95 cm.
Thickness	0.65 cm.

Weights:

Weight of adapter plug	1.53 kilograms.
Weight of metal plate	0.37 kilogram.
Weight of explosive charge	0.14 kilogram.
Total weight	2.04 kilograms.
Markings	The following is a translation of a label on the explosive charge in the adapter: "Temporarily designated 12-cm incendiary shrapnel rocket shell bursting charge; Lot No. 224; Mfg. June 1944; Navy Arsenal #3; Cast November 1944; Type of powder-picric."

FUZE

Nature	Powder delay train leading from propellent chamber to explosive charge in the warhead adapter.

Dimensions:

Length	9.52 cm.
Diameter	3.49 cm.
Weight	0.40 kilogram.
Length of delay train channel	----------
Diameter of delay train channel	----------
Length of delay train	----------
Weight of delay train	----------
Composition of delay train	----------

Warhead adapter threads:

Outside diameter	2.80 cm.
Length of threaded portion	1.43 cm.
Threads per inch (left-hand)	15.

Caine recess threads:

Outside diameter	----------
Length of threaded portion	----------
Threads per inch	----------

II–B.402

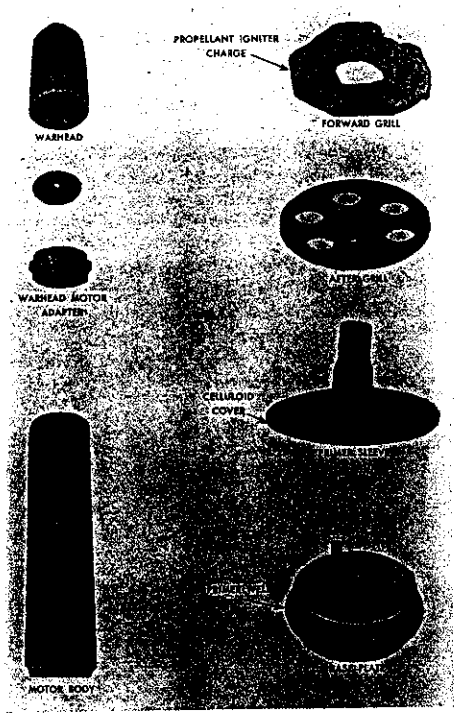


Figure 3.—Component parts of 12-cm incendiary shrapnel projectile.

ROCKET MOTOR:

General	Multiple annular venturi at base. Eight monoperforated propellent sticks. Total weight 28 pounds 9¾ ounces (excluding fuze).

Motor body:

Weight	6.16 kilograms.
Length	43.97 cm.
Length of propellent chamber	39.53 cm.
External diameter	12.06 cm.
Internal diameter	11.11 cm.
Wall thickness	0.476 cm.

Threads fore and aft:

Outside diameter	10.64 cm.
Length of threaded portion	2.22 cm.
Threads per inch (right-hand)	Eight.

Base plate:

Weight	2.2 kilograms.
Length	6.03 cm.
Diameter	12.22 cm.
Supporting studs, length	1.43 cm.
Supporting studs, diameter	0.95 cm.

II–B.402

Motor body threads:

Outside diameter	12.22 cm.
Length of threaded portion	2.22 cm.
Threads per inch (right hand)	Eight.
Igniter well, depth	3.33 cm.
Igniter well, diameter	5.55 cm.

Venturi:

Number and position	Six in annular ring at base.
Type	Convergent-slightly divergent.
Angle of cant	21 degrees (approx.).

Inlet:

Maximum diameter	----------
Minimum diameter	----------
Length	----------

Throat:

Diameter	----------
Length	----------

Outlet:

Minimum diameter	----------
Maximum diameter	----------
Length	----------

Forward supporting grid:

Weight	0.056 kilogram.
Diameter	8.89 cm.
Thickness	0.16 cm.
Length	1.59 cm.
Number of perforations	One central and six outer.
Diameter of central perforation.	4.76 cm.
Diameter of outer perforations	2.06 cm.

Rear supporting grid:

Weight	0.26 kilogram.
Diameter	10 cm.
Thickness	0.476 cm.
Forward projection from base plate.	2.06 cm.
Perforations, number	Six.
Perforations, diameter	1.9 cm.

Igniter sleeve threads:

Outside diameter	2.06 cm.
Length of threaded portion	2.06 cm.
Threads per inch	Nine.

II–B.402

Propellant:

Type	150 Special DT6.
Number of sticks	Seven long and one short.
Length of short stick	26.67 cm.
Length of long stick	35.56 cm.
Diameter	3.33 cm.
Diameter of perforation	0.476 cm.
Weight of short stick	0.38 kilogram.
Weight of long stick	0.49 kilogram.
Total weight	3.84 kilograms.
Composition	Smokeless powder, chemical composition not known.

Method of ignition:

General	Percussion igniter in igniter sleeve in base plate and ignition charge attached to forward supporting grid.
Percussion igniter	Type used is not known since no igniter was present in the recovered specimen.

Igniter sleeve:

Weight	0.099 kilogram.
Length	5.71 cm.
Diameter	2.54 cm.

Forward threads:

Outside diameter	2.06 cm.
Length of threaded portion	2.54 cm.
Threads per inch	Nine.

Rear threads:

Outside diameter	2.06 cm.
Length of threaded portion	0.95 cm.
Threads per inch	Nine.

Ignition charge:

Type	Black powder.
Weight of charge	0.028 kilogram.
Markings	The rocket motor is painted black over-all and has a ½-inch yellow band aft of the flange on the base plate.

A label in the rocket motor gives the following information:

Experimental Incendiary Shrapnel Rocket

Name	Propellant	Bursting charge	Incendiary powder	Special container
Powder Type	150 Special DT6	Picric Acid	Special Compound	
Lot	11 P	#224		
Powder Bag	3K 390	OK 211		
Manufactured:				
Date	Dec 1944	June 1944	Sept 1944	Dec 1944.
Place	#2 Powder Depot	Mitsui	Sagamino Yard	Kure Yard.

Sasebo Navy Yard Dec 1944 SA 9

3. Performance. A field report states that the projectile travels 2,000 to 3,000 yards before the main charge is detonated. There appears to be a hangfire of 2 to 3 seconds. When the warhead bursts, the pellets are scattered over an area approximately 600 feet forward and 60 feet to each side of the point of detonation.

Antitank Rocket Projectile (Unconfirmed).

Although it is fairly certain that the Japanese are producing, or possibly have already produced, some kind of antitank rocket for use in a launcher similar to the American "Bazooka," no specimen has yet been recovered and no report has been received of the use of such a weapon against our armor. Three factors, however, substantiate the belief in the existence of a weapon of this class.

A Tokyo broadcast early this year announced that an individual antitank rocket launcher is being produced at a rate of a million per month and is being issued to all householders. While this is undoubtedly a gross exaggeration it does show that the Japanese are conscious of the possibilities of such a weapon.

Information from a German source indicates that the Japanese have an antitank rocket launcher similar to the German *Panzerschreck*. (The *Panzerschreck* fires an 8.8-mm hollow-charge antitank projectile described under I–B.104.) The only available information on the launcher indicates that it fires a 70-mm projectile.

A recently captured Japanese document, published by the Tateyama Naval Gunnery School, refers to an experimental rocket launcher weighing 31.5 pounds and having a maximum range of 1,650 yards. Two rocket projectiles are mentioned. One of these is an 8-cm rocket for which a penetration of 80 mm of armor plate is claimed. The other rocket is 10 cm in diameter. No other details concerning it are given.

Section III
FUZES

Introduction.

This section is concerned only with those fuzes which are used in complete rocket projectiles and does not include those which are employed in bombs launched by detached rocket motors or bombs forming the warheads of rocket projectiles.

The fuzes used in Japanese rockets are of conventional design and present no features of particular interest. Only two types have been identified so far; these are the Army Type 100 mortar fuze, which can be used for either instantaneous or short delay action, and the Navy Type 4 impact fuze which is a plain point-detonating fuze. These are described under II–C.001 and II–C.002 respectively.

Army Type 100 Mortar Fuze.
(Instantaneous or Short-Delay Action.)
Used on: Army 20-cm projectiles and Navy 45-cm projectiles.

1. Description. a. General. The fuze consists of a nose, body, and gaine, all made of brass. The body is screw-threaded internally to accept the head housing the striker and detonator. The body carries the mechanism in the form of a rotor for setting the fuze for instantaneous action or delay. The base of the body of the fuze is screw-threaded internally to accept the gaine.

The over-all length of the fuze is 3.14 inches; it is 1.26 inches in maximum diameter, and the weight of the empty fuze is 6.45 ounces.

An anodized duralumin cup, with a deep cylindrical projection in the base, fits neatly into the head of the fuze. A small copper-shelled detonator container filled with fulminate of mercury slides easily into the base of the cup. It is held in place by an aluminum stirrup which bears two lugs to engage in slots in the walls of the cup. A shoulder inside the nose has two slots cut at diametrically opposite sides to allow the lugs of the aluminum stirrup to pass through. The whole assembly is rotated 90 degrees after insertion so that the lugs engage in shallow recesses. machined in the underside of the same shoulder. In this way the detonator is locked by the mechanical pressure exerted by the shoulder on the stirrup.

A creep spring holds the detonator and stirrup up against the base of the cup and is itself held by an anodized duralumin striker consisting of a flat head and central pin. The striker head completely covers the floor of the cup and the central pin projects down toward the detonator. An inverted anodized duralumin cup closes the fuze and fits inside the other cup and maintains the whole assembly in position. A copper shear wire, soldered at one end to hold it in the fuze, maintains the two duralumin cups in position. Positioned below the detonator and carried on a shoulder of the fuze body, below the recess for the fuze head, is a brass disc with seven flash holes.

It will be noticed that the cup, striker, and detonator assemblies are identical with those of the fuze for the 81-mm and 90-mm Japanese mortar bomb.

b. Direct action and delay mechanism. The delay mechanism consists of a rotor which can be set for instantaneous action or slight delay. The rotor fits into a semicircular groove, formed in the middle of the body, and is held in position by a brass plug. The rotor is cylindrical and is 20 mm (0.79 inch) long, and 8 mm (0.3 inch) in diameter. It weighs 0.48 gram. Through the rotor are three holes, two diametrically opposite and the third spaced equally between these two so that they join up to form a T channel, when a cross section is viewed. The holes diametrically opposite each other form a flash channel and are not filled; the third hole carries gunpowder.

For direct action the unfilled channel is vertical and the flash passes directly downwards. For slight delay, the rotor is moved through 90 degrees so that the flash channel is horizontal, and the gunpowder channel is underneath. The flash now enters the rotor through the sides and has to pass through the gunpowder channel. Instantaneous or delay action is achieved by turning the

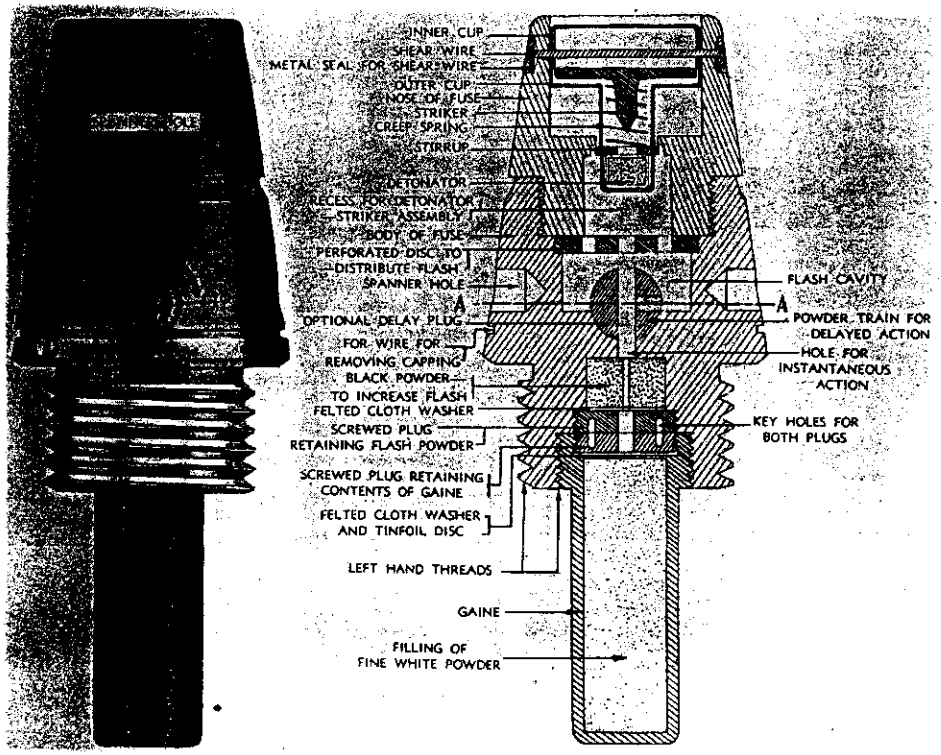


Figure 1.—Army Type 100 mortar fuze.

rotor by means of an external screw, which is covered by tinfoil. A stop screw in the side of the body engages in a groove in the rotor so that movement beyond 90 degrees is not permitted.

c. Booster pellet. This is a perforated gunpowder pellet, 9.65 mm (0.38 inch) high and 5.33 mm (0.21 inch) in diameter. It weighs 0.13 gram. A perforated brass plug screws below the pellet and holds it in position.

d. Gaine. A brass gaine, tubular in form, has an enlarged screwed head (left-hand thread) 17 mm in diameter for insertion in the base of the fuze body. The gaine is closed by a perforated screwed plug below which is a perforated cloth washer and a tinfoil disc. The gaine is 34 mm (1.34 inches) in length and 12 mm (0.47 inch) in diameter. When empty it weighs 0.91 gram. The filling is in two increments. The top filling consists of a small amount of lead azide. It was not possible to analyze the lower filling.

e. Fuze cover. The fuze cover is a thin metal envelope, apparently mainly aluminum, which fits over the fuze, and it is presumed that there is a waterproof seal between the base of the cover and the body of the fuze. A thin brass wire fits in a groove formed at the base of the fuze body, and the end is completed in the form of a ring. This facilitates the removal of the cover.

The cover is intended to render the fuze waterproof and ensure that the duralumin cup at the nose of the fuze is not damaged during transport. A steel stud fits in a small hole in the base of the cover, and this prevents the cover from undue rotation due to rough handling. It may be noted that the rotor cannot be adjusted without removing the cover, and any misplacement of the cover is clear evidence to the gunner that the fuze has been tampered with.

2. Action. On impact with the target, the shear wire is broken and the striker pin is driven inward. At the same time the inertia of the detonator forces the stirrup forward against the creep spring, so that the striker impinges on the detonator. The flash passes through the rotor and the booster pellet to the gaine.

The method of obtaining direct action or short delay is new and it seems doubtful whether it is entirely satisfactory, as the mechanism might not be correctly positioned if the rotor were set hurriedly or carelessly.

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Navy Type 4 Impact Fuze.

Used on: 20-cm Navy projectile and 45-cm Navy projectile.

1. Description. *a. Fuze body.* The body of the fuze is constructed in two parts, a lower body and an upper body or nose piece. The lower body is threaded internally at its upper end to receive the nose piece and both internally and externally at its lower end. The external threads enable the fuze to be screwed into the fuze socket in the nose of the projectile and secured in a slot cut in the upper threads. The internal threads receive the gaine, which is screwed into the fuze with a left-hand thread.

The lower body is bored in two diameters, the lower one being the larger. This lower portion contains the striker guide, which screws into the fuze body, centrifugal detents with their pivot pins, and the detent spring. The upper and smaller diameter drilling supports and provides a guide for the striker. The upper fuze body forms a housing for the striker extension and constitutes the nose of the fuze.

The striker is constructed in two parts: the lower portion or striker proper, and the upper portion which is known as the striker extension. The striker extension has a flat disc at the top which fits just below the copper cover

in the nose of the fuze. The lower end of the extension fits into a drilling in the nose of the striker proper where it is free to move for a short vertical distance like a piston. The extent of this vertical movement is limited by a shoulder on the striker extension. The striker proper is in two diameters. The upper and larger section receives the striker extension. The lower end of this larger diameter section has a shoulder where the diameter decreases to form the lower section which terminates in a needle-type striker. In the unarmed position the shoulder rests on the five eccentric detents, each of which is pivoted about a detent pivot pin located in the upper surface of the striker guide.

These five detents pivot inward and interlock, with the exception of the master detent which will clear the others. This master detent is the key element in the arming of the fuze. The detents are surrounded by a circular detent spring which tends to hold them in the locked position. In this unarmed position the detents engage the shoulder on the striker and positively prevent any downward movement. This assembly is mounted on the striker guide, which screws into the lower fuze body and is drilled axially to take the striker and provide a guide for it immediately above the gaine.

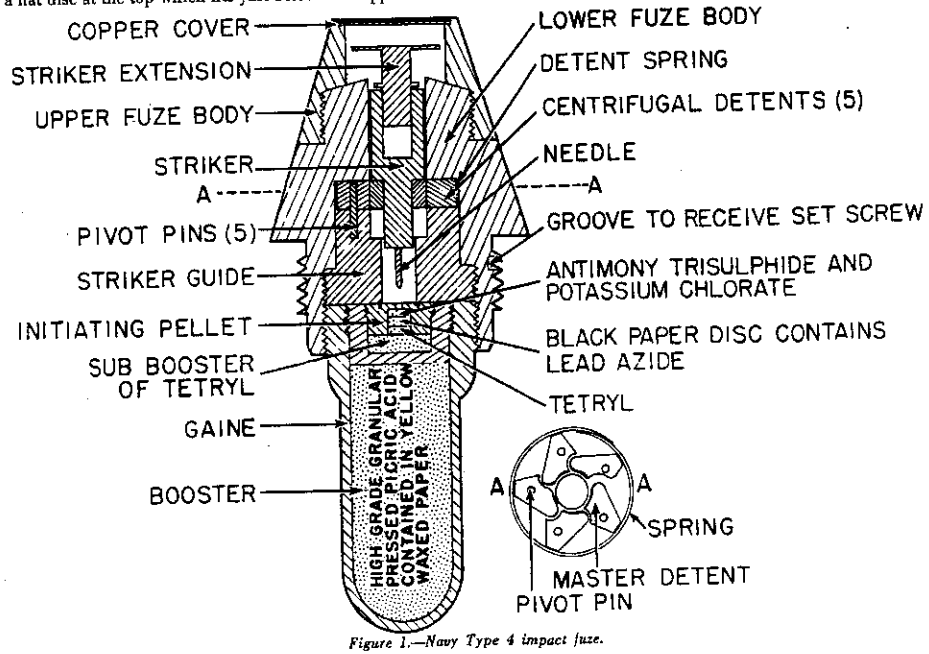

Figure 1.—Navy Type 4 impact fuze.

b. Gaine. The gaine used in this fuze is of standard construction and resembles the usual Japanese projectile gaine in appearance and design. The gaine is screwed into the lower fuze body and at its upper end has a screwed-in cup containing the upper gaine charge, which consists of the initiating pellet and a sub-booster. The initiating pellet consists of three layers of explosive arranged with the priming mixture of antimony trisulphide and potassium chlorate at the top, a black paper disc containing lead azide in the center, and tetryl at the bottom. The sub-booster is tetryl. Below the sub-booster is a booster in the form of a finger of high-grade picric acid contained in yellow waxed paper.

2. Operation. As the rocket moves forward, the striker moves back upon the centrifugal detents and, together with the detent spring, prevents their outward movement. As soon as the propellant has completely burned, the rocket decelerates and creep begins. The striker then creeps forward away from the detents, which swing out in sequence under centrifugal force and expand the detent spring. When the detents have all swung outward, the striker channel is clear and the striker is free to be driven forward on impact and pierce the initiating pellet, causing the detonation of the main charge.

3. Tabulated Data.

	Source 1	*Source 2*
Weight of fuze complete	807.2 grams	692.3 grams.
Weight of gaine complete	221.6 grams	100.2 grams.
Weight of picric booster	28.5 grams	28.5 grams.
Weight of striker complete	———	23.9 grams.
Weight of one detent	———	2.2 grams.
Weight of detent spring	———	1.5 grams.
Length of fuze over-all, with gaine	132 mm	134 mm.
Length of fuze over-all, less gaine	———	68 mm.
Length of gaine	70 mm	66 mm.
Maximum diameter of fuze	58 mm	54 mm.
Fuze threads:		
Length of threaded portion	16 mm	———
Outside diameter	47 mm	———
Threads per inch (U. S. Std.)	12	———
Gaine threads:		
Length of threaded portion	12 mm	———
Outside diameter	35 mm	———
Threads per inch (U. S. Std.)	16	———

4. Marking. A label on the fuze gives the following information:

Fuze for 20-cm Rocket Projectile

Loading No.	Kure AAA.
Lot	M 66.
Powder manufactured	February 1941.
Fuze manufactured	June 1944 at Kure Arsenal.

Instructions: Do not open except for actual use or testing.

Section IV

PROPELLANTS AND FILLINGS

1. Propellants. *a. General.* All Japanese propellants so far encountered have been of normal cylindrical monoperforated construction and manufactured from a conventional double-base powder. Similarly the methods of igniting the propellants have shown no features of interest and consist simply of mechanical or electrical igniters and an ignition charge attached to one of the propellent supporting grids.

b. 150 Special DT6. Following are the characteristics of this propellant, which is used in the 12-cm incendiary shrapnel rocket.

Type	Monoperforated.
Color	---------
Length of stick	26.67 cm.
Diameter	3.33 cm.
Diameter of perforation	0.476 cm.
Weight	0.38 kilogram.
Density	1.672 gm/cc.
Composition	Not known.

c. 240 Special DT2. This propellant is used in the 20-cm Navy projectile.

Type	Monoperforated.
Color	---------
Length of stick	29 cm.
Diameter	5.8 cm.
Diameter of perforation	1.1 cm.
Weight	1.162 kilograms.
Density	1.571 gm/cc.
Composition:	
Nitrocellulose	65 percent.
Nitroglycerine	30 percent.
Sodium chloride	2 percent.
Centralite	3 percent.

It is believed that the green sticks of propellant used in the 45-cm Navy projectile are also designated 240 DT2.

Composition:	
Nitrocellulose	65.1 percent.
Nitroglycerine	29.1 percent.
Stabilizer	5.8 percent.
Density	1.503 gm/cc.

d. 240 Special DT6. This propellant is used in the 45-cm Navy projectile.

Type	Monoperforated.
Color	Dark red.
Length of stick	38.735 cm.
Diameter	5.867 cm.
Diameter of perforation	1.041 cm.
Weight	1.517 kilograms.
Density	1.503 gm/cc.
Composition:	
Nitrocellulose	60 percent.
Nitroglycerine	37 percent.
Stabilizer	5.8 percent.

e. Propellant for 20-cm Army projectile. The nomenclature of this propellant has not been determined, although a Japanese document, referring accurately to the weight of propellant used in the Army 20-cm projectile, designates the propellant as "#5824 cylindrical grain powder."

Type	Monoperforated.
Color	---------
Length of stick	34 cm.
Diameter	5.8 cm.
Diameter of perforation	1.05 cm.
Weight	1.36 kilograms.
Density	1.563 gm/cc.
Composition:	
Nitrocellulose	65.4 percent.
Nitroglycerine	32.1 percent.
Stabilizer	2.5 percent.

f. Propellant for 19-cm Type 10 rocket motor. The Japanese designation for this propellant is not known.

Type	Monoperforated.
Color	---------
Length of stick	26 cm.
Diameter	7.95 cm.
Diameter of perforation	1.08 cm.
Weight	1.96 kilograms.
Density	1.548 gm/cc.
Composition:	
Nitrocellulose	43.3 percent.
Nitroglycerine	56.7 percent.

g. Propellant for 19-cm Type 3 rocket motor. The Japanese designation for this propellant is not known.

Type	Monoperforated.
Color	---------
Length of stick	51 cm.
Diameter	7.75 cm.
Diameter of perforation	1.12 cm.
Weight	3.9 kilograms.
Density	1.56 gm/cc.
Composition	Double-base powder; percentage composition not known.

2. Fillings. Only two types of fillings have been identified. These are the Type 91 explosive (trinitroanisol), which is used in the 20-cm Navy rocket and the Type 98 explosive used in the 45-cm Navy rocket. No analysis of the Type 98 is available.

Section V

FIRING SYSTEMS

The Japanese have produced no firing systems comparable in intricacy of design to the electrical igniters and initiators used by the Germans (I–C.000). The earlier types of rocket motors, 19-cm Types 10 and 3 and 30-cm Special Mark I, all used a simple ignition charge fired by a current supplied from a hand exploder. The 20-cm Army projectiles utilize a simple pull igniter and the three types of Navy rockets employ a percussion igniter.

Section VI

LAUNCHERS

CONTENTS

INTRODUCTION

The earlier types of rocket launchers, like the earlier projectiles, were essentially crude models improvised from materials available. They consisted of metal or wooden troughs. The first tube-type launcher was the one used with the Navy 20-cm rocket; although this was somewhat crudely designed and constructed, it showed a definite improvement over the original trough-shaped launchers for this projectile and represented the initial effect of the influence of German design.

The Type 4 (1944) launcher for the Army 20-cm rockets is the only launcher so far encountered to which a type number has been given and represents the first production model. This launcher is not copied from any German rocket launcher, but appears to be a pure Japanese design, although, of course, the principle of employing a tube to launch the projectile is originally German.

It seems doubtful whether the Japanese will produce a multiple launcher of the German *Nebelwerfer* type, since,

generally speaking, the terrain is not favorable for the employment of multiple-type launchers, which cannot be manhandled over distances as easily as a single launcher, which may be broken down into pack loads. At the same time, it is highly probable that in static positions, such as beach defenses, multiple launchers may be used to supplement mortar and artillery fire. It would seem probable that the heavier projectiles, such as the 45-cm Navy rocket, will be used in this role.

Figure 1.—Tube launcher for 20-cm Navy projectile

GROUND TUBE-TYPE LAUNCHERS

Launcher for 20-cm Navy Projectile.

1. General Description. This launcher (Figure 1), the first of the tube type to be captured from the Japanese, consists basically of a barrel or tube, from which the projectile is launched, and a light two-wheeled carriage with a fixed trail.

The barrel is an open smooth-bore tube about 6½ feet long and fitted with a reinforcing band at the breach end. It is trunnioned to the saddle about 50 cm. from the breech end. Elevation and depression are effected by means of a lever and quadrant arm attached to the left of the barrel and riding in an elevating arc on the saddle; the barrel is locked at the required elevation by means of a securing clamp (Figure 2). There is no traversing mechanism, and the trails must be raised and reset for every change in azimuth.

Inside the breech end of the barrel (Figure 2) and on the underside is a spring-loaded retaining plunger which is depressed as the projectile is loaded. When the projectile is fully home, the plunger rises and prevents the rocket from sliding to the rear.

The firing mechanism (Figure 2) consists of a hammer pivoted about a short horizontal shaft mounted on the top

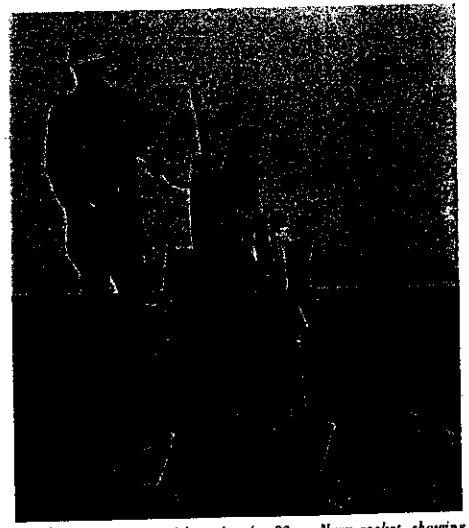

Figure 2.—Rear view of launcher for 20-cm Navy rocket, showing operation of elevating clamp and firing mechanism.

of the breech end of the barrel. A short arm, to which a firing lanyard is secured, is attached to the end of the shaft. When the lanyard is pulled, the hammer rotates in a vertical plane and strikes the percussion cap in the base of the projectile.

The carriage for the firing tube, shown at maximum elevation in Figure 3, consists of a saddle (U.S.: upper carriage) mounted on a cross-member and a light trail. The arms on each side of the cross-member carry the axle and wheels of the carriage. The wheels appear to be fitted with heavy solid-rubber tires and apparently have no brake drums or spring suspension. The trail consists of two tubular metal arms joined by two cross-members and fitted with heavy spades. No sighting mechanism appears to be fitted to the carriage.

2. Technical Data.

Over-all length, carriage and tube	3.18 meters.
Total weight	236 kilograms.
Maximum elevation	75 degrees.
Maximum depression	5 degrees.
Traverse	None.
Carriage length	1.87 meters.
Carriage weight	91 kilograms.
Barrel length	2 meters.
Barrel weight	74 kilograms.
Barrel diameter (inside)	203 mm.
Wheel diameter	0.68 meter.
Wheel weight	70 kilograms.
Wheel track	0.85 meter.

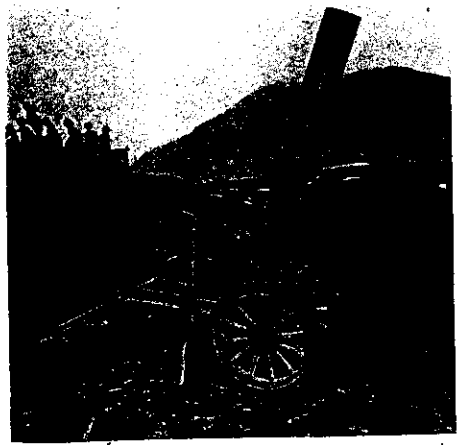

Figure 3.—Launcher for 20-cm Navy rocket at position of maximum elevation.

Type 4 (1944) Launcher.

Projectile fired: Army 20-cm rocket.

1. General Description. *a. General.* The Type 4 launcher (Figure 1) is used for launching the two models of the Army 20-cm spin-stabilized projectile, and is the first launcher to which a Japanese type number has been given. It is, for this reason, of particular interest since it represents the first proper production model. The launcher is similar in appearance to any standard mortar and consists basically of a barrel, bipod, and base plate. The whole assembly weighs about 230 kilograms (507 pounds) and may be transported either in one piece or broken down into the three component parts.

b. Launcher tube. The barrel or tube (Figure 3) is made of machined steel with a ¼-inch wall thickness throughout and is constructed in an upper and lower section. The upper section of the tube is supported at the forward end by a tube clamp which is attached to the bipod (Figure 1). The lower section is split longi-

Figure 1.—Type 4 (1944) launcher for Army 20-cm rocket.

Figure 2.—Type 4 launcher in action.

tudinally, permitting the upper half, which is hinged at the forward end, to be raised for loading the rocket into the breech of the launcher (Figure 3). After the rocket is placed in the tube, the hinged section is lowered and secured in place by four locking clamps, two on each side. Two studs in the lower section of the tube prevent the rocket from sliding to the rear after it has been loaded. As shown in Figure 3, the rocket is loaded by the use of two-handled loading tongs. The bottom half of the lower section of the tube has two hinged shutters, one on each side, which swing down to accommodate the tongs while the rocket is being loaded (Figure 3). The shutters are grooved at the top and are locked in the closed position by the hinged upper half.

The hinge of the upper part of the lower section is constructed of ⅝-inch steel stock, and the machined steel hinge bolt is 7.38 inches long by 11/16 inch in diameter. A machined steel hoop, 4 inches wide by ⅜ inch thick, is riveted and welded to the top of the lower part of the tube. The upper half of the hinge is welded to this hoop. Three ⅝-inch toggle bolts, which fasten the upper and lower sections of the tube together, are also welded to this hoop.

A wooden buffer is fastened to the middle of the hinged section to support the tube when the segment is raised to the open position. Two wedge-shaped steel studs

Figure 3.—Type 4 launcher with rear cover raised and projectile in position. Note tongs used to carry projectile. The spades on the base plate should be forward of the breech and not to the rear, as shown here.

made from ⅝-inch bolt stock are inserted into drilled holes located ⅞ of an inch from the open breech end of the lower tube section. These studs are spaced 4.5 inches apart, and extend 1 inch into the tube. The studs are secured to the outer surface of the breech by a ⅜-inch bolt. The base of the rocket rests against these studs when it is loaded into the tube. A heavy steel stud is riveted and welded 4 inches up from the breech end of the lower segment of the tube. To this is welded the spherical projection which fits into the socket of the base plate. The upper tube section is 28.25 inches long and is machined in one piece. The upper and lower tube sections are beveled and machined to fit at the junction point. They are clamped together by the three ⅝-inch toggle bolts which fasten into adapters on a hoop fastened to the lower end of the upper tube section.

Provision is made for rapidly carrying the entire tube assembly. One carrying pole adapter is placed at the muzzle end and two are placed at the breech end. These allow the fitting of three carrying poles for rapid movement of the assembled tube. Another pole adapter at the top of the lower tube section permits that section to be carried by three poles when the tube is disassembled.

c. Base plate. The base plate (Figure 4) is 15 inches long and 8 inches wide, with a reinforced raised socket 8 inches high. The base plate is bolted to an open framework constructed of four pieces of angle iron. The outside dimensions of this framework are 31.5 inches by 28.25 inches. Two spades of the standard artillery type are driven through brackets at the front corners of the outrigger. These spades can be clamped into position across the framework for transport. The base plate with the raised socket is fastened almost at the extreme rear of the framework. The main portion of the framework extends toward the bipod. Firing tests have shown that if the driven spades are placed behind the tube, the rocket blast will dig out the spades.

d. Bipod. The bipod (Figure 5) contains an elevating and traversing mechanism which appears to be almost identical with that of the standard Japanese trench mortars. However, the cross-leveling device is not the standard Japanese type, but consists of a horizontal screw which, instead of lengthening one leg, tilts the elevating screw holder. This system is very similar to that used on the German 81-mm mortar. The elevating and traversing gears are buttress type. The elevating crank is located on the front of the elevating gear case. The crank has a 5-inch arm, with a ball counterbalance on one end. The traversing gear handwheel is located on the left side, and is equipped with a small 2-inch hinged hand-crank extension.

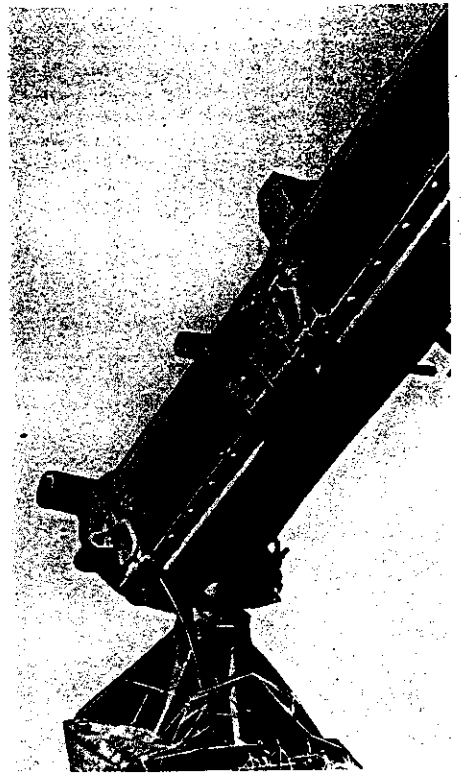

Figure 4.—Lower half of Type 4 launcher tube showing catches for securing rear cover, rear carrying handle, and base plate.

The collimator sight bracket is bolted to an extension of the saddle (U. S.: upper carriage). The saddle, an integral part of the yoke, is, for the most part, made of 7/16-inch-by-3.125-inch rolled steel, with welded construction. The cross-leveling screw is located on the right side, as in the Japanese mortars, so the launcher can be cross-leveled from the right, using the level built into the yoke, but cannot be leveled by the operator from the left side at the sight position. The bipod legs are 36 inches long and, for the most part, are manufactured of two pieces of ⅜-inch-by-1.5-inch steel. The two parts of the leg are hinged to each side of the elevating gear box. The leg sections are fastened to extensions of the feet, and are braced at two points between the upper and lower fastenings. A 36-inch chain is fastened to the lower portion

of the bipod legs. The legs end in cupped steel feet, with spiked points. The cup is 6 inches in diameter.

e. Firing mechanism. The firing mechanism is simply a lanyard consisting of a 23.5-foot piece of ⅜-inch rope which is attached to a 23-inch section of doubled ⅛-inch steel cable by means of a hook. A hook is fastened to the far end of this cable for fitting into the loop of the pull igniter. There are apparently no safety features to prevent accidental discharge of the weapon once the lanyard is attached to the primer.

Figure 5.—Bipod joint and sight bracket of Type 4 launcher. Note junction of upper and lower halves of tube.

2. Tabulated Data.

Length of tube	190.5 cm.
Diameter of tube	20.3 cm.
Length of upper part of tube	71.1 cm.
Length of lower part of tube	119.4 cm.
Length of bipod legs	91.4 cm.
Length of base plate	38.1 cm.
Width of base plate	19.3 cm.
Weight of upper part of tube	31 kilograms.
Weight of lower part of tube	86 kilograms.
Weight of bipod	20 kilograms.
Weight of yoke and sight	46.3 kilograms.
Weight of base plate	44 kilograms.
Total weight	227.3 kilograms.

GROUND FRAME-TYPE LAUNCHERS

Launcher for 19-cm Type 10 Rocket Motor.

Projectiles fired: 19-cm Type 10 rocket motor and 60-kilogram aircraft bomb.

1. General Description. The launcher (Figure 1) is a V-shaped trough built in two sections and made of wood reinforced with sheet metal. The two sections, carried separately, are locked together in position for firing by a plate on the underside of the trough. At the rear end of the trough is a sheet-metal cover which serves as a motor-and-bomb positioner. This cover is hinged in three places on the right of the launcher. It is closed over the projectile for firing.

The trough is supported by a bipod, hinged to the underside of the plate locking the two sections of the trough. A cable runs from the base plate to the base of each leg and between the legs. This cable has a number of hooks corresponding to angle of elevation for the launcher. The required elevation may be obtained by attaching the appropriate hooks to the bipod legs.

Two electrical leads are attached to the left side of the launcher. The wires found with one launcher were about

20 meters long and the igniter leads were opposite the connections when the motor was in position.

The base plate is a rectangular metal plate with spikes on the underside. The launcher is secured by a pin to two vertical lugs on the upper side of the base plate. The cables leading to the bipod legs are attached to the corresponding ends of this pin.

2. Tabulated Data.

Over-all length	6 meters.
Length of base section	3.5 meters.
Length of front section	2.5 meters.
Thickness over-all	2.6 cm.
Thickness of wood	2.55 cm.
Height at −30 degrees range setting	3.3 meters.
Length of leg	3.7 meters.
Diameter of leg	2.75 cm.
Width, outside of trough at base	25.4 cm.
Width, outside of trough at front	19.1 cm.
Width, inside of trough at base	21.6 cm.
Width, inside of trough at front	15.2 cm.
Length of cable, base plate to leg	6.1 meters.
Length of metal cover	1.2 meters.
Thickness of base plate	1.2 cm.
Width of base plate	47.7 cm.
Length of base plate	36.5 cm.
Number of base plate spikes	Six.
Length of base plate spikes	15.3 cm.

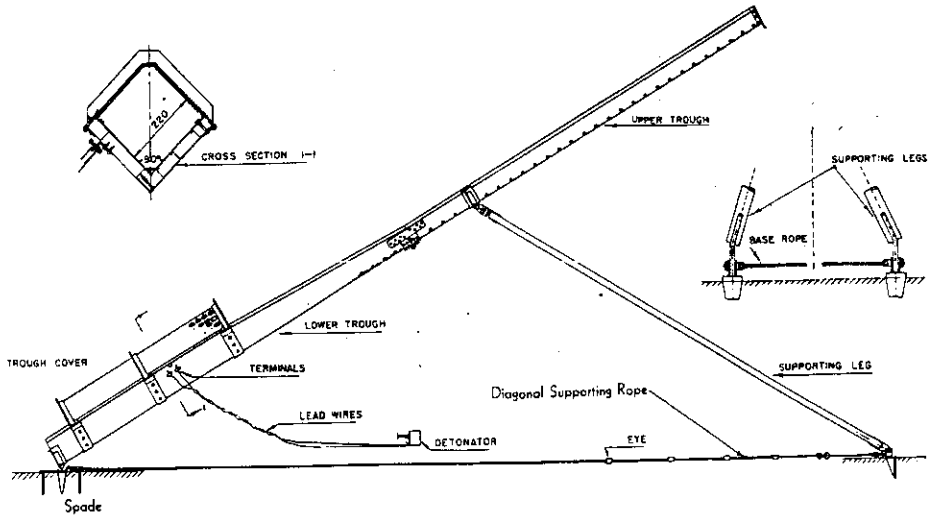

Figure 1.—Launcher for 19-cm Type 10 rocket motor.

Launcher for 19-cm Type 3 Rocket Motor.

Projectiles fired: 60-kilogram Type 97 land bomb and 63-kilogram ordinary bomb.

The full description of this launcher is not available. However, it consists merely of a single wooden ramp supported at the forward end by a bipod as shown in Figure 1 of section II-B.102 (page 56). As with the launcher used for the 19-cm Type 10 rocket motor, the rocket motor and bomb are loaded into the launcher and the firing leads from the motor connected to an exploder in a flank firing position.

Launcher for 45-cm Navy Projectile.

This launcher (Figure 1) resembles a small oxcart and when it was used in test firing of the 45-cm rocket it fell to pieces. The launcher contains two 12-foot beveled timber rails, 3 inches by 4 inches, mounted on a two-wheel carriage. The wheels are solid wooden discs approximately 36 inches in diameter. The wooden wheel brakes and rail extensions are used to prevent movement caused by blast. The rear view of the launcher (Figure 2) shows the firing hammer to which a lanyard is attached.

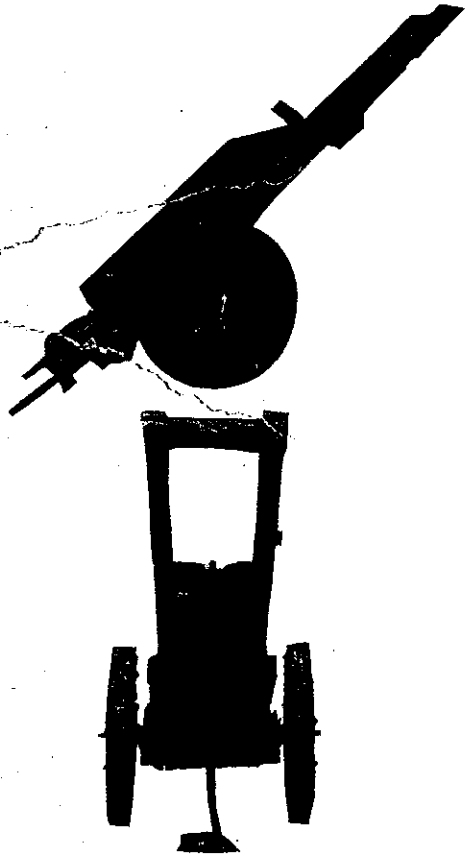

Figure 1.—Launcher for 45-cm Navy projectile.

Figure 2.—Rear view of launcher for 45-cm Navy rocket, showing firing hammer.

ANTIAIRCRAFT AND AERIAL LAUNCHERS

12-cm Shipborne Multiple Antiaircraft Rocket Launcher (Unconfirmed).

1. General Description. A recently captured Japanese document, emanating from the Yokosuka Naval Gunnery School, gives brief details of this launcher, which is intended for use against torpedo planes and dive bombers. Marginal notes on the document indicate that it is to be installed in battleships, cruisers, and escorts.

The launcher, which bears a certain external resemblance to the German *Föhn Gerät*, consists of a launching assembly and a mounting. The launching assembly is a rectangular box containing 28 launching tubes arranged in four horizontal rows, each of seven tubes. Four cables lead from a junction box on the side of the assembly to the rear ends of the four rows of tubes. A common lead from the junction box is connected to a switch box which appears to house a selector mechanism of some kind. Details of the electrical firing mechanism are not available, but this layout suggests that the projectiles may be fired either in four salvoes, each of seven rounds, or all 28 together.

The mounting consists of a standard 25-mm triple gun mount, with the launching assembly trunnioned to the two vertical supports. An elevating handwheel is provided on the left support. No traversing mechanism can be seen, but it seems probable that an electric motor on the base of the mount is used for this purpose.

2. Technical Data.

Number of tubes	28.
Length of tubes	150 cm.
Elevation	10 to 80 degrees (no depression).
Traverse	360 degrees.
Maximum range	4,500 meters at 50 degrees.
Maximum height	2,600 meters at 80 degrees.
Loading time	3 to 5 minutes (estimated).

3. Performance. The projectile appears to be identical with the 12-cm incendiary shrapnel rocket described under II-B.402, with the percussion igniter replaced by an electrical igniter of some kind. According to the Japanese document, the projectile has a maximum initial velocity of about 240 meters per second and, with a delay of 8 seconds, will burst at 1,500 meters. A note with these figures states that with its present construction, a 28-round salvo is "difficult."

Detailed instructions for the use of this launcher show that the gun crew must wear fireproof clothing, flying shoes, gloves, and a gas mask for protection against the blast. When firing against dive bombers, the second or third plane is to be tracked and three or four salvoes are fired against each target. Against torpedo planes, instructions are to aim at the point of enemy torpedo launching at about 15 degrees elevation.

LAUNCHERS FOR NON-STANDARD AND UNCONFIRMED PROJECTILES

Launcher for 68-mm Projectile.

1. General Description. This launcher (Figure 1) consists basically of launching rails, elevating and traversing gears, and a tripod mount. For carrying, the launcher is broken down into two sections. The launching assembly consists of three rails, one on top and two below, secured by two spacing segments and a circumferential locating ring at the rear. The rear spacing segment is trunnioned to two light metal supports about which the launching rack is elevated. These supports are mounted on a circular disc which fits into the top of the tripod and enables the launching assembly to be traversed. Normal elevating and traversing handwheels are fitted. Open sights are mounted on the forward and rear spacing segments. There is no firing mechanism included in the construction of the launcher.

2. Tabulated Data.

Length of guide rails	79.8 cm.
Width of guide slots	0.78 cm.
Depth of guide slots	0.31 cm.
Weight of tripod	13.5 kilograms.
Weight of launching assembly	26.9 kilograms.
Length of tripod legs	94.5 cm.
Approximate height of launcher	126.5 cm.
Traverse	50 degrees.
Elevation	0 to 90 degrees.

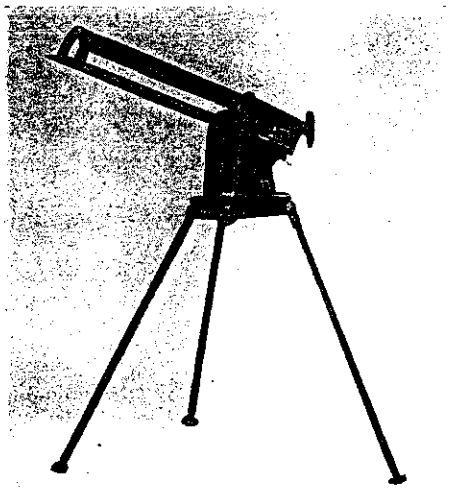

Figure 1.—Launcher for 68-mm projectile.

Launcher for 12-cm Navy Projectile.

Two types of launcher for this projectile have been found. The two are the same except that one is fixed in elevation whereas the elevation of the other type may be changed. The launcher (shown in II–B.402, Figure 1), consists of a wooden trough with metal brackets secured to the after and forward ends. The after-end bracket is fitted with a pivoted striker. Until operated by a lanyard, the striker is held away from the primer cap by a spring. A small wooden peg is inserted through the hole in the forward bracket to secure the rocket in place. The peg is removed immediately before the rocket is fired.

Section VII

TABULATION OF TECHNICAL AND BALLISTIC DATA

General Analysis

TYPE OF PROJECTILE	12-cm Incendiary Shrapnel Rocket	20-cm Navy Projectile	20-cm Army Projectile	45-cm Navy Projectile
1. Caliber	12.06	21.05	20.30	45.09
2. Stabilization	Spin	Spin	Spin	Spin
3. Filling	Incendiary pellets and HE charge	Trinitroanisol	Cast TNT	Type 98 Explosive
4. Fuzing	Delay train from propellant	P. D.	P. D.	P. D.
5. Igniter	Percussion	Percussion	Pull	Percussion
6. Total Length (cm.)	75.08	107.1	92.9	171.45
7. Total Weight (kg)	22.84	90.7	81.63	682.29
8. Maximum Range (m)	2000–3000	1800	3020	2000
9. Weapons from which Fired	Launcher on suicide craft	Tube or frame type launchers	Type 4 Launcher	Wooden trough launcher

Weight Analysis

TYPE OF PROJECTILE	12-cm Incendiary Shrapnel Rocket	20-cm Navy Projectile	20-cm Army Projectile	45-cm Navy Projectile
1. Weight of Filling (kg)	4.83	17.5.	16.2	180.45
2. Weight of Propellant (kg)	3.83	8.3	9.52	59.18
3. Motor Weight (complete) (kg)	12.9	40.0	42.43	258.07
4. Weight of Empty Projectile (kg)	14.18	64.9	55.91	442.66
5. Total Weight	22.84	90.7	81.63	682.29
6. Ratio: Charge/Total Weight	1/4.72 21.2%	1/5.18 19.3%	1/5.03 19.9%	1/3.78 26.5%
7. Ratio: Propellant/Total Weight	1/5.96 16.8%	1/10.9 9.17%	1/8.55 11.7%	1/11.5 8.70%
8. Ratio: Propellant/Motor Weight	1/3.35 29.9%	1/4.80 20.8%	1/4.44 22.5%	1/4.37 22.9%
9. Ratio: Charge/Propellant	1.26/1	2.11/1	1.69/1	3.04/1

Tabulation of Technical and Ballistic Data—Continued.

Propellant Analysis

TYPE OF PROJECTILE	12-cm Incendiary Shrapnel Rocket	20-cm Navy Projectile	20-cm Army Projectile	45-cm Navy Projectile
1. Number of Sticks	(a) 7 long (b) 1 short	7	7 (Central divided in 2)	39
2. Shape and Perforations	Monoperforated	Monoperforated	Monoperforated	Monoperforated
3. Length (cm)	(a) 35.56 (b) 26.67	29.0	34.0	38.735
4. Outer Diameter (cm)	3.33	5.8	5.8	5.867
5. Inner Diameter (cm)	0.476	1.10	1.05	1.041
6. Web (cm)	1.427	2.35	2.38	2.413
7. Diameter of other Perforations (cm).	Nil	Nil	Nil	Nil
8. Total Weight (kg)	3.83	8.3	9.52	59.18
9. Surface Area (cm^2)	3985	5542	6384	40560
10. Volume (cm^3)	2351	5165	6088	39555
11. Density (gm/cm^3)	1.6289	1.6069	1.5638	1.4959
12. Composition	Smokeless powder	N. C./N. G.	N. C./N. G.	N. C./N. G.

Motor Design Analysis

TYPE OF PROJECTILE	12-cm Incendiary Shrapnel Rocket	20-cm Navy Projectile	20-cm Army Projectile	45-cm Navy Projectile
A. MOTOR BODY				
1. Weight (including baseplate and grids) (kg)	8.676	29.678	32.31	198.83
2. Wall Thickness (mm)	4.76	10.0	(a) Ends 14 (b) Center 7	21
3. External Diameter (cm)	12.06	21.05	(a) 20.3 (b) 18.9	45.09
4. External Length (cm)	43.97	46.0	48.4	68.58
5. Cubic Capacity (cm^3)	3831	11259	9621	61745
6. Density of Loading	61.38%	45.88%	63.29%	64.08%
B. VENTURI				
1. Number	6	6	6	6
2. Type	Convergent/slightly divergent	Convergent/parallel	Convergent/parallel	Convergent/divergent
3. Final Diameter D_f (mm)	.....	15	15	52.37
4. Throat Diameter D_t (mm)	.....	15	15	41.15
5. Expansion Ratio	.....	1	1	1.27
6. Angle of Cant	c. 21°	25°	25°	18°30′

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APPENDIX A

GLOSSARY OF TERMS USED IN CONNECTION WITH REACTION PROPULSION

Angle of cant: The angle formed by the axis of a venturi tube and the longitudinal axis of the projectile in a spin-stabilized rocket.

Angle of roll: The angle formed by the diametral axis of a missile and the perpendicular to the vertical trajectorial plane.

Angle of pitch: The angle formed by the longitudinal axis of the projectile and the trajectorial tangent.

Angle of yaw: The angle formed by the longitudinal axis of the projectile and the vertical trajectorial plane.

Athodyd: Abbreviation for aerial thermodynamic duct. See Constant flow pulsating jet.

Axial flow turbo-jet: The main difference between this type of jet and the centrifugal flow type lies in the construction of the compressor. In this unit, air is drawn in at the front and passes axially along the compressing unit into the combustion chamber.

Axis of pitch: Diametral and perpendicular to the vertical trajectorial plane.

Axis of roll: Central and along the length of the missile.

Axis of yaw: Diametral and in the vertical trajectorial plane.

Bifuel: A term referring to the propelling medium of a propulsion system and indicating that it consists of two separate media.

Burning rate: The rate at which a propellant is consumed. For solid fuels this is given by the equation: $M_b = S\rho r$ (pounds per second), where S = surface area (square inches); ρ = density (pounds per cubic inch), and r = rate of surface regression (inches per second).

Burnt velocity: The velocity of a projectile at the moment when the propellant is completely consumed.

Centrifugal flow turbo-jet: The principle of operation of this type of jet is as explained under Turbo-jets and the name is derived from the type of compressor used. The type incorporated in this unit draws air in through the front and expels it through circumferential ducts leading into the combustion chamber.

Centrifugal or axial flow propellor turbine: This is not, in the strict sense, a turbo-jet, but is a development of the centrifugal flow and axial flow turbo-jets with the addition of a propellor on the front of the compressor.

Chuffing: The burning of a propellant at a sub-normal pressure. Either a small ratio of the surface area of the powder to the nozzle area or a low powder temperature will produce this effect. This reduction in pressure causes the propellant to burn spasmodically in a series of cycles. The small puff of smoke and flame often observed after the main body of the propellant has burnt is a minor form of chuffing.

Coefficient of thrust: This is a dimensionless quantity obtained by dividing the thrust by the product of the chamber pressure and the throat area. See Thrust.

Constant flow duct: This is a true athodyd, that is it has no moving parts, consisting merely of a double venturi tube (open at both ends) with a combustion chamber in the center. This method of reaction propulsion represents the simplest form of jet. The disadvantage of this system is that it relies entirely on an initial forward motion for its air supply, and therefore, no thrust can be obtained while this duct is in static condition.

Control, electrical: The control of the flight of a missile by a self-contained electrical unit. An example is the use of the accumulated static charge on the surface of a missile to control the fuel supply.

Control, homing: A system by which a missile steers itself towards a target by a self-contained mechanism, actuated by heat, light, or sound, or by electromagnetic waves emanating from the target.

Control, mechanical: Control of the flight of a missile by clockwork, airlog, gyroscope, or similar mechanism.

Control, radio: The control of a missile after launching by means of electrical impulses transmitted by radio from the launching agency to a radio receiver in the missile.

Control, wire: The control of a missile after launching by means of electrical impulses transmitted over a wire circuit connecting the missile with the launching agency.

Density of loading: Ratio of the volume of the propellant to the internal volume of the propellent chamber.

Double base: A term used in connection with propellent powders indicating that the powder is composed of two main constituents, such as nitroglycerine and nitrocellulose.

Expansion ratio: Ratio of the final area of a venturi tube to the throat area ($R = A_f/A_t$).

Fin stabilization: In this method of stabilization, the projectile is maintained on its trajectory by the fitting of fins to the tail. A fin-stabilized projectile does not rotate about its axis during flight. See Stabilization and Spin stabilization.

Fissuring: An abnormal type of burning in which the powder apparently ignites below the burning surface. This causes a powder break-up, the exposure of fresh burning surfaces, and the consequential rise in pressure.

Grain: Solid stick of propellant.