U
113
.A2
C343156 A

WAR DEPARTMENT FIELD MANUAL

FM 9-40

ORDNANCE

•

UNEXPLODED BOMBS

ORGANIZATION AND OPERATION

FOR DISPOSAL

WAR DEPARTMENT • OCTOBER 1943

Digitized by Google
Original from UNIVERSITY OF MICHIGAN



Digitized by Google
Original from
UNIVERSITY OF MICHIGAN

WAR DEPARTMENT FIELD MANUAL

FM 9–40

ORDNANCE

•

UNEXPLODED BOMBS

ORGANIZATION AND OPERATION FOR DISPOSAL



WAR DEPARTMENT • OCTOBER 1943

UNITED STATES GOVERNMENT PRINTING OFFICE
WASHINGTON • 1943

For sale by the Superintendent of Documents, U. S. Government Printing Office, Washington, D. C.

Digitized by Google

Original from
UNIVERSITY OF MICHIGAN

WAR DEPARTMENT,
WASHINGTON 25, D. C., 20 October 1943

FM 9–40, Organization and Operation for Disposal of Unexploded Bombs, is published for the information and guidance of all concerned.

[A. G. 300.7 (17 Jun 43).]

BY ORDER OF THE SECRETARY OF WAR:

G. C. MARSHALL,
Chief of Staff.

OFFICIAL:

J. A. ULIO,
Major General,
The Adjutant General.

DISTRIBUTION:

R 1 (4); Bu 5 (4), 9 (5); C 9 (5).
(For explanation of symbols, see FM 21–6.)

Digitized by Google
Original from UNIVERSITY OF MICHIGAN

DEPOSITED BY THE
UNITED STATES OF AMERICA
DEC 16 '43

TABLE OF CONTENTS

	Paragraphs	Page
CHAPTER 1. GENERAL		
Section I. Bomb disposal problem	1–2	1
II. Personnel requirements and training	3–6	2
III. Intelligence and research	7–9	4
CHAPTER 2. ORGANIZATION FOR BOMB DISPOSAL		
Section I. General policies	10–14	6
II. Specific missions	15–16	8
CHAPTER 3. OPERATIONS		
Section I. Matters affecting bomb reconnaissance	17–27	11
II. Incident reporting	28–32	40
III. Evacuation and protective works	33–35	49
CHAPTER 4. BOMB DISPOSAL COMPANY		
Section I. Organization and operations	36–53	58
II. Headquarters platoon	54–56	64
III. Operating platoon	57–64	66
CHAPTER 5. BOMB DISPOSAL SQUAD SEPARATE	65–73	71

Digitized by Google
Original from UNIVERSITY OF MICHIGAN

CHAPTER 6. SPECIAL OPERATING PERSONNEL		
Section I. Bomb disposal staff officer	74–82	74
II. Bomb reconnaissance officer	83–86	78
III. Bomb reconnaissance non-commissioned officer	87–89	79
CHAPTER 7. OPERATING TECHNIQUE	90–92	80
CHAPTER 8. GERMAN BOMBS	93–96	85
CHAPTER 9. ITALIAN BOMBS	97–100	97
CHAPTER 10. JAPANESE BOMBS	101–102	107
CHAPTER 11. PROJECTILES	103–104	113
CHAPTER 12. MISCELLANEOUS OBJECTS	105–112	117
APPENDIX I. MILITARY EXPLOSIVES	1–4	124
APPENDIX II. DEFINITIONS	1	141
INDEX		147

Digitized by Google
Original from UNIVERSITY OF MICHIGAN

CHAPTER 1

GENERAL

SECTION I

BOMB DISPOSAL PROBLEM

1. GENERAL.

a. A compilation based on many air raids shows that from 5 to 10 percent of all bombs fail to explode. The proportion of these containing delayed-action fuzes may be as high as 75 percent. All unexploded missiles are a menace to life and property, hamper all activities, and lower morale.

b. Bomb disposal is a scientific and technical procedure for handling and rendering safe unexploded bombs or other missiles; it has been standardized to a certain degree. Each bomb, however, presents a special problem of its own. Variable factors are almost endless, and the personnel charged with bomb disposal must constantly exercise ingenuity, and combine this with courage and determination, tempered by good judgment.

c. Anyone assigned to a bomb disposal organization may take this appointment as evidence of confidence in his qualities. The job is a dangerous one, but so is any assignment which calls for action in the face of the enemy. To a great degree, hazards can be reduced or eliminated entirely by bomb disposal personnel who have mastered the details of technique, who do not rely on improvisation,

Digitized by Google
Original from UNIVERSITY OF MICHIGAN

and who are properly organized for the job. This manual deals primarily with the latter point—the organization of of bomb disposal units, made up of Ordnance Department personnel who are trained to disarm or defuze bombs without detonating.

2. NEED FOR PREPARATION. It is necessary to have a well-organized system for verifying the presence of unexploded bombs and reporting them to trained bomb disposal units capable of handling these unexploded bombs. *This system should be in existence and ready to operate before the need for it arises.*

SECTION II

PERSONNEL REQUIREMENTS AND TRAINING

3. BASIS FOR PERSONNEL REQUIREMENTS. Requirements for bomb disposal personnel cannot be based on a type army or corps, since the need for protection against unexploded bombs depends primarily upon probable targets within an area. Under the present War Department policy, the commanding general of each service command, defense command, department, base, or theater of operations will estimate his requirements for bomb disposal personnel and will make appropriate recommendations to the War Department.

4. TRAINING. Specially trained military personnel are provided to deal with unexploded bombs. The duties of such personnel are to assist in the accomplishment of the missions of all arms and services of the armed forces.

Digitized by Google
Original from UNIVERSITY OF MICHIGAN

a. Holding to a minimum the enemy's efforts to disrupt and disorganize the civilian population in large war production centers.

b. Removing and disposing of such unexploded bombs as constitute a danger to military installations in the theater of operations.

5. SPECIAL PERSONNEL.

a. Bomb disposal personnel. Military personnel will be trained in the techniques of bomb reconnaissance, which is the act of proceeding to the location of a reported incident, determining the presence of an unexploded bomb, and subsequently reporting the necessary information. They will also be trained in disposal and will be designated as—

(1) Bomb disposal staff officers.

(2) Bomb disposal officers. Such an officer is a commissioned officer of the Ordnance Department who is an expert on bomb disposal.

(3) Bomb disposal enlisted personnel.

b. Bomb reconnaissance personnel. Officers and noncommissioned officers trained only in bomb reconnaissance will be respectively designated as bomb reconnaissance officers (officers trained in the identification and reporting of unexploded bombs and the use of protective works) and bomb reconnaissance noncommissioned officers who have been similarly trained. Civilian personnel trained only in bomb reconnaissance will be designated as bomb reconnaissance agents. This term refers to selected civilians trained by ordnance bomb disposal officers to investigate, identify, report, and classify unexploded bombs in civilian areas; to indicate the distance (that is, evacuation distance), to which the inhabitants of these areas must be removed for their protection; and to close

Digitized by Google
Original from UNIVERSITY OF MICHIGAN

such roads and institute such protective works as are thought necessary.

6. TRAINING AIDS. (See FM 21–6 and 21–7.) In addition, visual aids are available from the Bomb Disposal School, Aberdeen Proving Ground, Md., upon request by commanding officers charged with responsibility for bomb disposal. These visual aids are most effective when used by qualified bomb disposal officers.

SECTION III

INTELLIGENCE AND RESEARCH

7. GENERAL. By slight alterations in material design, the enemy may cause changes in bomb disposal technique. It is important that bomb disposal officers in the field be kept in touch with these developments.

8. TECHNICAL INFORMATION SECTION.

a. Continuity of information. To maintain the continuity of information, the Technical Information Section of the Bomb Disposal School maintains constant liaison with all bomb disposal officers. All pertinent information regarding new material is immediately furnished to officers in the field.

b. Expediting reports. In order that there may be no delay in receiving this information, sample bombs and fuzes should be turned over to the nearest bomb disposal officer, a report being made simultaneously to the G–2 of the command served by these troops. The samples will then

Digitized by Google
Original from UNIVERSITY OF MICHIGAN

be sent by the bomb disposal officer to the Office of the Chief of Ordnance in Washington.

c. Form of reports. Written reports made to the Chief of Ordnance on new material should contain the indicated information pertaining to the following subjects if possible.

(1) Bombs. (a) General dimensions, including over-all length when it can be determined; length and diameter of body; wall thickness; length and width of tail; and estimated weight.

(b) Type of explosive filling.

(c) Fuzes found in bomb.

(d) Nationality of bomb.

(e) Any information on penetration that is available.

(2) Fuzes. A fuze is a device designed to initiate the explosive train of a bomb or projectile at the time and place desired.

(a) A description of the fuze, including dimensions, material of construction, and number of vanes.

(b) Method of operation, if this can be determined.

9. EXPERIMENTAL SECTION. Upon the receipt of above information at the Bomb Disposal School, new methods will be developed, or old ones revised, for the safe handling of this material.

Digitized by Google
Original from UNIVERSITY OF MICHIGAN

CHAPTER 2

ORGANIZATION FOR BOMB DISPOSAL

SECTION I

GENERAL POLICIES

10. GENERAL. To meet the bomb disposal problem, certain missions were assigned to the military, naval, and civilian authorities. Such widespread areas and varied targets are liable to be attacked, that no one authority was sufficiently large to handle them all.

11. WAR DEPARTMENT MISSION.

a. Mission. The War Department is responsible for the disposal of any bomb so fuzed that detonation takes place either at a predetermined time after impact, or when the bomb or fuze is disturbed after coming to rest on the surface or under the ground, and known commonly as unexploded or delayed action bombs—

(1) In all military installations and other areas of military occupation.

(2) In all civil installations and areas within the continental United States, oversea territories, and possessions.

(3) In all civil installations in areas occupied by the United States, when the tactical or political situation demands it.

Digitized by Google
Original from UNIVERSITY OF MICHIGAN

(4) The recovery and disposal of all United States Army-controlled mines only; all other mines, torpedoes, and depth charges will be the responsibility of the United States Navy bomb disposal organizations.

b. Responsibilities. This mission includes, except as specifically assigned other governmental agencies by the President or Congress, all phases of—

(1) Organization within the Army of the United States.
(2) Training or necessary military personnel.
(3) Administrative functions.
(4) Intelligence functions.
(5) Research in and development of technical requirements.
(6) Procurement, storage, issue, and maintenance of the necessary supplies and equipment.

12. NAVY DEPARTMENT MISSION. The naval bomb disposal division has agreed to a policy of coordination and cooperation with military and civil bomb disposal agencies wherever and whenever required.

13. CIVILIAN MISSION. The Office of Civilian Defense has been charged with the mission of providing those civilian agencies necessary to supplement the mission of the War Department as carried out by the personnel of the ordnance bomb disposal units.

14. RESPONSIBILITIES. The Army will be primarily responsible for recovery and disposal of all unexploded bombs and projectiles not falling within the naval jurisdiction as set forth in paragraph 12.

Digitized by Google
Original from UNIVERSITY OF MICHIGAN

SECTION II

SPECIFIC MISSIONS

15. MILITARY. The general mission of the War Department must of necessity be carried out by subordinate units. This mission will be carried out as follows:

a. By the Ordnance Department. The Ordnance Department is assigned the primary mission of disposing of all unexploded missiles and the following secondary missions:

(1) The supervision of research in methods of disposal in coordination with appropriate technical agencies.

(2) The preparation of Technical Manuals and other literature in coordination with appropriate technical agencies for distribution to the Army and the Office of Civilian Defense.

(3) The provision of advice and information on training methods and organization to the Army and the Office of Civilian Defense.

(4) The provision of advice to the Assistant Chief of Staff (G–1) on the assignment of trained bomb disposal officers.

(5) Acting as liaison for the War Department with the Navy Department, the Office of Civilian Defense, and other civilian agencies.

(6) Operation of the Bomb Disposal School for the training of selected personnel in disposal methods and allied subjects.

(7) Direct correspondence on technical matters with bomb disposal officers of service commands, defense commands, oversea departments, bases, and theaters.

Digitized by Google
Original from UNIVERSITY OF MICHIGAN

b. By the Chemical Warfare Service. Cooperation with the Ordnance Department in the training of military and civilian personnel in the identification and handling of chemical and incendiary bombs. A chemical bomb is a thin-cased bomb containing one of a number of chemical agents, for example, a smoke-producing agent, mustard gas, Lewisite, or other toxic gases, and incendiary bombs. An incendiary bomb is a bomb constructed of, or filled with, an inflammable substance designed to start fires.

c. By defense commands. **(1)** Coordination and training of military personnel and units assigned.
(2) Coordination of operational activities with military commands and civil agencies.
(3) Determination of the need for and requisition of personnel, subject to current War Department policy.
(4) The collection and forwarding of intelligence.
(5) The supervision of bomb disposal activities of other arms and services.
(6) The distribution of technical literature, information, and other instructional matter within the limits of the command.

d. By service commands not included in defense commands. **(1)** The training of all military personnel within the limits of the service command.
(2) The training of necessary civilian defense personnel in connection with bomb disposal activities.
(3) Cooperation with the Office of Civilian Defense in the proper organization of an efficient reporting system.
(4) The distribution of technical literature, information, and other instructional matter within the limits of the command.
(5) Determination of the need for and requisitioning of personnel, subject to current War Department policy.

Digitized by Google
Original from UNIVERSITY OF MICHIGAN

(6) The collecting and forwarding of intelligence.
(7) The supervision of bomb disposal and activities of pertinent services.

e. By oversea departments, base commands, task forces, and expeditionary forces. (1) Operational activities in connection with bomb disposal within zones of jurisdiction.
(2) Training activities, to include training of necessary civilian and military personnel.
(3) Determination of need for and requisitioning of personnel, subject to current War Department policy.
(4) Collection and forwarding of intelligence.
(5) Distribution of technical literature, information, and other instructional matter.

16. CIVILIAN. The Office of Civilian Defense will be responsible for the following measures in the continental United States, exclusive of military and naval reservations and theaters of operation:

a. The disposal of incendiary bombs.

b. The extinguishing of fires.

c. Bomb recognition, to include the ability to distinguish between different types of bomb craters (the irregular depression formed by the explosion of a bomb) parachute flares, mines, etc.

d. The locating and reporting to the proper agency of unexploded bombs for disposal by military personnel.

e. The immediate application of safety precautions at the site of the unexploded bomb.

f. The selection of civilians, in numbers recommended by the various service commands, for attendance at Army-operated bomb disposal courses, provided no expense to the Army is involved.

Digitized by Google
Original from UNIVERSITY OF MICHIGAN

CHAPTER 3
OPERATIONS

SECTION I
MATTERS AFFECTING BOMB RECONNAISSANCE

17. GENERAL. For the sake of simplicity, operations will be considered in three sections: bomb reconnaissance, incident reporting, and evacuation and protective works. Information pertaining to the access and removal procedures, but not presented in the text, will be found in the appendixes.

18. BOMB FLIGHT.

a. Trajectory of bomb. A trajectory is the curved path of flight of a bomb or projectile after release from the aircraft, cannon, or mortar. For typical characteristics of flight and penetration of high-explosive bombs, see figure 1.

b. Angle of entry. The angle of entry is the degree of inclination, with the perpendicular, at which the bomb or projectile strikes the target area. The tremendous speed of a bomb dropped from a high altitude enables the bomb to penetrate deeply into the earth or into buildings. The bomb enters the earth at an angle of 15° to 45° from the perpendicular, depending on the height from which it is dropped.

19. HOLE OF ENTRY (figs. 2, 3, and 4). The size of the hole of entry is usually slightly larger than diameter of

Digitized by Google
Original from UNIVERSITY OF MICHIGAN

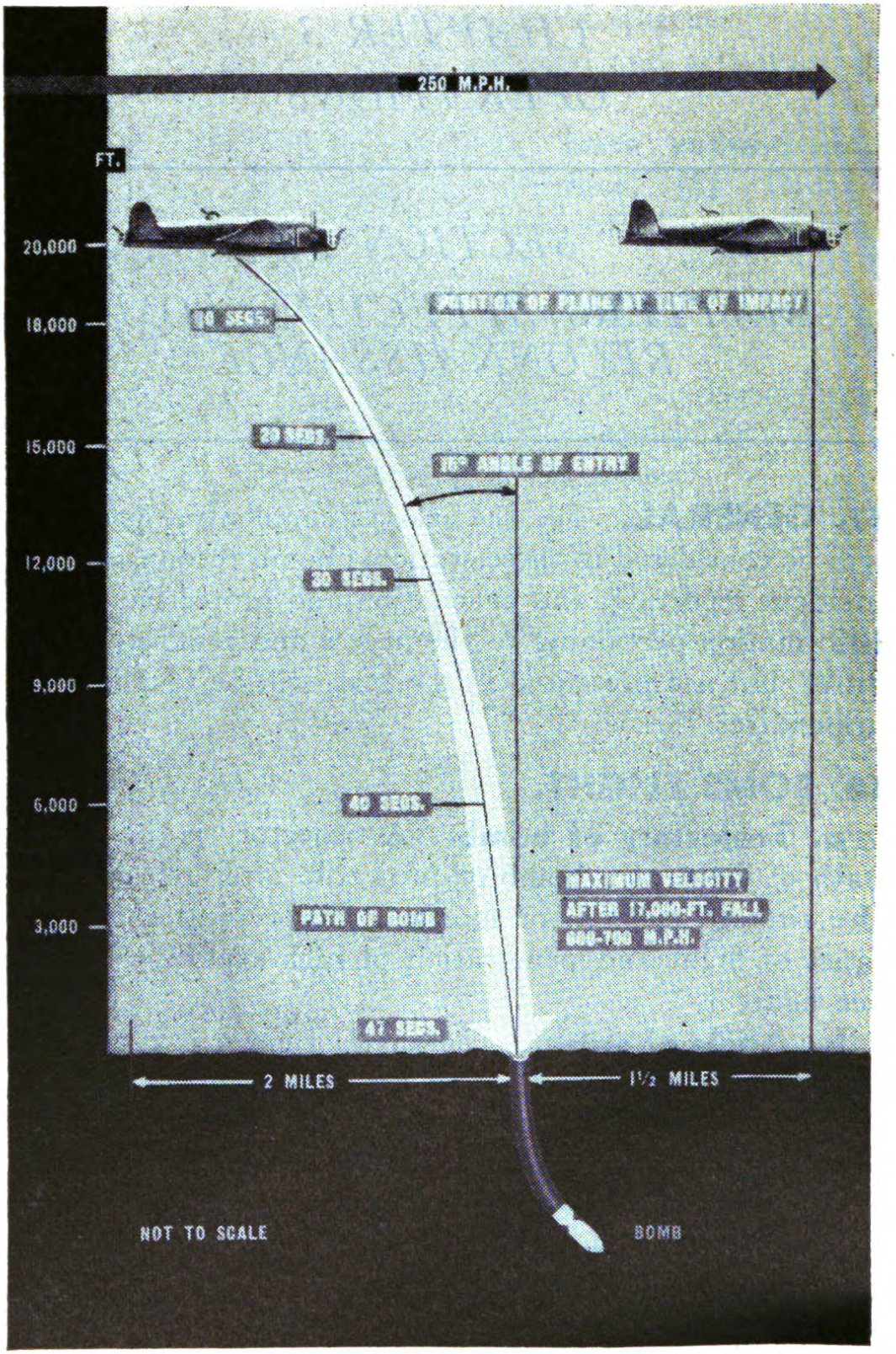


Figure 1.—Flight and penetration of bomb.

Digitized by Google
Original from UNIVERSITY OF MICHIGAN

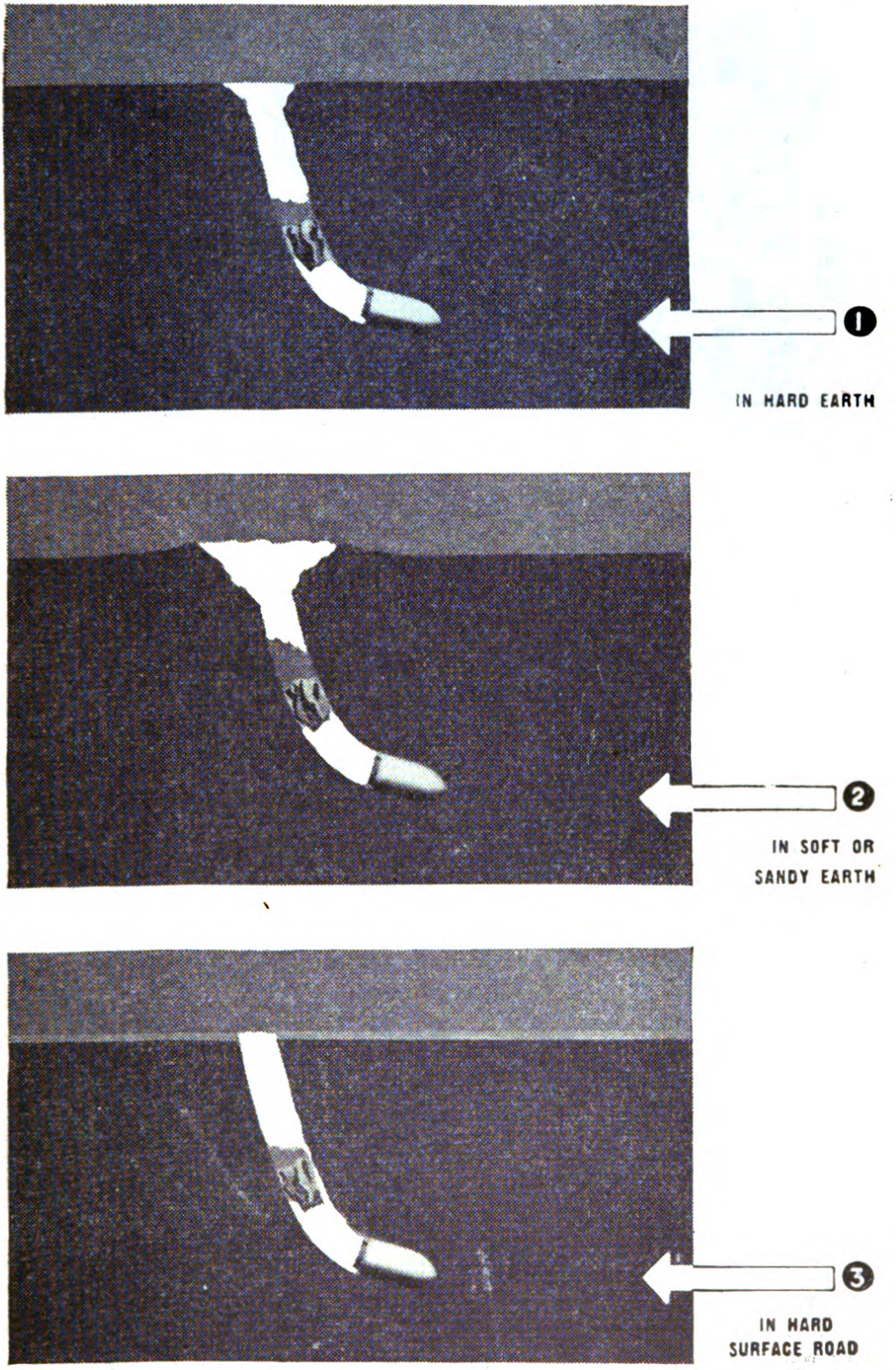


Figure 2.—Typical flight and penetration of high exploding bomb.

Digitized by Google

Original from
UNIVERSITY OF MICHIGAN

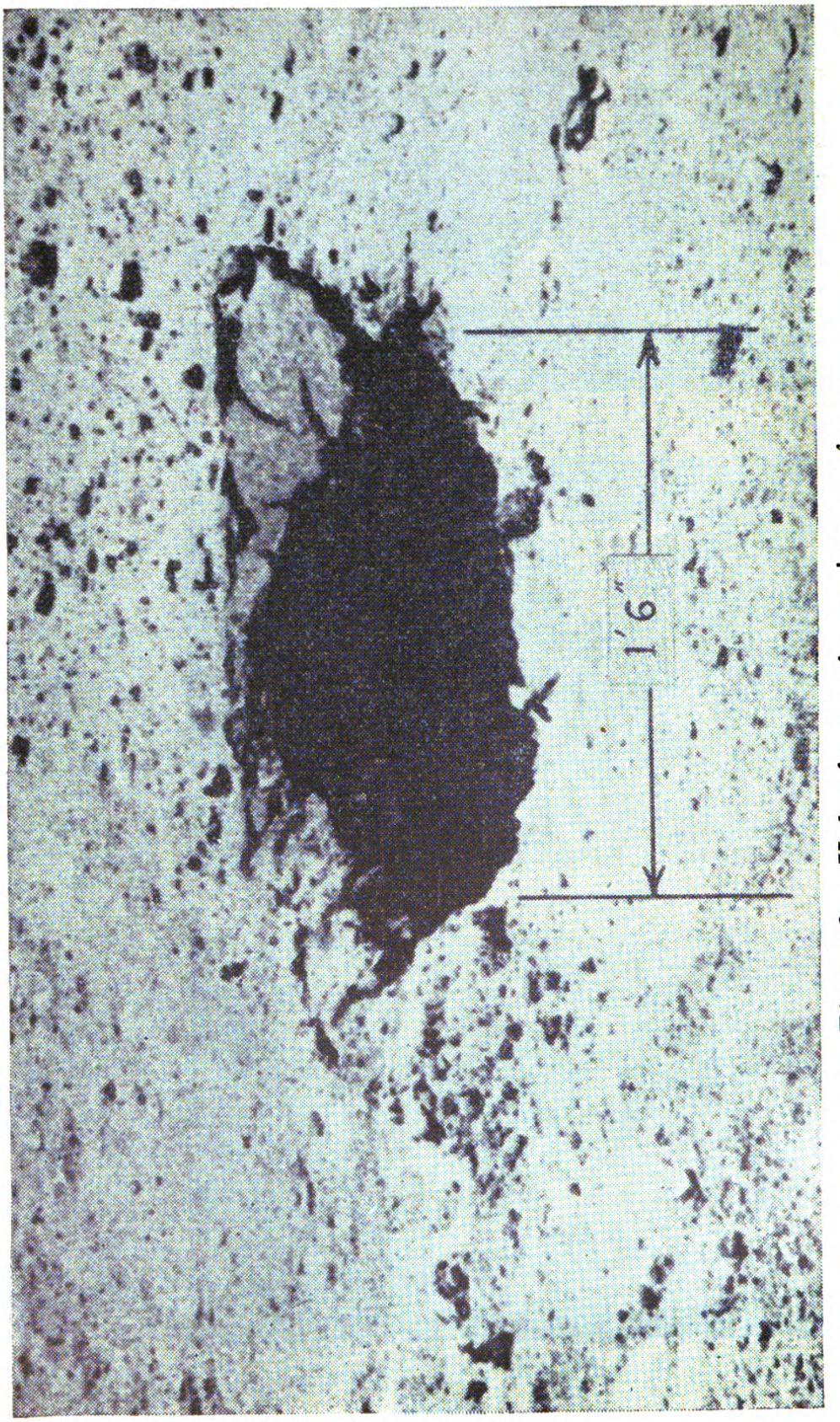


Figure 3.—Hole of entry for various surfaces.

Digitized by Google
Original from
UNIVERSITY OF MICHIGAN



Figure 4.—Hole of entry in soft earth.

Digitized by Google

Original from
UNIVERSITY OF MICHIGAN

bomb, but varies with the type of object penetrated. When the hole is made, some of the surface material will usually be carried into the shaft of entry; it it therefore necessary to measure the diameter of the hole at a point slightly below the surface. The following table will give a fair indication of the size of bomb present:

Table I.—Holes of entry

Diameter of hole of entry (inches)	Probable type of projectile	Weights	
		Kilograms	Pounds
Up to 8	Antiaircraft shell		
8 to 12	Bomb	50	110
14 to 18	Bomb	250	550
18 to 26	Bomb	500	1, 100
Over 26	Bomb	500 or over	1, 100

20. PENETRATION.

a. Factors governing penetration (figs. 5 and 6). The depth to which the bomb will penetrate depends upon—

(1) Size, weight, and shape of bomb.
(2) Height from which dropped.
(3) Angle of entry.
(4) Type of soil encountered.

b. Penetration in high-level bombing. In the case of high-level bombing, the angle of entry will be small and the bomb will probably be buried. The path of a buried bomb is difficult to trace. Much probing with a metal rod is reported to follow it closely. The bomb, unless deflected, will maintain its original direction for an unpredictable distance underground and then tend to assume a horizontal direction. The location of the bomb is thus "offset" from the hole of entry. (Offset is the

Digitized by Google
Original from UNIVERSITY OF MICHIGAN

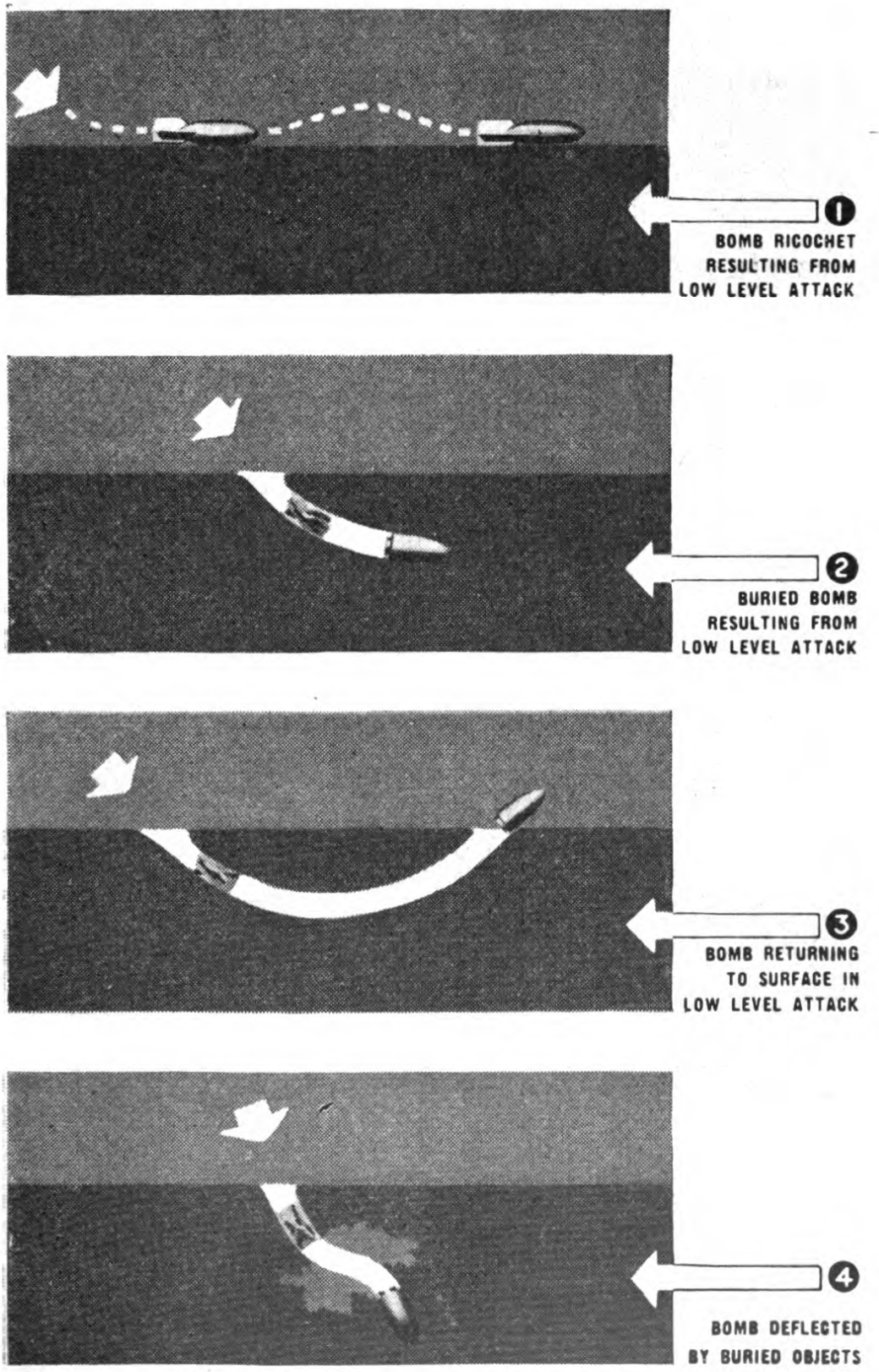


Figure 5.—Examples of bomb impacts.

Digitized by Google
Original from
UNIVERSITY OF MICHIGAN

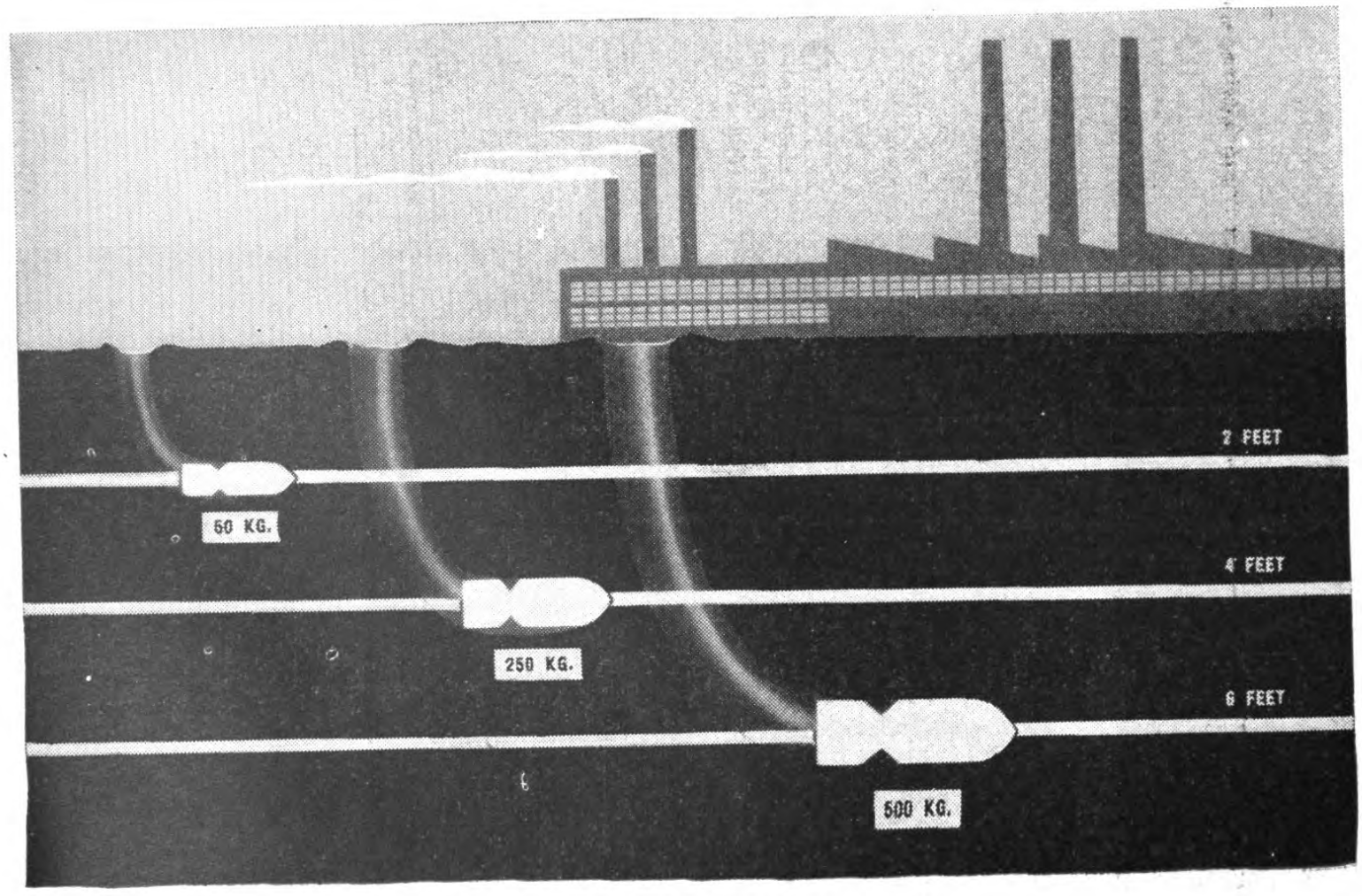


Figure 6.—Possible shaft of bombs.

Digitized by Google
Original from UNIVERSITY OF MICHIGAN

horizontal distance of forward travel covered by the missile after it strikes the ground. This distance is measured from the center of the hole of entry to the most forward part of the missile). Tables II and III (compiled by the British) should be useful in predicting the location of the bomb.

Table II.—Percentage of penetration of all unexploded bombs

40 percent less than 15 feet
40 percent from 15 to 20 feet
15 percent from 20 to 25 feet
4 percent from 25 to 30 feet
1 percent over 30 feet

Table III.—Bomb penetration and offsets

Size of bomb		Penetration in feet		Offset in feet	
Kilograms	Pounds	Average	Maximum	Average	Maximum
50	110	10.4	35	3.6	18
250	550	15.1	36	4.6	20
500	1,100	14.9	40	6.7	20
1,000	2,200	21.0	35	7.5	24
1,400	3,080	30.5	45	13.4	27
1,800	3,960	29.8	62	16	28

c. Penetration in low-level bombing. There is very little or no bomb penetration from low-level and dive bombing attacks. Because of this low penetration, unexploded bombs which may occur are unburied. This may happen in two ways:

(1) The angle of entry may be so large that the bomb, upon striking a hard surface, will ricochet and come to rest upon the surface of the ground.

(2) Due to the large angle of entry the bomb may curve sharply, possibly returning to the earth's surface and com-

Digitized by Google
Original from UNIVERSITY OF MICHIGAN

ing to rest upon it or, as is more usual, coming to rest a short distance below the surface. Table IV gives the maximum depth at which a bomb may be considered unburied.

Table IV.—Unburied bombs

Bomb size		Penetration
Kilograms	*Pounds*	*Feet*
50–60	110–120	2
100	220	3
250	550	4
500	1, 100	6

d. Penetration in buildings. **(1)** Normally a bomb dropped in a high-altitude attack upon a frame building of one, two, or three stories will pass through a building and bury itself in the ground. In low-level or dive-bombing attacks, the bomb may come to rest in the building itself. **(2)** In concrete or steel buildings a bomb will not, as a rule, penetrate more than 10 floors. Consequently, bombs have been found on the floors of buildings or lodged in the walls or ceilings.

21. EFFECTS OF EXPLOSION. There are four effects of an explosion. An inspection of the damage resulting from these effects will be helpful in distinguishing between exploded and unexploded bombs.

a. Fragmentation. This is the term for a projection of bomb fragments or splinters in all directions at high velocities when explosion occurs. (See figs. 7 and 8.)

(1) Upon detonation, the bomb case tends to swell and rupture along longitudinal lines. The splinters from a general-purpose bomb, a bomb having a high charge/weight ratio and depending on blast for its principal effects, tend to break on a 45° angle. Those of the armor-piercing

Digitized by Google
Original from UNIVERSITY OF MICHIGAN

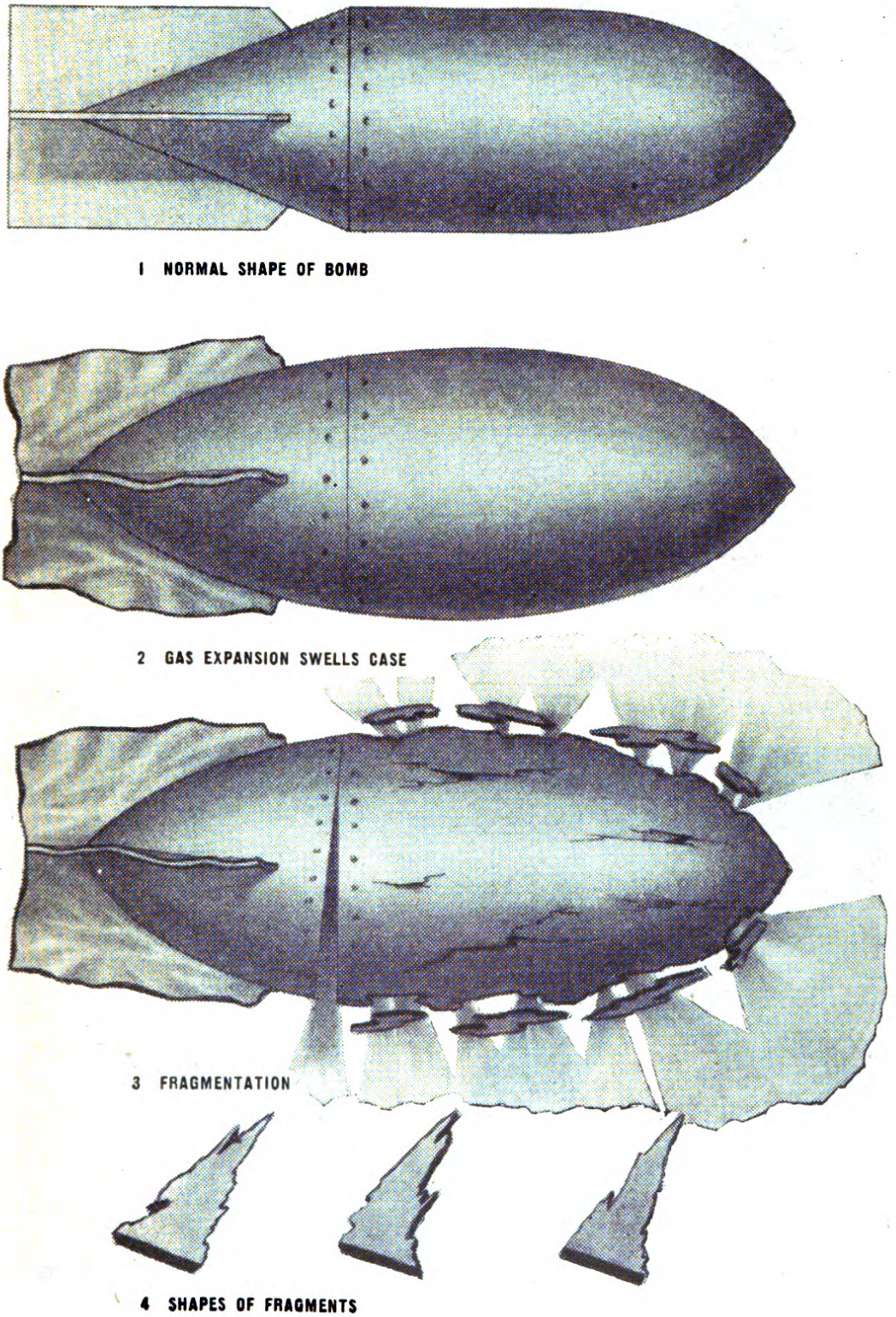


Figure 7.—Fragmentation.

Digitized by Google
Original from UNIVERSITY OF MICHIGAN

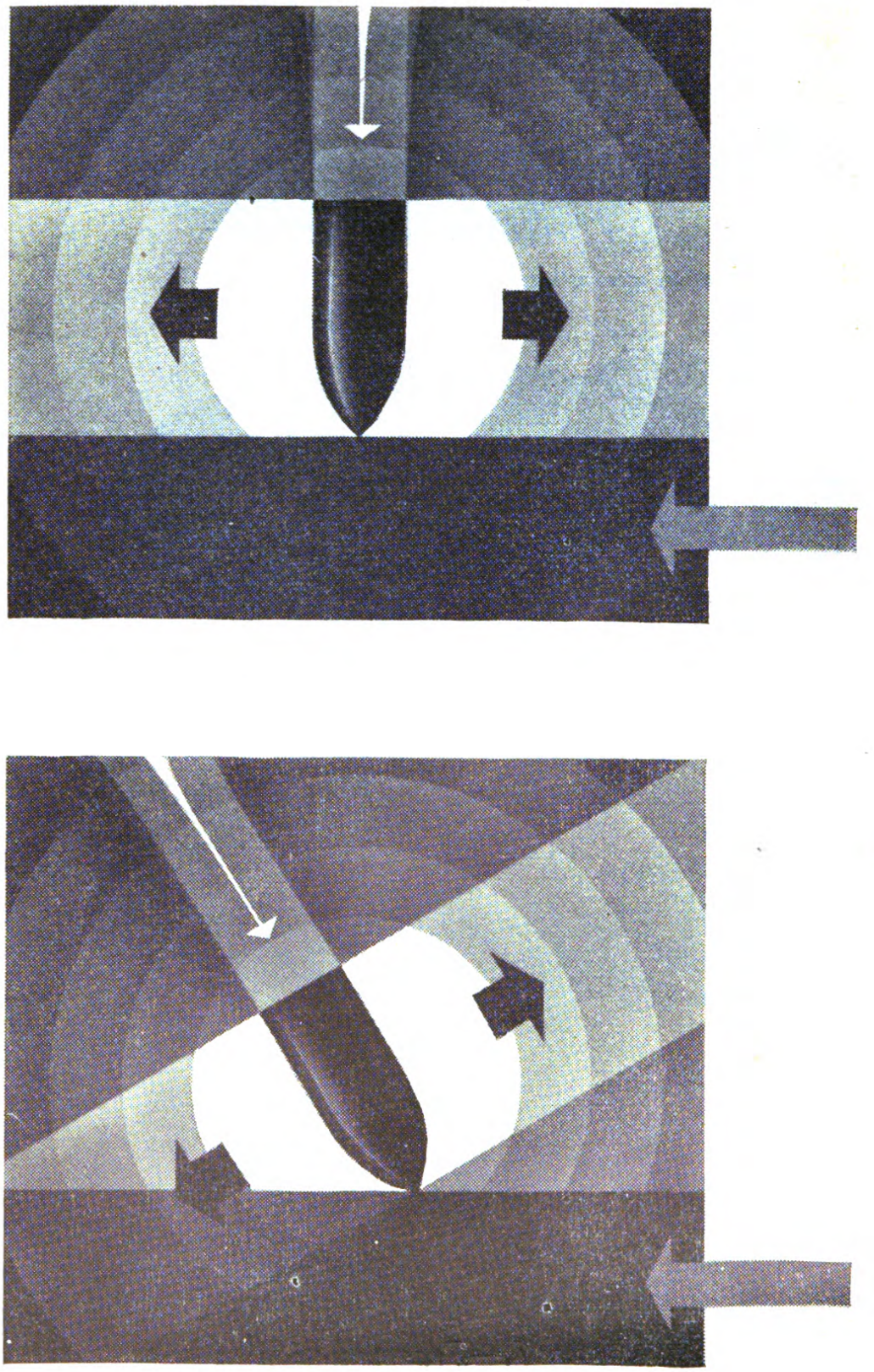


Figure 8.—Dispersal of fragments.

Digitized by Google
Original from UNIVERSITY OF MICHIGAN

type, a bomb having a low charge/weight ratio and designed for penetration prior to burst, due to the thicker case and resultant smaller expansion, will approach a 90° angle of fracture.

(2) As the fragments tend to come off at right angles to the axis of the bomb, the greatest splinter damage will occur when the axis is perpendicular to the earth's surface, since any angle less than this allows some of the fragments to bury themselves in the ground.

b. Blast. A shock or nontranslational wave transmitted through the air as a direct consequence of the sudden transformation of an explosive material into gas at high temperature and pressure.

(1) The blast effect of an explosion is a pressure wave in the atmosphere extending radially from the point of explosion. It produces first an increase in pressure and the second half is a decrease in pressure, or partial vacuum. The wave subsides rapidly. Normally, only the increased pressure is effective. The actual values of a blast wave at a point 50 feet from the explosion of a 500-pound general-purpose bomb containing 125 pounds of explosive are shown in figure 9, and table V indicates how these figures will vary with the distance from the bomb.

Table V.—Maximum blast and vacuum pressures caused by 500-pound GP bomb

Distance from Bomb (feet)	Maximum positive (Pressure in lb. per sq. in.)	Maximum negative (Pressure in lb. per sq. in.)
30	24	---------
50	6	1.4
100	2.3	0.8
200	0.3	0.2

Digitized by Google
Original from UNIVERSITY OF MICHIGAN

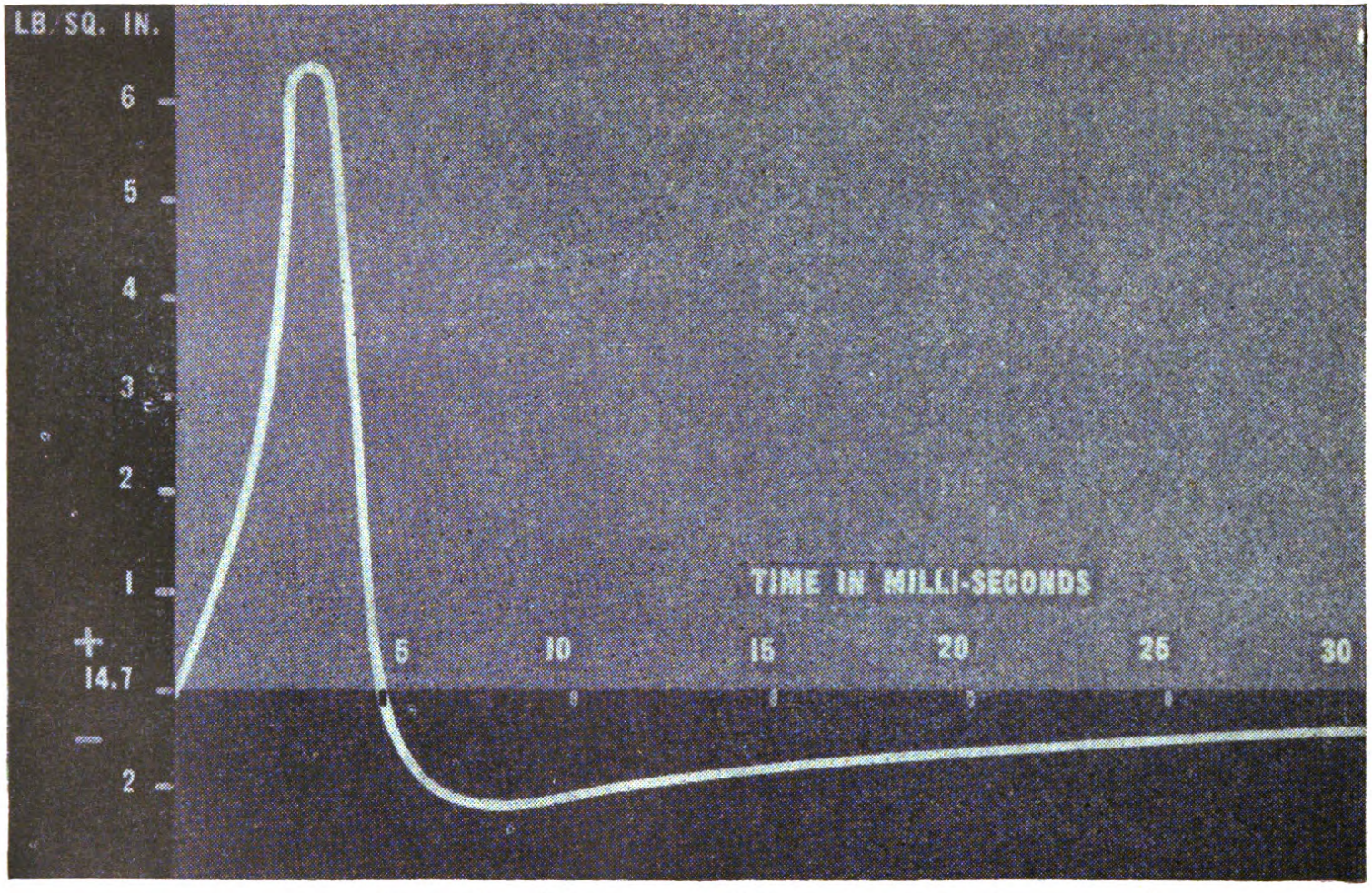


Figure 9.—Blast wave of 500 pound bomb.

Digitized by Google
Original from UNIVERSITY OF MICHIGAN

(2) A further understanding of the blast effect may be gained by considering the two characteristics of the blast effect.

(a) The pressure half. The pressure portion of the wave—

1. Travels in a straight line, thus allowing objects to be shielded by intervening obstructions.
2. Is more limited in range than vacuum wave.
3. May be reflected, thus tending to sustain the pressure over an abnormally long period, or actually to increase it should the reflected waves come into phase (see fig. 10).
4. Tends to damage objects by pressure on outer surfaces, causing walls to fall inward.

(b) The vacuum half. The vacuum portion of the wave—

1. Has a fluid effect, that is, it flows around objects thus preventing them from being shielded by obstructions.
2. Damages objects by lowering pressure on outer surfaces and allowing internal pressure to force the walls outward, giving the appearance of an explosion.

c. Earth shock. The transmission of the compression wave caused by the detonation of a buried bomb through the earth and all structures adjacent to the point of explosion is known as earth shock. This effect occurs when the bomb penetrates the ground and explodes, compressing the earth as it does so.

(1) Two effects will be noted:

(a) The maximum movement of the earth, that is, the amount the earth moves when the explosion occurs and the force is exerted against it.

Digitized by Google
Original from UNIVERSITY OF MICHIGAN

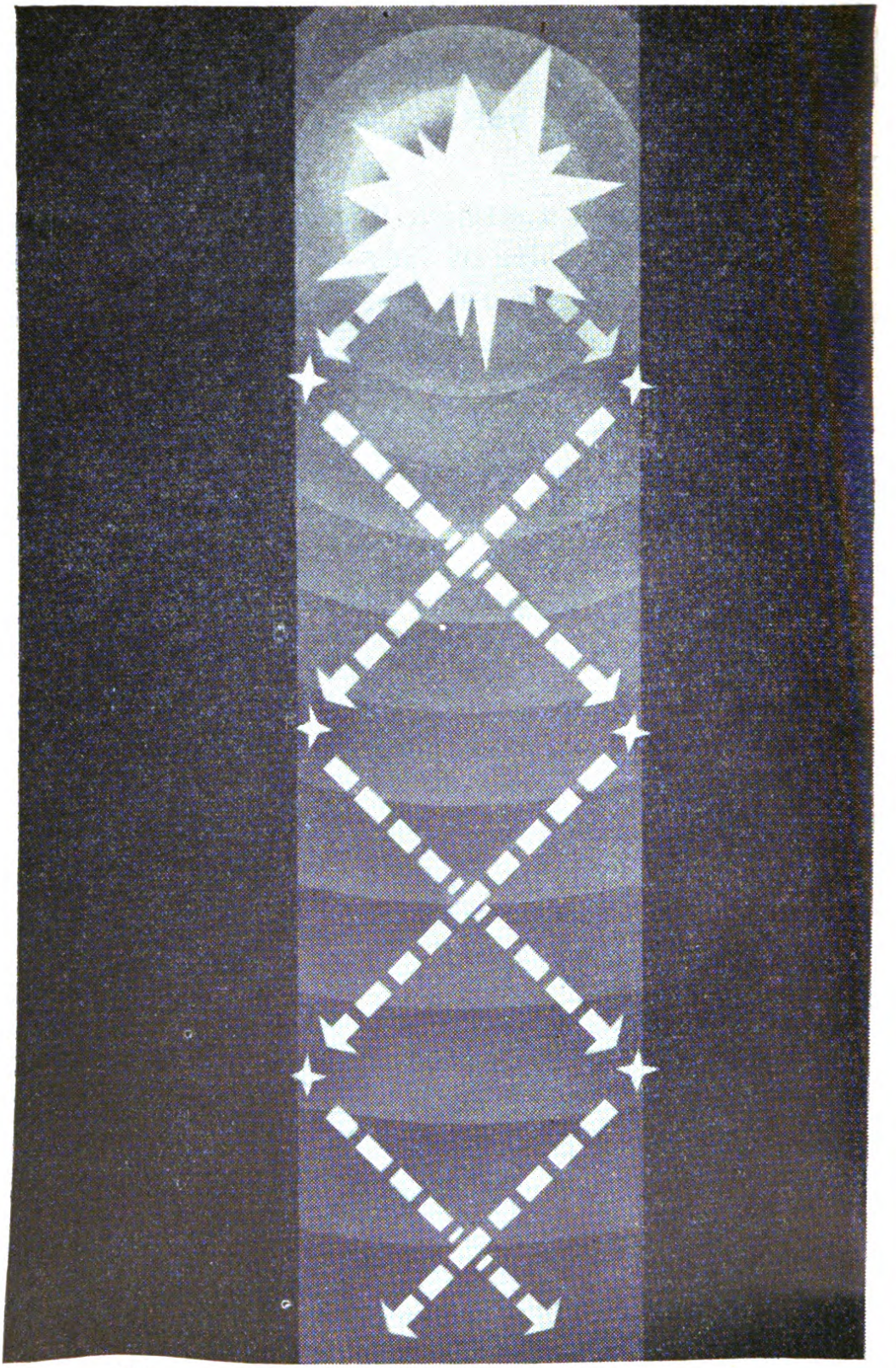


Figure 10.—Pressure waves come into phase.

Digitized by Google
Original from UNIVERSITY OF MICHIGAN

(b) The permanent set of the earth, that is, the position to which the earth returns after the force is removed.

(2) In connection with buildings, the following effects may be noted:

(a) Small buildings, in which the effect of earth shock is almost the same throughout, will not be affected.

(b) Larger buildings, where the effect varies, will show pronounced cracks in the walls.

(3) In connection with pipes, cables, conduits, sewers, etc., the following will hold true:

(a) Flexible materials will be displaced and will return to shape.

(b) Rigid materials will be displaced and will tend to fracture.

d. Debris damage. Flying debris will cause a certain amount of damage which will closely resemble that done by fragments of the bomb case. Two differences will be noted however:

(1) Objects usually will not be perforated. The debris will be found near the object and on the side on which the explosion took place.

(2) The damage caused by debris will be greater if the bomb penetrates the earth before exploding, whereas the fragmentation damage will be greater if the bomb fails to penetrate.

22. BOMB CRATERS. a. Formation. Bomb craters result from both instantaneous (surface) and delayed-action (underground) detonation of bombs. The formation of the crater by a delayed-action detonation is shown in the five diagrams of figure 11. (In the case of instantaneous detonation, the explosion takes place before penetration, thus limiting the cratering action to the displacement of surface soil.) These five steps are:

Digitized by Google
Original from UNIVERSITY OF MICHIGAN

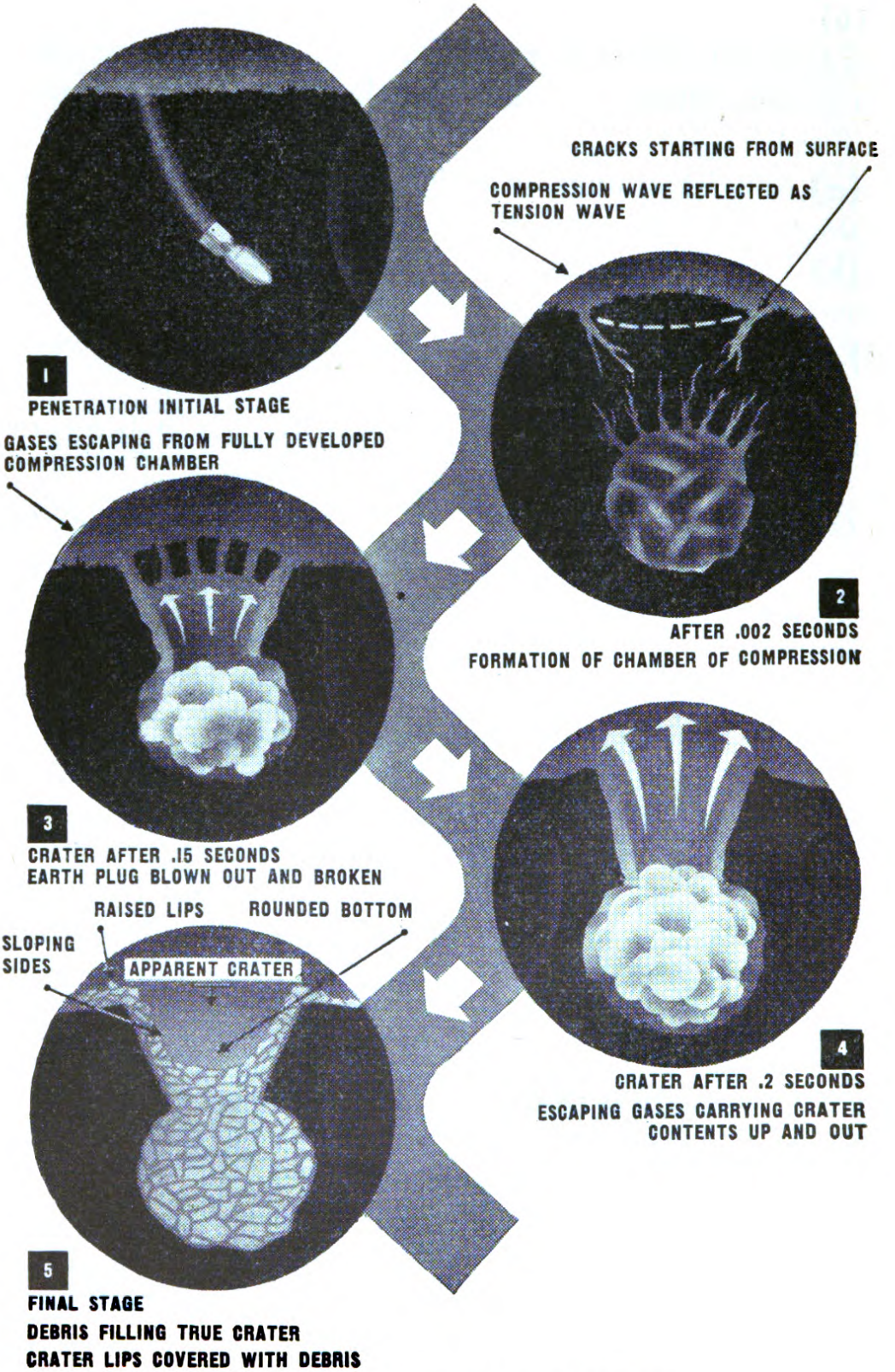


Figure 11.—Formation of craters.

Digitized by Google
Original from UNIVERSITY OF MICHIGAN

(1) Initial stage, wherein the bomb penetrates the ground.
(2) The formation of the chamber of compression, occurring 0.002 second after the functioning of the fuze and caused by the explosion of the bomb underground.
(3) The earth plug blown out and broken, occurring 0.15 second after the fuze has functioned, when the force of the explosion is sufficient to form the chamber of compression.
(4) The formation of the true crater, occurring 0.05 second after the earth plug is blown out. Figure 11 shows the true crater formed by the force of the explosion blowing everything out of the crater.
(5) The final stage, when some of the material blown from the crater falls into it, forming the apparent crater seen after the explosion.

b. Appearance of crater. The crater formed by an exploded bomb has several unmistakable signs:
(1) Raised lips.
(2) Sloping sides.
(3) Rounded bottom.

c. Dimension of crater. The size of crater formed when a buried bomb explodes varies with the size of the bomb, the penetration, and the nature of the soil. The following table gives the average crater formed by the size of bomb indicated after penetration has occurred.

Table VI.—Average bomb craters

Bomb size		Crater diameter
Kilograms	*Pounds*	*Feet*
50	110	10 to 15
250	550	18 to 25
500	1, 100	25 to 50
Over 1,000	2, 200	Up to 65–75

Digitized by Google Original from UNIVERSITY OF MICHIGAN

23. SIGNS OF EXPLOSION. As may be seen from paragraph 22, there will be certain definite signs that an explosion has taken place. Moreover, there are other signs that indicate whether a bomb exploded before or after pentrating the earth. These are important, since they indicate the nature of the fuze that may be found in adjacent unexploded bombs.

a. Instantaneous detonation. In the case of a bomb exploding on impact the indications will be (see figs. 12, 13, and 14)—

(1) Splinters scattered over a large area. These fragments will be small and will travel at a high velocity.

(2) Splinter marks on buildings.

(3) Striation marks (radial furrows) in the earth.

(4) Severe blast damage.

(5) Shallow crater.

(6) Smoke and flame visible at night; smoke only during the day.

(7) Blackening near crater due to free carbon released by explosion.

(8) Debris widely scattered and free from objects blown down by the explosion.

b. Delayed detonation. The indications of a bomb exploding beneath the surface are (fig. 15)—

(1) Negligible splinter effect, as most splinters are absorbed by the ground.

(2) Deep crater.

(3) Total demolition of buildings due to destruction of foundations.

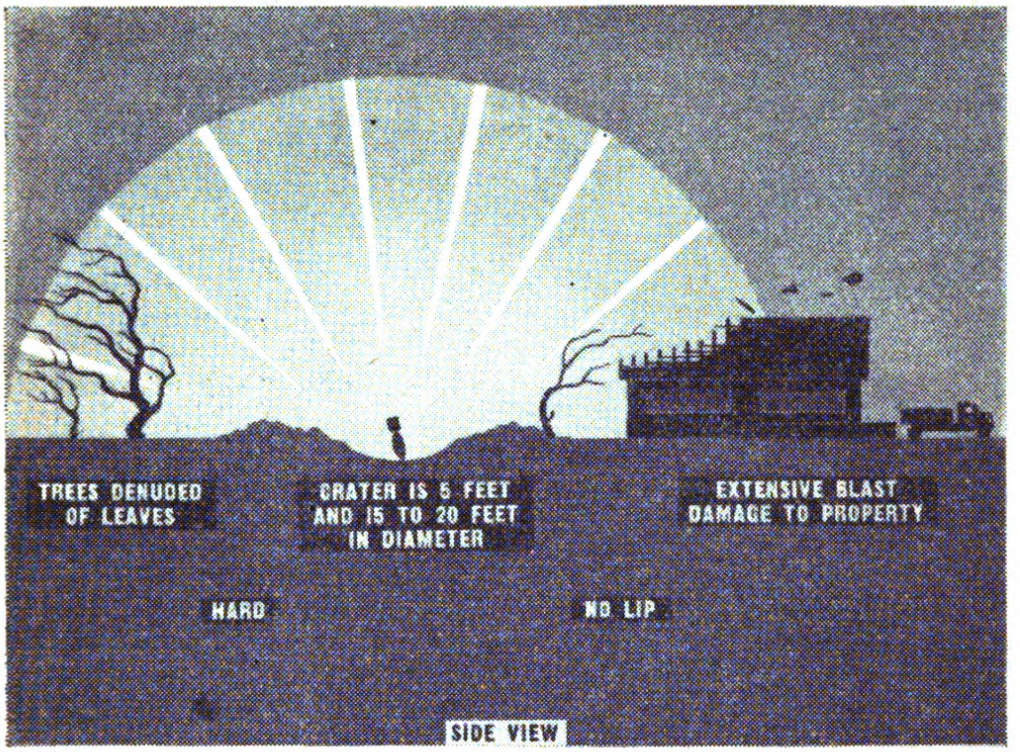
(4) Blackening in crater.

(5) Blast effect over much smaller area.

(6) Debris flung high in the air, resulting in its being found near the crater.

(7) Violent earth shock.

Digitized by Google
Original from UNIVERSITY OF MICHIGAN



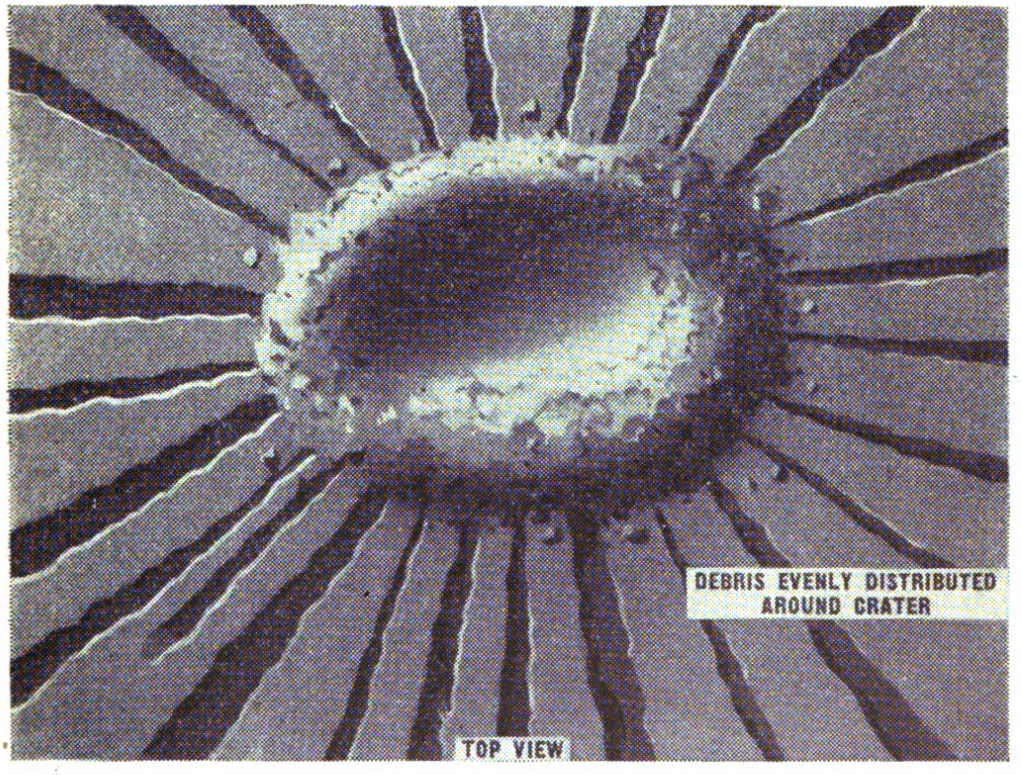


Figure 12.—Signs of bomb exploding near earth's surface.

Digitized by Google
Original from UNIVERSITY OF MICHIGAN

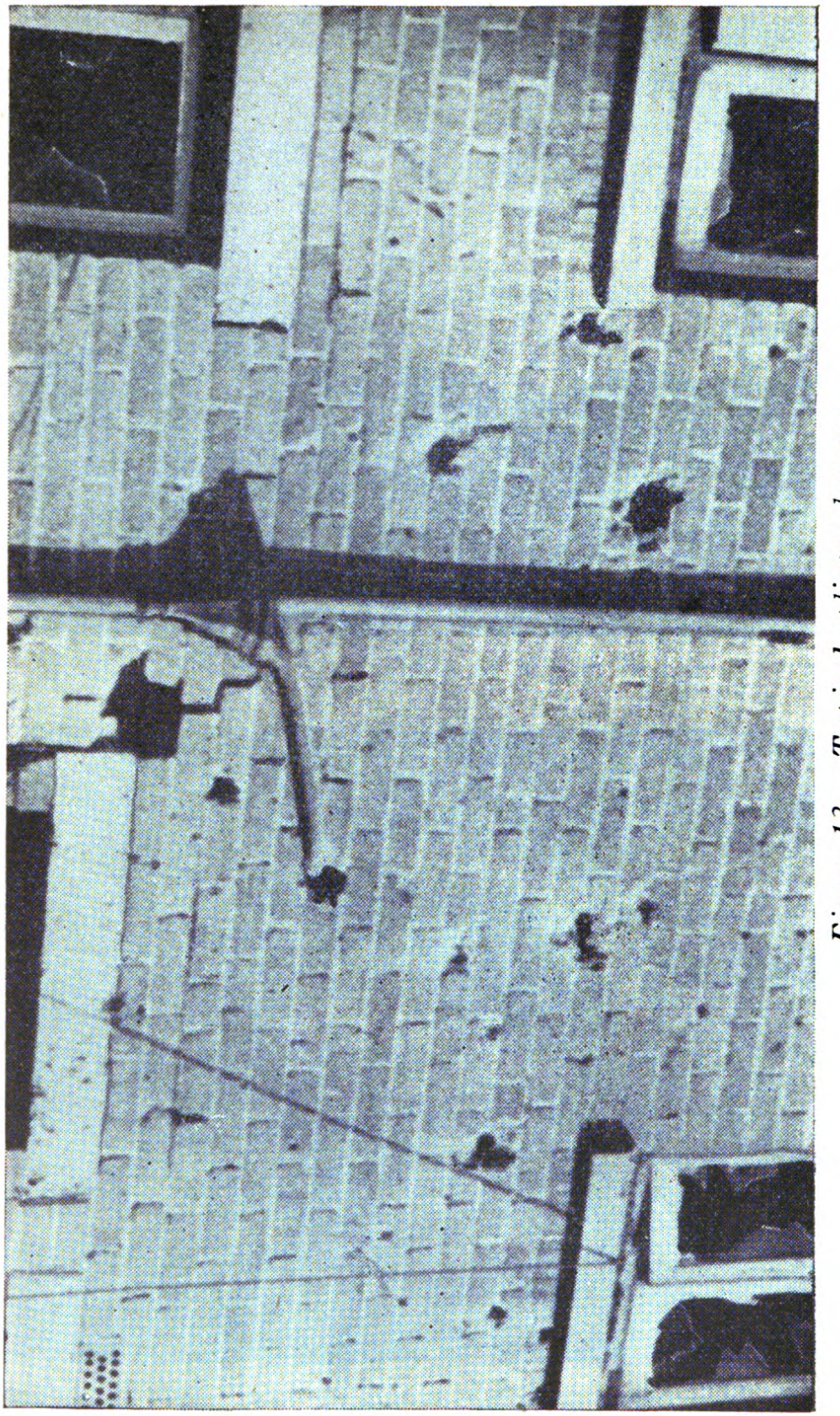


Figure 13.—Typical splinter damage.

Digitized by Google
Original from
UNIVERSITY OF MICHIGAN

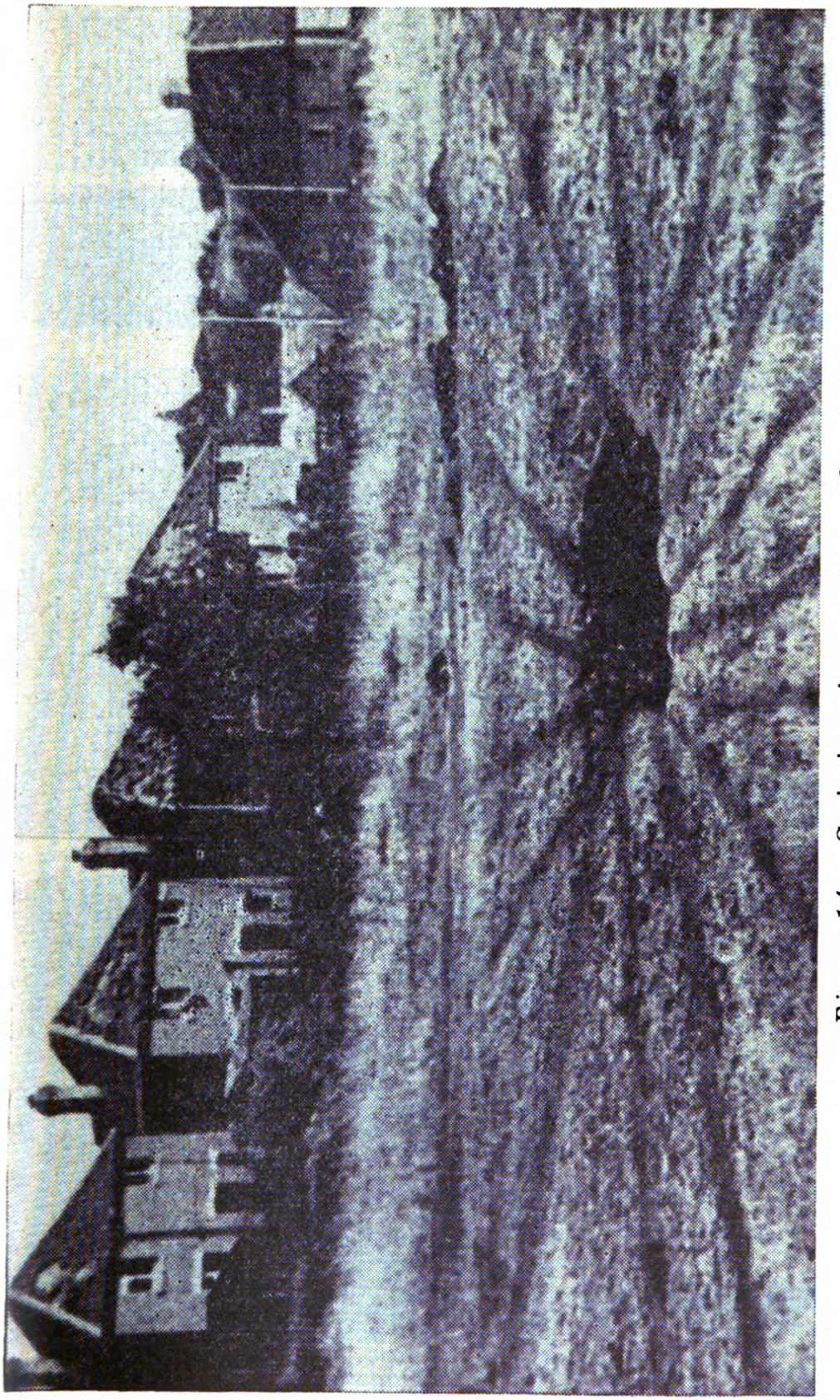


Figure 14.—Striations in grass around crater.

Digitized by Google

Original from
UNIVERSITY OF MICHIGAN

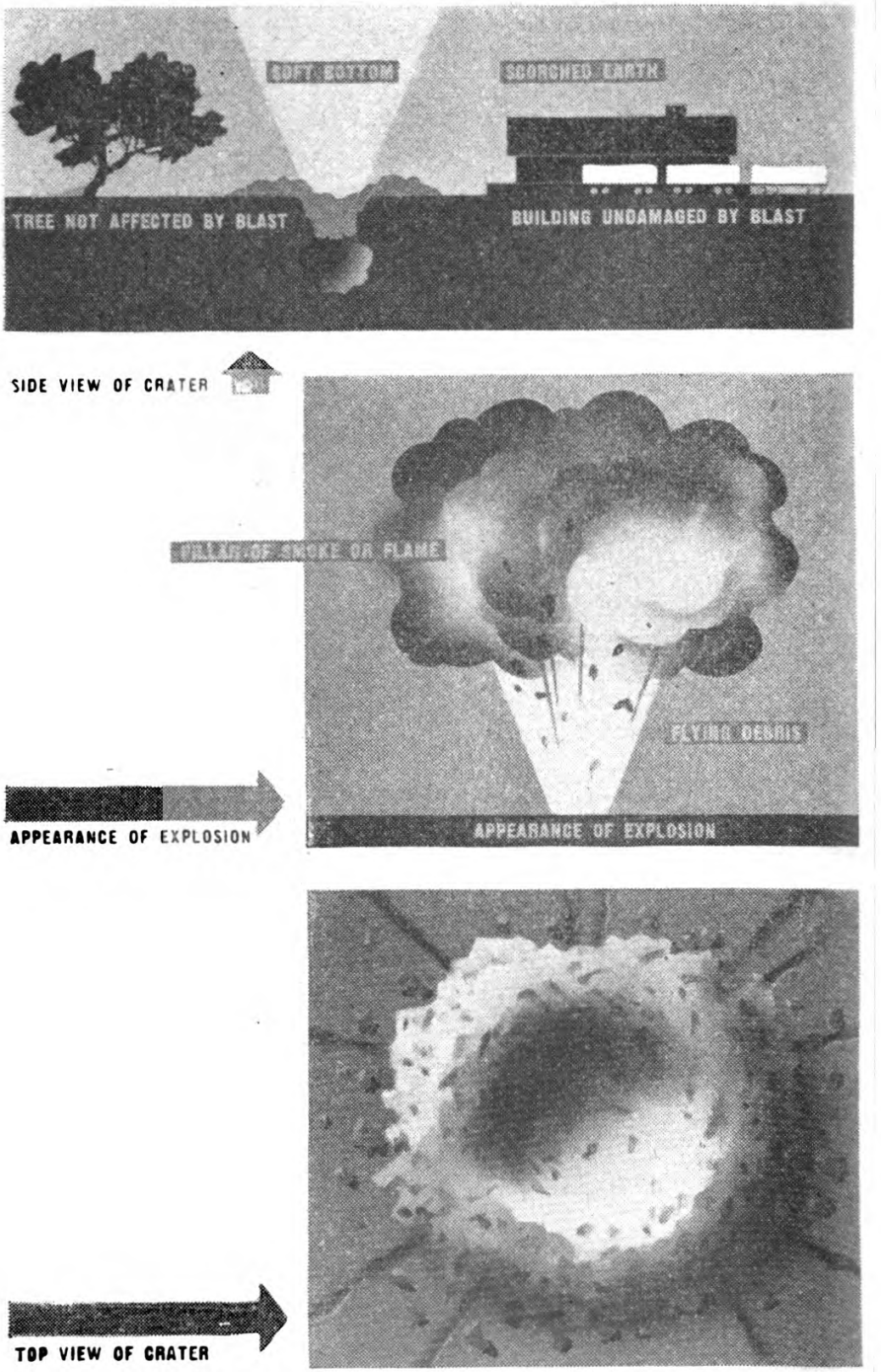


Figure 15.—Signs of bomb exploding below earth's surface.

Digitized by Google
Original from UNIVERSITY OF MICHIGAN

24. DIAGNOSIS OF UNEXPLODED BOMBS.

The indications of an unexploded bomb in certain locations are:

a. In open ground. **(1)** No signs of an explosion (see par. 23).

(2) A visible hole of entry (see par. 19). Unless this is examined within 24 hours it may be found that the earth has fallen into the hole, making it difficult to determine its size.

(3) Pieces of the tail fin, kopfring (a metal ring which is welded to the nose of a bomb to reduce its pentration in earth or water), or other bomb accessories in the hole of entry.

(4) Signs of earth shock (in the case of very large bombs only).

(5) The presence of an apparent crater (in the case of large bombs only).

b. In roads (fig. 16). **(1)** A clean hole of entry on the road's surface if the bomb is small.

(2) Pavement cracked and sagging for an area several times the size of the bomb if it is a large bomb (fig. 16).

(3) Cracking in pavement extending radially from hole of entry.

(4) The signs of explosion will be absent.

c. In buildings. **(1)** Small frame buildings will be demolished by shock of impact.

(2) In large buildings a hole of entry will be visible, as well as holes in partitions and ceilings showing path of bomb.

(3) The signs of explosion will be absent.

(4) There will be a large amount of debris due to collapse of walls, etc.

(5) The buildings will have the appearance of being crushed in instead of being torn apart.

Digitized by Google
Original from UNIVERSITY OF MICHIGAN

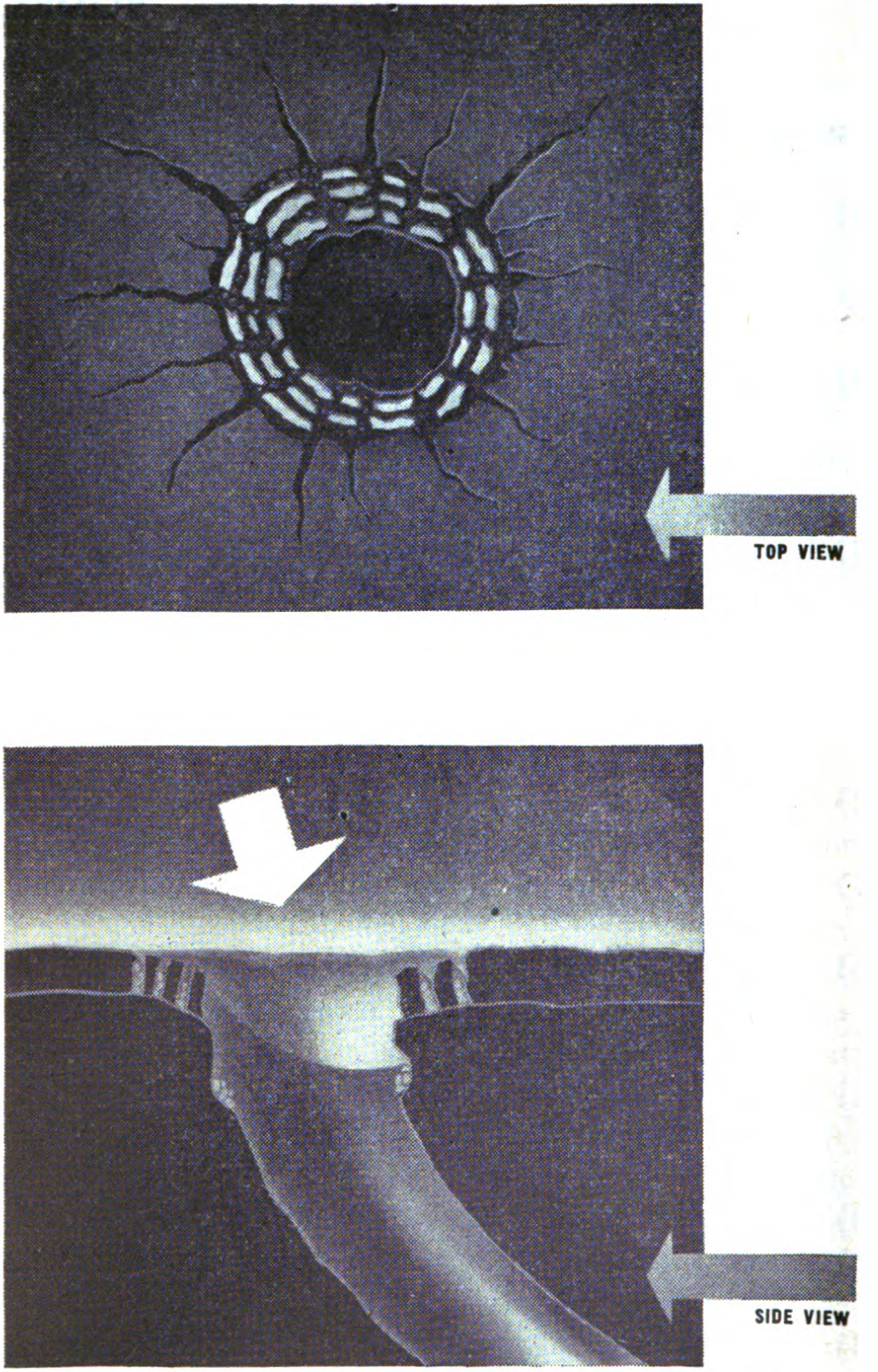


Figure 16.—Appearance of hole of entry in roads.

Digitized by Google
Original from
UNIVERSITY OF MICHIGAN

d. False craters (fig. 17). False craters are craters resulting from the displacement of the surface soil by the shock of impact caused by large bombs. A false crater may often be mistaken for the crater made by the explosion of a small bomb. Therefore, in investigating these craters before deciding whether or not an explosion has occurred, the following points should be noted:

(1) Lips or edges of craters turned in.
(2) Almost straight crater sides.
(3) Almost flat crater bottom.
(4) Signs of earth shock but no other signs of explosion.
(5) Use of the probe will reveal the shaft of entry made by the bomb.

e. False hole of entry. A false hole of entry is caused by flying debris after an explosion. The shaft of entry does not extend below the debris, which will invariably be only a short distance below the surface of the earth.

25. CAMOUFLETS (fig. 18). An underground cavity is often caused by an underground bomb explosion which may fail to rupture the surface of the earth. The chamber retains a portion of the gases of combustion within itself. A high concentration of carbon monoxide is usually present. Such a chamber is called a "camouflet." There are three distinct types of camouflets, each having its own distinctive characteristics.

a. Type A. The type A camouflet is usually formed when the bomb has penetrated 12 feet of hard clay. The indications of this type will be—

(1) A slight mound of pulverized earth with visible subsoil.
(2) A smell of explosives, which may linger in the soil.
(3) The hole of entry entirely blocked.

Digitized by Google
Original from UNIVERSITY OF MICHIGAN

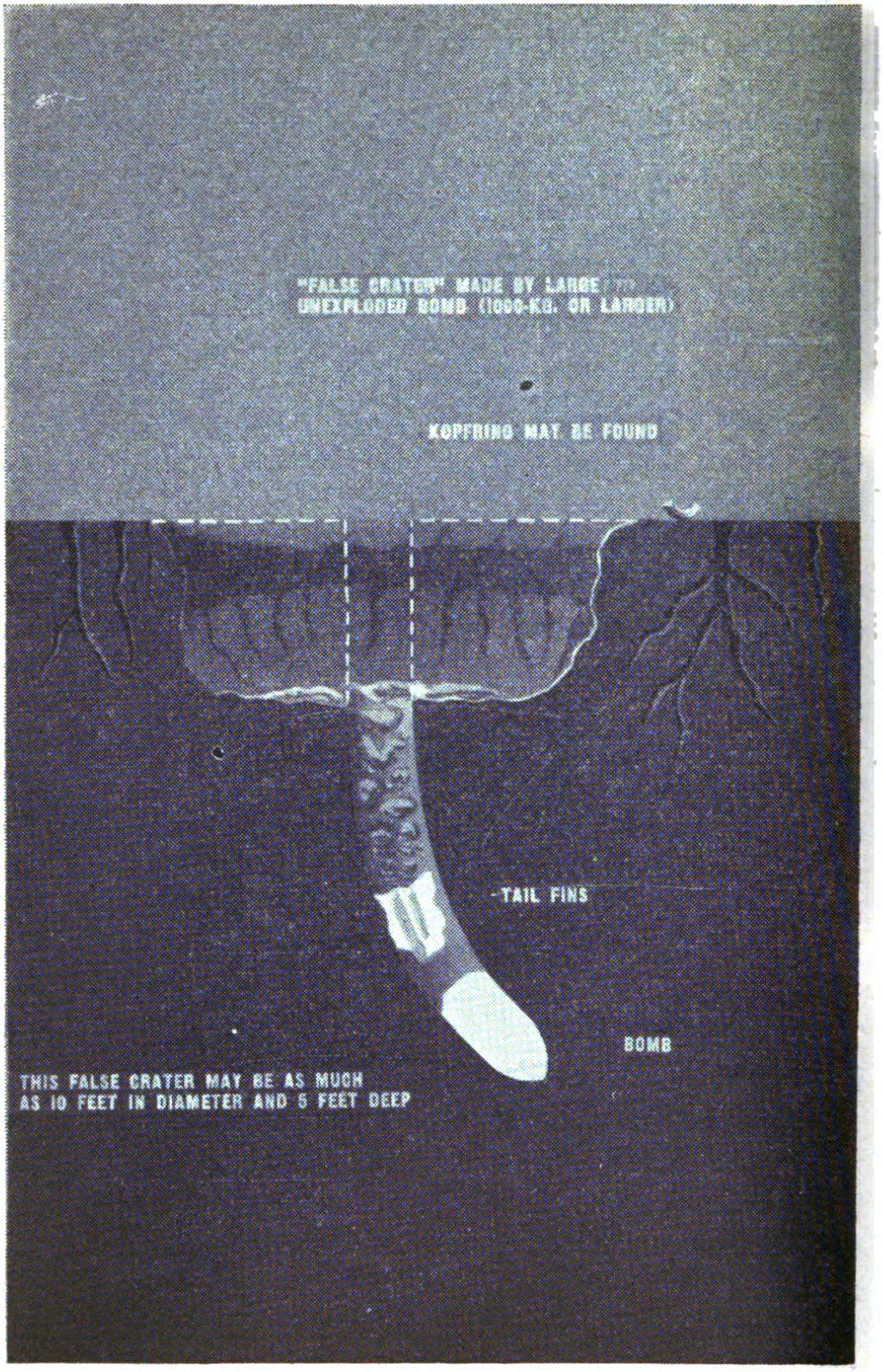


Figure 17.—False crater of unexploded bomb.

Digitized by Google
Original from UNIVERSITY OF MICHIGAN

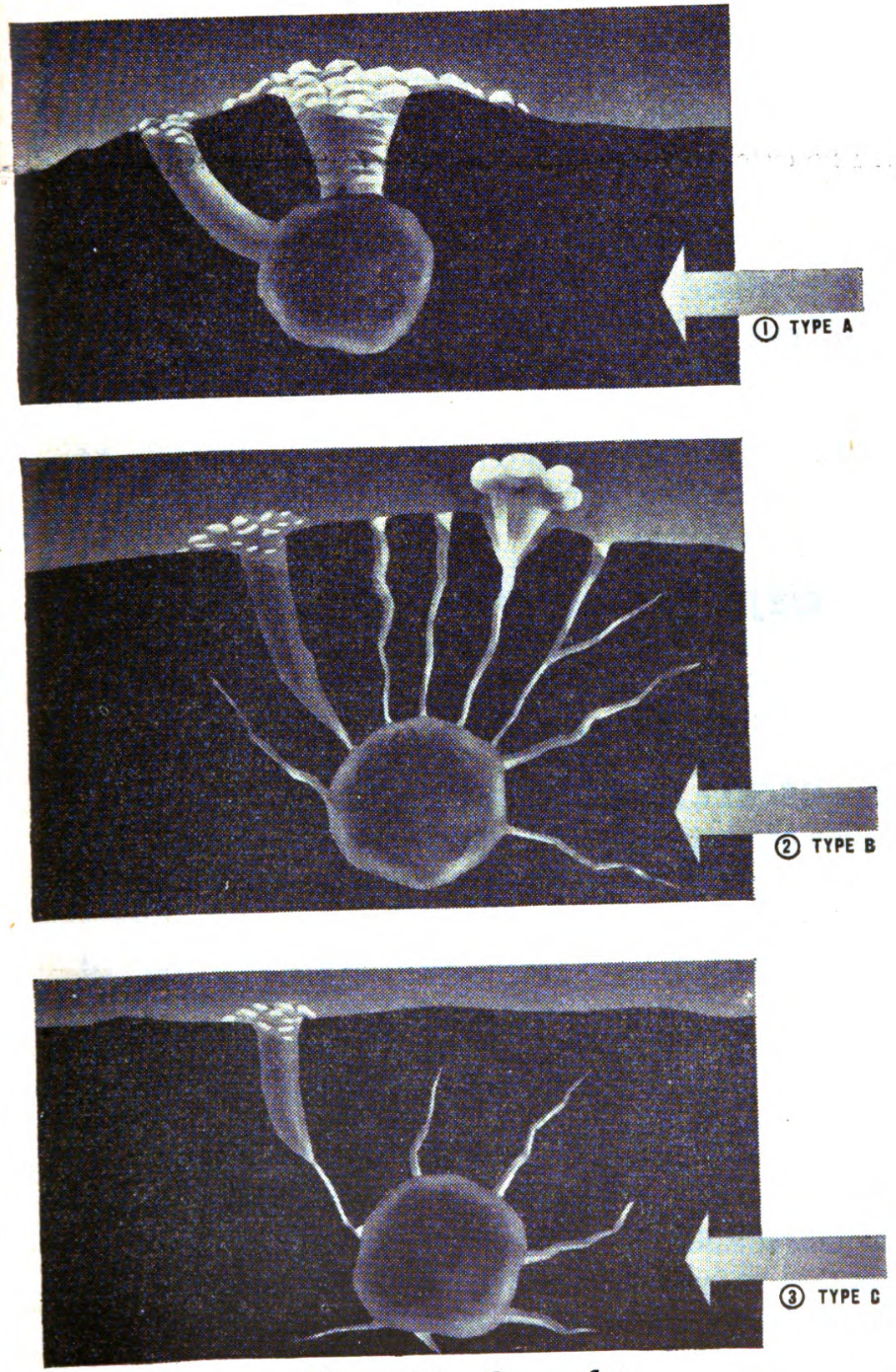


Figure 18.—Camouflets.

Digitized by Google
Original from UNIVERSITY OF MICHIGAN

b. Type B. The type B camouflet is usually formed when the bomb has penetrated 16 feet of hard clay. The indications of this type are:

(1) The earth may be raised above the camouflet but will be cracked instead of pulverized.

(2) No subsoil will be visible.

(3) The shaft of entry may be partially closed below the earth's surface.

c. Type C. The type C camouflet is usually formed when the bomb has penetrated 21 feet of hard clay. There will be no surface indications of this type of camouflet other than the hole of entry made by the bomb. Most type C camouflets will be diagnosed as 50- to 60-kilogram unexploded bombs.

26. OBJECTS DROPPED FROM AIRCRAFT. Aerial mines dropped from aircraft, with or without parachute, designed for use against water targets but sometimes used against land targets.

27. MISCELLANEOUS OBJECTS. A complete discussion of enemy matériel will be found in chapters 8 to 10, inclusive, presented as an aid and guide to the identification of any objects that may be found on the surface of the ground after an air attack.

SECTION II
INCIDENT REPORTING

28. GENERAL.

a. A system for reporting bomb incidents involves—

(1) The act of transmitting any information in connection with an unexploded bomb or a suspected unexploded bomb.

Digitized by Google
Original from UNIVERSITY OF MICHIGAN

(2) The entire sequence of operations beginning with the discovery of a bomb incident and terminating with the negative report of the bomb reconnaissance agent or the reporting of disposition of the unexploded bomb by the bomb disposal unit.

b. Careful investigation has been found to be necessary because, in the excitement of the raid, soldiers and civilians alike are prone to report many incidents which do not actually involve unexploded bombs. As the amount of bomb disposal personnel available in any one location is limited, false reports must be reduced in number. This may be done by application of the principles set forth in section I when rendering the report of the incident.

29. PRELIMINARY REPORT TO CONTROL CENTER. After an air raid, many unexploded bombs and missiles may be found.

a. On a civilian installation. The finder should report the object to the nearest air-raid warden or policeman, who will report the incident to the nearest control station, and a civilian bomb reconnaissance agent will be dispatched to the scene of the incident as rapidly as possible.

b. On a military installation. The soldier discovering the object will report directly to the commanding officer of the establishment, who will be responsible for sending a bomb reconnaissance officer to the scene of the incident.

30. CATEGORIES. Before the subject of the final report by the reconnaissance agent is discussed, it is necessary to understand the reasons for assigning different categories to bombs. There are three of these that may be assigned.

Digitized by Google
Original from UNIVERSITY OF MICHIGAN

a. Category A. This is given to a bomb whose immediate disposal is so vital to the war effort that it outweighs the loss of personnel resulting from an explosion.

b. Category B. This is given to any bomb the removal of which is urgent but not sufficiently so as to justify the risk to personnel occasioned by commencing operations before the expiration of the required safety period.

c. Category C. This is given to those bombs which do not threaten loss of life or damage to vital installations and may be disposed of at the convenience of the bomb disposal unit.

31. REPORTING CHANNELS. The reporting channels for unexploded bomb reports are shown in figure 21. In connection with these channels, the following should be kept in mind:

a. Military channels. Reports made by bomb reconnaissance officers on military installations will be forwarded to the primary control center through the commanding officer of the installation.

b. Civilian channels. Civilian bomb reconnaissance agents may be dispatched to the reported incident by either primary or secondary control centers, the agent rendering his report to the center from which he was dispatched.

c. Assignment of category. Final reports received by secondary control centers will be sent to primary control centers for assignment of category.

d. Control channels. The primary control center will render duplicate reports, one through the operation channel and one through the administrative channel.

Digitized by Google
Original from UNIVERSITY OF MICHIGAN

32. REPORT BY CONTROL CENTER. a. Report (figs. 19 and 20). The investigation or reconnaissance of the incident will be performed by the qualified bomb reconnaissance agent or officer, bearing in mind the basic theories and data set forth in section I of this chapter, and a complete report of the incident will be rendered—

(1) By the civilian bomb reconnaissance agent on O. C. D. Form No. 104 (Unexploded Bomb Report) in accordance with the instructions on the reverse thereof.

(2) By the reconnaissance officer on W. D., A. G. O. Form No. 430 (Unexploded Bomb Report) in accordance with the instructions on the back thereof.

b. Assignment of category. (1) After part I of the Unexploded Bomb Report has been satisfactorily completed, the report will be dispatched to the proper control center where the Controller fills out part II of the report.

(2) The Office of the Civilian Defense Regional District Commander will then approve the category given the bomb or indicate such category as he thinks suitable.

(3) The senior bomb disposal officer will then approve the category in which the bomb has been placed or recommend such category as he believes correct before sending the report to the subordinate officer in charge of disposal operations. *In all cases, the senior bomb disposal officer will have the final decision as to the category of a bomb.*

(4) Part III will be filled out by the bomb disposal officer in charge of operations, and part IV will be completed upon the disposition of the incident.

Digitized by Google
Original from UNIVERSITY OF MICHIGAN

OCD-6644 Sept. 1942
OCD Form No. 104

UNEXPLODED BOMB REPORT

To....., Control Center

PART I

1. Exact location .....
   .....
   Time of falling ..... Date .....
2. Phase affected:
   Industrial war effort ☐ General industry ☐ Civil population ☐
   Communications or public utility services ☐ Military installations ☐ Other (specify) ☐
3. State:
   (a) Diameter of hole of entry ..... *Inches.* (b) Estimated depth ..... *Feet.*
   (c) Type of ground—surface ..... (d) Type of subsoil .....
   (e) Type of building, if bomb went through building .....
   (f) Reasons for suspecting UXB .....
   .....
4. Will explosion damage:
   Buildings ☐ Gas mains ☐ Water mains ☐
   Electric cables ☐ Telephone cables ☐ Sewers ☐ Other (specify) ☐
5. If on, or near, railroad property, state if explosion will damage:
   Main lines ☐ Sidings ☐ Fills ☐ Bridges ☐ Other (specify) ☐
6. Describe:
   (a) Any parts of bomb exposed .....
   .....
   (b) Any parts of bomb found anywhere .....
   .....
   (c) Color markings found on any part .....
7. State where recovered parts of bomb have been deposited .....
   .....
8. What evacuations have been enforced? (Sketch on reverse side if necessary):
   .....
9. Other remarks ..... (Signed) .....
   ..... Title .....
   ..... Post .....

PART II

1. Bomb category recommended ☐ (Signed) ..... *Controller.*
2. Bomb category allocated ☐ (Signed) ..... *Comm. Cit. Def. Corps.*
3. Final category approved ☐ (Signed) ..... *Senior B. D. O.*
   Rank ..... Unit .....

PART III

To: C. O. ..... B. D. Co. to C. O. ..... B. D. Platoon ..... Co.

1. Report verified: Time ..... Date .....
2. Operations commenced: Time ..... Date .....

3. Nationality	Size	Type of Bomb

4. Fuses fitted .....
   .....
5. Penetration ..... *Feet.* Offset ..... *Feet.*
   Return to:
   ..... B. D. Co.
   .....
6. How fuzes dealt with .....
   .....
7. How bomb disposed of .....
   .....
8. Operations completed: Time ..... Date .....
9. Clearance certificate handed to;
   ..... Time ..... Date .....
10. Remarks: Signed .....
    ..... Rank .....
    ..... Unit .....
    .....
    .....

PART IV

The unexploded bomb at (place):
.....
Has been { 1. Disposed of ☐ / 2. Discredited ☐ / 3. Abandoned ☐ } Time ..... Date .....
(Signed) .....
Rank .....
Unit .....

Figure 19.—Office of Civilian Defense unexploded bomb report

Digitized by Google
Original from UNIVERSITY OF MICHIGAN

INSTRUCTIONS AND SUGGESTIONS FOR MAKING UNEXPLODED BOMB REPORT

METHOD OF OPERATION

Upon receipt of report of an unexploded bomb (UXB), the Controller sends a specially trained Bomb Reconnaissance Agent to investigate. If, after investigation, he verifies the fact that an unexploded bomb is present, he fills out *Part I* of this report and sends it at once to the Controller.

The Controller fills out *Part II* of the report, recommending a category for the bomb. The Commander of the U. S. Citizens Defense Corps passes on this recommendation, either approving or altering it. The form is then forwarded to the Senior BD (Bomb Disposal) Officer, who has been detailed by the United States Army to supervise the disposal of UXB's in the area.

The Senior Bomb Disposal Officer passes on the recommendation as to category of the bomb, making a final decision. He then forwards the report to a subordinate officer, by using *Part III*, and the latter disposes of the bomb, filling out the Clearance Certificate, *Part IV*.* He then sends the Clearance Certificate to the Controller, who forwards it to the Air Raid Warden responsible for the local area in which the UXB was located.

Following issuance of the Clearance Certificate, any evacuation measures or safety precautions which were in effect, due to the presence of the UXB, may then be lifted.

DETAILED INSTRUCTIONS

Part I

Par. 1. Be sure to be exact. Detailed statement of location is necessary to help the BD Officer locate the UXB. The time and date of falling, estimated if necessary, are needed because the time elapsed since the bomb's fall sometimes determines the risk involved and, therefore, affects the BD Officer's disposal plan.

Par. 2. If a phase is affected, other than those listed, which is thought to be important to the war effort, check "Other" and explain in detail in paragraph 9 or on back of report form.

Par. 3. Under (*f*) list such reasons as "Windows within ——— feet not broken." "No splinter marks on nearby walls," etc.

Par. 4. If an important installation other than those listed is affected, check "Other" and explain in detail in paragraph 9 or on back of report form.

Par. 5. Proceed as in paragraph 4.

Par. 6. Describe everything known about the bomb. Even an apparently insignificant detail may give a clue to the BD Officer as to the type of bomb he must deal with.

Pars. 7 and 8. Self-explanatory.

Par. 9. Under "Other remarks" give details on other paragraphs or any additional details that may help identify the bomb or be useful in planning disposal operations.

Part II

Self-explanatory.

Part III

and

Part IV

These parts are filled in by United States Army BD Personnel.

☆ U. S. GOVERNMENT PRINTING OFFICE 16—30336-1

Figure 19.—Office of Civilian Defense unexploded bomb report—Continued.

Digitized by Google

Original from UNIVERSITY OF MICHIGAN

UNEXPLODED BOMB REPORT
MILITARY FORM

To _____, Control Center.

Part I

1. Exact location _____

Time of falling _____ Date _____

2. Phase affected:
Industrial war effort ☐ General industry ☐ Civil population ☐
Communications or public utility services ☐ Military installations ☐ Other (specify) ☐

3. State:
a. Diameter of hole of entry _____ inches. b. Estimated depth _____ feet
c. Type of ground, surface _____ d. Type of subsoil _____
e. Type of building, if bomb went through building _____
f. Reasons for suspecting UXB _____

4. Will explosion damage—
Buildings ☐ Gas mains ☐ Water mains ☐ Electric cables ☐ Telephone cables ☐ Sewers ☐ Other (specify) ☐

5. If on or near railroad property, state if explosion will damage—Main lines ☐ Sidings ☐ Fills ☐ Bridges ☐ Other (specify) ☐

6. Describe—
a. Any parts of bomb exposed _____
b. Any parts of bomb found anywhere _____
c. Color markings found on any part _____

7. State where recovered parts of bomb have been deposited _____

8. What evacuations have been enforced? (Sketch on reverse side if necessary.) _____

9. Other remarks _____ (Signed) _____
Title _____
Post _____

Part II

1. Bomb category recommended _____ ☐ (Signed) _____ BRSO
2. Bomb category allocated _____ ☐ (Signed) _____ Controller
3. Final category approved _____ ☐ (Signed) _____ Senior BDO
Grade _____ Unit _____

Part III

To CO _____ BD Co to CO _____ BD Platoon _____ Co

1. Report verified: Time _____ Date _____
2. Operations commenced: Time _____ Date _____
3. Nationality _____ Size _____
Type of bomb _____
4. Fuses fitted _____
5. Penetration _____ feet. Offset _____ feet.
Return to _____ BD Co.
6. How fuzes dealt with _____
7. How bomb disposed of _____
8. Operations completed: Time _____ Date _____
9. Clearance certificate handed to _____ Time _____ Date _____
10. Remarks _____
(Signed) _____
Grade _____
Unit _____

Part IV

The unexploded bomb at (place) has been—
1. Disposed of ☐
2. Discredited ☐ } Time _____ Date _____
3. Abandoned ☐

(Signed) _____
Grade _____
Unit _____

W. D., A. G. O. Form No. 480
April 14, 1943

16—84087-1

Figure 20.—Military unexploded bomb report.

Digitized by Google
Original from UNIVERSITY OF MICHIGAN

INSTRUCTIONS AND SUGGESTIONS FOR MAKING UNEXPLODED BOMB REPORT

METHOD OF OPERATION

1. Upon receipt of report of an unexploded bomb (UXB), the *bomb reconnaissance staff officer*, or his qualified representative, sends a specially trained *bomb reconnaissance officer* to investigate. If, after investigation, he verifies the fact that a UXB is present, he fills out PART I of this report and sends it at once to the *bomb reconnaissance staff officer* (BRSO).

2. The BRSO fills out PART II of the report, recommending a category for the bomb. The form is then forwarded to the predetermined *Office of Civilian Defense primary control center.* The *controller* either accepts the recommended category of the bomb or indicates a change. The *controller* then forwards the report to the senior *bomb disposal* (BD) *officer*, who has been detailed by the United States Army to supervise disposal of the unexploded bombs in the area.

3. The *senior* BD *officer* passes on the recommendation as to category of the bomb, making final decision. He then forwards the report to a subordinate officer, by using PART III, and the latter disposes of the bomb, filling out *clearance certificate*, PART IV. The *clearance certificate* is then forwarded to the *Office of Civilian Defense primary control center* so that clearance may be noted. *Clearance certificate* is then forwarded to originating BRSO who forwards it to the pertinent commander of the area affected.

4. Following issuance of the *clearance certificate*, any evacuation measures or safety precautions which were in effect, owing to the presence of the UXB, may then be lifted.

WARNING: In the event the bomb reconnaissance agent or bomb reconnaissance officer determines that the incident involves an unexploded mine, the Navy Department should be advised and jurisdiction over the incident given the Navy mine disposal personnel unless such procedure results in unwarranted danger to life and property, in which case Army bomb disposal personnel are authorized to dispose of the mine.

DETAILED INSTRUCTIONS

Part I

One copy of this report must be forwarded to predetermined *Office of Civilian Defense primary control center.*

Par. 1. Be sure to be exact. Detailed statement of location is necessary to help the BD officer locate the UXB. The time and date of falling, estimated if necessary, are needed because the time elapsed since the bomb's fall sometimes determines the risk involved and therefore affects the BD officer's disposal plan.

Par. 2. If a phase is affected, other than those listed, which is thought to be important to the war effort, check "Other" and explain in detail in paragraph 9 or on back of report form.

Par. 3. Under *f* list such reasons as "Windows within ..... feet not broken," "No splinter marks on nearby walls," etc.

Par. 4. If an important installation other than those listed is affected, check "Other" and explain in detail in paragraph 9 or on back of report form.

Par. 5. Proceed as in paragraph 4.

Par. 6. Describe everything known about the bomb. Even an apparently insignificant detail may give a clue to the BD officer as to the type of bomb he must deal with.

Para. 7 and 8. Self-explanatory.

Par. 9. Under "Other remarks" give details on other paragraphs or any additional details that may help identify the bomb or be useful in planning disposal operations.

Part II

Self-explanatory

Part III

and

Part IV

These parts are filled in by United States Army BD personnel

U. S. GOVERNMENT PRINTING OFFICE 16—84697-1

Figure 20.—Military unexploded bomb report—Continued.

Digitized by Google

Original from UNIVERSITY OF MICHIGAN

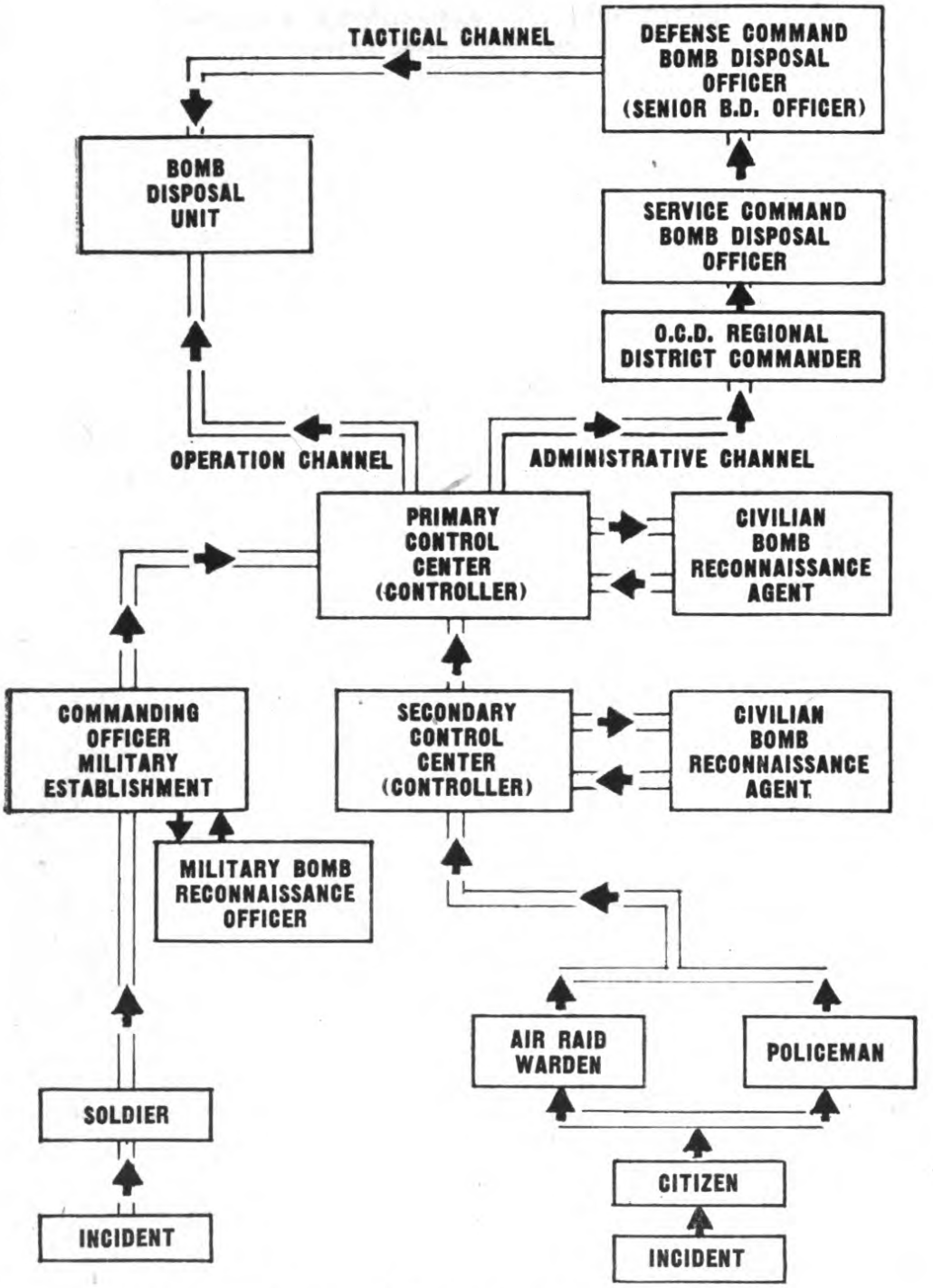


Figure 21.—Channels for reporting bomb incidents.

Digitized by Google
Original from UNIVERSITY OF MICHIGAN

SECTION III

EVACUATION AND PROTECTIVE WORKS

33. GENERAL. Often it will be impossible to render the bomb safe immediately, and in these cases evacuation of personnel and application of protective works will greatly reduce the damage done should an explosion occur.

34. EVACUATION (normally accomplished by a bomb reconnaissance agent). **a. General.** Evacuation is the removal from the zone of dispersion of the unexploded bomb of all persons within that zone, pending the disposal of the unexploded bomb. Evacuation includes the completion of all arrangements for transporting, housing, and feeding the evacuees. Prompt and proper evacuation should be accomplished as soon as the unexploded bomb is discovered. The danger area in the open for a buried bomb is 100 yards, and that for an unburied bomb is 300 yards (these distances are increased by 50 percent when the bomb is known to be larger than 1,100 pounds). The following evacuation procedure should be put into effect as soon as an incident is reported:

b. In a populated area. (1) For buried bombs—

(a) Evacuate all buildings within 50 yards.

(b) Open all windows and doors of buildings within 100 yards.

(c) Allow no wheeled traffic within 50 yards of the bomb.

(d) Allow no pedestrian traffic within the evacuated area.

Digitized by Google
Original from UNIVERSITY OF MICHIGAN

(2) For unburied bombs. **(a)** Evacuate all buildings within 100 yards.

(b) In other buildings within 200 yards of the bomb, evacuate all rooms with windows facing the bomb.

(c) Allow no wheeled traffic within 150 yards.

(d) Allow no pedestrian traffic within the evacuated area.

(e) Open all doors and windows of evacuated buildings.

(3) For parachute mines. **(a)** Evacuate all buildings within 400 yards.

(b) Open all doors and windows of buildings within 800 yards, and warn persons away from objects containing panes of glass.

(c) Allow no wheeled traffic within 400 yards of the mine.

(d) Allow no pedestrian traffic within the evacuated area.

NOTE.—As these distances are for the largest size bomb, the bomb disposal officer in charge of the disposal operations may relax any of the above restrictions if he so desires.

35. PROTECTIVE WORKS. **a. Use.** Protective works are used, as a rule, only in the case of category A bombs (par. 30*a*). They have two main functions:

(1) To allow work to continue in buildings or factories while the bomb is being removed.

(2) To allow the bomb to be reclassified in lower category due to the protective structures.

b. Types. **(1) Sandbagging** (fig. 22). Sandbagging is used to protect against blast and fragmentation. As a blast wave can be deflected, it is evident that a sandbag will protect a structure from blast in this manner, and, furthermore, the sandbags will absorb the fragments.

Digitized by Google
Original from UNIVERSITY OF MICHIGAN

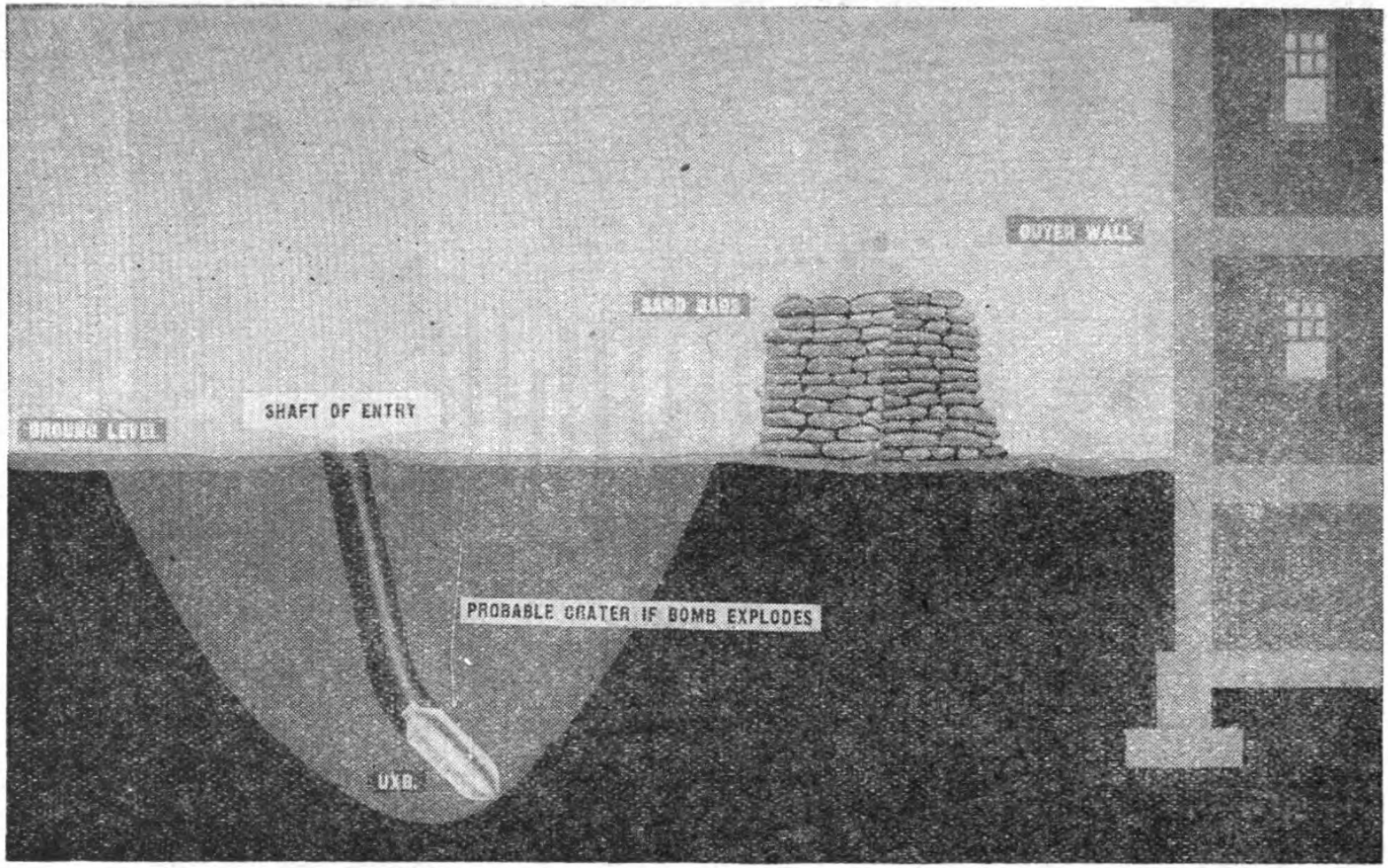


Figure 22.—Method of protecting building with sandbags.

Digitized by Google
Original from UNIVERSITY OF MICHIGAN

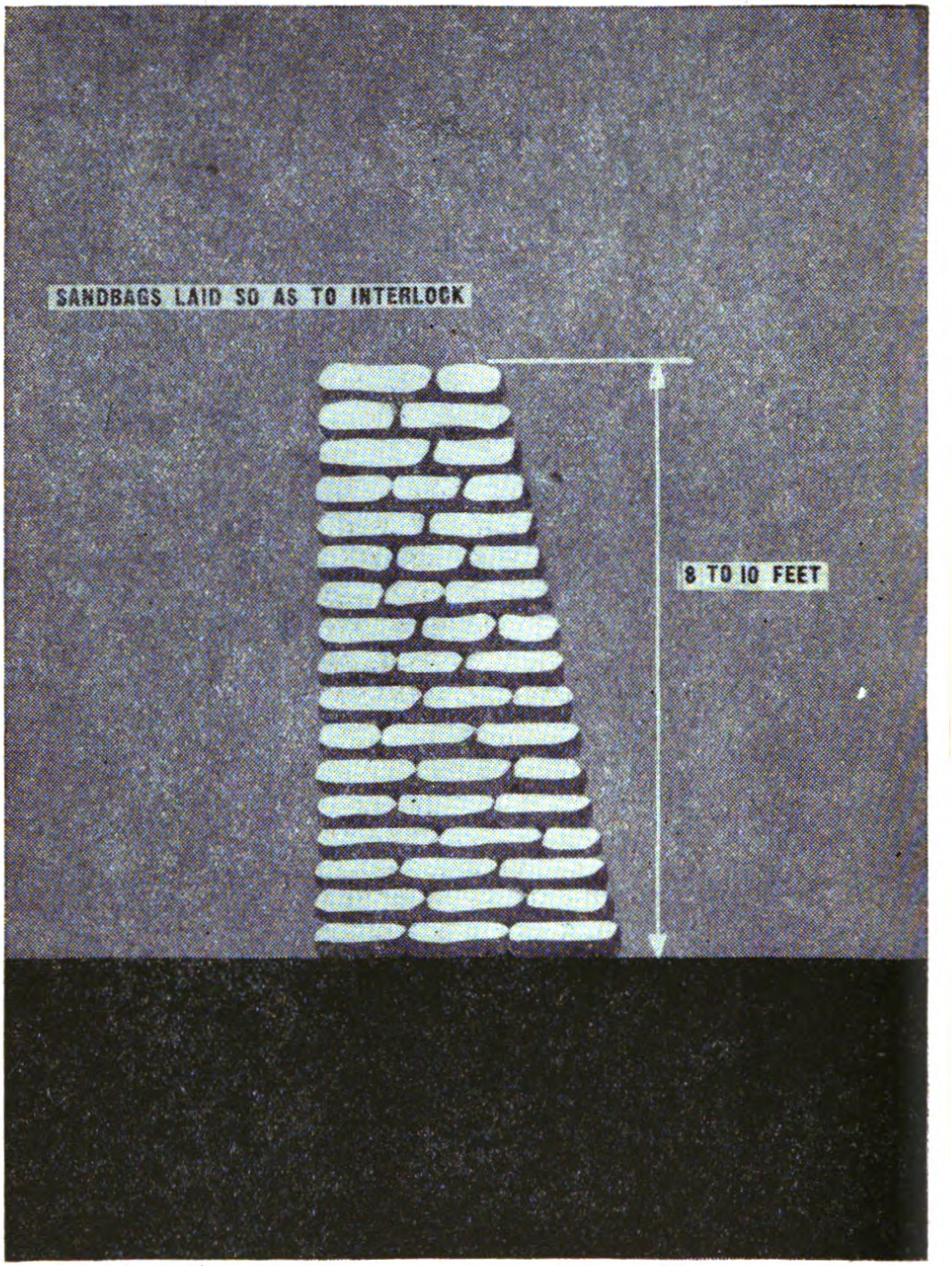


Figure 23.—Proportions of sandbag wall.

Digitized by Google
Original from
UNIVERSITY OF MICHIGAN

These walls should be made and employed in the following manner:

(a) The wall should have the dimensions shown in figure 23 and should be placed with the sloping face away from the bomb.

(b) The wall will serve its purpose when placed at either A or B as shown in figure 24. Its location must be governed by the radius of the possible crater, as it will not protect the wall if placed within this radius.

Table VII.—Location of sandbags

Size of bomb		Minimum distance from hole of entry
Kilograms	*Pounds*	*Feet*
50	110	10
250	550	20
500	1, 100	30

(c) The use of sandbags for this purpose has three advantages.

1. They are easily obtained.
2. They will not form dangerous missiles if the wall is destroyed.
3. They will absorb splinters.

(2) Trenching. **(a)** Trenching is used to protect against earth shock by interrupting the shock wave between the bomb and the object to be protected. To give this protection, the trench must be of sufficient depth to interrupt a direct line from the bomb to the object and long enough to interrupt that part of the shock wave likely to reach the object. (See fig. 25.) The following table gives the radius of the earth-shock damage for the various size bombs and objects being protected:

Digitized by Google
Original from UNIVERSITY OF MICHIGAN

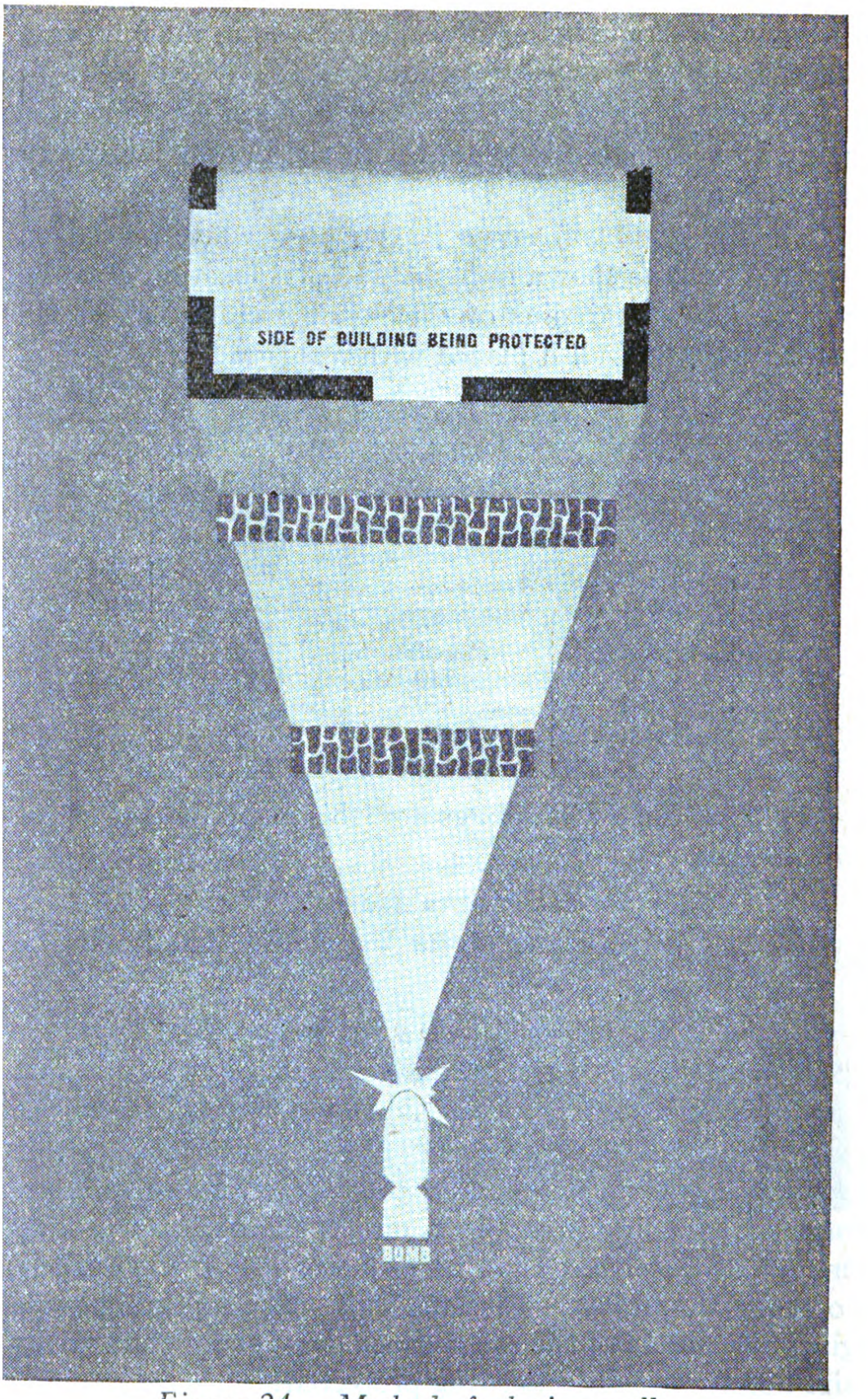


Figure 24.—Method of placing wall.

Digitized by Google
Original from UNIVERSITY OF MICHIGAN

Table VIII.—Radius of earth-shock damage

Size of bomb		Cast iron or concrete pipe	Steel pipes and cables	Pipes and brick sewers
Kilograms	*Pounds*	*Feet*	*Feet*	*Feet*
50	110	20	15	30
250	550	30	24	50
500	1,100	35	27	60
1,000	2,200	45	34	70
1,800	3,960	50	38	90
C, D, G Mines	----------	20	20	40
	----------	15	15	30
	----------	50	38	80

(b) Earth-shock damage depends on the type of soil encountered. Table IX gives the conversion factors to be used for different soils. These factors are to be used in conjunction with table VIII. For example, if a 1,000-kg unexploded bomb were in made ground, then the radius of earth-shock damage for pipes and brick sewers would be 1.3×70 or 91.0 feet. However, if the same unexploded bomb were buried in sand then the radius of earth-shock damage for pipes and brick sewers would be $.8 \times 70$ or 56 feet.

Table IX.—Conversion factors

Type of soil	Factors
Made ground	1.3
Chalk	0.9
Sand	0.8

(3) Buttressing (fig. 26). Buttressing may be used in the case of a building with a deep foundation where protection against earth shock by trenching may be found to be impractical or impossible. If this is the case, the inside of the foundation wall should be reinforced with sandbags as shown. Care should be taken that the sandbag buttress does not abut on any interior partition.

Digitized by Google
Original from UNIVERSITY OF MICHIGAN

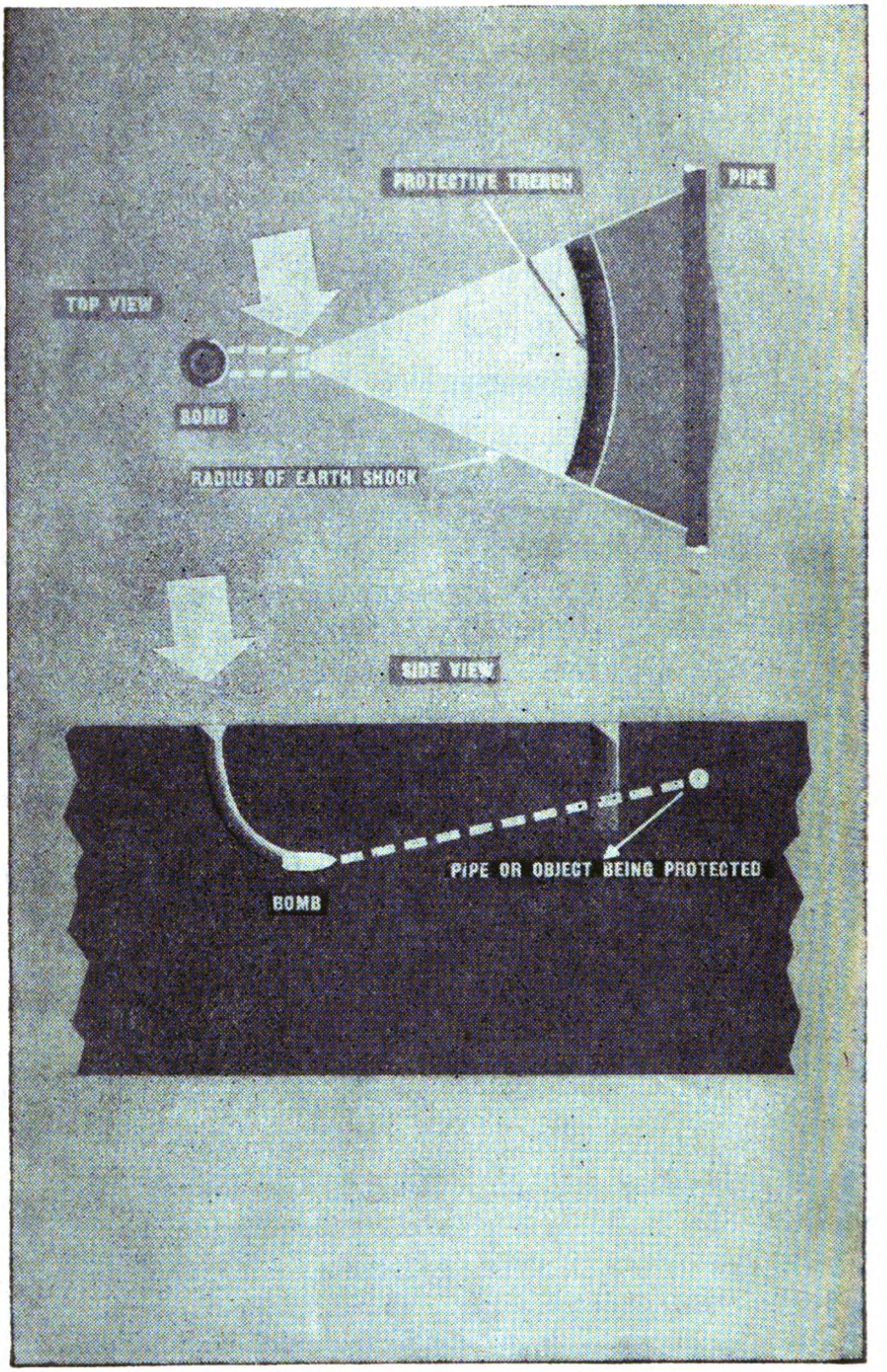


Figure 25.—Trenching.

Digitized by Google
Original from UNIVERSITY OF MICHIGAN

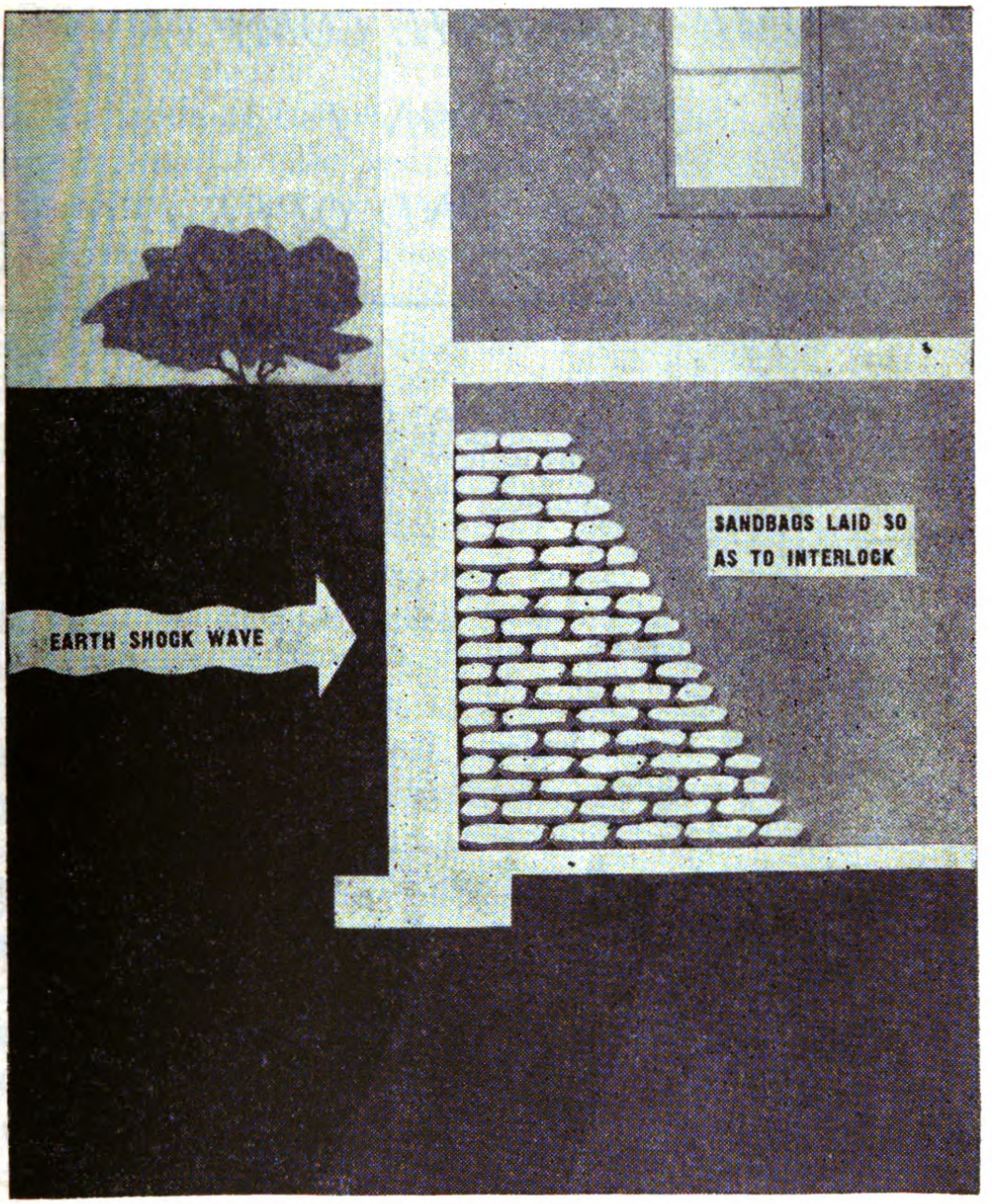


Figure 26.—Method of buttressing a wall.

Digitized by Google
Original from
UNIVERSITY OF MICHIGAN

CHAPTER 4

BOMB DISPOSAL COMPANY

SECTION I

ORGANIZATION AND OPERATIONS

36. MISSION. The mission of the bomb disposal company is to insure the safety and continued operation of the war effort whenever it may be threatened by unexploded bombs.

37. ASSIGNMENTS. Bomb disposal companies will be assigned to—

a. Ground force units. Under normal conditions none will be assigned. Bomb disposal units or detachments may be attached to army headquarters as required.

b. Air force units. Normally one bomb disposal company will be assigned to each Army Air Forces headquarters.

c. Service force units. Bomb disposal companies will be assigned to the Army Service Forces units as required by theater commanders.

38. RESPONSIBILITIES. In the fulfillment of its mission, the bomb disposal company is responsible for performing all bomb disposal operations within the limits of its capabilities.

Digitized by Google
Original from UNIVERSITY OF MICHIGAN

39. PLANNING. A bomb disposal company commander must continually plan to meet all contingencies.

40. MAINTENANCE OF RECORDS. It is thought advisable that records of operations be kept to serve as a source of information. These will be of two types.

a. Records of future operations. These will show the unexploded bombs assigned to the company for disposal and may be of two types.

(1) Written records. These will usually consist of a file of Unexploded Bomb Reports (sec. II, ch. 3) showing the size, location, category, and other data pertaining to each bomb.

(2) Visual records. In an area subjected to heavy and frequent air raids, an operational map will be kept in company or platoon headquarters, showing the location and category of each unexploded bomb.

b. Records of completed operations. A file will be kept of the reports turned in by officers conducting removal and disposal operations. Such a file will be found extremely valuable for future operations if the reports include—

(1) Appearance of the hole of entry and other signs reported in the reconnaissance.

(2) A summary of the access operations, including—

(a) Any unusual operational problems and the solution thereof.

(b) The depth at which tail fins, etc., were found.

(c) Type of soil and any peculiarity thereof.

(d) Recommendations for any changes or improvements in operating technique.

(3) Notes on any irregularities encountered in the disposal of the bomb.

Digitized by Google
Original from UNIVERSITY OF MICHIGAN

41. QUARTERING TROOPS.

a. Operating as a company. The personnel of the bomb disposal company will be quartered at a point centrally located in respect to their activities. This will be a military installation if possible, though other arrangements may be made when necessary.

b. Operating as a separate platoon. The personnel of each platoon will be quartered in the vicinity of their operations, permanent or temporary quarters being provided in accordance with the duration of their stay at each location. The subject of bivouacs or shelters is covered in FM 100–5.

42. TRAINING. All persons of the company should be thoroughly trained not only in the efficient performance of their specific duties, but also in the duties of related assignments. Such training should include tactical operations for the protection of the company, as well as technical operations. In addition to the usual training of personnel in matters pertaining to bomb disposal operations and the basic military training necessary to weld the company into an efficient military organization, certain other subjects should be stressed.

a. Officers. Company officers should receive as much training as possible on all military subjects which will increase their effectiveness and efficiency in the combat zone and in their relations with the combat branches. Such training should cover the following matters:

(1) A complete knowledge of the entire ordnance service picture in the combat zone, including knowledge of specific capabilities and functions.

(2) The art of small maneuvers and a knowledge of the ground in their vicinity. Whenever the organization moves to a new location, officers should make every effort to gain for themselves a thorough knowledge of the ground

Digitized by Google
Original from UNIVERSITY OF MICHIGAN

in all directions for a distance up to 50 miles or more according to the nature of the country. Particular attention should be paid to difficult places, alternate routes, etc.

(3) Steps necessary for unit defense, antiaircraft and ground.

(4) Map and compass reading.

(5) Motor movements by night, using only odometer readings and a compass (without reliance on sign posts).

(6) A personal knowledge of all small arms.

(7) A knowledge of military and staff terms.

(8) A thorough knowledge of first aid.

(9) A knowledge of vehicle and driver discipline, and the habit of observing the country on both sides of the road in order that immediate cover can be taken against aircraft attack. On the appearance of enemy aircraft, drivers must not park their vehicles in the road and run for cover. Burning or otherwise disabled vehicles will block the road.

(10) The fact that an officer should always consider his vehicle and equipment first, his men next, and himself last.

(11) The interior administration of units, in order that every officer may operate a small unit when it is not being administered by a parent echelon.

(12) The fact that it is better to use initiative and act, even if wrong, than to do nothing.

b. Enlisted men. Enlisted men should receive training in all of the matters mentioned above which are particularly applicable to them in the performance of their duties.

43. ORGANIZATION. The organization of the bomb disposal company as prescribed in T/O 9–177 has been designed to allow operation of the company as a separate unit, grouped with other companies, or with more or less than its four basic platoons.

Digitized by Google Original from UNIVERSITY OF MICHIGAN

44. ADDITIONAL PLATOONS. When the four operating platoons of the bomb disposal company are considered insufficient for the operations at hand, additional platoons may be requested from the bomb disposal staff officer. These additional platoons will be administered by the company headquarters requesting them.

45. EQUIPMENT. A complete list of all the equipment for the company may be obtained from T/BA 9. Special bomb disposal equipment is listed in SNL N–177.

46. OPERATIONS. The operations of the bomb disposal company will vary with its assignment. All operations may be roughly classified into two categories; those which are military or tactical in nature, and those which are technical in nature. In the discussion which follows, no effort has been made to establish a clear-cut division between these two categories.

47. MOVEMENTS OF COMPANY. The bomb disposal company is mobile in the sense that it can be moved in its entirety with all personnel and equipment by its organic transportation.

48. MOTOR MARCHES. All motor marches made by the company, and the details of the conduct of marches and all matters pertaining thereto, will be governed by FM 25–10.

49. TECHNICAL OPERATIONS. All necessary information concerning access and disposal operations will be found in chapter 7.

50. CONTINUITY OF OPERATIONS. All personnel, commissioned or enlisted, should endeavor to insure continuity of policy in operations by keeping the next person in the chain of command or supervision informed of the current status of operations or of any changes of policies

Digitized by Google
Original from UNIVERSITY OF MICHIGAN

effecting the work in question. Standing operating procedures should be specified in every bomb disposal company. Some of the advantages of their use are:

a. They reduce the load of minor decisions on the company commander and allow him more time for consideration of major policies and unusual situations.

b. Every man knows exactly what to do and becomes an expert in his particular duties.

c. Every man knows who attends to other duties. Coordination is simplified.

d. Complete coverage of all details is obtained—nothing is forgotten in the rush.

The net result is increased efficiency of the whole company, but sufficient rotation of duty should be practiced to provide several replacements for any man who is lost through sickness or otherwise.

51. DUTIES OF PERSONNEL. The duties of the company commander are outlined in paragraph 53. General remarks concerning the duties of the other officers and of the enlisted men are included in this section. The specific duties of the other officers and of the enlisted men are given in the sections dealing with the units to which they are assigned.

52. FLEXIBILITY OF ASSIGNMENTS. The duties given to individuals will be their normal assignments. Consideration of sickness and losses will indicate that all individuals may be given assignments other than normal. (See par. 42.)

53. COMPANY COMMANDER. Responsibilities of the company commander will be those common to company commanders.

Digitized by Google
Original from UNIVERSITY OF MICHIGAN

SECTION II

HEADQUARTERS PLATOON

54. ORGANIZATION. The organization of the headquarters platoon is shown in figure 27. This may be used as a guide by the company commander in organizing this unit.

55. EQUIPMENT. The vehicles assigned to headquarters platoon include the following:

a. Truck, ¼-ton, 4 x 4.
b. Truck, ¾-ton, 4 x 4, weapons carrier.
c. Truck, 2½-ton, 6 x 6, cargo.
d. Compressor, air, motorized.

56. OPERATIONS AND DUTIES. The responsibilities governing the operations of the various sections of the headquarters platoon and the duties of the personnel in these sections are the same as in normal organizations. Certain special personnel and their duties are described below.

a. Bricklayer. (1) Assignment. The bricklayer is assigned to headquarters platoon but will be dispatched to any operating platoon requiring his services.

(2) Duties. He will be responsible for all repairs to masonry structures, including buildings, brick or tile drains, and walls, necessary to permit the work of bomb disposal to be carried out.

b. Pump mechanic. (1) Assignments. The pump mechanic is assigned to headquarters platoon and will, as a rule, operate within the transportation and mechanics section.

Digitized by Google
Original from UNIVERSITY OF MICHIGAN

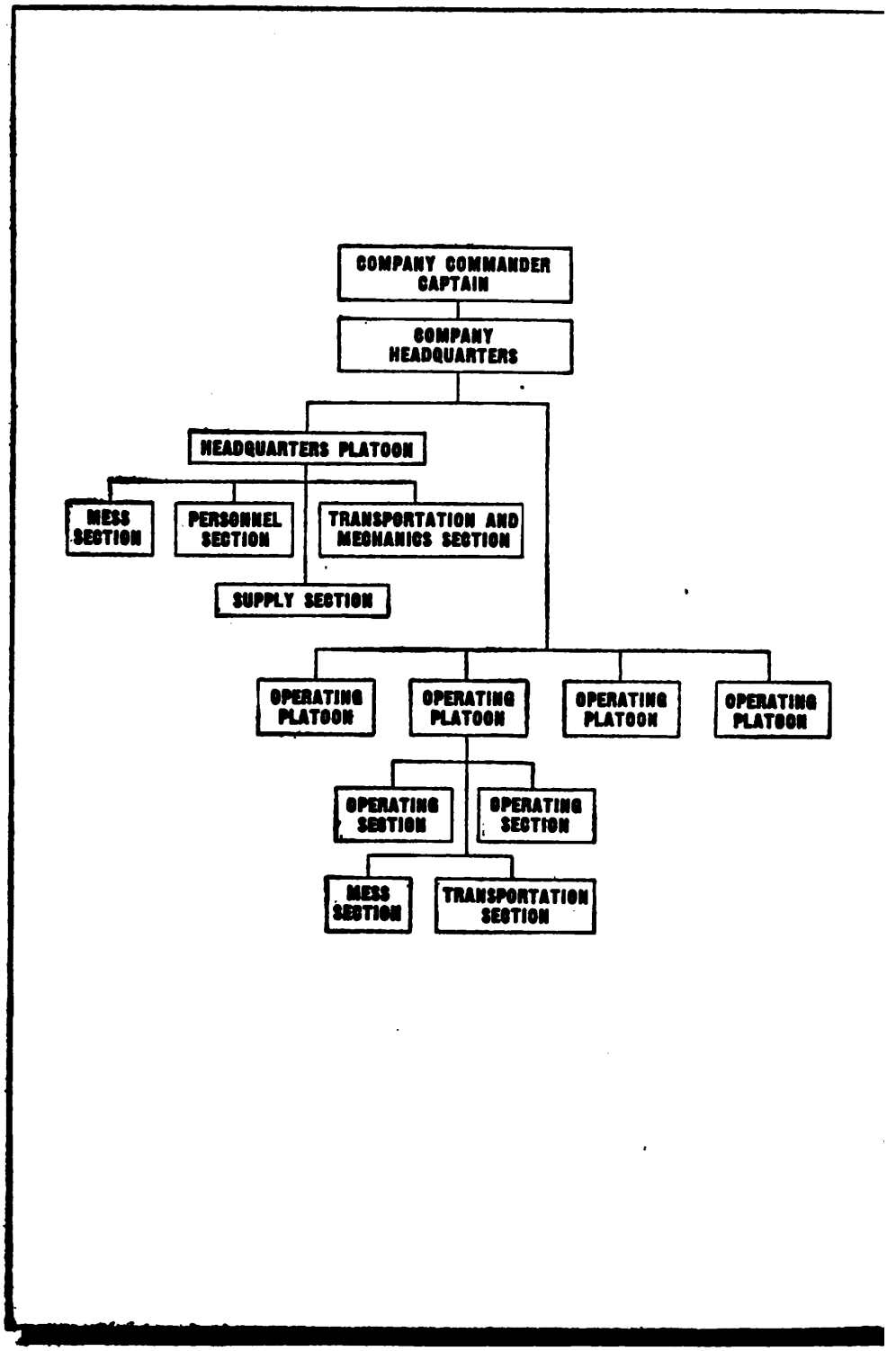


Figure 27.—Organization of headquarters platoon.

Digitized by Google
Original from
UNIVERSITY OF MICHIGAN

(2) Duties. He will be responsible for all repairs to pumps that require special service.

c. Air compressor operator. (1) Assignment. The air compressor operator is assigned to headquarters platoon but will be assigned to any operating platoon requiring the services of the air compressor.

(2) Duties. (a) He will be in charge of the air compressor and be responsible to the company commander for its proper operation.

(b) He will oversee its vehicular maintenance and be responsible for the maintenance of the compressor unit.

(c) He will be responsible for the maintenance of all pneumatic equipment.

d. Plumber. (1) Assignment. A specially trained plumbing technician will be assigned to headquarters platoon and will be reassigned to the operating platoons as required.

(2) Duties. (a) He will repair all broken water, gas, and sewer mains impeding bomb disposal operations.

(b) He will operate the steam generator whenever the services of this unit are required.

SECTION III

OPERATING PLATOON

57. ORGANIZATION.

a. Requirement. The organization of the operating platoon (fig. 27) must be of such a nature as to allow the platoon to function efficiently under varying conditions.

Digitized by Google
Original from UNIVERSITY OF MICHIGAN

b. Flexibility. (1) Operation in the company. When operating as an integral part of bomb disposal company, the platoon will—

(a) Be administered by the company headquarters.

(b) Combine its mess, supply, and transportation sections with those of the headquarters platoon.

(c) Assume its share of company duties in the prescribed manner.

(d) Carry on such disposal operations as directed by the company commander.

(2) Operation as a separate unit. The tactical situation may require operation of the platoon as a separate unit. Additional personnel will be absorbed from headquarters platoon by the platoon headquarters to handle the administration of the unit. The transportation section will take care of the dispatching of all vehicles and such maintenance as is possible. It should be noted that this maintenance will usually be of a lower echelon than that performed by the transportation and mechanics section of the parent organization. The mess and supply sections will function in the same manner as that of the parent organization. The operating sections will be capable of performing access operations in different locations simultaneously.

58. EQUIPMENT. The vehicles assigned to each operating platoon include the following:

a. Truck, ¼-ton, 4 x 4. This vehicle is used primarily for transportation of personnel and for reconnaissance.

b. Truck, ¾-ton, 4 x 4, weapons carrier. This vehicle is used for general transportation on the march and during disposal operations.

Digitized by Google
Original from UNIVERSITY OF MICHIGAN

c. Truck, 2½-ton, 6 x 6, cargo. Three of these vehicles are used for general transportation on the march and for hauling work during disposal operations.

59. OPERATION AND DUTIES. The responsibilities governing the operations of the various sections and platoons and the duties of the personnel in these sections are listed in the paragraphs below under the proper headings. *It should be remembered that these apply only when the platoon is operating as a separate unit.*

60. PLATOON LEADER. a. Regular duties. The platoon leader will—

(1) Direct his platoon in all necessary activities when functioning as part of the company.

(2) Oversee all access operations.

(3) Personally conduct all disposal operations.

b. Duties when platoon is operating as a separate unit. In addition to his regular duties, the platoon leader will assume the duties of the company commander when the platoon is operating as a separate unit.

61. PLATOON HEADQUARTERS.

a. Responsibilities. This section will correspond to the company office and will function in the same manner.

b. Platoon sergeant. The platoon sergeant will function as a first sergeant when the platoon is operating as a separate unit.

c. Platoon clerk. Each platoon will be assigned one general clerk, who will function as platoon clerk, corresponding to the company clerk, when necessary.

d. Munitions worker. The munitions worker will be a technician trained in all phases of bomb disposal work. When the situation requires, he will—

Digitized by Google
Original from UNIVERSITY OF MICHIGAN

(1) Instruct the enlisted men in any and all phases of bomb disposal operations.

(2) Make any decisions necessary in the absence of the platoon leader.

(3) Operate as assistant to the platoon leader in disposal operations.

62. PLATOON SUPPLY OFFICE.

a. Responsibilities. This will correspond to the company supply office and will function in the same manner.

b. Supply sergeant. A duly qualified enlisted man will be designated as acting supply sergeant.

63. THE MESS.

a. Responsibilities. This section will have the same duties as the company mess.

b. Mess sergeant. A duly qualified enlisted man will be designated as acting mess sergeant.

64. OPERATING SECTION.

a. Duties. This section will conduct all access operations that are carried on by the platoon.

b. Personnel. Specially trained personnel will be assigned to the operating section as follows:

(1) Excavators. Six excavators will be assigned to each section and will be trained to—

(a) Assist the timberman in placing the timber.

(b) Carry on the excavation in the proper manner, observing all safety precautions.

(c) Operate any pneumatic tools required in the access operations.

(d) Assist the rigger whenever necessary.

(e) Assist the munitions worker in any demolition work.

Digitized by Google
Original from UNIVERSITY OF MICHIGAN

(2) Timberman. One timberman will be assigned to each operating section and will—

(a) Plan the timbering for each excavation.

(b) See that the necessary material is on hand and ready for use.

(c) Supervise the excavators in the installation of all timbering.

(d) Be responsible for the salvage of such timber as may be worth reclaiming after the removal of the bomb.

(3) Rigger. One rigger will be assigned to each operating section and will—

(a) Be responsible for the maintenance of all rigging equipment.

(b) Study the situation with a view to using his equipment most advantageously.

(c) Supervise the excavators in the installation and employment of the rigging equipment.

(4) Section leader. The section leader will be trained in all phases of access operations so that he can—

(a) Efficiently direct and supervise his men.

(b) In the absence of the platoon leader, meet any emergencies that may arise.

Digitized by Google
Original from UNIVERSITY OF MICHIGAN

CHAPTER 5

BOMB DISPOSAL SQUAD SEPARATE

---

65. MISSION. The mission of the bomb disposal squad separate is the same as that of the bomb disposal company (see par. 36).

66. ASSIGNMENT. Bomb disposal squads separate will be assigned to—

a. Ground force units. One for each infantry division or equivalent organization.

b. Air force units. One for each Army Air Forces group.

c. Service force units. As required by theater commander.

67. RESPONSIBILITIES. The bomb disposal squad separate will be responsible for—

a. Performing all bomb disposal activities within the limits of its capabilities.

b. Supplying technical information for all routine operations when more than one incident requires immediate attention.

c. Maintenance of equipment to insure proper functioning.

d. Enforcing safety precautions during access, removal, and disposal operations.

Digitized by Google
Original from UNIVERSITY OF MICHIGAN

68. MAINTENANCE OF RECORDS. It is suggested that the squad separate maintain the same records as the bomb disposal company (see par. 40), though an operational map should not be necessary.

69. OPERATIONS. In all operations not specifically mentioned, the bomb disposal squad separate will function in the same manner as will the bomb disposal company.

70. ORGANIZATION. This unit is organized, in accordance with T/O 9–179, on the basis of economy of manpower. As the organization is very simple in nature, no diagram is necessary.

71. EQUIPMENT. The vehicular equipment for the squad separate is one ¾-ton weapons carrier. This vehicle is used for personnel transport and general hauling.

72. SQUAD OFFICER.

a. Duties. As the squad separate will be attached for mess and administration, the squad officer will not be responsible for these duties. He will, however—

(1) Be responsible for all equipment and supplies used by his organization.

(2) Personally conduct all disposal operations.

(3) Assume such other duties of a company commander as may be necessary, or delegate them to subordinates.

73. ENLISTED PERSONNEL. Enlisted personnel consists of—

a. Squad leader. The squad leader will function as the squad officer's assistant in all matters and will—

(1) Assist the squad officer in disposal operations.

(2) Function as munitions worker when necessary.

Digitized by Google
Original from UNIVERSITY OF MICHIGAN

(3) Direct and supervise access operations.
(4) Oversee evacuation and protective works.

b. Assistant squad leader. The assistant squad leader will be qualified to act as squad leader should the necessity arise and will—

(1) Drive and maintain the organic transportation.
(2) Operate and maintain such other bomb disposal equipment as is employed.

c. Bomb salvager. The bomb salvager will be a specialist trained in the technique of removing bombs once access to them has been gained.

d. Excavator. See paragraph 64.

e. Rigger. See paragraph 64.

Digitized by Google
Original from UNIVERSITY OF MICHIGAN

CHAPTER 6

SPECIAL OPERATING PERSONNEL

SECTION I

BOMB DISPOSAL STAFF OFFICER

74. MISSION. The bomb disposal staff officer acts as liaison agent between civilian and military authorities and bomb disposal troops, and assists in whatever way possible in the bomb disposal mission.

75. ASSIGNMENT. Bomb disposal staff officers will be assigned to—

a. To ground force units. One for each army headquarters and corps headquarters.

b. To air force units. One for each Army Air Forces headquarters.

c. To service force units. As required by the theater commander.

76. RESPONSIBILITIES. The bomb disposal staff officer will be a qualified ordnance officer acting as an assistant to the ordnance officer on the special staff of each army or corps and will have the following duties:

a. When attached to an army. (1) He will act as adviser to the commanding general in all matters pertaining to bomb disposal.

Digitized by Google
Original from UNIVERSITY OF MICHIGAN

(2) He will collect, investigate, and forward through the proper channels all bomb disposal intelligence.
(3) He will instigate any necessary training program in bomb reconnaissance for civilian and military personnel.
(4) He will make any reconnaissance necessitated by bomb disposal.
(5) In the absence of trained bomb disposal personnel, he will requisition labor and equipment for any necessary operations.
(6) He will establish a system for the purpose of reporting all unexploded bombs within the organization and within lower organizations.

b. When attached to a corps. **(1)** He will have the same duties as outlined for a bomb disposal staff officer attached to an army.
(2) He may have additional duties required of him by assignment as assistant to the corps ordnance officer.

77. PLANNING. The bomb disposal staff officer must continually plan to meet all contingencies.

a. Current requirements. To meet the current requirements the bomb disposal staff officer must—
(1) Plan for and secure adequate facilities for the instruction of necessary bomb reconnaissance personnel. (See par. 90.)
(2) Plan a satisfactory incident report system and modify this system so as to keep it operating efficiently at all times.
(3) Constantly study current bomb incidents to insure a proper distribution of work among the available bomb disposal organizations.

b. Future requirements. He must constantly study the tactical situation so that he can predict possible future air attacks and plan for and recommend any additional bomb disposal personnel that may be needed.

Digitized by Google
Original from UNIVERSITY OF MICHIGAN

c. Emergency requirements. He should make provisions for requisitioning additional labor and equipment in the event that he is called upon to perform bomb disposal operations.

78. MAINTENANCE OF RECORDS. The bomb disposal staff officer should, for his own convenience, maintain—

a. Records of future operations. These may be of two types:

(1) Written records. These need consist of no more than a notation as to the category, location, and size of the bomb and the organization to which it is assigned for disposal.

(2) Visual records. An operational map may be employed in the place of the written form if desired. It should, however, show the same data.

b. Records of completed operations. If such records are kept, they need be only those of operations personally conducted by the staff officer. (See par. 40.)

79. PROPERTY RESPONSIBILITY. The bomb disposal staff officer will be personally responsible only for such equipment as is assigned directly to him, equipment assigned to other bomb disposal organizations being their responsibility.

80. TRAINING.

a. Training duties. The bomb disposal staff officer will see that the necessary personnel has been thoroughly trained in the technique of bomb reconnaissance.

b. Requirements. In carrying out his training program, he will—

(1) Estimate and recommend the number of civilian bomb reconnaissance agents and commissioned and noncommissioned officers required by the tactical situation.

Digitized by Google
Original from UNIVERSITY OF MICHIGAN

(2) Establish the qualifications for the selection of this personnel.
(3) Make adequate training provisions.
(4) Make sure that the training program is carried out completely and efficiently.
(5) Conduct refresher course, whenever necessary, to insure the completeness of this training.
(6) Conduct additional course in bomb reconnaissance for the training of any necessary personnel replacements.

c. Training of staff officers. The bomb disposal staff officer should receive to as great an extent as possible the same training as the officers in bomb disposal companies. (See par. 42.)

81. EQUIPMENT.

a. Bomb disposal equipment. No specialized bomb disposal equipment will be issued to the bomb disposal staff officer. If called upon to perform emergency operations, he will obtain such equipment from a regular bomb disposal organization.

b. Training aids. He will be given such visual aids as thought necessary for the instruction of reconnaissance agents. (See par. 6.)

82. TECHNICAL OPERATIONS. Bomb disposal officers will, in emergencies, supervise all disposal operations as outlined in chapter 7.

Digitized by Google

Original from UNIVERSITY OF MICHIGAN

SECTION II
BOMB RECONNAISSANCE OFFICER

83. MISSION. The bomb reconnaissance officer investigates and reports pertinent facts about all unexploded bombs.

84. ASSIGNMENT. A commissioned officer of the staff of each division, regiment, separate battalion, or similar organizations of the Army Air Forces and Army Service Forces, will be designated as the bomb reconnaissance officer.

85. RESPONSIBILITIES. The bomb reconnaissance officer, in addition to his regular duties as an officer of his organization, will—

a. Identify all unexploded bombs.

b. Be able to recognize their possible effects.

c. Institute necessary safety precautions and protective measures.

d. Report all bomb incidents to bomb disposal units through the proper channels.

e. Train noncommissioned officer in bomb reconnaissance.

86. TRAINING. The bomb reconnaissance officer will make adequate provisions to train such noncommissioned bomb reconnaissance officers as are necessary, these provisions to include—

a. Selecting suitable personnel.

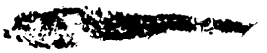
b. Securing a suitable place for instruction.

c. Securing such training aids as may be required and are available.

Digitized by Google
Original from UNIVERSITY OF MICHIGAN

SECTION III

BOMB RECONNAISSANCE NON-COMMISSIONED OFFICER



87. MISSION. See paragraph 83.

88. ASSIGNMENT. A noncommissioned officer of each company or similar unit will be designated as the organizational noncommissioned bomb reconnaissance officer.

89. RESPONSIBILITIES. The bomb reconnaissance noncommissioned officer will be responsible for—

a. Identification of unexploded bombs.

b. Reporting of all bomb incidents to bomb disposal units through proper channels.

c. Recognition of the possible effects of unexploded bombs.

d. Institution of necessary safety precautions and protective measures.

Digitized by Google

Original from UNIVERSITY OF MICHIGAN

CHAPTER 7

OPERATING TECHNIQUE

90. ACCESS. The operations required to approach or uncover an unexploded bomb.

a. Operations (fig. 27). When the site for the shaft has been decided upon, the work of access begins. This may be considered in the following stages:

(1) Starting excavation. A template is laid out as shown and staked in place, care being taken that the diagonals are equal to assure a true rectangle. The internal dimensions of the template are 6 feet 8 inches by 8 feet 0 inches, as this size shaft offers sufficient working space with an economy of timber. Excavation then proceeds, the sides of the shaft being kept vertical, until the officer or noncommissioned officer feels it unsafe to go deeper without installing timbering.

(2) Installation of timbering. The following has been found to be the best method of installing the timbering.

(a) Four pieces of 2-inch by 10-inch sheathing (vertical timbering used to keep the sides of the shaft from collapsing inward) are placed vertically in adjacent corners on a short side of the shaft.

(b) One piece of short waling (horizontal timbering used to support the sheathing against the inward pressure exerted by earth shock) is then installed, notched side upward, by wedging it against the sheathing on a long side of the shaft, the wedges being driven from the bottom.

(c) Steps **(a)** and **(b)** are repeated at the opposite sides of the hole.

Digitized by Google
Original from UNIVERSITY OF MICHIGAN

(d) Long walers are installed by fitting them into notches on short walers and wedging them into place.

(e) Installation is completed by fitting sheathing in place, using alternate 5- and 10-foot lengths. (This prevents the joints from being all at the same level and avoids the "plane of weakness" formed when sheathing of equal length is used.)

(3) Driving the shaft. Once installed, the sheathing is driven in the following manner:

(a) The earth is dug away from the foot of the sheathing to form a trench along one side of the hold, and the wedges are loosened to let the sheathing slide down. In hard soil, the sheathing may be chisel-pointed so that it may be driven more easily.

(b) When the sheathing has been lowered on all four sides, the mound left in the center of the shaft is removed and the operation repeated.

(c) As the shaft is driven downward, it will require a waling ring every 5 feet. Once the sheathing has been placed, however, this work entails no difficulties. It should be remembered that the first waling ring remains stationary, all additional rings being added *below* the first ring.

(d) After the first tier of sheathing has been installed, all additional sheathing used should be 10 feet long.

(e) If at any time it is found necessary to support machinery of any weight on the waling rings, vertical timbers should be inserted at the corners and steel tie rods used to hold the rings in place.

(4) Headings. If the reconnaissance was faulty and the shaft has been sunk to one side of the bomb, a horizontal shaft or heading may be driven to the point at which the bomb rests. The methods of timbering are the same as for the shaft except that the floor need not be timbered

Digitized by Google
Original from UNIVERSITY OF MICHIGAN

and the wedges may be omitted. Except under unusual circumstances, it is considered better practice to abandon the old shaft and sink a new one.

b. Safety precautions. **(1)** Use a minimum number of men in and around excavation. Keep all who are not working at a safe distance.

(2) When in doubt about the need for timbering, use it.

(3) Have security of timbering checked frequently. This will help prevent cave-ins.

(4) Have safety ropes hanging in excavation at all times.

(5) Do not fasten safety ropes to the A-frame or timbering. Use a holdfast.

(6) Use probe freely to avoid striking bomb with tools and to avoid digging into a camouflet. Probe horizontally as well as vertically.

(7) Apply stethoscope to the probe as soon as bomb is contacted. This will help determine presence of an operating clockwork fuze.

(8) Use safety helmets at all times while in the excavation.

(9) Use nonmagnetic tools within 2 feet of a "G" mine.

(10) Do not jump into any excavation. Always step gingerly to avoid vibration, which may detonate sensitive fuzes.

(11) Do not move or disconnect pneumatic tools while air remains in the lines.

(12) Watch men closely while they are in the hole to observe first indications of faintness or exhaustion, which may be caused by leakage of carbon monoxide from a camouflet.

(13) Always observe the following distances in using power tools;

Digitized by Google
Original from UNIVERSITY OF MICHIGAN

Tool	Distance of tool from bomb (feet)	
	Bomb deeper than 5 feet	Bomb not more than 5 feet deep
Paving breaker	4½	2½
Pile driver (pointed sheathing)	3	1½
Pile driver (sheathing not pointed)	5	2½
Clay spade	3	1½

Use of tools at distances less than those given is apt to cause detonation of sensitive fuzes. Distances are measured from the bomb itself to the tool, not from the fuze.

(14) Do not leave tools or equipment lying loose on the frames or stages. They may fall on the man below.

(15) Always use a ladder in holes 10 feet or more in depth. Do not permit climbing up the walers and spreaders.

91. POWER-DRIVEN EQUIPMENT. Pumps. For information on operation and maintenance of pumps see TM 9–1865.

92. SAFETY PRECAUTIONS.

a. General. (1) Always keep equipment in good working order. The pump that won't pump or the saw that won't cut is of no use to anyone.

(2) Maintain good discipline at all times. In a tight spot, everything may depend on the promptness with which men follow instructions. Make obedience habitual.

(3) Never utilize dangerous short cuts in apparently harmless cases. Remember, "Familiarity breeds contempt." Avoid it.

Digitized by Google
Original from UNIVERSITY OF MICHIGAN

(4) Do not tolerate careless workmanship in yourself or in others. It is never an admirable trait, and in this work it is dangerous to all.

(5) Keep the importance of safety precautions constantly before everyone. In doing this, it is essential to keep interest in the subject aroused. Try mixing lectures with contests, posters, and anything else your ingenuity can devise.

(6) Before moving to the scene of operations, check all equipment.

(a) Be sure it is in proper working order.

(b) Be sure all needed items are being taken.

(7) Remember—

(a) *No bomb is safe until final disposal is complete.*

(b) Accidental casualties are unnecessary and, therefore, more harmful than those due to enemy action.

b. During reconnaissance. **(1)** Only the minimum number of men required should accompany the officer making the reconnaissance.

(2) Do not linger around the site of a U. X. B. Take notes swiftly then move to a safe distance before starting discussions and making decisions.

(3) In instances where camouflets are suspected, stand on planks and use lifelines while examining the site. Remember that bombs of approximately 50 kilograms are the most likely to cause camouflets.

(4) Lay out the work, remembering to select a safe spot, with cover if possible, for men and equipment.

(5) Find out *in advance* where and how to get medical aid quickly in cases of need. Keep this information readily available to all, throughout the job.

Digitized by Google
Original from UNIVERSITY OF MICHIGAN

CHAPTER 8

GERMAN BOMBS

93. HIGH-EXPLOSIVE BOMBS. German high-explosive bombs are divided into two classes. Each has definite identifying characteristics.

a. General-purpose bombs. These are designated as "S. C." by the Germans and may be identified by the following:

(1) Case construction. Three-piece welded-steel construction consisting of—

(a) Cast steel nose.

(b) Drawn steel tube.

(c) Cast steel tail cap.

(2) Tail construction. Three-piece sheet-steel tail construction consisting of—

(a) Four tail fins.

(b) Sheet-steel cone.

(c) Box-type struts bracing the fins.

b. Armor-piercing bombs. The Germans designate these by the letters "S. D." Their characteristics are given below.

(1) Case construction. The case is constructed of a heavy streamlined, one-piece steel casting.

(2) Tail construction. The tail consists of a one-piece magnesium alloy casting.

94. ANTIPERSONNEL BOMBS. Antipersonnel or fragmentation bomb is a small, thick-walled bomb which, upon detonation of the explosive filler, produces a large

Digitized by Google
Original from UNIVERSITY OF MICHIGAN

number of small, rapidly moving fragments. Such bombs are normally used against lightly protected targets and personnel, both military and civilian. Antipersonnel bombs used by the Germans are of two types.

a. The 2-kg (4¼ lb.) "butterfly" bomb. This is carried in containers which may hold as many as 80 of these bombs. IF FOUND UNEXPLODED, THIS BOMB SHOULD NOT BE DISTURBED, AS THE FUZE IS SENSITIVE WHEN ARMED.

b. The 12-kg (26 lb.) S. C.-10 bomb. This bomb is carried in clusters of five, and, like the 2-kg (4¼ lb.) size, has a very sensitive fuze.

95. INCENDIARY BOMBS. Two types of incendiary bombs are being used by the German Air Force.

a. Combustible case type. **(1)** The 1-kg (2⅛ lb.) incendiary is of the combustible case type and may be fitted with a small exploder. It is always released from bomb containers.

(2) The 2.2 kg (4¼ lb.) incendiary and antipersonnel bomb is composed of an incendiary body and a steel explosive container screwed to the nose of the incendiary. The incendiary body closely resembles the 1-kg. (2⅛ lb.) incendiary bomb.

b. Combustible filling type. This type includes—
(1) The C 250 Flam bomb, having a total weight of 110 kg (220 lb.).

(2) The C 500 Flam bomb, having a total weight of 210 kg (460 lb.).

96. AERIAL MINES. These are explosive objects dropped from aircraft, with or without parachute, designed for use against water targets, but sometimes used against

Digitized by Google
Original from UNIVERSITY OF MICHIGAN

land targets. There are many different types of mines laid by aircraft, the most common of these being—

a. Type C parachute mine. This mine (without parachute cap) is 8 feet 8 inches long and 2 feet 2 inches in diameter. The case is dark green in color and made of aluminum. As this mine is lowered by parachute, it will almost always be found on the surface of the ground. CARE SHOULD BE TAKEN IN APPROACHING THIS MINE, AS IT MAY BE DETONATED BY A LOUD NOISE OR THE PRESENCE OF METAL.

b. Type D parachute mine (fig. 28). This mine resembles the type C in all respects other than its length (5 feet 8 inches without parachute cap). IT SHOULD BE APPROACHED IN THE SAME WAY.

c. Type G mine. This mine has a case of light blue manganese steel and is a freely falling mine, no parachute being used. The case is 2 feet 2 inches in diameter and 6 feet 4 inches long and is equipped with plastic fins. The fins are seldom found attached to the mine, but the presence of fragments of plastic material is an indication of the presence of a "G" mine. These mines may be found buried, as they have no parachute to check their fall.

Digitized by Google
Original from UNIVERSITY OF MICHIGAN

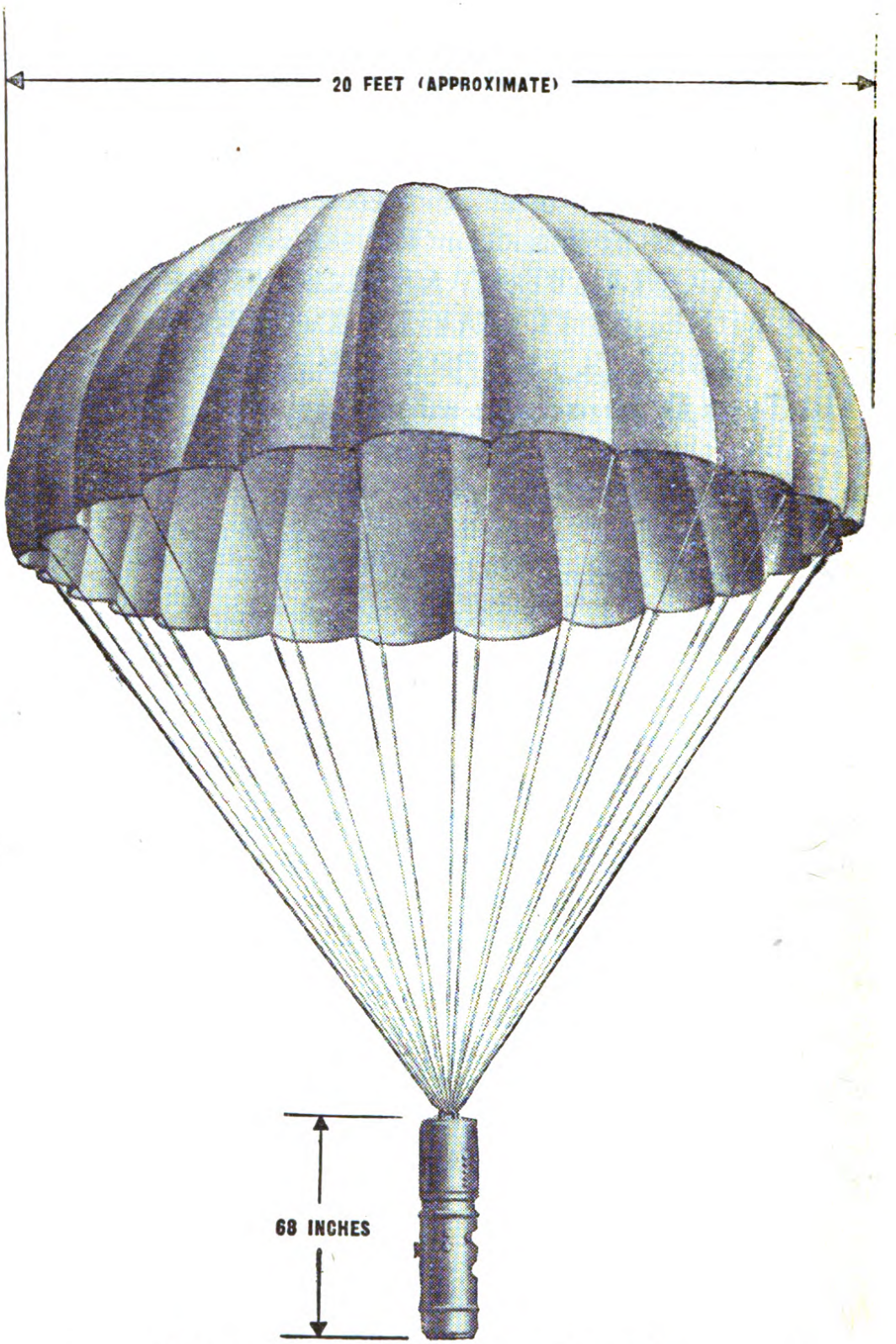


Figure 28.—Type D parachute mine.

Digitized by Google
Original from UNIVERSITY OF MICHIGAN

Table X.—German bombs

Weight		Type	Diameter	Length of body
Kilograms	*Pounds*		*Inches*	*Inches*
2	4¼	Antipersonnel "Butterfly" bomb.	3.0	3.1.
12	26	S. C. 10 anti-personnel	3.25	15.0.
30	66	"Blitz-Licht" photo flash-bomb (B. L. C. 50).	7.8	25.4.
New type		Photo flash bomb	8.0	Not known
30–35	66–77	S. Be 50 cement bomb	7.0	27.0.
		Parachute flare (single-candle).	8.0	42.0.
		Parachute flare (four-candle).	8.0	42.0.
1	2.2	Incendiary	2.0	9.75.
2.2	4½	1.0-kg. incendiary with antipersonnel attachment.	2.0	Incendiary 9.25. Sleeve 3.25. Antipersonnel, 4.38.
50	110	Sprengbrand C 50	8.0	28.0.

Tail size (inches)	Filling	Illustration
Four wings fold around body.	Cast TNT	Fig. 29 (1) and (2).
9.0 x 5.0	TNT	Not shown.
16.0 x 11.0	Flare composition	Fig. 29 (3).
16.3 x 11.0	Incendiary mixture of finely divided aluminum powder.	Not shown.
15.0 x 10.9	TNT	Do.
Parachute, 13′0″ dia.	Flare composition	Fig. 29 (4).
Parachute, 13′0″ dia.	do	Fig. 29 (4).
4.75 x 2.0	Thermite or penthrite	Fig. 30 (1) and (2).
4.75 x 2.0	Thermite—TNT in antipersonnel section.	Fig. 30 (3).
16.0 x 11.3	Thermite firepots	Fig. 30 (4).

Digitized by Google
Original from UNIVERSITY OF MICHIGAN

Table X.—German bombs—Continued

Weight		Type	Diameter	Length of body
Kilograms	*Pounds*		*Inches*	*Inches*
500	1, 100	S. C., type II, general-purpose. May have one or two fuze pockets.	19. 0	54. 5
500	1, 100	S. C., type III, general-purpose. May have one or two fuze pockets.	18. 0	60. 0
1, 000	2, 200	S. C., type I, general-purpose. One fuze pocket.	26. 0	75. 0
1, 000	2, 200	S. C., type II, general-purpose. One fuze pocket.	Not known	65. 5
1, 200	2, 640	S. C., general - purpose. One fuze pocket.	25. 6	73. 5
1, 800	3, 960	----do----------	26. 0	107. 0
2, 500	5, 500	S. C., general - purpose. Two fuze pockets.	30–31	Not known.
50	110	S. D., semi-armor-piercing. Single fuze pocket.	8. 0	23. 5
250	550	----do----------	14. 5	36. 0
500	1, 100	S. D., type II, semi-armor-piercing. Has only one fuze pocket.	15. 0	32. 5

Tail size (inches)	Filling	Illustration
32.0 long	TNT or amatol	Fig. 31 (7).
30.0 x 20.0	TNT or amatol	Not shown.
46.5 x 24.0	Cast and granular TNT	Fig. 31 (8).
Not known	Not known	Not shown.
Not known	Cyclonite	Not shown.
56.3 x 36.0	TNT or amatol	Fig 31 (9).
Not known	TNT	Not shown.
25.0 x 10.5	TNT	Fig. 32 (1).
38.0 x 20.0	TNT	Fig. 32 (2).
26.0 x 15.0	TNT	Fig. 32 (3).

Digitized by Google
Original from UNIVERSITY OF MICHIGAN

Table X.—German bombs—Continued

Weight		Type	Diameter	Length of body
Kilograms	*Pounds*		*Inches*	*Inches*
50	110	Incendiary	8.0	30.0
110	220	C 250 Flam bomb incendiary	14.5	40.0
210	460	C 500 Flam bomb incendiary	18.0	62.0
500	1,100	A. B. B. 500 incendiary container bomb.	18.4	61.8
50	110	S. C., type I, general-purpose. Single fuze pocket.	8.0	28.0
50	110	S. C., type II, general-purpose. Single fuze pocket.	8.0	28.0
50	110	S. C., type III, general-purpose. Single fuze pocket.	8.0	31.0
250	550	S. C., type I and II, general-purpose. May have one or two fuze pockets.	14.5	47.0
250	550	S. C., type IV, general-purpose. May have one or two fuze pockets.	14.5	47.0
500	1,100	S. C., type I, general-purpose. May have one or two fuze pockets.	18.5	52.0

Tail size (inches)	Filling	Illustration
Not known	Benzine, phosphorus, rubber	Fig. 30 (5).
25.0 x 21.0	TNT burster and oil filler	Fig. 30 (6).
21.5 x 24.0	TNT burster and oil filler	Fig. 30 (7).
24.6 x 25.0	Incendiary bombs	Not shown.
16.0 x 11.0	TNT or amatol	Fig. 31 (1).
16.5 x 10.0	TNT or amatol	Fig. 31 (2).
28.3 x 11.0	TNT or amatol	Fig. 31 (3).
25.0 x 18.0	TNT or amatol	Fig. 31 (5).
25.0 x 18.0	TNT or amatol	Fig. 31 (5).
30.0 x 24.0	TNT or amatol	Fig. 31 (6).

Digitized by Google
Original from UNIVERSITY OF MICHIGAN

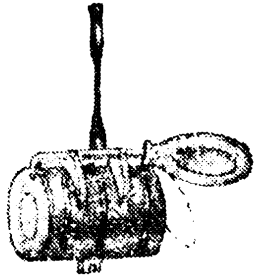
Table X.—German bombs—Continued

Weight		Type	Diameter	Length of body
Kilograms	*Pounds*		*Inches*	*Inches*
500	1, 100	S. D. Type I, Semi-armor-piercing. Has only one fuze pocket.	15. 6	54. 0
500	1, 100	S. D., Type III Semi-armor-piercing. Has only one fuze pocket. Not streamlined.	17. 5	54. 0
500	1, 100	Armor-piercing rocket bomb	15. 0	47. 0
1, 000	2, 200	S. D. Semi-armor-piercing. One fuze pocket.	19. 8	57. 8
1, 000	2, 200	Armor-piercing rocket bomb	16. 0	81. 0
1, 400	3, 080	S. D. Semi-armor-piercing. One fuze pocket.	22. 0	75. 0
1, 700	3, 740	S. D. Semi-armor-piercing. One fuze pocket.	22–26	92. 0

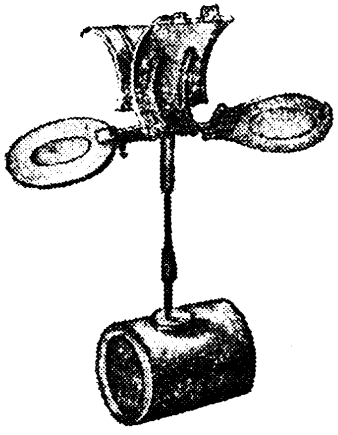
Tail size (inches)	Filling	Illustration
26.0 x 16.0	TNT	Fig. 32 (4).
Not known	Not known	Not shown.
33.0 x 16.0	Cast TNT	Not shown.
32.0 x 19.8	TNT/Wax	Fig. 32 (5).
32.0 long	Cast TNT	Not shown.
43.3 x 22.0	TNT/Wax	Fig. 32 (6).
46.5 x 24.0	Cast TNT	Fig. 32 (7).

Digitized by Google
Original from UNIVERSITY OF MICHIGAN

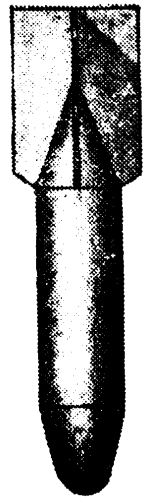
Digitized by Google



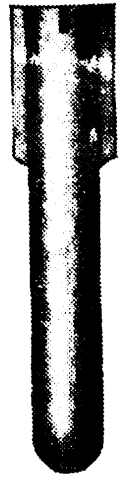
1 2-KG. "BUTTERFLY" BOMB (VANES CLOSED)



2 2-KG. "BUTTERFLY" BOMB (VANES OPEN)



3 B.L.C. — 50 PHOTOFLASH BOMB



4 PARACHUTE FLARE

Figure 29.—German bombs, miscellaneous.

Original from UNIVERSITY OF MICHIGAN

Figure 30.—German bombs, incendiary.

Digitized by Google
Original from
UNIVERSITY OF MICHIGAN

Figure 31.—German bombs, general-purpose (S. C.).

Digitized by Google
Original from UNIVERSITY OF MICHIGAN

Figure 32.—German bombs, semi-armor-piercing.

Digitized by Google
Original from UNIVERSITY OF MICHIGAN

CHAPTER 9

ITALIAN BOMBS

---

97. HIGH-EXPLOSIVE BOMBS. Italian high-explosive bombs vary widely in design, but will, as a rule, resemble each other in—

a. Case construction. **(1)** General-purpose bombs have a mild steel case ¼-inch to ½-inch thick.
(2) Armor-piercing bombs are made of hardened steel ½-inch to 1½-inch thick.
(3) All bombs are of variable case thickness, increasing as the nose is approached.
(4) Baseplates are screwed to the bomb body.

b. Tail assemblies. **(1)** Vary considerably in design but are generally of sheet steel.
(2) Usually of the same diameter as the bomb body.
(3) Attached to body by either screws or rivets.

c. Explosive filling. Usually cast TNT, though a mixture of amatol, TNT, and aluminum powder may be used.

d. Fuzing. Bombs may be fitted with—
(1) Nose fuze screwed into nose.
(2) Tail fuze screwed into baseplate with a sleeve running through the center of the tail assembly and connecting it to the arming vanes, which rotate in a recess in the tail fins.
(3) A combination of nose and tail fuzes.

Digitized by Google
Original from UNIVERSITY OF MICHIGAN

98. ANTIPERSONNEL BOMBS. These differ from high-explosive bombs in—

a. Case construction. Usually consists of a sheet-steel explosive container wrapped spirally with strip steel.

b. Size. Generally smaller than the high-explosive bombs.

c. Tail assembly. Some of the smaller antipersonnel bombs lack tail assemblies.

99. INCENDIARY BOMBS. Italian incendiary bombs have the following characteristics:

a. Construction. The case is usually of cast magnesium alloy with a filling of thermite.

b. Appearance. **(1)** Bombs 2 kg (4¼ lbs.) or less in weight are cylindrically shaped and have no tail assembly. **(2)** Bombs weighing more than 2 kg (4¼ lbs.) are similar, externally, to high-explosive bombs.

100. BOMB MARKINGS. The following table may be found useful in the identification of bombs part or all of which are visible. It should be kept in mind, however, that the markings may be varied for the sake of deception.

Table XI.—Color markings

Type	Body	Nose
Antipersonnel	Black or blue	Red.
Fragmentation	Blue	Red.
High-explosive	Gray	Red.
Incendiary	Reddish brown	Red.
Gas	Bright yellow	Red.
Practice	Gray	Gray.

Digitized by Google
Original from UNIVERSITY OF MICHIGAN

Table XII.—Italian bombs

Weight		Type	Diameter	Length of body
Kilograms	*Pounds*		*Inches*	*Inches*
1	2⅛	Incendiary	2.7	4.5.
2	4¼	Antipersonnel	2.7	4.5.
2	4¼	Incendiary	2.7	10.6.
2	4¼	Incendiary	2.7	12.0.
2	4¼	Gas	2.7	4.5.
3	6⅜	Antipersonnel	2.7	8.2.
3	6⅜	Antiaircraft	3.2	6.4.
3	6⅜	Antiaircraft	3.2	8.5.
4	8½	Gas	2.7	10.6.
4	8½	Antipersonnel	2.7	7.2.
12	26¼	Antipersonnel	3.5	17.3.
12	26¼	Antipersonnel	3.5	16.0.
15	33	Semi-armor-piercing. High-explosive.	4.7	20.7.
15	33	Gas	4.7	21.0.
20	44	Incendiary	6.3	20.0.
20	44	Antiaircraft	5.6	15.5.
24	52½	General-purpose. High-explosive.	6.4	19.9.
25	55	Gas	6.2	Not known.
31	68	Semi-armor-piercing. High-explosive.	6.4	22.5.
40	88	Gas	9.0	19.7.
40	88	Gas	10.0	Not known.
40	88	General-purpose. High-explosive.	9.0	19.7.

Tail size (inches)	Filling	Illustration
No tail	Thermite	Fig. 33 (1).
No tail	TNT	Fig. 33 (2).
No tail	Thermite and oil	Not shown.
No tail	Magnesium, mercuric oxide, nitrobenzene.	Not shown.
Not known	Diphenyl-chlorarsine and high-explosive.	Not shown.
4.5 x 2.7	TNT	Fig. 33 (4).
7.0 x 3.2	Amatol	Fig. 33 (3).
7.5 x 3.2	TNT	Not shown.
Not known	D. A	Not shown.

Digitized by Google
Original from UNIVERSITY OF MICHIGAN

Table XII.—Italian bombs—Continued

Tail size (inches)	Filling	Illustration
6.8 long	TNT	Not shown.
14.5 x 3.5	Not known	Fig. 33 (6).
16.5 x 3.5	TNT	Fig. 33 (5).
13.8 x 4.7	TNT	Fig. 34 (5).
13.8 x 6.3	D. A	Fig. 34 (5).
15.8 x 6.3	Thermite	Fig. 34 (3).
18.0 x 5.7	Not known	Fig. 34 (4).
14.8 x 6.4	TNT	Fig. 34 (2).
No tail	Not given	Not shown.
12.5 x 6.4	TNT	Fig. 34 (1).
16.1 x 9.0	D. A	Not shown.
Not known	H. S	Not shown.
16.1 x 9.0	TNT	Fig. 35 (3).

Weight		Type	Diameter	Length of body
Kilograms	*Pounds*		*Inches*	*Inches*
50	110	General-purpose. High-explosive.	9.9	21.7.
55	120	Gas	9.8	Not known.
62	136	Incendiary	10.0	23.5.
100	220	Incendiary. Fragmentation	10.7	29.0.
100	220	Gas	10.7	32.5.
100	220	General-purpose. High-explosive.	10.7	32.0.
100	220	Semi-armor-piercing. High-explosive.	9.9	31.0.
104	228	do	10.0	28.0.
160	352	Antisubmarine	13.3	36.2.
160	352	do	12.6	50.4.
250	550	General-purpose. High-explosive.	17.6	35.4.
250	550	Armor-piercing	10.0	30.0.
500	1,100	Gas	18.0	54.3.
500	1,100	General-purpose. High-explosive.	18.0	52.0.
500	1,100	Time bomb	18.1	50.9.
800	1,760	General-purpose. High-explosive.	18.0	77.1.
800	1,760	Time bomb	18.0	Not known.
1,000	2,200	Parachute flare	4.0	20.25.

Digitized by Google
Original from UNIVERSITY OF MICHIGAN

Table XII.—Italian bombs—Continued

Tail size (inches)	Filling	Illustration
18.4 x 9.9	Amatol	Fig. 35 (2).
Not known	Phosgene	Not shown.
26.7 x 10.0	Thermite	Fig. 35 (1).
20.8 x 11.5	Not known	Fig. 36 (4).
20.8 x 10.7	Diphenyl-chlorasine TNT	Not shown.
22.0 x 10.7	TNT	Fig. 36 (2).
21.3 x 9.9	Amatol	Fig. 36 (3).
15.0 x 11.0	TNT	Fig. 36 (1).
27.2 x 15.3	TNT	Fig. 37 (5).
27.6 x 15.6	TNT	Not shown.
39.4 x 17.6	TNT	Fig. 37 (4).
18.0 long	Not known	Not shown.
39.9 x 17.7	Diphenyl-chlorasine TNT	Not shown.
35.7 x 18.0	TNT	Fig. 37 (2).
43.3 x 18.0	TNT	Fig. 37 (3).
52.8 x 18.0	TNT	Fig. 37 (1).
Not known	TNT	Not shown.
14.25 x 4.125	Magnesium powder	Not shown.

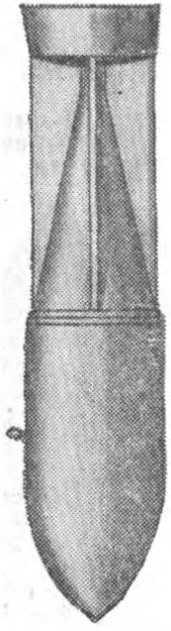
Digitized by Google
Original from UNIVERSITY OF MICHIGAN

Figure 33.—Italian bombs, miscellaneous.

Digitized by Google
Original from UNIVERSITY OF MICHIGAN

Figure 34.—Italian bombs, miscellaneous.

Digitized by Google
Original from UNIVERSITY OF MICHIGAN



1 62-KG. INCENDIARY



2 50-KG. GENERAL PURPOSE HIGH EXPLOSIVE

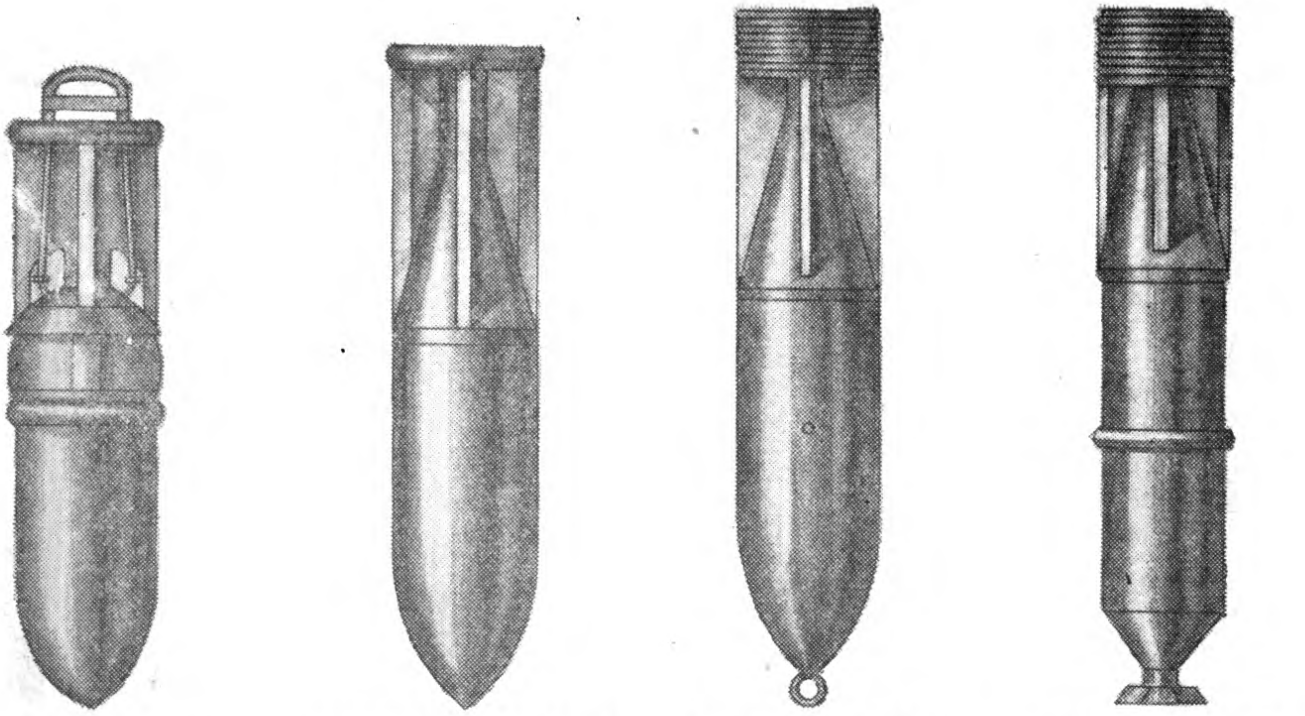


3 40-KG. GENERAL PURPOSE HIGH EXPLOSIVE

Figure 35.—Italian bombs, miscellaneous.

Digitized by Google

Original from UNIVERSITY OF MICHIGAN



1 104-KG. SEMI ARMOR PIERCING HIGH EXPLOSIVE

2 100-KG. GENERAL PURPOSE HIGH EXPLOSIVE

3 100-KG. SEMI ARMOR PIERCING HIGH EXPLOSIVE

4 100-KG. INCENDIARY AND FRAGMENTATION

Figure 36.—Italian bombs, miscellaneous.

Digitized by Google
Original from UNIVERSITY OF MICHIGAN

Figure 37.—Italian bombs, miscellaneous.

Digitized by Google
Original from UNIVERSITY OF MICHIGAN

CHAPTER 10

JAPANESE BOMBS

101. HIGH-EXPLOSIVE BOMBS. Japanese high-explosive bombs have the following characteristics:

a. Body construction. **(1)** General-purpose bombs are usually of three-piece steel construction, the nose and tail sections being welded, riveted, or screwed to the body.
(2) Streamlining is usually very poor.
(3) Armor-piercing and semi-armor-piercing bombs are usually of one-piece cast steel construction.

b. Tail construction. **(1)** Composed of cone, four fins, and box type struts, all made of sheet steel.
(2) Cone sometimes filled with explosive in general-purpose bombs.

c. Fuzing. Japanese bombs are fuzed--
(1) With nose fuzes.
(2) With tail fuzes (screwed into the baseplate or the apex of the cone, depending upon whether or not the cone is filled with explosive).
(3) A combination of the two.

102. INCENDIARY BOMBS. Certain characteristics of Japanese incendiary bombs are—

a. Case construction. **(1)** The three large incendiaries have the combustible filling contained in an inner case, an exploder tube in the inner casing, and a small ejecting charge in the nose of the outer casing.

Digitized by Google
Original from UNIVERSITY OF MICHIGAN

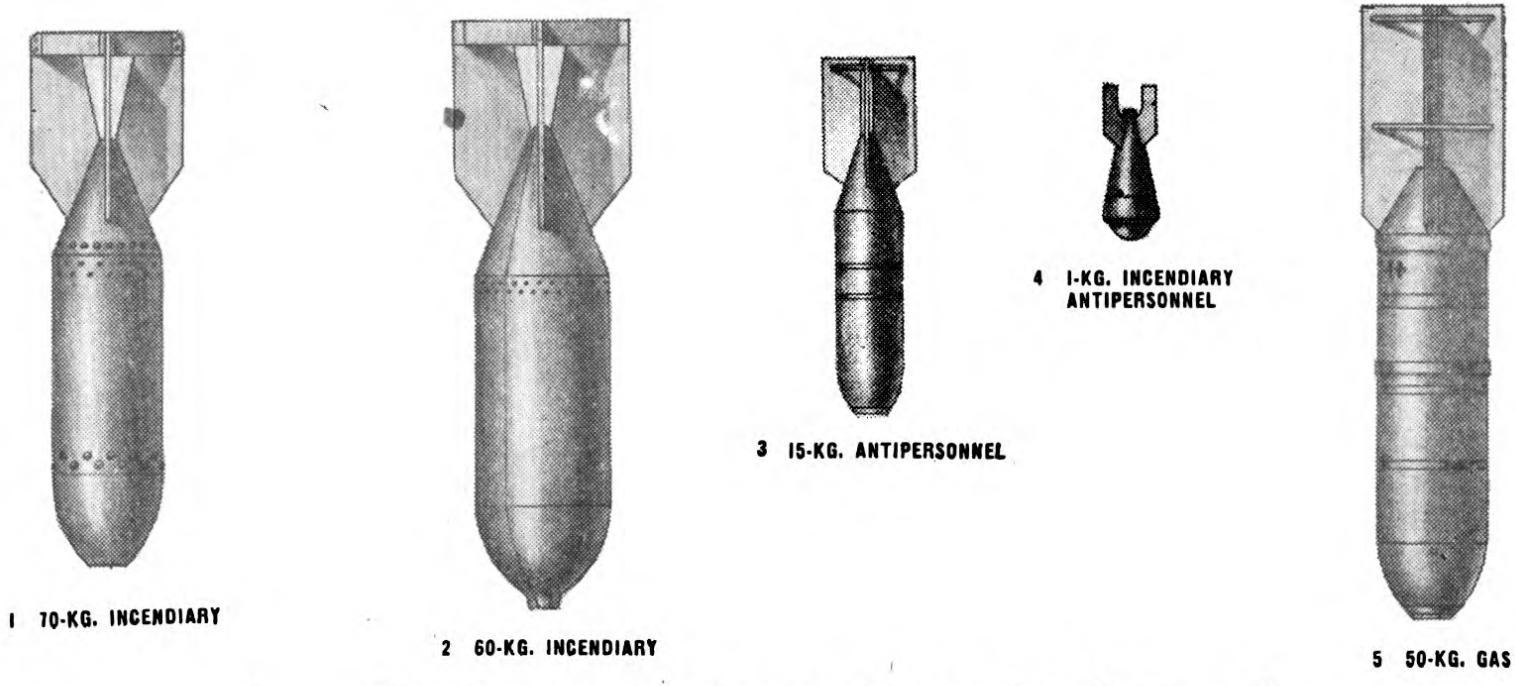


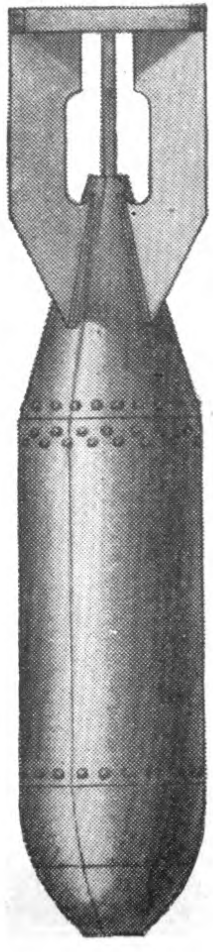
Figure 38.—Japanese bombs, incendiary and antipersonnel.

Digitized by Google
Original from UNIVERSITY OF MICHIGAN

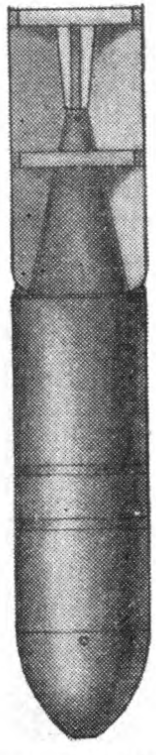
Figure 39.—Japanese bombs, high-explosive.

Digitized by Google

Original from UNIVERSITY OF MICHIGAN



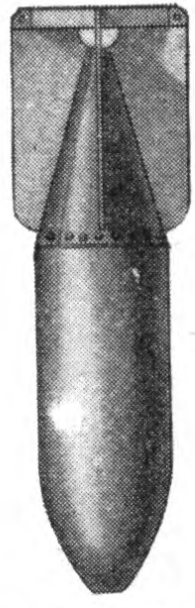
1 250-KG. GENERAL-PURPOSE HIGH EXPLOSIVE



2 100-KG. GENERAL-PURPOSE HIGH EXPLOSIVE



3 63-KG. GENERAL-PURPOSE HIGH EXPLOSIVE



4 63-KG. GENERAL-PURPOSE HIGH EXPLOSIVE

Figure 40.—Japanese bombs, high-explosive.

Digitized by Google

Original from UNIVERSITY OF MICHIGAN

(2) The small incendiary bombs are of conventional construction.

b. Function. (1) The three larger incendiaries will function as follows: Upon impact the fuze will detonate the expelling charge in the nose of the outer case. This explosion ejects the inner case through the rear of the bomb, lighting a delay train as it does so. This delay then ignites the exploder in the inner case, which scatters and ignites the combustible filling. If this type of bomb penetrates too deeply the incendiary charge may burn underground, leaving a trace of the powder on the sides of the shaft.

(2) The smaller 2-kg (2¼-lb.), incendiary, functions in the conventional manner.

Table XIII.—Table of Japanese bombs

Weight		Type	Diameter	Length of body
Kilograms	*Pounds*		*Inches*	*Inches*
1	2⅛	Incendiary. Antipersonnel	3.0	9.05
15	33	Antipersonnel	4.0	14.2
50	110	Gas	7.5	26.4
60	130	Incendiary	9.5	25.3
70	154	Incendiary	7.9	28.2
30	66	General-purpose. High-explosive	6.0	20.0
50	110	General-purpose. High-explosive	7.0	24.0
60	130	Incendiary. High-explosive	7.0	33.0
60	130	General-purpose. High-explosive	7.85	21.8
60	130	General-purpose. High-explosive	9.4	21.0
63	138	General-purpose. High-explosive	8.0	21.9
63	138	General-purpose. High-explosive	9.0	25.8
100	110	General-purpose. High-explosive	9.4	31.0
250	550	General-purpose. High-explosive	12.0	39.6
250	550	General-purpose. High-explosive	13.8	35.5
250	550	Semi-armor-piercing. High-explosive.	11.5	39.75
750	1,650	Armor-piercing. High-explosive	16.1	48.3

Digitized by Google
Original from UNIVERSITY OF MICHIGAN

Table XIII.—Table of Japanese bombs—Continued

Tail size (inches)	Filling	Illustration
4.3 x 3.1	Red phosphorus	Fig. 38 (4).
11.0 x 5.5	TNT or picric acid	Fig. 38 (3).
18.5 x 9.2	50% Lewisite, 50% mustard gas	Fig. 38 (5).
16.4 x 13.2	Parafin, kerosene, and thermite	Fig. 38 (2).
18.2 x 9.7	Thermite in electron containers	Fig. 38 (1).
14.5	Picric, hexamite, or anisole	Not shown.
15.8 x 9.5	Hexamite and anisole mixture or picric acid.	Fig. 39 (2).
15.0 x 9.0	Phosphorus-impregnite rubber pellets, and picric acid.	Fig. 39 (1).
18.3 x 10.6	Mixture of hexamite and anisole	Fig. 39 (3).
21.0 x 13.2	Picric acid	Fig. 39 (4).
15.0 x 7.9	Lyddite	Fig. 40 (3).
17.5 x 13.2	Picric acid	Fig. 40 (4).
22.0 x 13.3	Hexamite and anisole mixture or picric acid.	Fig. 40 (2).
32.4 long	Hexamite and anisole mixture	Fig. 40 (1).
37.1 x 19.3	Hexamite and anisole mixture	Not shown.
28 x 16.25	Trinitro-anisole	Not shown.
Not known	Trinitro-anisole	Not shown.

Digitized by Google
Original from UNIVERSITY OF MICHIGAN

CHAPTER 11
PROJECTILES

103. ANTIAIRCRAFT SHELLS (fig. 41). A large number of antiaircraft shells may be found on or near the surface after an air raid. Such objects are easily distinguishable from bombs by the rotating band and should be treated with care, as they have nose fuzes which are usually in a sensitive condition. No evacuation is necessary, but the shell should not be disturbed by inexperienced personnel.

Table XIV. Antiaircraft shell sizes

Caliber	Length (inches)	Weight (pounds)
20-mm	3	⅓
37-mm	6	1⅔
40-mm	7	2
3-mm	12	12
90-mm	16	21
105-mm	18	33

104. AIRCRAFT CANNON SHELLS (fig. 2). Aircraft cannon shells may likewise be found after an air raid. If necessary, .30- and .50-caliber shells may be collected in a box, but not more than three should be put in one container and they should be wrapped in cotton. Others, as the 20-, 37-, and 40-mm shells, should be treated in the same manner as antiaircraft shells.

Digitized by Google
Original from UNIVERSITY OF MICHIGAN

Table XV.—Aircraft cannon shell sizes

Caliber	Length (inches)	Caliber	Length (inches)
.30	1	37-mm	6
.50	2	40-mm	7
20-mm	3–4		

Digitized by Google
Original from UNIVERSITY OF MICHIGAN

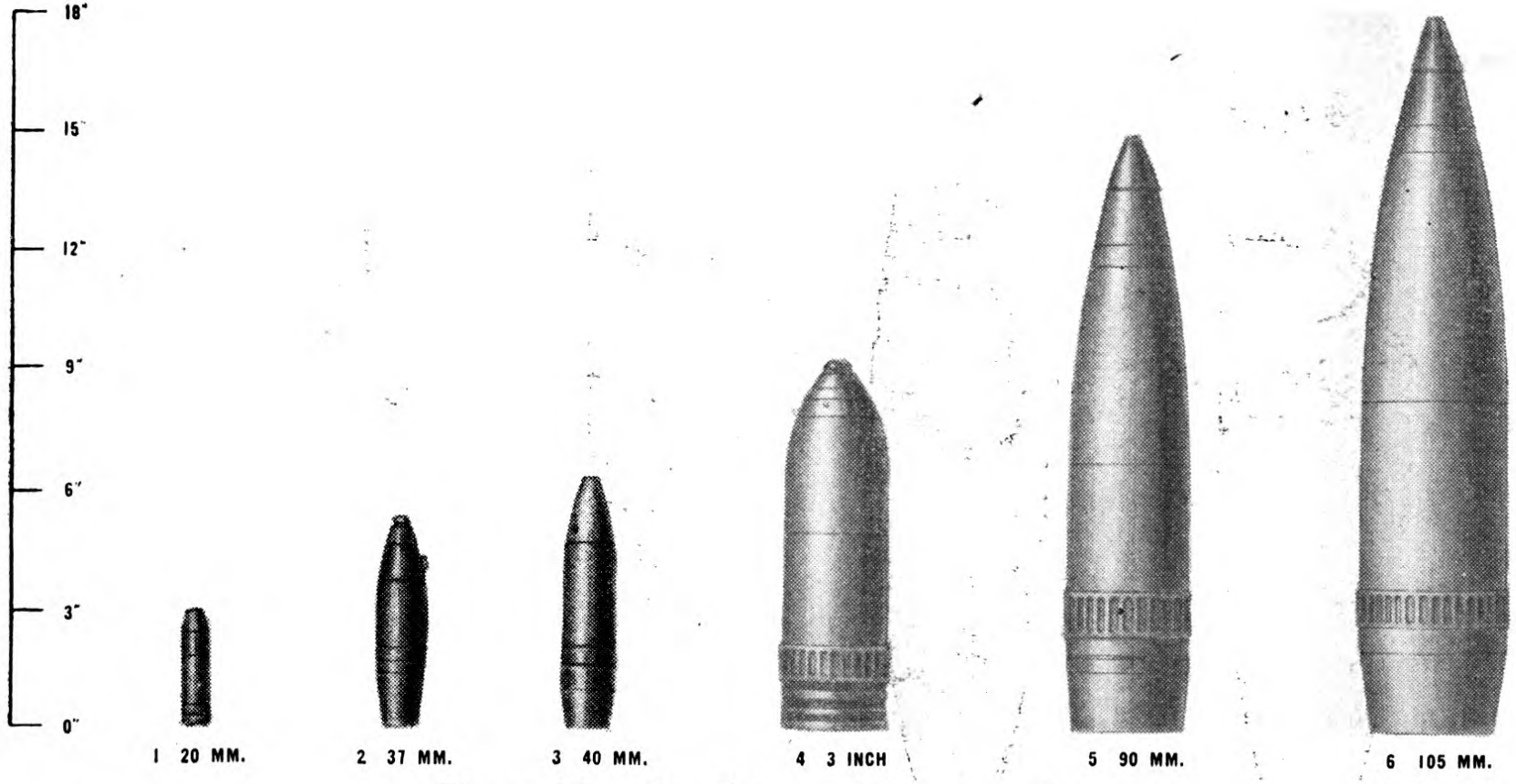


Figure 41.—American antiaircraft shells.

Digitized by Google
Original from UNIVERSITY OF MICHIGAN

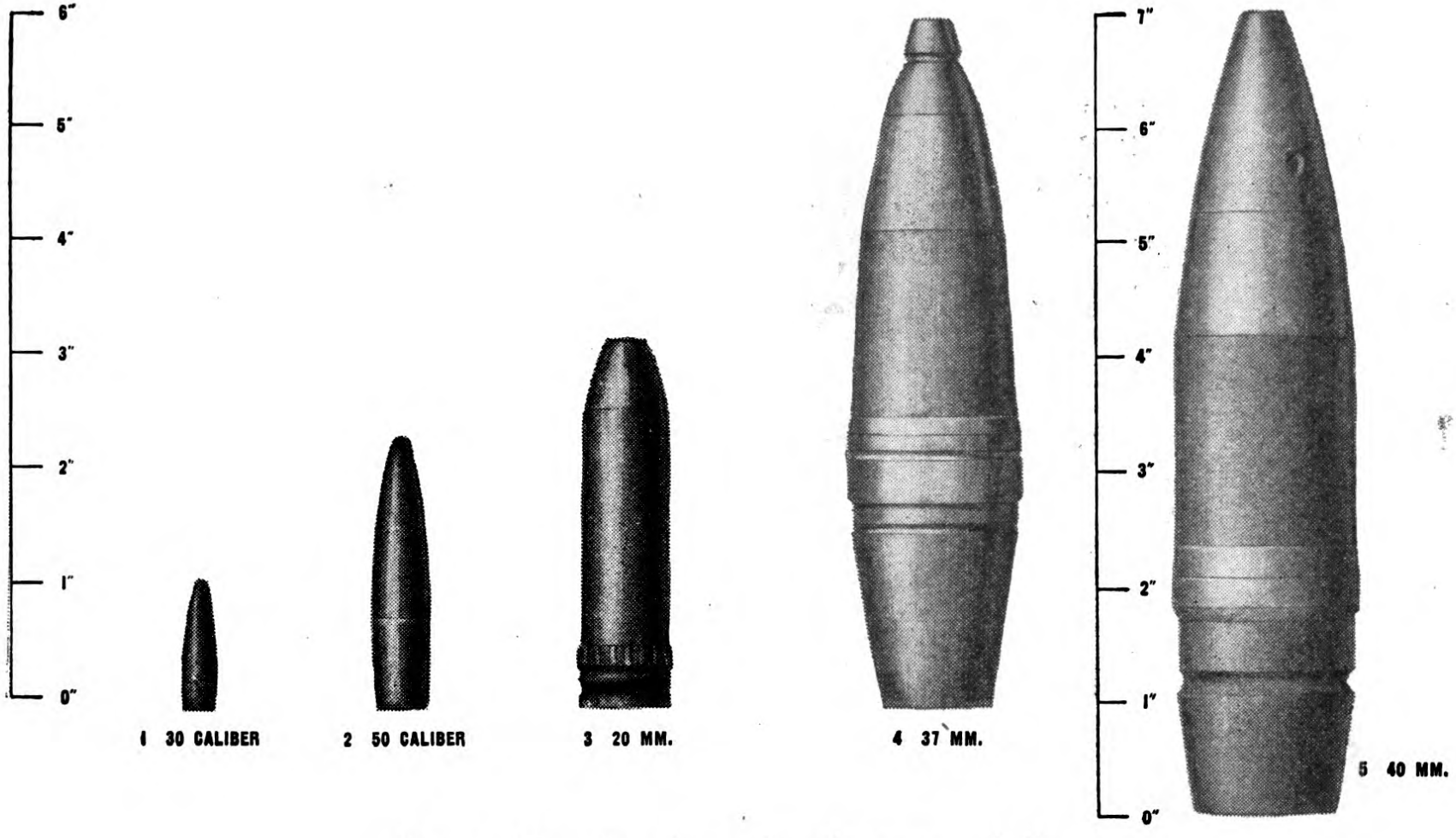


Figure 42.—American aircraft cannon shells.

Digitized by Google
Original from UNIVERSITY OF MICHIGAN

CHAPTER 12

MISCELLANEOUS OBJECTS

105. GENERAL. In addition to the bombs and projectiles shown in chapters 7 to 10, inclusive, there are other objects that may be found after an air raid. Usually these will be harmless, but they should not be disturbed until positive identification has been made.

106. PARACHUTE FLARE CONTAINERS.

a. Types. These containers will be of two types and may or may not have functioned.

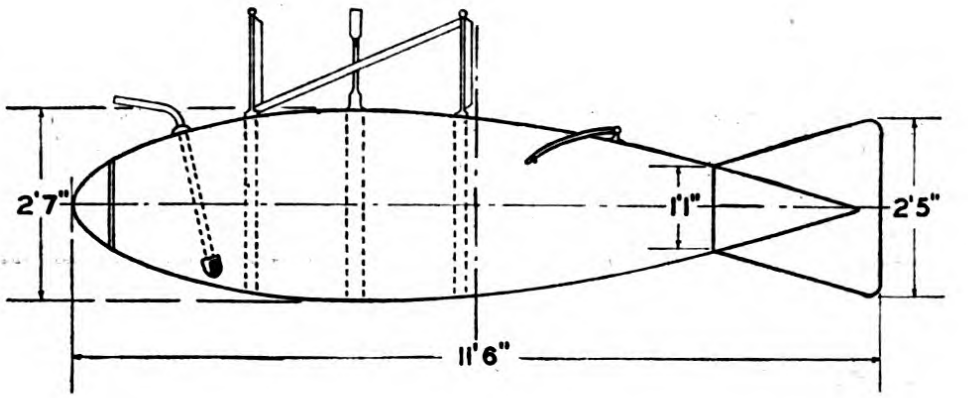
(1) The German model is 42 inches long and 8 inches in diameter. The case contains the parachute, detonator, and candle, the latter being about 24 inches long. The case will resemble that shown in figure 43 except that it has no vanes.

(2) The Japanese flare is 27 inches long and 6 inches in diameter. This, too, will be composed of an outer case containing the parachute, detonator, and flare proper. This container will be somewhat similar in appearance to the German model, but will have four vanes.

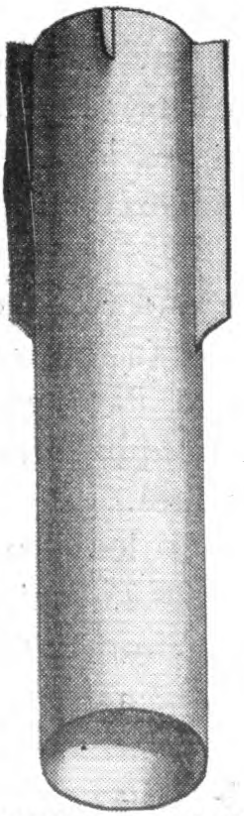
(3) The Italian flare case is 36.9 inches long and 4 inches in diameter, the flare itself being 20.25 inches in length. As the tail unit serves as a parachute retainer, there will be no vanes found on this container if the flare has functioned.

b. Four-candle flare container. This type of flare is used by the Germans and has the same external appearance as the single-candle flare container before functioning.

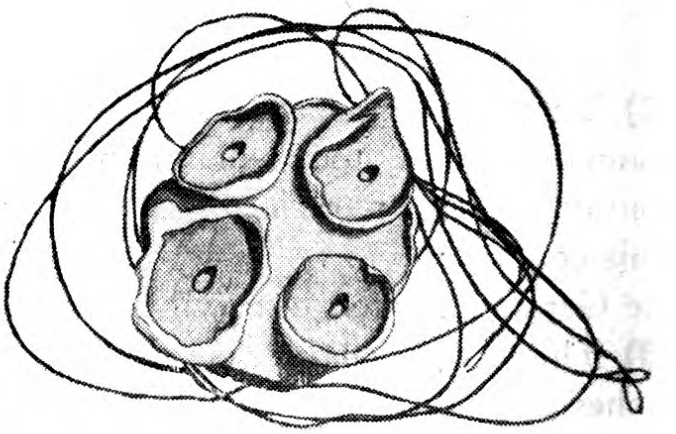
Digitized by Google
Original from UNIVERSITY OF MICHIGAN



AUXILIARY GAS TANK



2 PARACHUTE FLARE CONTAINER



3 BASE OF FOUR-CANDLE PARACHUTE FLARE

Figure 43.—Miscellaneous objects.

Digitized by Google
Original from UNIVERSITY OF MICHIGAN

The candles in this flare are about 24 inches long and 3 inches in diameter and, if the unit has functioned, the burned-out candle stubs will be found mounted on a steel pressing (see fig. 43).

c. It is possible to judge by their appearance whether these flares have functioned, flame or smoke markings and partially or entirely burned candles being reliable indications of this state. If it is apparent that the flare has not functioned, care should be taken to see that no wires attached to the flare are pulled, as this may result in igniting it and cause serious burns. No evacuation is required, and the flare may be moved safely if the above precaution is observed.

107. INCENDIARY BOMB CONTAINERS (fig. 44). These are used by the Germans and the Italians.

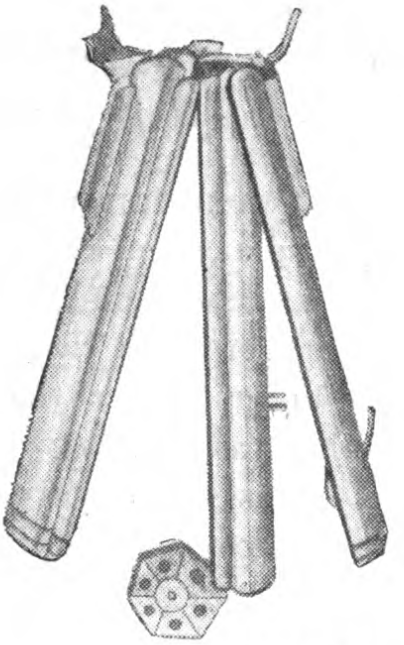
a. German incendiary bomb containers. There are five types in use by the Germans, all of which carry the 2-kg (4¼-lb.) bomb.

(1) The 24-bomb type is a vertical rod 43 inches long with an eyebolt at the top and an external housing. The bombs are stacked vertically around the rod on three felt-padded trays and are scattered when the outer housing is opened by an aerial-burst fuze. (Aerial-burst fuze is a fuze the functioning time of which is predetermined to detonate the bomb at a given altitude or at a certain time after release from the airplane.)

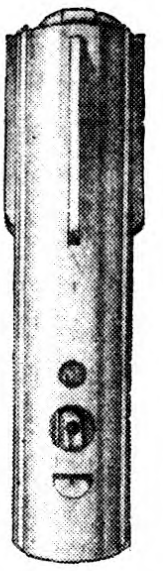
(2) The type I 36-bomb container has three sidepieces and an endpiece, which are opened by a clockwork fuze, thus scattering the bombs as it falls.

(3) The type II 36-bomb container has two sidepieces and a bottom plate hinged in the middle. This functions by having the top of the cylinder blown open by a clockwork or electric fuze and detonator.

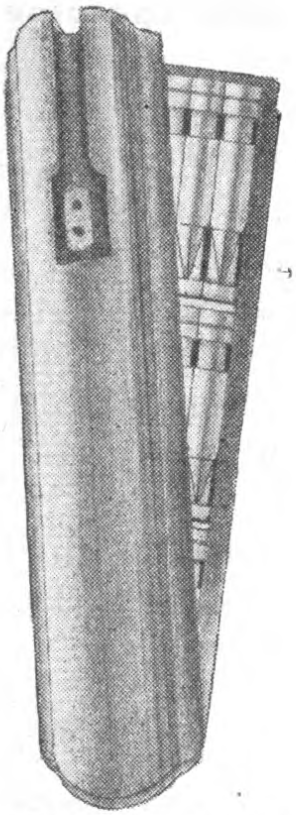
Digitized by Google
Original from UNIVERSITY OF MICHIGAN



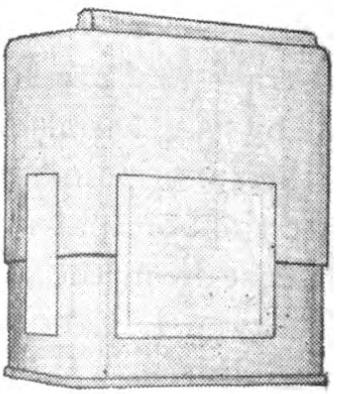
1 TYPE I 36-BOMB CONTAINER



2



3 TYPE II 36-BOMB CONTAINER



4 15-BOMB CONTAINER

Figure 44.—German incendiary bomb containers.

Digitized by Google

Original from
UNIVERSITY OF MICHIGAN

(4) The 15-bomb type is a rectangular metal box, 12 x 10 x 6 inches, and carries the bombs stacked vertically on end. The lid is 8 inches deep, has a folding handle and felt lining, and is covered by a label.

(5) The 360-bomb type consists of a cylinder divided into compartments. It is 20 inches in diameter, 93 inches in length. The container is of steel construction with a blunt nose, tapered tail, and doors for releasing the incendiaries. It resembles a demolition bomb.

b. Italian bomb container. The dimensions of the Italian container are given in table XII, where it is listed as a 100-kg incendiary and fragmentation bomb. The incendiary bombs are stacked around the outside of the fragmentation unit and are spring-loaded at the base of each stack so they will be forced out of the nose of the bomb.

108. EMPTY SHELL CASES. Empty shell cases will be found after any aerial combat and once definitely identified as empty, offer no threat whatsoever.

109. AUXILIARY GAS TANKS. The auxiliary gas tank (fig. 43) is often carried by bombers to increase their range. When empty, or when the airplane engages in combat, this tank may be jettisoned and therefore, may be found on the ground. Though containing no explosive charge it should be handled with care, as enough gasoline fumes may remain in it to cause a serious explosion.

110. AERIAL MINE CAPS. These are hemispherical domes 16 inches deep covering the rear opening of parachute mines. When the mine is dropped, this cap is released and acts as a pilot parachute. The cap is harmless in itself, but a bomb disposal officer should be notified

Digitized by Google
Original from UNIVERSITY OF MICHIGAN

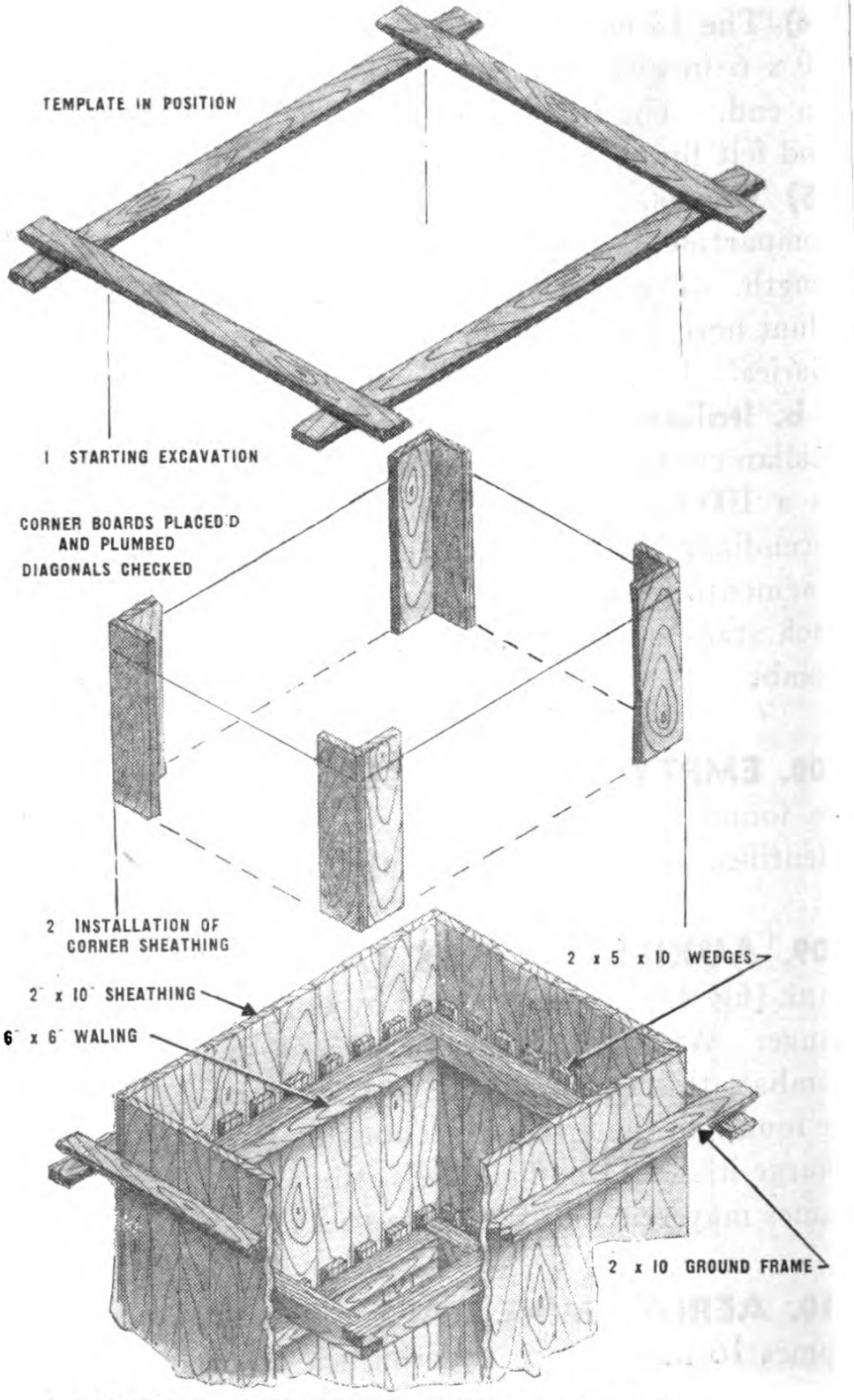


Figure 45.—Standard timbering for excavations.

Digitized by Google
Original from UNIVERSITY OF MICHIGAN

when one of these is found, as it may indicate the presence of a parachute mine.

111. MACHINE-GUN MAGAZINES. These are of various types and should be treated with care as they may contain live ammunition. That most commonly found is the so-called spectacle type, about 10 inches long and 4½ inches high, containing 75 rounds.

112. WHISTLE ATTACHMENTS. These are of two types and are attached to the fins of high-explosive bombs, the purpose being to make the bomb scream as it falls, thus lowering morale. One type is made of a cardboard tube shaped like an organ pipe, the other is an adapted bayonet scabbard. Both are about 14 inches long and 1½ inches in diameter, with the vent 4 inches from the rounded end. They are both harmless, but may be mistaken for small bombs if found unbroken.

Digitized by Google
Original from UNIVERSITY OF MICHIGAN

APPENDIX I

MILITARY EXPLOSIVES

---

1. GENERAL. The properties and certain other characteristics of the more common military explosives are given in this appendix, as this information is considered vital for the safe handling of unexploded bombs. These explosives will be considered from the viewpoints of—

a. Toxic effect on personnel.

b. Properties.

c. Field tests for indentification.

2. TOXICITY.

a. Toxic effects of explosives. Some of the more commonly used military explosives have the following toxic effects:

(1) Tetryl irritates the skin in the same manner as poison ivy.

(2) Picric acid and picric acid derivatives will color the skin yellow.

(3) Hexamite has harmful effects on the mucous membranes of the mouth, nose, throat, and lungs and will cause dermatitis (medical term meaning inflammation of the derma, or true skin).

(4) The hexanitrodiphenylamine-trinitroanisole mixture used by the Japanese is extremely irritating to the skin.

(5) The fumes from burning TNT are slightly toxic and may cause jaundice.

b. Safety precautions. Because of this toxic effect, certain safety precautions should be observed when handling explosives.

Digitized by Google
Original from UNIVERSITY OF MICHIGAN

(1) Wash hands with bicarbonate of soda or soap and water after handling dry, cold explosives.
(2) Wear rubber gloves whenever possible, and wash gloves thoroughly after using.
(3) Remove splashes of wet explosives from the skin or clothing immediately.
(4) Obtain medical attention whenever any skin irritation or yellow staining is noticed.

3. PROPERTIES OF MILITARY EXPLOSIVES. See table XVII.

4. FIELD TESTS. The following field tests may be used for identifying a known explosive or determining the characteristics of an unknown one:

a. Determination of melting point. To determine the melting point of an explosive, the procedure outlined below should be followed:
(1) Powder the explosive and place it in a test tube.
(2) Fasten the test tube to a thermometer in such a way that the bottom of the test tube is even with the bulb of the thermometer.
(3) Immerse the combination in an oil or water bath and heat slowly.
(4) Note temperature at which explosive changes from a solid to a liquid. Several tests should be made to obtain the average value.

b. Color test. Compare the color with that of other known explosives.

c. Solubility tests. As different explosives are soluble to varying degrees in specific solvents, the solubility test gives a good indication as to the compound present. The solubility is expressed in grams per 100 cc. of the solvent at a given temperature.

Digitized by Google Original from UNIVERSITY OF MICHIGAN

Table XVI.—Solubility of explosives

Explosive	Water	Alcohol	Ether	Other liquids
Ammonium nitrate.	118.3 gm at 0° C.	3.8 gm at 20° C.		
Explosive D	1.1 gm at 20° C.			Ethyl acetate–0.5 gm at 60° C. Most soluble in acetone.
Mercury fulminate.	0.01 gm at 15° C.			Decomposed by solution of sodium thiosulphate.
Picric acid	6.8 gm at 100° C.	4.9 gm at 20° C.	1.43 gm (cold)	Very soluble in acetone, benzene, and toluene. Neutralized by sodium carbonate or sodium sulphite solution.
Tetryl [1]	0.0195 gm at 50° C.	1.72 gm [2] at 50° C.	0.49 gm at 30° C.	Soluble in acetone, benzene, carbon tetrachloride, and toluene. May be destroyed by sodium sulphite solution.
TNT	1.99 gm at 32° C.	18.6 gm at 74° C.	3.33 gm at 20.-3° C.	Very soluble in acetone, benzene, and toluene.
Trinitroanisole	Insoluble	Soluble	Soluble	Very soluble in acetone, benzene, and toluene.

[1] Expressed in grams/100 grams in solvent.
[2] Use 95% alcohol for solvent.

Digitized by Google
Original from UNIVERSITY OF MICHIGAN

d. Other tests. (1) Specific tests for lead azide. **(a)** Lead azide will be decomposed by the following solvents:

1. Béta-beta-dichlorodiethyl ether.

2. Ammonium acetate solution.

3. A solution of 2.55 grams of sodium nitrate and 3.1 cc. concentrated nitric acid in 500 cc. of water for each gram of explosive.

(b) Ferric chloride will turn red when lead azide solution is added.

(2) Solubility of Hexanitrodiphenylamine. Hexanitrodiphenylamine has the following solubility:

(a) Insoluble in chloroform.

(b) Slightly soluble in ether, cold acetic acid, and alcohol.

(c) Very soluble in cold acetone, warm acetic acid, and warm nitric acid.

Digitized by Google
Original from UNIVERSITY OF MICHIGAN

Table XVII.—Properties of military explosives

	Trinitritoluene	Amatol	Trinitrophenol
Names	TNT, triton, trotyl	50/50, 60/40, 80/20 amatol	Picric acid. When cast: British, Lyddite; Japanese, Shimose; French, Melimite.
Manufacture	Nitration of toluene (from coal coking or petroleum cracking) in three steps.	Mechanical mixture of ammonium nitrate and TNT 50/50 and 60/40 cast loaded; 80/20 extruded.	Benzene from coal coking or petroleum cracking converted to phenol, which is nitrated to picric acid.
Color	From light honey or pale straw to light brown.	From color of TNT to dark brown. The greater the ammonium nitrate content, the darker the color.	Lemon yellow.
Melting point	76–80.6° C	80–85° C. 80/20 does not melt.	122° C.
Detonating temperature.	470° C	50/50—265° C. 80/20—290° C.	320° C.
Sensitivity	Very insensitive to shock, heat, and friction. Will burn without detonating in small quantities in the open. The impact of an ordinary bullet will not detonate it, but a tracer bullet may. Granular may be detonated by one gram of mercury fulminate, pressed	Varies from same as TNT to slightly less. Addition of ammonium nitrate reduces sensitivity.	Slightly less than TNT to shock. Somewhat more easily detonated by a booster. Cast loading increases sensitivity, as large crystals formed by recrystallization are more sensitive.

Digitized by Google
Original from UNIVERSITY OF MICHIGAN

	by two grams, but cast requires a tetryl booster of the equivalent.		
*Brisance	Very high	Varies from same as TNT to considerably less. The greater the ammonium content the lower the brisance.	Somewhat higher than TNT.
Velocity	7,000 meters/second when cast.	50/50–7,000 meter/sec; 60/40–6,400 meters/sec; 80/20–5,100 meters/sec.	7,400 meters/second.
Use	By all nations as a bursting charge in bombs, shells, mines, and demolition charges. Used pressed by Italy and by Germany as a booster.	By almost all nations as a substitute bursting charge for TNT to conserve the latter. Generally, the greater the percentage of ammonium nitrate the larger the missile.	By U. S. and by Britain as bursting charge in Explosive D; by Germany as a booster; by Japan as a booster and bursting charge; and by France as a bursting charge in Trimonite and Tridite.
Stability	Entirely stable	Ammonium nitrate is hygroscopic; therefore, stability is decreased as percentage of ammonium nitrate is increased.	Entirely stable.
Reaction with metals.	None	Forms dangerous compound with tin and copper.	Forms dangerous compounds with all metals but aluminum and tin. Expecially dangerous with lead and iron. These compounds are apt to be extremely sensitive.

*Brisance is the ability of an explosive to shatter the medium which confines it; in other words, the shattering effect of the explosives

Digitized by Google
Original from UNIVERSITY OF MICHIGAN

Digitized by Google

Table XVII.—Properties of military explosives— Continued

	Trinitritoluene	Amatol	Trinitrophenol
Remarks	Usually cast loaded but may be pressed or granular, especially as a booster. Fumes slightly toxic and may cause form of jaundice. Impurities may cause exudation. This is undesirable because of probability of low order detonation and increased sensitivity to shock of the explosive.	50/50 will exude as does TNT.	High melting point makes cast loading difficult and the cast product is apt to be sensitive. Picric Acid must be protected from contact with the explosive container generally by a coat of lacquer or asphalt. Imparts yellow color to anything it contacts.

	Ammonium Picrate	Trimonite	Tridite
Names	Explosive D		
Manufacture	Neutralization of picric acid with ammonia.	90% picric acid and 10% mononitronapthalene.	90% picric acid and 10% dinitrophenol.
Color	Reddish to orange yellow	Yellow	Yellow.
Melting point	Detonates before melting	92° C	85–90° C.
Detonating temperature.	320° C	314° C	315° C.

Original from UNIVERSITY OF MICHIGAN

Sensitivity	The most insensitive of all military explosives. Where a very severe impact will detonate TNT, Explosive D will not detonate except from the influence of a booster.	Same order as TNT	Same order as TNT.
Brisance	About 10% lower than TNT	About the same as TNT	About the same as TNT.
Velocity	6,500 meters/second	6,300 meters/second	6,300 meters/second.
Use	By U. S. and Britain in A. P. ammunition.	By France as a bursting charge in HE bombs. Percentage of picric acid runs as low as 60%.	By France as a bursting charge in HE bombs. Percentage of picric acid runs as low as 60%.
Stability	Unstable due to hygroscopicity of ammonium nitrate.	Somewhat hygroscopic; therefore, not entirely stable.	Somewhat hygroscopic; therefore, not entirely stable.
Reaction with metals.	Same as picric acid but to a lesser degree.	Same as picric acid	Same as picric acid.
Remarks	Must be press loaded and protected from contact with container. Has same tendency to stain as picric acid.	Has same tendency to stain as picric acid. Also must be protected from contact with metals. Mixture is manufactured to reduce melting point of picric acid for cast loading. Loses brisance in same proportion that picric acid is diluted.	Has same tendency to stain as picric acid. Also must be protected from contact with metals. Mixture is manufactured to reduce melting point of picric acid for cast loading. Loses brisance in same proportion that picric acid is diluted.

Digitized by Google
Original from UNIVERSITY OF MICHIGAN

Digitized by Google

Table XVII.—Properties of military explosives—Continued

	Cyclotrimethlenetrinitramine	Trialen	Torpex
Names	RDX, Hexogen, Trialen, Torpex, Plastic C, Cyclonite.	----------	
Manufacture	Formaldehyde condensed with ammonia to form hexamethyletetramine, which is nitrated to form cyclonite.	Cyclonite and wax	Varying percentages of Cyclonite, TNT, and aluminum powder.
Color	White	Either yellow or pink, depending on wax used.	Gray.
Melting Point	202° C	Information not available	Information not available.
Detonating Temperature.	Information not available	Information not available	Information not available.
Sensitivity	Of intermediate sensitivity or the same order as tetryl.	Somewhat greater than TNT. Bombs containing Trialen may detonate from impact from a drop of 10,000 feet.	Somewhat greater than TNT. Impact of a bullet causes a low-order detonation.
Brisance	Highest brisance	Very high. Greater than TNT.	Very high. Greater than TNT.
Velocity	9,300 meters/second. Highest known.	Exact information not available. Should be around 8,500 meters/second.	Exact information not available. Should be around 8,500 meters/second.
Use	By Italy and Japan as a booster. By U. S., Britain, Germany, and Italy as a bursting charge.	By Germany as a filler for large HE bombs.	By U. S., Britain, and Germany as a bursting charge in mines, torpedoes, and depth charges.

Original from UNIVERSITY OF MICHIGAN

Digitized by Google

ability	Entirely stable	Entirely stable	Entirely stable.
Reaction with metal.	None	None	None.
Remarks	Has the highest velocity known and is as strong as nitroglycerin. Its use would preclude the necessity of sacrificing strength for brisance in military explosives. Experiments are now being conducted to combine it with other substances for desensitizing it and so that it may be suitably cast or press loaded. British bursting charge made of Cyclonite and TNT is yellow in color. Italian bursting charge made of Cyclonite, TNT, and wax is pink in color. Italian booster of Cyclonite and wax is pink in color. Addition of TNT desensitizes it and permits melt loading. Wax desensitizes it and acts as a lubricant for press loading.	Aside from sensitivity should be a very powerful explosive. Would probably be press loaded.	Addition of TNT desensitizes and permits melt loading. Aluminum increases the heat of detonation and thereby the expansion of gases. It also has an affinity for oxygen and extracts oxygen from water, thereby causing a more complete combustion. The mixture develops over 50% more efficiency than TNT under water.

Original from UNIVERSITY OF MICHIGAN

Digitized by Google

Table XVII.—Properties of military explosives—Continued

	Plastic C	Hexanitrodiphenylamine	Hexamite
Names		HND, Hexil, Hexite, Hexamin.	
Manufacture	Cyclonite and wax	Aniline and Phenol condensed to form diphenylamine, which is then nitrated. Use of dinitrochlorobenzene with aniline will simplify this process.	(1) HND, TNT, and aluminum powder. (2) HND and TNT 50–50.
Color	Brownish yellow	Orange yellow	(1) Greenish gray. (2) Yellow.
Melting point	Becomes semifluid at 100° C.	250° C.	80° C.
Detonating	Information not available.	260° C.	Exact information not available.
Sensitivity	Less sensitive than TNT. Is not sure of detonation by Engineer's No. 8 blasting cap.	About the same as Tetryl, i. e., intermediate sensitivity. Can be used in small quantities but too sensitive to use straight in large bursting charges.	Somewhat more sensitive than TNT.
Brisance	Considerably greater than TNT.	About the same as Picric Acid.	About the same as picric acid.
Velocity	Exact information not available. Probably around 8,500 meters/second.	7,200 Meters/second.	7,400 meters/second.

Original from UNIVERSITY OF MICHIGAN

Use	By U. S. as a Commando, demolition explosive.	By Germany and Japan as a bursting charge.	By Germany as a bursting charge in mines, torpedoes, and depth charges.
Stability	Entirely stable. Tends to harden in cold weather.	Entirely stable	Entirely stable.
Reaction with metals.	None	None	None.
Remarks	An experimental explosive. Further use will depend on results and ability of U. S. to produce nitrates in sufficient quantities for large-scale production.	Extremely toxic. Causes dermatitis and is extremely harmful and painful to the mucous membranes of the throat and lungs.	Toxicity same as HND. Develops 30% more power under water than TNT owing to use of aluminum powder. The latter has a tendency to increase strength but decrease brisance. When used in proportions up to 20% it will increase strength without decreasing brisance in HND and Cyclonite. Addition of TNT desensitizes and lowers melting point for cast loading.

Digitized by Google
Original from UNIVERSITY OF MICHIGAN

Table XVII.—Properties of military explosives—Continued

	Trinitroanisole	Symtrinitroanisole	Trinitrophenylmethylnitramine
Names			Tetryl, tetralite, tetrylite.
Manufacture	Nitration of the ether anisole	64% trinitroanisole and 36% hexanitrodiphenylamine.	Aniline treated with methyl alcohol to form dimethylaniline. This is nitrated to form tetryl. Tetralite is 50 to 75% tetryl and 50 to 25% TNT.
Color	Colorless	Orange yellow	Tetryl canary yellow. Tetralite a deeper yellow.
Melting point	68° C	Information not available	130° C.
Detonating temperature.	Information not available	Information not available	260° C.
Sensitivity	Somewhat lesser than TNT	Somewhat greater than TNT	Tetryl is of intermediate sensitivity, that is, it can be used successfully in small quantities but in large quantities would be likely to detonate from the impact of rifle fire, set-back, or other moderate mechanical impact. Tetralite is intermediate between tetryl and TNT.

Digitized by Google
Original from UNIVERSITY OF MICHIGAN

Brisance	About the same as picric acid	About the same as picric acid	Tetryl is one of the most brisant of military explosives Considerably more than TNT. Tetralite is somewhat greater than TNT.
Velocity	7,400 meters/second	7,400 meters/second	7,400 meters/second.
Use	By Japan as a bursting charge	By Japan as a bursting charge	By the U. S. as a booster and bursting charge (Tetralite). By Britain as a booster. By Japan as a subbooster.
Stability	Somewhat hygroscopic; therefore, not entirely stable.	Not entirely stable	Entirely stable.
Reaction with metals.	None	None	None.
Remarks	Formerly anisole was expensive and its nitration dangerous. Trinitroanisole can now be manufactured synthetically from synthetic methyl alcohol and dinitrochlorobenzene, which will probably account for its recent use by Japan. Poisonous and produces severe skin irritation.	Combination used to desensitize and reduce the melting point of hexanitrodiphenylamine. Texicity would approximate that of both its components.	High brisance makes it an ideal booster as it will insure a high order of detonation for all types of bursting charges. The combination of tetryl and TNT is used to desensitize and lower the melting point for cast loading. Tetryl irritates the skin like poison ivy. It also stains everything that it contacts yellow.

Digitized by Google
Original from UNIVERSITY OF MICHIGAN

Table XVII.—Properties of military explosives—Continued

	Pentaerythritetetranitrate	Mercury fulminate	Lead azide
Names	PETN, Penthrite, Penthrite Wax, Pentalite.		
Manufacture	PETN—the reaction of formaldehyde, acetaldehyde, and calcium hydroxide forms pentaerythritol. This is nitratated to form PETN. Penthrite Wax-PETN and lignite wax. Pentalite-50–50 PETN and TNT.	Metallic mercury, ethyl alcohol and nitric acid.	Reaction of lead acetate and sodium azide.
Color	PETN, white. Penthrite, wax-pink. Pentalite, yellow.	White to gray or brownish yellow.	White to buff.
Melting point	140° C	140° C	280° C.
Detonating temperature.	260° C	210° C	335° C.
Sensitivity	PETN a little greater than tetryl. Penthrite wax about the same as tetryl. Pentalite about halfway between TNT and tetryl.	Extremely sensitive to shock, friction, and heat. The slightest spark or shock will detonate. Stored under water.	Varies with crystal size. Amorphous form insensitive. Large crystals detonate spontaneously. Almost as sensitive to flame as mercury fulminate. Stored under water.
Brisance	Very high. Second only to Cyclonite.	Very low	Slightly higher than mercury fulminate.
Velocity	8,300 meters/second	5,400 meters/second	5,300 meters/second.
Use	PETN, by U. S. in primacord detonating fuse; by Germany as a detonator ele-	By practically all nations as a primer element. Usually mixed with potassium chlo-	By all nations as a detonator element in the explosive train.

Digitized by Google
Original from UNIVERSITY OF MICHIGAN

Digitized by Google

	ment. Penthrite wax, by Germany as a subbooster. Pentalite, by U. S. and Japan as a bursting charge.	rate and antimony sulfide.	
Stability	Difficult to stabilize	Unstable. Becomes insensitive if stored at 50 C. for 10 months or pressed at 25,000 pounds/square inch.	Entirely stable.
Reaction with metals.	None	Reacts rapidly with aluminum and magnesium and slowly with copper, zinc, brass, and bronze.	None.
Remarks	A so-called super explosive in that it is as strong as nitroglycerin and considerably more brisant than TNT. Work is now in progress to combine with other substances such as TNT for desensitizing and melt loading or suitable press loading. Lignite wax desensitized to some extent and acts as a lubricant.	Formerly very popular, as it could be used in all elements of the explosive train except bursting charge. Lately it has been displaced except for primer elements because of its inefficiency, its instability, its semistrategic nature, and the fact that it will not detonate cast TNT and Explosive D.	Because it will perform the same function as two to two and one-half times as much mercury fulminate it has largely replaced the latter as a detonator element. It is frequently used as a primer mixed with potassium chlorate, antimony sulfide, and an abrasive. It is not sufficiently sensitive to stab action for use as a primer unmixed. Lead azide dust will expand the blood vessels and cause the heart to beat rapidly much the same as nitroglycerin.

Original from UNIVERSITY OF MICHIGAN

Table XVII.—Properties of military explosives—Continued

	Lead Styphnate	Mercury fulminate	Lead azide
Names			
Manufacture	Reaction of lead nitrate and Styphnic acid.		
Melting point	220°C		
Detonating temperature.	280°C		
Sensitivity	Same order as mercury fulminate.		
Brisance	Lowest of the primary explosives.		
Velocity	Very low. About 4,500 meters/second.		
Use	As a primer element. By Germany in combination with lead azide in their detonator to increase the ignitability of lead azide.		
Stability	Entirely stable		
Reaction with metals.	None		
Remarks	Not sufficiently violent to be used alone as a detonator element.		

Digitized by Google
Original from UNIVERSITY OF MICHIGAN

APPENDIX II

DEFINITIONS

1. TERMS COMMON IN BOMB DISPOSAL.

a. Access. The operations required to approach and uncover an unexploded bomb.

b. Aerial-burst fuze. A fuze whose functioning time is predetermined to detonate the bomb at a given altitude or at a certain time after release from the airplane.

c. Aerial mines. Explosive objects dropped from aircraft, with or without parachute, designed for use against water targets but sometimes used against land targets.

d. Angle of entry. The angle of entry is the degree of inclination, with the perpendicular, at which the bomb or projectile strikes the target area.

e. Antihandling fuze. A fuze designed to arm and be in a sensitive condition after it has come to rest on the ground, so that any further movements or disturbance after it has become armed will detonate the bomb.

f. Antipersonnel or fragmentation bomb. A small, thick-walled bomb which, upon detonation of the explosive filler, produces a large number of small, rapidly moving fragments. Such bombs are normally used against lightly protected targets and personnel, both military and civilian.

g. Armor-piercing bomb. A bomb having a low charge/weight ratio and designed for penetration prior to burst.

Digitized by Google Original from UNIVERSITY OF MICHIGAN

h. Blast. A shock or nontranslational wave transmitted through the air as a direct consequence of the sudden transformation of an explosive material into gas at high temperature and pressure.

i. Bomb. A bomb is a missile containing an explosive or chemical filling designed to be dropped from aircraft.

j. Bomb cemetery. An assigned area to which bombs are taken for final disposal operations after the fuze is made safe.

k. Bomb crater. An irregular depression formed by the explosion of a bomb.

l. Bomb disposal. A scientific and technical procedure for handling and rendering safe unexploded bombs or other missiles.

m. Bomb disposal officer. A commissioned officer of the Ordnance Department who is an expert on bomb disposal.

n. Bomb disposal units. Military organizations made up of Ordnance Department personnel who are trained to disarm or defuze bombs without detonating them.

o. Bomb reconnaissance. The act of proceeding to the location of a reported incident, determining the presence of an unexploded bomb, and subsequently reporting the necessary information.

p. Bomb reconnaissance agents. Selected civilians trained by ordnance bomb disposal officers to investigate, identify, report, and classify unexploded bombs in civilian areas; to indicate the distance (evacuation distance) to which the inhabitants of these areas must be removed for their protection; and to close such roads and institute such protective works as are thought necessary.

q. Bomb reconnaissance noncommissioned officers. Noncommissioned officers who have been trained in the identification and reporting of unexploded bombs and in the use of protective works.

Digitized by Google
Original from UNIVERSITY OF MICHIGAN

r. Bomb reconnaissance officer. A commissioned officer trained in the identification and reporting of unexploded bombs and the use of protective works.

s. Bomb reporting. **(1)** The act of transmitting any information in connection with an unexploded bomb or a suspected unexploded bomb.

(2) The entire sequence of operations beginning with the discovery of a bomb incident and terminating with the negative report of the bomb reconnaissance agent or the reporting of disposition of the unexploded bomb by the bomb disposal unit.

t. Booby trap. Any device so arranged that it will detonate an explosive substance when the object within which it is contained or to which it is attached is moved or tampered with in any way.

u. Brisance. Brisance is the ability of an explosive to shatter the medium which confines it; in other words, the shattering effect of the explosive.

v. Camouflet. An underground cavity caused by an underground bomb explosion which may fail to rupture the surface of the earth. The chamber retains a portion of the gases of combustion within itself. A high concentration of carbon monoxide is usually present.

w. Charge/weight ratio. A percentage showing the ratio of the weight of explosive filling to the total weight of the bomb.

x. Chemical bomb. A thin-cased bomb containing one of a number of chemical agents, such as a smoke-producing agent, mustard gas, Lewisite, or other toxic gases.

y. Delayed-action bomb. Any bomb so fuzed that detonation takes place either at a predetermined time after impact or when the bomb or fuze is disturbed after coming to rest on the surface or under the ground.

Digitized by Google
Original from UNIVERSITY OF MICHIGAN

z. Dispersal. Normally accomplished by an air raid warden. The temporary removal of persons and the diversion of traffic from a danger zone surrounding an unexploded bomb. During inclement weather or enemy air activity, dispersal will include provision of nearby temporary shelter for dispersed persons.

aa. Dud. An explosive-filled missile whose failure to detonate has been proved to be due to mechanical or structural failure.

ab. Earth shock. The transmission of the compression wave caused by the detonation of a buried bomb through the earth and all structures adjacent to the point of explosion.

ac. Evacuation. (Normally accomplished by a bomb reconnaissance agent.) The removal from the zone of dispersion of the unexploded bomb of all persons within that zone, pending the disposal of the unexploded bomb. Evacuation includes the completion of all arrangements for transporting, housing, and feeding the evacuees.

ad. Fragmentation. Projection of bomb fragments or splinters in all directions at high velocities when explosion occurs.

ae. Fuze. A fuze is a device designed to initiate the explosive train of a bomb or projectile at the time and place desired.

af. General-purpose bomb. A bomb having a high charge/weight ratio and depending on blast for its principal effects.

ag. Impact fuze. A fuze designed to explode the bomb when it strikes the target. It can be set to go off instantaneously or after a short delay ranging from a fraction of a second to several seconds.

Digitized by Google
Original from UNIVERSITY OF MICHIGAN

ah. Incendiary bomb. A bomb constructed of, or filled with, an inflammable substance designed to start fires.

ai. Kopfring. A metal ring which is welded to the nose of a bomb to reduce its penetration in earth or water.

aj. Long-delay time fuze. A fuze designed to explode a bomb at a certain time after it strikes the target. It can be set to explode after a minimum of a few minutes or a maximum of several days.

ak. Offset. Offset is the horizontal distance of forward travel covered by the missile after it strikes the ground. This distance is measured from the center of the hole of entry to the most forward part of the missile.

al. Projectile. A projectile is a missile containing an explosive or chemical filling designed to be propelled from a cannon or mortar.

am. Sheathing. Vertical timbering used to keep the sides of the shaft from collapsing inward.

an. Trajectory. A trajectory is the curved path of flight of a bomb or projectile after release from the aircraft, cannon, or mortar.

ao. Unexploded bomb. Any bomb dropped from aircraft which fails to explode on impact or immediately thereafter. It must be considered as a delayed-action bomb until the contrary is proved.

ap. Waling. Horizontal timbering used to support the sheathing against the inward pressure exerted by earth shock.

Digitized by Google
Original from UNIVERSITY OF MICHIGAN

Digitized by Google

Original from
UNIVERSITY OF MICHIGAN

	Paragraph	Page
Aerial mine cap	110	121
Auxiliary gas tank	109	121
Bomb:		
German	93–96	85
Italian	97–100	97
Japanese	101–102	107
Bomb Disposal Company	36–64	58
Bomb Disposal Squad separate	65–73	71
Bomb Disposal Staff Officer. (*See* Staff Officer.)		
Camouflet	25	37
Categories	30	41
Channels, reporting	31	42
Civilian mission	13, 16	7, 10
Control center, reports to and by	29, 32	41, 47
Crater	22	23
Definitions	App. II	141
Diagnosis	24	35
Disposal:		
Organization	10–16	6
Problem	1, 2	1
Disposal Company, Bomb. (*See* Bomb Disposal Company.)		
Empty shell case	108	121
Equipment:		
Bomb disposal	81	77
Power-driven	91	83
Evacuation and protective works	33–35	49
Explosion	21, 23	20, 30
Explosives, military	App. I	124
Flight	18	11
German bomb	93–96	85
Headquarters platoon	54–56	64
Hole of entry	19	11
Incendiary bomb container	107	119
Intelligence	7–9	4
Italian bomb	97–100	97
Japanese bomb	101–102	107
Machine-gun magazine	111	123
Military explosives	App. I	124
Military mission	15	8
Mines, aerial:		
General	26	40
German	96	86
Miscellaneous objects	105–112	117
Missions	10–16	6
Navy Department mission	12	7
Objects, miscellaneous	105–112	117
Operating platoon	57–64	66

Digitized by Google

Original from UNIVERSITY OF MICHIGAN

	Paragraph	Page
Operating technique:		
Access	90	80
Safety precautions	90	82
Operations	17–35, 36–53, 90	11, 58, 80
Organizations:		
Bomb disposal	10–16	6
Bomb Disposal Company	36–53	58
Parachute flare container	106	117
Penetration	20	16
Personnel:		
Requirements and training	3–6	2
Special operating	74–89	74
Platoons:		
Headquarters	54–56	64
Operating	57–64	66
Profectile:		
Aircraft cannon shell	104	113
Antiaircraft shell	103	113
Protective works	33–35	49
Pump	91	83
Reconnaissance noncommissioned officer:		
Assignment	88	79
Duties	89	79
Mission	87	79
Reconnaissance officer:		
Assignment	84	78
Duties	85	78
Mission	83	78
Training	86	78
Reconnaissance, matters affecting	17–27, 92	11, 84
Records, maintenance	78	76
Reports	28–32	40
Requirements, personnel	3	2
Research	7–9	4
Responsibility	14	7
Safety precautions	90, 92	82, 83
Sheathing	90	80
Signs of explosion	23	30
Staff Officer:		
Assignment	75	74
Duties	76–82	74
Mission	74	74
Training	80	76
Timbering	90	80
Tool, use of	90	82
Training aids	6, 81	4, 77
Training, personnel	4	2
Trajectory of bomb	18	11
War Department mission	11	6
Whistle attachment	112	123

Digitized by Google
Original from UNIVERSITY OF MICHIGAN

UNIVERSITY OF MICHIGAN
3 9015 08030 3905



Digitized by Google
Original from UNIVERSITY OF MICHIGAN

Digitized by Google
Original from UNIVERSITY OF MICHIGAN