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Survey of Anti-Tank Mine Counter-Measures

26,000—10-43 (2326)
H.Q.S. 6665-3 Tech. 5018.

1. **OBJECT:** The purpose of this lecture is to survey systematically the problem of how to deal with anti-tank mines. A considerable number of widely different counter-measures have been proposed, each with its special advantages and limitations, and each raising the question of the probable enemy reply. These counter-measures may be classified, however, thus eliminating unessential complexity and affording a perspective of the whole subject which those working on individual items might not otherwise possess. This procedure may also be helpful to those approaching the problem for the first time, by presenting its essential features in the simplest possible form, and by providing a convenient summary of work which is already being done. Moreover, such a general survey may assist in the decision as to the methods on which effort should be intensified, and in the recognition of lines of investigation which have hitherto been unduly neglected.

2. **STATEMENT OF THE PROBLEM:** Attention will be confined to the minefield in depth, such as is employed in field warfare. Narrow, thickly-sown belts forming part of permanent fortifications should be in some respects easier to penetrate, and methods of dealing with deeper belts will, in general, be applicable to them. The problem presented by scattered mines which are commonly sown outside the minefield proper will not be specifically considered, but it should be fairly obvious which of the methods mentioned would be applicable to them. The detection of minefields as a whole (e.g., by aerial photography) is also excluded from consideration here.

The problem is to clear a lane of at least two tank widths (say, 8 yards) through a mine-belt, either by day or night or under cover of smoke, with reasonable safety to the personnel involved, as rapidly as possible and silently enough to minimise the risk of drawing fire. As a minefield usually consists of several mine-belts, the method should be capable of immediate repetition on successive belts. It will be a great advantage also if the method is capable of dealing with wire entanglements, which are usually incorporated in minefields.

The usual density of mines in a belt is about one per yard of front, e.g., there may be 8 rows 10 yards apart, the mines in each row being 8 yards apart. The spacing of both rows and mines (in one row) varies a good deal but there is a minimum allowable spacing of individual mines (e.g., 5 yards for Tellermine 1935 pattern). Increase in the spacing of rows does not decrease the efficiency of the minefield but does increase the difficulty of neutralising it, and we must, therefore, expect the enemy to use the maximum width of mine-belt which local conditions allow. In clearing an 8-yard lane, a minimum of about 8 mines are, therefore, likely to be encountered, but this may be much exceeded if the lane is not at right angles to the edge of the belt. A proportion of these will be "booby-trapped," the number so fitted depending upon the conditions under which the field was laid.

Before classifying possible counter-measures we may rule out certain proposals which are considered to be impracticable, such as:

(1) Neutralising mines in situ by some physical agency other than pressure, e.g., heat. No known agency would be suitable unless the mines were previously located, in which case simpler means could be used.

(2) Modifying tanks in such a manner as to render them capable of either:

(a) Passing over mines safely, or

(b) Surviving the explosion of a mine without serious damage.

Under 2 (a) above pressure measurements have indicated the bearing surface of the tank track would require to be increased at least ten times;

Solution (b) would require very great strengthening of tracks and belly-plates.

The former is out of the question, but the latter is not necessarily so and requires special investigation. At present the explosion normally occurs beneath the track, but the advantage to the enemy of causing it to occur beneath the body of the tank is so great that we should be prepared to counter this as soon as possible. Damage to tracks will immobilise the tank, but is frequently repairable on the spot, whereas a mine exploding between the tracks may be expected to wreck the tank and cause heavy casualties among the crew. (a) should not be taken as excluding the possibility of a vehicle being specially constructed so as to pass over a minefield safely. The pressure produced on the ground should not exceed about 2 lb. per square inch for any surface of a square foot or more in area. For a smaller bearing surface (e.g., motor cycle tyre) the pressure could be somewhat greater, so long as the load did not exceed about 200 lb. on any square foot of ground. These figures are based on the Tellermine 35 which may operate with loads down to 200 lb., the area of the cover being about 110 square inches. They were not very different for other types of mine, since these appear to be all designed to operate for loads somewhat greater than can be caused by a walking man. Data given in the following section refer to the Tellermine 35 unless otherwise stated.

3. **CLASSIFICATION OF PROPOSED METHODS:** Counter-measures may be broadly classified as either localised, i.e., applied to individual mines, or unlocalised, i.e., applied to the whole area to be cleared. The former usually involve preliminary detection of the mines and tend to be slow in operation. The latter are essentially uneconomical, especially if they require the expenditure of material, and this objection is greater in proportion to the depth of the mine belt. A more detailed classification may be made as follows:

I. DETECTION

(a) **By prodding**—Laborious and slow, but applicable to all types of mine. Could be improved by using special prodder (instead of bayonet) if operationally acceptable.

(b) **By electrical apparatus:** Quicker than prodding, but applicable only to metallic mines. Requires special apparatus and trained personnel. May be hampered by presence of other metallic objects.

(c) **By auscultation, i.e.,** listening for the effect of the proximity of a mine on the sound produced by thumping the ground. Preliminary tests show some promise. Some training and apparatus and quiet conditions would be necessary. The position of mines so detected will be marked, and removal effected by hand (after examination for booby traps), by pulling out on the end of a 50-yard cable or possibly by aimed fire from a special weapon mounted on a tank.

II. MECHANICAL REMOVAL WITHOUT DETECTION

(a) **By harrow**—Required pull of some 5 tons for width of 6 feet and either it or a pulley and holdfast must be transported to far side of belt before operating. Could be towed behind tank to clear space between tracks if device available for clearing in front of tracks. Is not effective in all types of soil but development is in hand. A modified form towed from a boom in front of the tracks is an attractive idea if practicable.

(b) **Plough**—Much work has been done, but results discouraging until recently. If development now in progress is successful, the furrows produced will have tactical advantages, and if deep enough booby-trapped mines may be removed without detonation.

Both of these devices would operate by bringing mines to the surface, and subsequent lifting by hand would be necessary. Both would be rendered unserviceable by explosion of booby-trapped mines. The harrow could be very quickly replaced, the plough not so quickly.

III. MECHANICAL DETONATION

(a) **By roller**—Plain, spiked and finned types have been tried, but best design not yet settled. Difficulty is to apply enough load to mine without increasing weight of roller unduly. Development has chiefly been directed to production of a pilot device, capable of operating on roads. Difficulties of "bridging" and excessive wear would be much less on ordinary ground. Rollers are blown out of their bearings, and are likely to be damaged also, by every mine encountered.

(b) **By flail**—Beating the ground by rotating chains, as in the Scorpion and Baron, has the advantages that the apparatus, apart from the loss of a few links of chain, is not damaged by an exploding mine and will deal with all types of mine. But it is unwieldy, requires high power to drive it, obscures the driver's view and is not yet completely effective in all types of soil. If it flails in the forward direction it tends to deposit earth in front, thus increasing the cover of any mines there and making it more difficult to detonate them. If it flails in the backward direction mines are liable to be thrown on the tank and the tank has to be completely closed during a run.

IV. BLAST DETONATION

(a) **Single charges**—The "Flying Dustbin," with a charge of 26 lb. fired at 6 to 8 feet above ground, is reputed to clear a circle of about 30 feet diameter. Considerable variation may be expected according to depth of burial of mines and nature or condition of soil.

25 pr. artillery fire has been found to be extremely inefficient. Mines are only affected if within the area of the crater and are not always detonated even then. This is due to the low charge-weight ratio of the projectiles, whereby the blast effect is relatively feeble. Their small radius of action would make it impossible to lay down an effective aimed pattern, and an enormous expenditure of ammunition would be required. The efficacy of larger calibres is under examination.

Aircraft bombs, which can have a much higher charge-weight ratio, are more suitable than shells, but accuracy of aiming is lower. For maximum effect from a given charge there is probably an optimum height of burst, but sufficient information on this is not yet available. A stick of bombs fired by blast-operated fuzes would seem to offer distinct possibilities for minefield detection, but it would be extremely difficult to join up successive sticks to clear a continuous lane or to obtain a long enough stick to straddle a mine-belt effectively.

(b) **Line charge**—The "Snake," a steel tube up to 400 feet long, carrying about 3 lb. of explosive per foot, is reputed to clear a lane 30-40 feet wide. It is the only mine-clearing device which will also clear wire but is liable to detonate prematurely in a zone of fire. This could be minimized by choosing a suitable explosive. Better blast effects are obtained for a given charge if it is enclosed in a flexible (instead of a steel) tube, but this is much less effective against wire and is more difficult to position. Rocket projection may be practicable, however.

(c) **Area charge**—Cordtex net laid on the ground may detonate buried mines beneath it and to a short distance each side, but could not be relied upon without previous local test, as the nature of the soil appears to influence the results considerably. Rocket projection is possible in suitable wind conditions, but not of a net sufficiently wide to clear a lane for tanks, e.g., 100 yards. 10 feet might be cleared in exceptionally favourable circumstances. At present the method is only capable of clearing a footpath.

4. **ENEMY REPLIES:** In order to compare the value and promise of the various methods, it is necessary to take into account the extent to which they are susceptible of frustration by the enemy. The following methods have either been employed by him or should be reckoned with as obvious replies which he may be expected to make. They are classified under the same headings as before:

I. Detection by hand-operated apparatus is hampered by anti-personnel mines. These constitute a separate problem from anti-tank mines, which is not considered here. Apart from this:

(a) Prodding—Decreasing the operating load of the mine to such an extent that it would be liable to be detonated by the impact of the prodder is not likely, as it would render the application of counter-measures III (a) and (b) much easier, but special anti-prodding mines have recently been reported. See also 1 (c).

(b) Electrical detection can be hampered by burying metal objects in the minefield with the object of making it difficult to discriminate between them and the mines. It is possible to construct entirely non-metallic mines, of which the present forms of detector would give no indication. The difficulty of clearing such minefields might deter the enemy from using them, except in purely defensive operations. It is very unlikely that any scientific method of detection of such mines will be found.

(c) Auscultation—No obvious reply, except a radical change in mine design (e.g., to a vertical tube).

II. The obvious counter to automatic mechanical removal is the booby-trap. These are already in use as a deterrent to rapid hand lifting, for which purpose only a small proportion of mines need be so fitted. The proportion could be increased up to 100 per cent. in favourable circumstances of laying. No type of harrow or plow could be expected to survive the explosions of a mine in contact with it. The only alternative is to make them of simple design, preferably capable of being constructed in field workshops, and quickly replaceable. But a deep cutting plough may be free from this risk. (See Para. 3, II (b).)

III. Since both roller and flail have to be pushed by a tank, and neither can be more than a few feet in advance of it, a possible reply is to utilise the primary detonation to cause an explosion below the tank. This can be done either by fitting the mine with a delay action fuze, or by connecting it by means of a detonating cord to another, unarmed mine, say, 15 feet to the rear. The latter method, although it requires twice as many mines, appears the more satisfactory, in that it is independent of the speed of the tank.

IV. Blast detonation can be rendered more difficult by decreasing the area of the mine cover to which the operating load has to be applied. If this is carried to the limit, as in the British Mark V, the mine ceases to be pressure-operated (using the term "pressure" in its scientific sense of "force per unit area") and requires the direct application of load to operate it. Therefore, it cannot be buried more than an inch or so, or the tank track may not come in contact with the spider. In the Tellermine 42 the moveable lid to which the load must be applied is about one-quarter the area of that in Tellermine 35. The total load required is probably about the same (600 lb. maximum), so that the pressure needed will be four times as great as before. The area cleared by a given charge will, therefore, be less for Tellermine 42 than for Tellermine 35, or conversely a larger charge will be required to clear a given area. The ratio will probably vary with the weight of charge used, but the consequent decrease in the efficiency of blast methods will certainly be considerable, and may so increase the quantities of explosive required as to render all of them impracticable.

The consumption of explosive will also be greater if the rows of mines are spaced more widely, i.e., if the belt is deeper. This has no effect of the efficiency of the field, i.e., the percentage chance of a tank striking a mine in crossing a belt, and also slows down all the other methods, particularly I.

5. **DISCUSSION**: The above does not profess to be a comprehensive list of all the devices which have been used, tried or suggested. The object rather has been to focus attention on the principles on which such devices are based and on which also, so far as can be seen, future devices must be based. Such an approach to the problem seems essential for an assessment of the relative advantages, present and future, of so many and diverse methods. It is not to be expected that a single solution will be found applicable to all types of mine and every local and operational condition. It is, therefore, desirable that a number of different methods, each with its peculiar merits and limitations, should be simultaneously developed. On the other hand, energetic but undiscriminating development of every idea which offers even a remote prospect of success will involve much waste of effort, and it is, therefore, worth while to consider what are the salient features of the above review and what lines of attack they suggest as the most profitable, having regard to probable future conditions as well as those obtaining at present.

The two major considerations which should be borne in mind are:

(1) That the electrical detection method (I) can be defeated by non-metallic mines, and no alternative of similar type is in prospect.

(2) That the blast detonation method (IV) can be defeated by suitable modifications in mine design.

It is essential, therefore, to develop methods which are not subject to these limitations, and which do not depend on special features of the mines, e.g., its material or design. Now the fundamental features common to every mine are:

(1) It is a coherent lump of material, lying in a shallow hole and covered by a thin layer of disturbed earth.

(2) It will be detonated if sufficient pressure is applied to the surface of the ground above it.

Property No. (1) is utilised in methods II (a) (harrow) and II (b) (plough).

The harrow principle is more attractive, in that it discriminates between mines and the surrounding earth instead of removing the whole surface layer. It, therefore, requires less power than the plough and exposes the mine more satisfactorily. It also possesses mechanical advantages inherent in towing as compared with pushing, but it is difficult to operate in advance of a tank. In both cases, subsequent removal of mines by hand is necessary, and both would be put out of action by booby-trapped mines.

Property No. (2) is the more fundamental of the two, since it must necessarily apply to any mine whatever which is mechanically operated. (N.B.—Magnetic or acoustical operation does not appear to be feasible for A/Tk mines). It is, therefore, the soundest possible basis for counter-measures, and demands the most exhaustive investigation.

With reference to methods III (a) and III (b), which depend upon this property, there is one additional point which should be made, namely, that in the first instance it is only essential to clear a space for the tracks in advance of the tank. It is easier, for several reasons, to effect clearance behind the tank, and since it is only the tracks which detonate mines, attention should be primarily concentrated on the problem of clearing paths for them. This is, in fact, the purpose of the roller (III (a)) which at present, however, does not give sufficiently high pressure and does not survive an explosion. The pressure can be increased by incorporating fins or spikes (in order to decrease the bearing area) by increasing its weight and by loading its axle. Damage to the roller could be reduced, or possibly even prevented, by constructing it from armour plate. The remaining problem is how to prevent it being blown bodily out of its bearings. This is merely a question of how to absorb the kinetic energy communicated to it at the moment of explosion. The most promising suggestion hitherto put forward is to mount it on an arm capable of free rotation about a horizontal axle sufficiently far behind to be clear of the explosion, so that the effect of the latter will be to cause it to describe a vertical semi-circle, hitting the ground behind the axle. The kinetic energy it receives from the explosion would thus be eventually dissipated harmlessly on impact with the ground. It would continue to function in this position until a second mine is encountered, which similarly returns it to its original position, and so on. It is understood that experiments are being made on these lines, with encouraging results so far.

With reference to the flail (III (b)), application of the principle of restricting forward clearance to two track widths appears likely to remove most of the difficulties of the method. By removing the chains from the central portion of the axle, the power required would be about halved, or for the same power the speed of rotation could be considerably increased. Further, the driver's view ahead might not be obstructed by the dirt-cloud as at present, and steering would become possible. Finally, it is probable that only a fraction of the dirt thrown up would fall exactly ahead of the tracks, and the consequent increase of soil coverage might not be nearly so serious. A new design of flail is being developed which may overcome most of the above difficulties.

There remains the problem of how to deal with the pair of mines so disposed that the rear one explodes under the tank when the roller or flail detonates the front one. The simplest measure, if practicable, is to provide suitable protection for the belly of the tank. As already pointed out, the track cannot be so protected, but with a separation of 15 feet between the pair of mines the chance of the rear one exploding under the track is fairly small, as the direction of approach may vary over a considerable angle.

If adequate belly protection is not possible, the only soluation appears to be to draw a roller assembly behind a vehicle which is designed to produce a ground pressure insufficient to detonate mines. A roller assembly is suggested as requiring much less power than a harrow or plough. The vehicle could not carry much armour and both engine and driver would consequently be vulnerable, but this cannot be avoided.

6. **CONCLUSIONS:** The principal conclusions reached in the preceding section are summarized below:

(1) Mechanical anti-mine methods are preferable to any others, since they cannot be defeated by non-metallic or blast-proof mines.

(2) Of these, methods which cause detonation of mines by pressure, should take precedence, since they utilize the most fundamental property of the A/Tk. mine.

(3) Any method which can be operated in front of a tank can be operated more easily as a rule, behind it. It is, therefore, only necessary to clear two track widths in advance, which is much easier than clearing a full tank width. Present methods (e.g., Scorpion) should be re-considered from this point of view.

(4) Having regard to the capabilities and limitations of all known methods and to possibly enemy replies, it is concluded that the most promising line of development is in the direction of a vehicle which could traverse a mine-belt without setting off mines, towing a roller-type assembly which would detonate them by pressure. It would fulfil all the requirements given in Section 2, providing that protection for personnel could be given by smoke instead of by armour. Rollers might need replacing, however, and it would be held up by wire.

7. **NOTE:** It should be pointed out that in so far as this survey is based upon operational experience, it is apt to give undue weight to that gained in the course of the North African campaign, and especially under desert conditions. These differ so much, both as regards soil and topography, from those likely to be encountered in a European campaign, that it is necessary to have the point in mind when the results of such experience are being utilised. For example, desert conditions probably favor such methods as prodding, electrical detection, and the Scorpion. On the other hand, the greater variety of natural features suitable for incorporation in a defence scheme in European terrain may profoundly modify the tactical use of the mine. That is to say, one must not assume that the conventional type of minefield (see Para. 2) will be employed in the European zone. Where a natural defence line exists it is reasonable to expect that the enemy will use mines chiefly to defend the natural approaches and to hinder deployment on the far side. It is impossible to foresee or provide for all contingencies, but it is at least clear that the use of any but the simplest methods may be much restricted, and that the importance attaching to such methods is thereby enhanced.

Description Pressure Characteristics of

GERMAN TELLERMINES

Tellermines have been found in a series of models whose general outlines and dimensions are closely alike.

TELLERMINE No. 1 or 1935 model is circular in plan, diameter 12¾", height 3¼", has a convex top and a flat bottom.

When fully armed the mine is equipped with a main pressure igniter screwed into the center of the top cover and one or two standard pull igniters in its base as secondary firing devices.

The body of the mine is a circular metal box with a "floating" cover attached to the body and supported in the center by a heavy spring.

A load, varying from 200 lbs. at the center to 350 lbs. at the edge, applied to the "floating" cover compresses the spring, which in turn shears the pin in the main pressure igniter, releasing a striker that sets off the primer and explodes the mine. Total weight of mine is 20 lbs. filled with 11 lbs. of TNT (Tolite).

Material of cover and rims—aluminum.

Material of explosive container—iron.

Material of main fuse—brass body, steel parts.

TELLERMINE No. 2 or 1942 model is similar in size to the No. 1 mine. The mine is so constructed that a pressure plate of 5.7" diam. centrally located in the dome-shaped top initiates the charge. The pressure plate works on the same principle as the "floating" cover of the No. 1 mine.

Also fitted with two igniters located in the side and base.

Total weight of mines is 19.3 lbs. filled with 12 lbs. TNT. and Penthrite (PETN).

The essential changes from the standard No. 1 mine has been a reduction in the size of the pressure plate and the introduction of a cylindrical penthrite detonating charge surrounding the main detonator in the TNT filling.

TELLERMINE No. 3.

This is similar to the No. 1 Tellermine in all respects except that the "floating" pressure plate is flat and fluted or grooved, probably to prevent sand being blown off when the mine is buried. In the top center is a screwed main detonator.

TELLERMINE No. 4.

General dimensions similar to the No. 1 mine. Has a pressure plate of 7.5" diam. on dome-shaped top.
Total weight is approximately 18 lbs.

COMPARISON:

Pressure plates on No. 1 and No. 3 mines extend over entire top but on No. 2 and No. 4 cover only the center portion of the mine. Accordingly a tank might pass over the edge or rim of Tellermines No. 2 and No. 4 without detonating the mines, whereas it would detonate the No. 1 and No. 3.

TELLERMINE 43 (MUSHROOM).

Overall diameter, 12.5 inches; overall height, 3.5 inches; diameter of mushroom head, 7.5 inches.

Total weight of mine, 17 lbs. 5 oz.

Similar in size and shape to other Tellermines.

Mushroom or pressure head in the dome-shaped top connected to main detonator. All 3 igniters connected to cylindrical penthrite detonating charge in the TNT filling.

Body consists of a steel pressing.

GENERAL NOTES ON ALL TELLERMINES.

1. Tellermines are usually laid buried 4" deep; the density in any belt is about one per yard of front.

2. No. 1 or 1935 model mines examined had cast TNT filling and pressed flake TNT exploders, with a fulminate -CE- TNT detonator.

In the No. 2 or 1942 model examined the main filling was the same but pressed PETN—Wax 91/9 was used for the exploders and azide-waxed PETN for the detonator.

An earlier 1935 type mine had been filled with creamed TNT poured in 4 increments.

3. In a priming charge containing 90% PETN and 10% Wax (M.Pt. 59-62°) the PETN was very fine but showed no needle crystals.

4. Tellermines have been found with a cast charge of 57% and 43% Ammonium Nitrate.

5. Tellermines exposed to direct sunlight in storage have burst open as a result of expansion caused by excessive heat; when this occurs the explosive fillers are exposed, creating a dangerous hazard.

6. A split pin or nail inserted into the safety pin holes will neutralize any igniter.

7. Various observations have shown that the blasting effect of Tellermines will:

(a) Disable any vehicle.

(b) Permanently disable lighter vehicles.

(c) Probably disable light tanks to an extent necessitating shop repairs.

(d) On medium tanks necessitate field repairs.

Experiments with medium tanks (28 tons) showed that considerable damage would be caused and generally consisted of:

(i) Broken tank tracks; flattened or badly damaged bogey, or bogey suspension sheared off.

(ii) Slight internal damage.

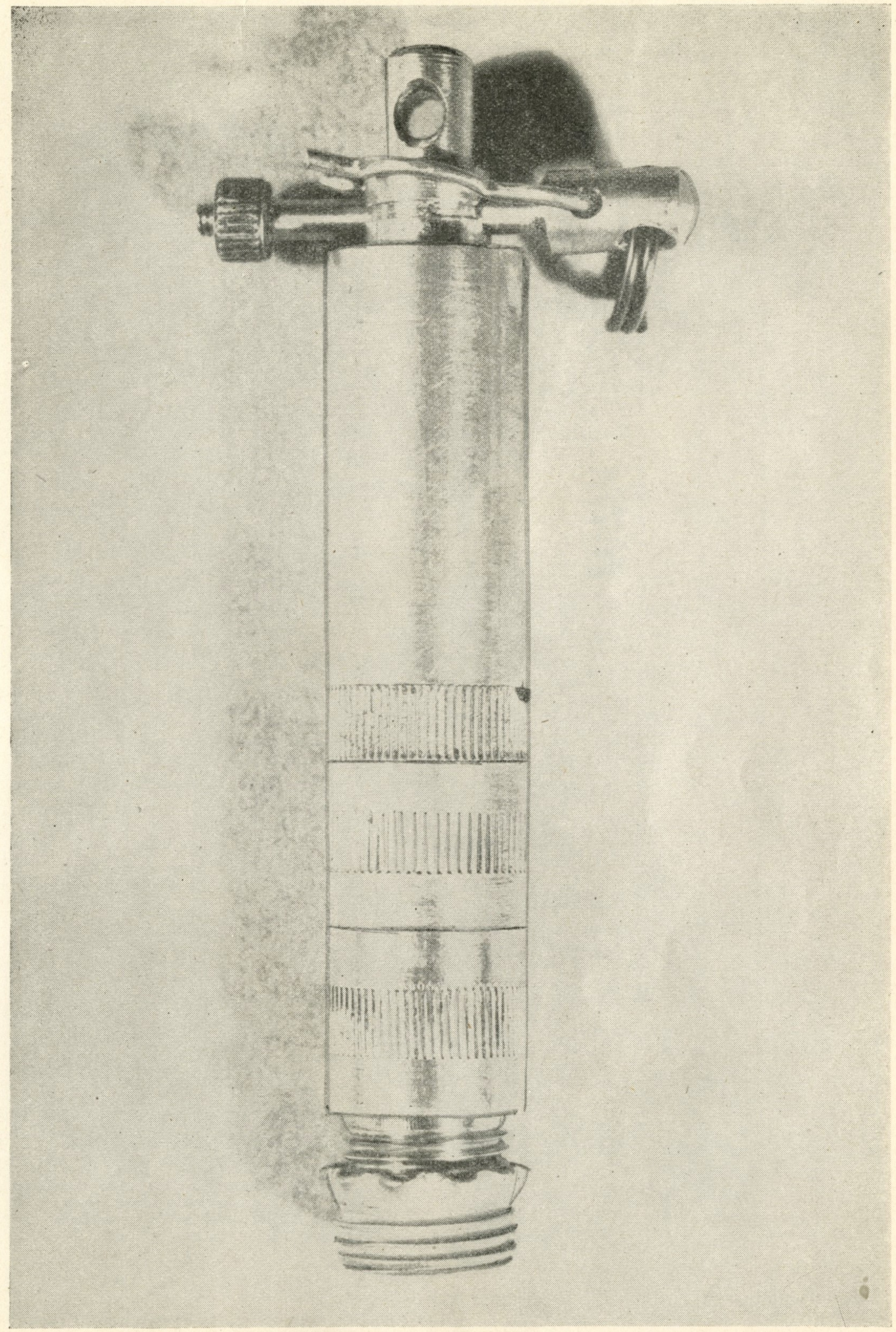

Figure I. Igniter, Pull and Tension Wire Type Z.u.Z.Z. 35, View Assembled

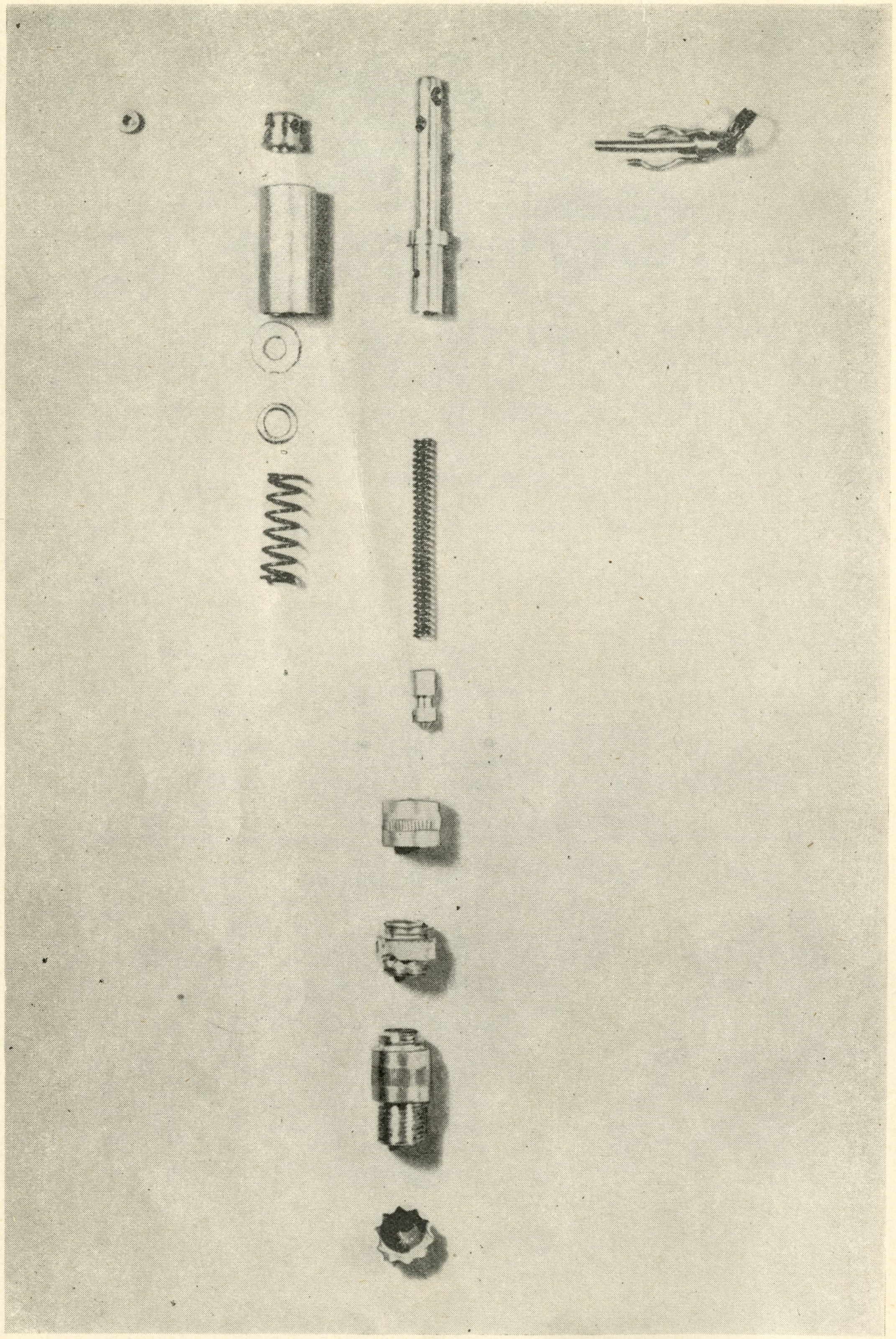

Figure II. Igniter, Pull and Tension Wire Type Z.u.Z.Z 35, Parts

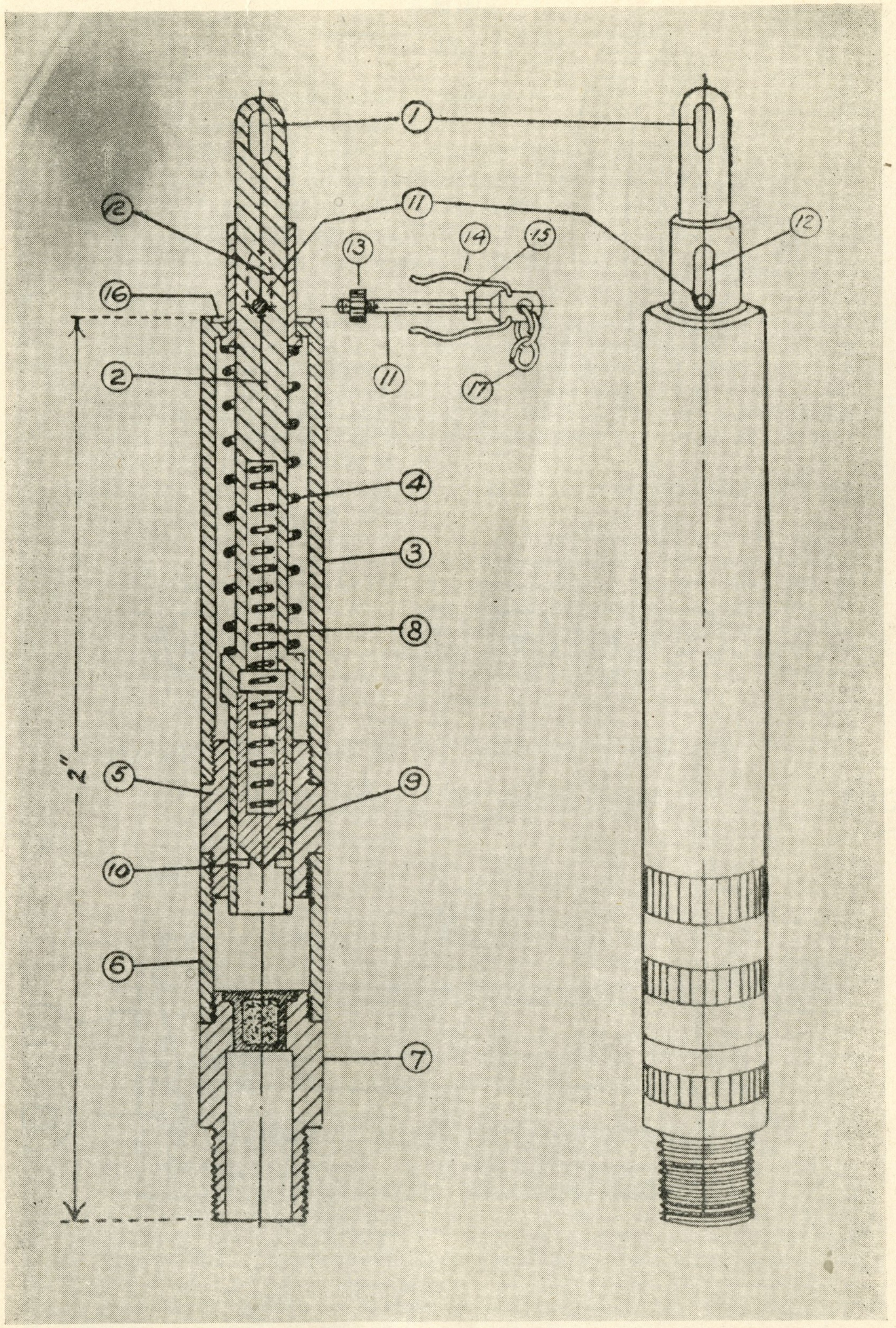

Figure III. Igniter, Pull and Tension Wire Type Z.u.Z.Z. 35, Sectional View

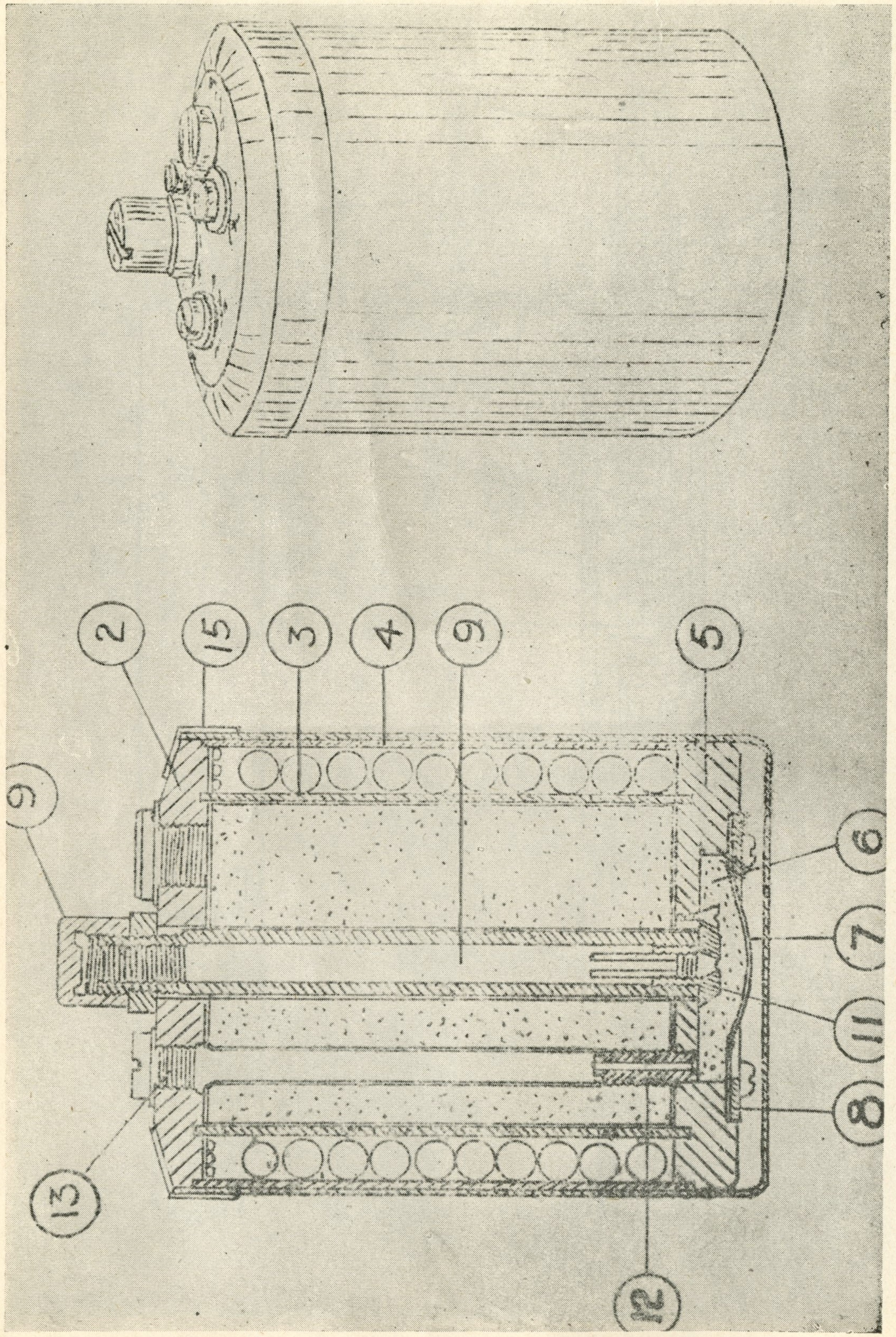

Figure IV. The S or Shrapnel Mine

S-MINE

See Fig. IV.

(a) **Dimensions:**

Height (less igniter) 5 inches.
Diameter, 4 inches.
Weight of mine, approximately 9 lbs.
Weight of filling, approximately 1 lb.
Type of filling, TNT or Hexanite.
German designation, S-Mine 35.
Abbreviated designation, S-Mi. 35.

Description:

This is an anti-personnel mine which may be operated by direct pressure on the push igniter in the head or by a pull on one or more trip wires attached to pull-igniters. If the tactical situation permits, the mine can also be fired by electrical methods. The push igniter S. Mi. Z. 35 functions at a pressure of about 15 lbs. When set to detonate by means of pull-igniters of the type Z.u.Z.Z. 35, a Y-piece is screwed on the mine in place of the protecting cap (9).

The mine is cylindrical in shape and for transport the mines are carried three in a wooden box.

The cover (2) rests on the two steel cylinders (3) and (4), and is made a close fit to the mine by a band of metal (15) welded round the top edge. On earlier types of this mine the metal band was not fitted and the reason for the addition may be to exclude water which may get into the inside of the mine. In the annular space between the two cylinders are about 360 3/8" diameter steel balls, which constitute the loading of the mine. The cylinders (3) and (4) are located by grooves in the base plate (5). This latter has, on its underside, a recess (6) to hold a charge of powder. The recess is closed by a dome-shaped soft metal plate (7), secured by the steel ring (8), which is in turn screwed to the base plate (5).

The central steel tube (10) is threaded externally to take the Y-piece, or the igniter, S. Mi. Z. 35. It is also threaded internally to take the electric detonator for deliberate firing. At its lower end, the tube passes through the base plate (5), and is secured by the union (11).

Inside this latter is a short steel tube containing compressed powder to act as a short delay (about 4.5 seconds). This is the standard delay used in the BZ. 24 and the BZE igniters.

Equally spaced in the base plate are a further three holes leading into the recess (6), and containing short brass tubes (12) filled with compressed powder to act as a delay.

Located in the cover of the mine are three brass tubes, lower ends of which screw on to the tubes (12). These are for the detonators which are inserted through the holes (13). These latter are closed by screw plugs.

When the igniter functions, the powder pellet in (11) provides a short delay before igniting the charge in the recess (6). The burning of this charge blows out the soft metal plate (7), and projects the base with the cylinders (3) and (4) into the air. Simultaneously the powder delays in (12) are ignited and after a short delay sufficient to allow the main charge to rise in the air, the detonators are fired, and explosion of the main charge results. The explosion therefore takes place when the contents of the mine are some 3 to 5 feet above ground, depending upon the nature of the ground and the density of the camouflage layer.

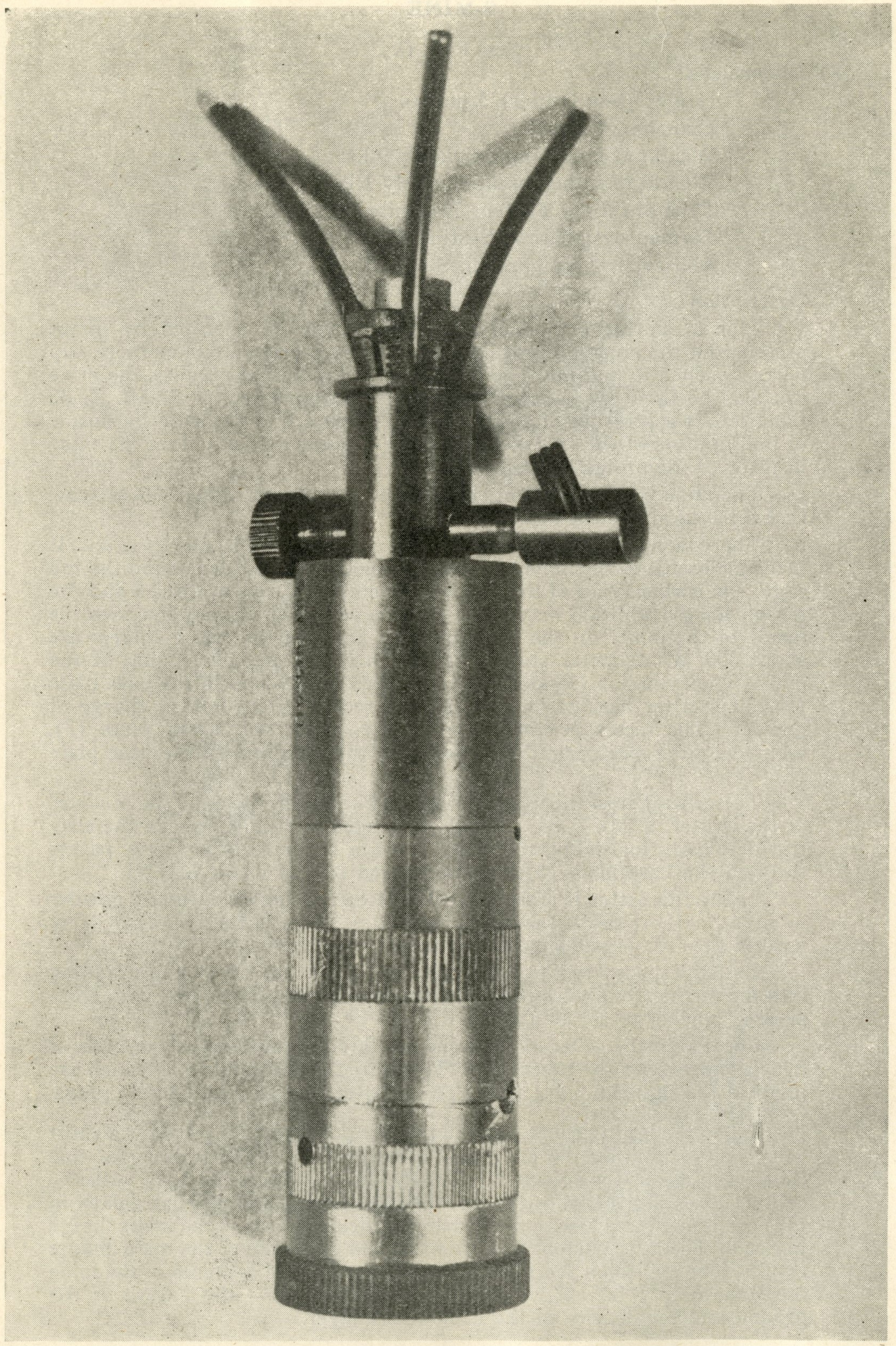

Figure V. Igniter, Pressure Type S.M.i. Z. 35 For S. (Shrapnel) Mines, View Assembled

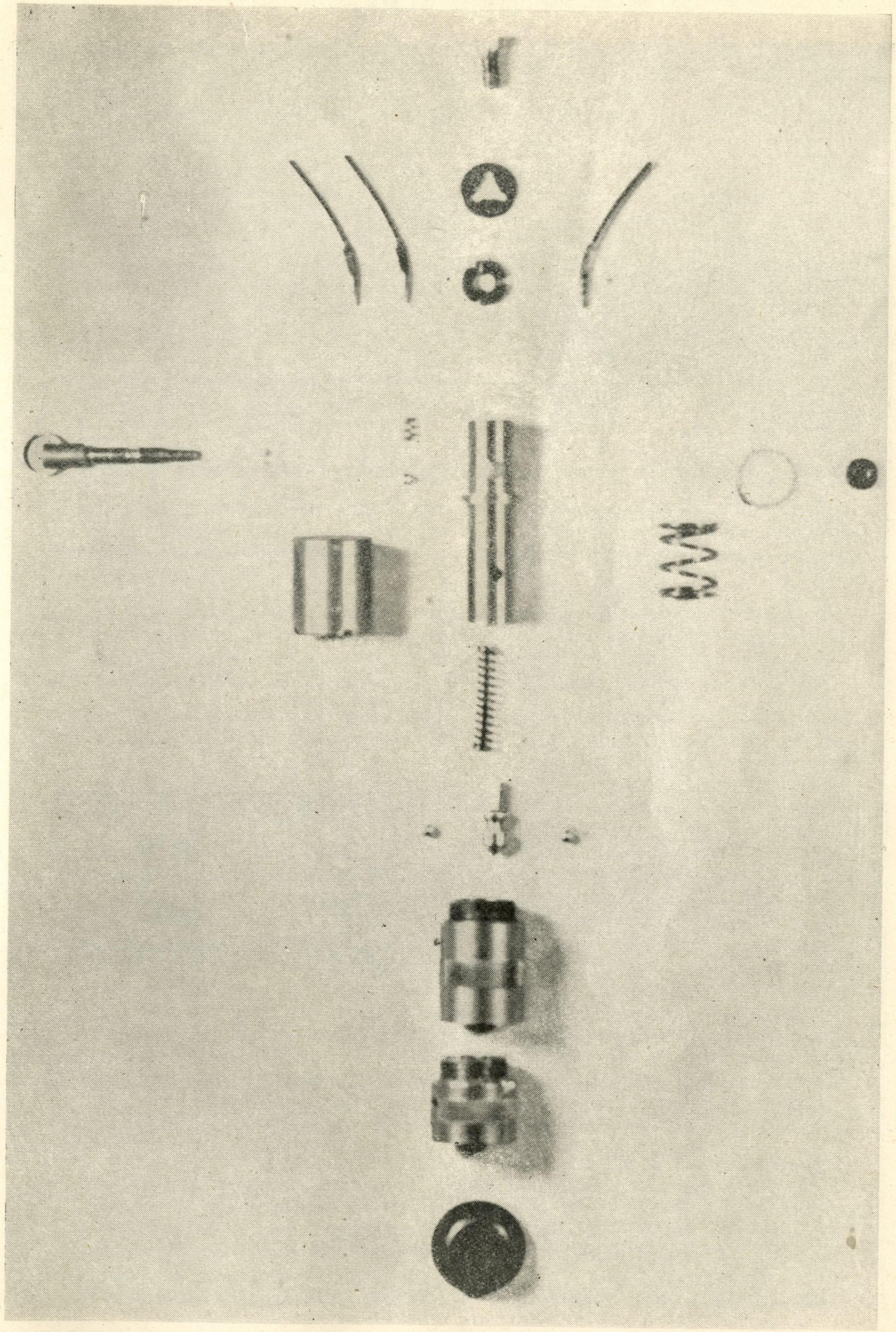

Figure VI. Igniter Pressure Type S.M.i., Z. 35, For S. (Shrapnel) Mines, Parts

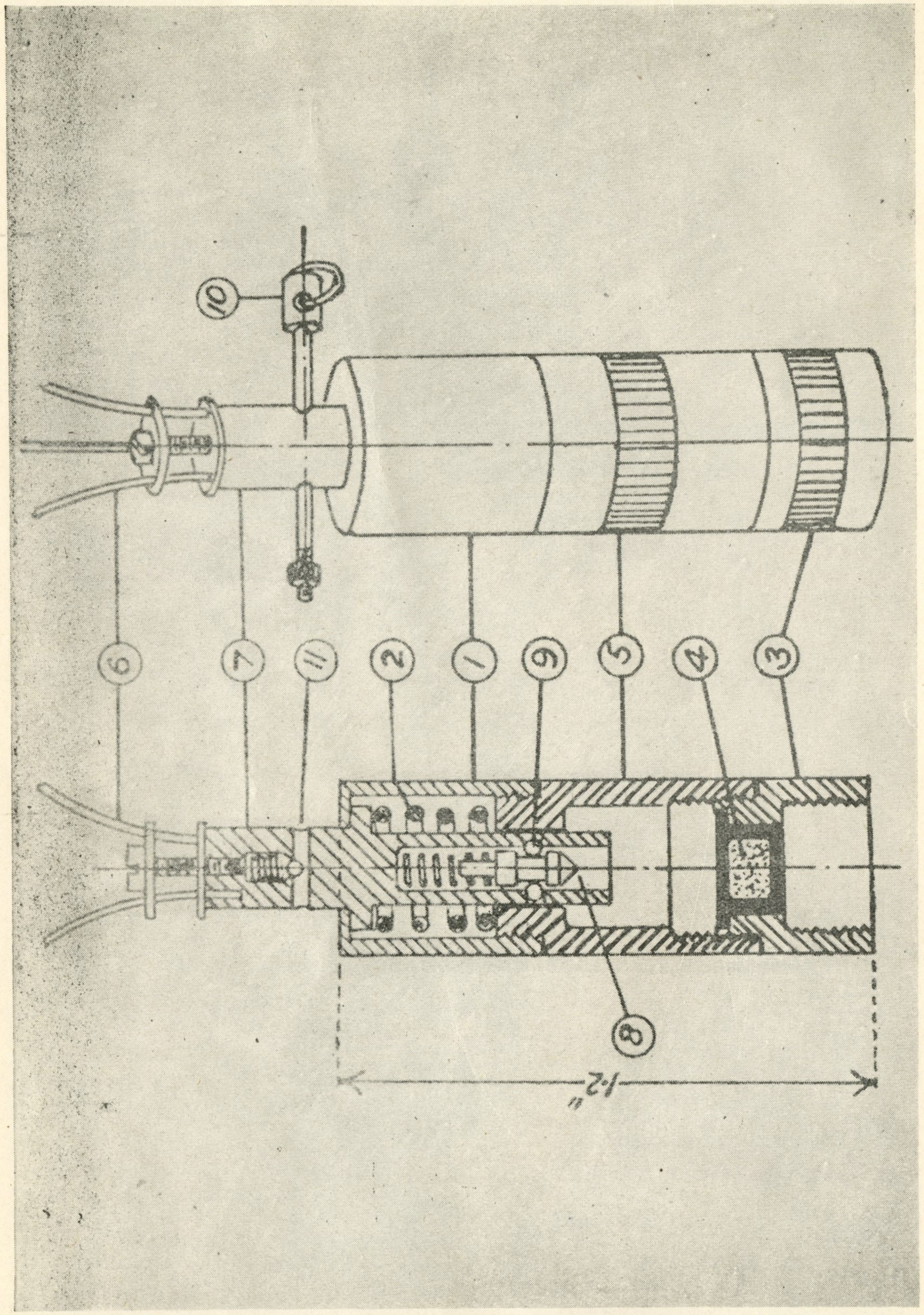

Figure VII. Igniter Pressure Type, S.M.i., Z. 35, For S. (Shrapnel) Mines, Section

GERMAN IGNITERS

1. **Pressure Igniter S. Mi. Z35. For S (Shrapnel) Mines.** (See Fig. VII.):
The body of the igniter is made of aluminum and is divided into three portions. The upper portion (1) which houses the pressure spring (2) and the lower portion (3) which contains the cap (4) are joined by the central portion (5).

The three steel antennae (6) are fastened in the head of (7) which is hollow to take the striker (8). This latter is held in the firing position by two steel balls (9). The safety pin (10) passes through the hole (11) in (7). When the safety pin is withdrawn the igniter is armed. Pressure on the antennae (6) causes (7) to descend and, after moving a distance of approximately 0.5 cm., the steel balls are freed and the striker released. When found in the armed condition this igniter can be made safe by pushing a nail in the safety pin hole (11). Care should be exercised in handling this igniter, as a pressure of about 15 lb. will cause it to function. The safety bar (10) has a constriction into which the spring (11) presses the steel ball (13). This prevents the bar falling out after the nut (14) is removed.

2. **Pull and Tension Wire Igniter Z.u.Z.Z. 35.** (See Fig. III.):

I. This igniter can function in two ways—either by a pull on the tension wire, or by cutting the wire. In either case, when setting the igniter the wire is securely fastened through the hole (1) at the head of the moveable cylinder (2).

II. The body of the igniter consists of four parts—the main housing (3) for the spring (4); the guide piece (5); the distance piece (6) and the cap holder (7). Within the moveable cylinder (2) is the striker spring (8) and the striker (9). The latter is held in position by the two bolts (10).

When the igniter is to be armed, the wire is attached at (1) and given sufficient tension so that the safety pin (11) is located about the centre of the window (12). In no circumstances must the safety pin bear against the outer end of the window, a clearance of 1 mm. being essential. This arrangement permits the easy withdrawal of the safety pin, after the mine or charge is laid. The final act, in arming the igniter, is the withdrawal of the safety pin by means of a cord attached to the ring (17). If after setting the mine the tension wire has broken, or the stake to which it is attached has moved, the safety pin will return to its "safe" position and cannot be withdrawn. Before withdrawal the nut (13) is removed and when the igniter is properly set, the pin will be prevented from falling out by the clip (14). In the "safe" position, the projection (15) on the pin rests within the groove (16) on the head of the fuze, and unless the tension in the trip or pull wire has raised the pin to about the middle of the window (12) the pin will not withdraw. The rings will then open out and the cord become detached. When satisfactorily armed the igniter will function if the tension wire is pulled. The cylinder (2) then moves outwards in the guide (5) till the bolts (10) are free to escape into the space above the guide. The striker is then released and the cap is fired.

Should the tension wire be cut, the cylinder (2) under the pressure of the spring (4) moves inward till the bolts (10) escape into the space below the guide piece. The striker is then released and the cap fires. This igniter is used chiefly by Engineers in places where tension wires can easily be concealed. Hence it is employed with mines and prepared charges in barricades, street barriers, etc. When the igniter is in position the moveable parts are protected by a protective tube, made of some material similar to American cloth and 22 cm. in length. This tube ensures free movement of both the moveable cylinder (2) and the tension wire when the igniter is buried in the ground or amongst camouflage materials. If the length required to clear encumbrances be less than 22 cm. the protective tube may be shortened as necessary.

3. To Neutralize the Igniter:

(a) If the safety pin (11) is in position but the rings are missing, the igniter has not been satisfactorily armed. It is safe to unscrew the igniter.

(b) If the safety pin (11) is missing and the tension wire intact, push a nail through the hole (1) and cut the tension wire.

After neutralizing the igniter, unscrew it from the mine or charge. The nail should be secured from pulling out accidentally by wire or other means.

NOTE: Never cut the wire before neutralizing the mine. Do not remove the nail from the igniter after taking it from the mine, as this would fire the cap.

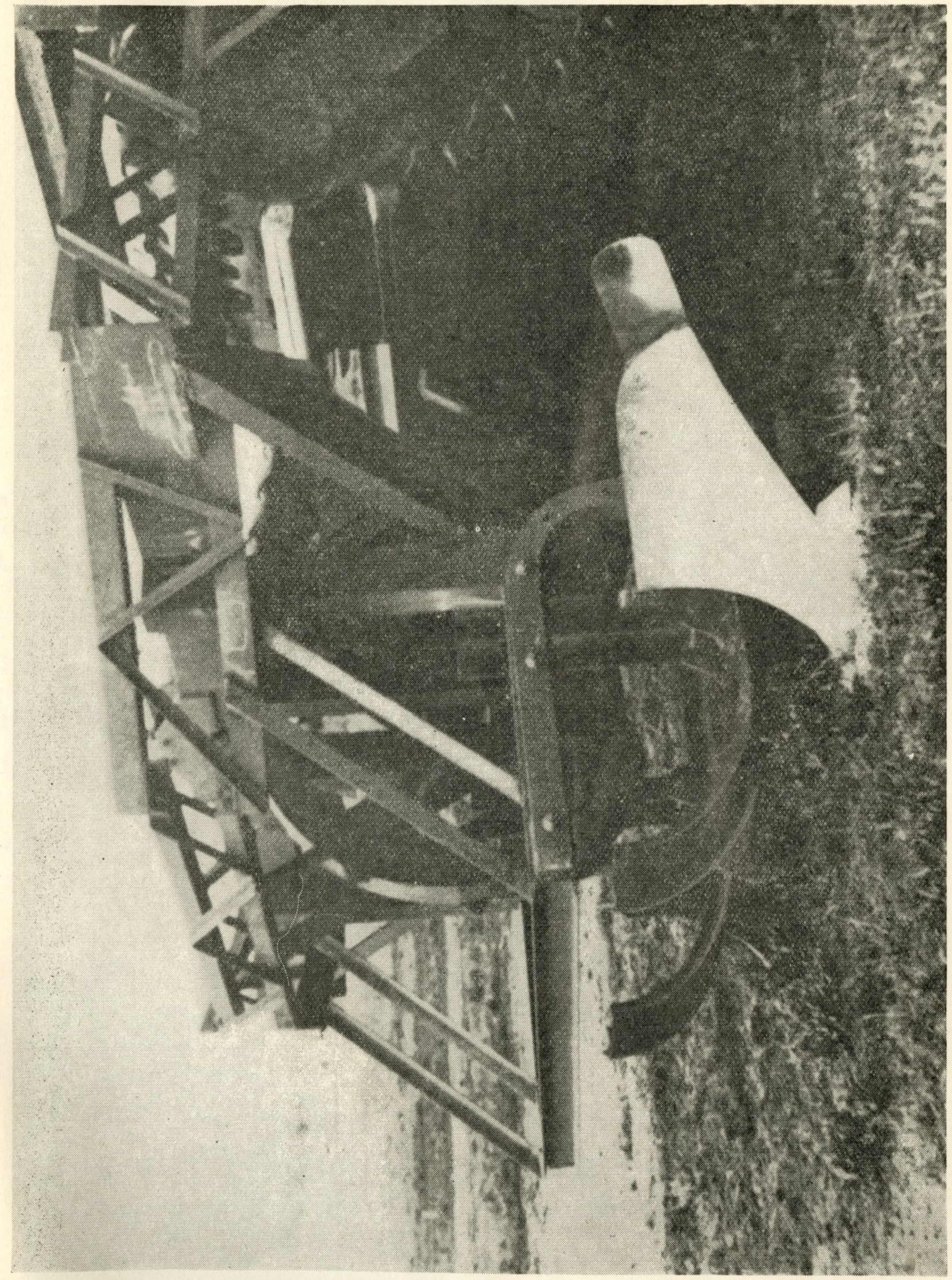

Figure VIII. Mine Plow

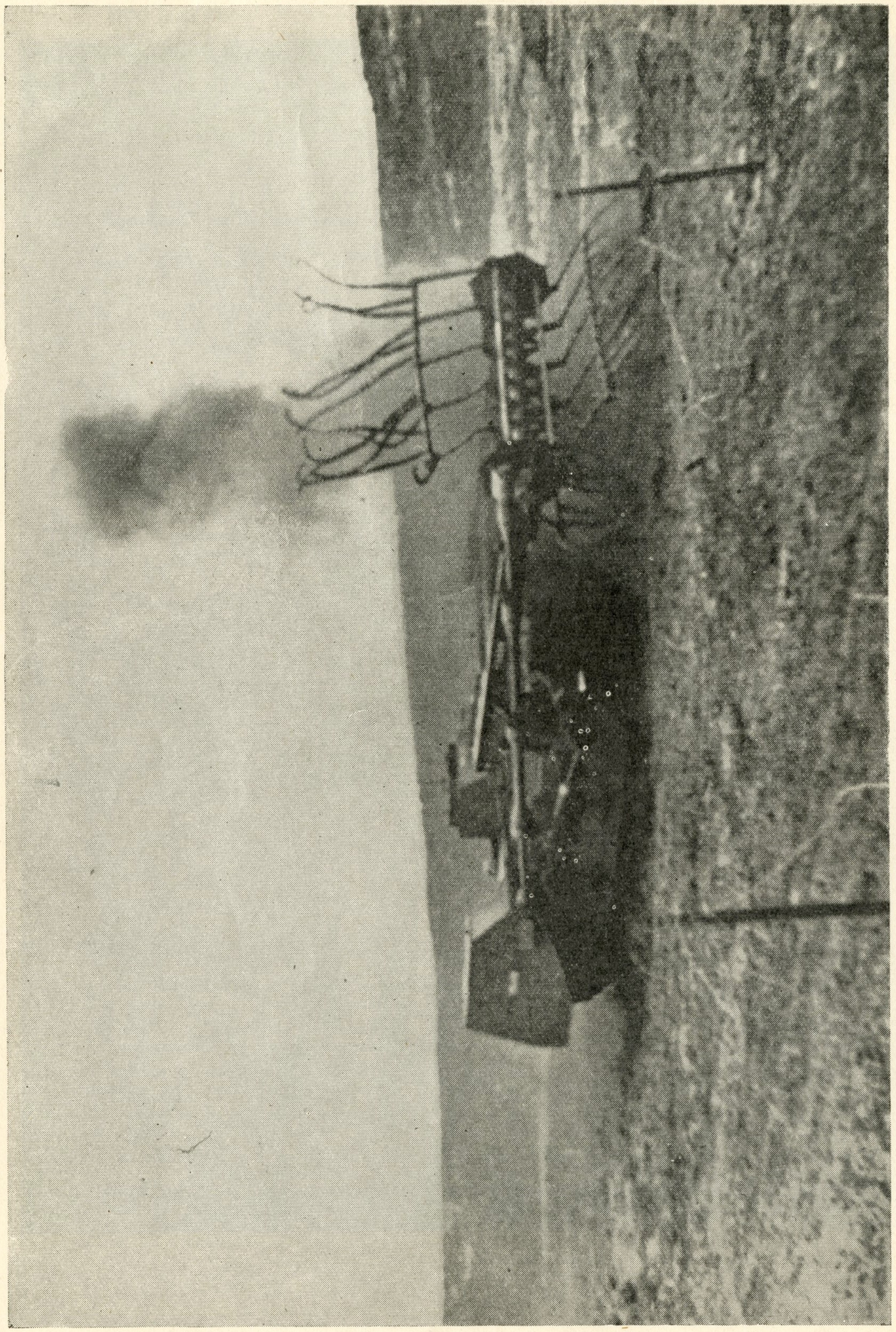

Figure IX. Mine Clearance by Flail

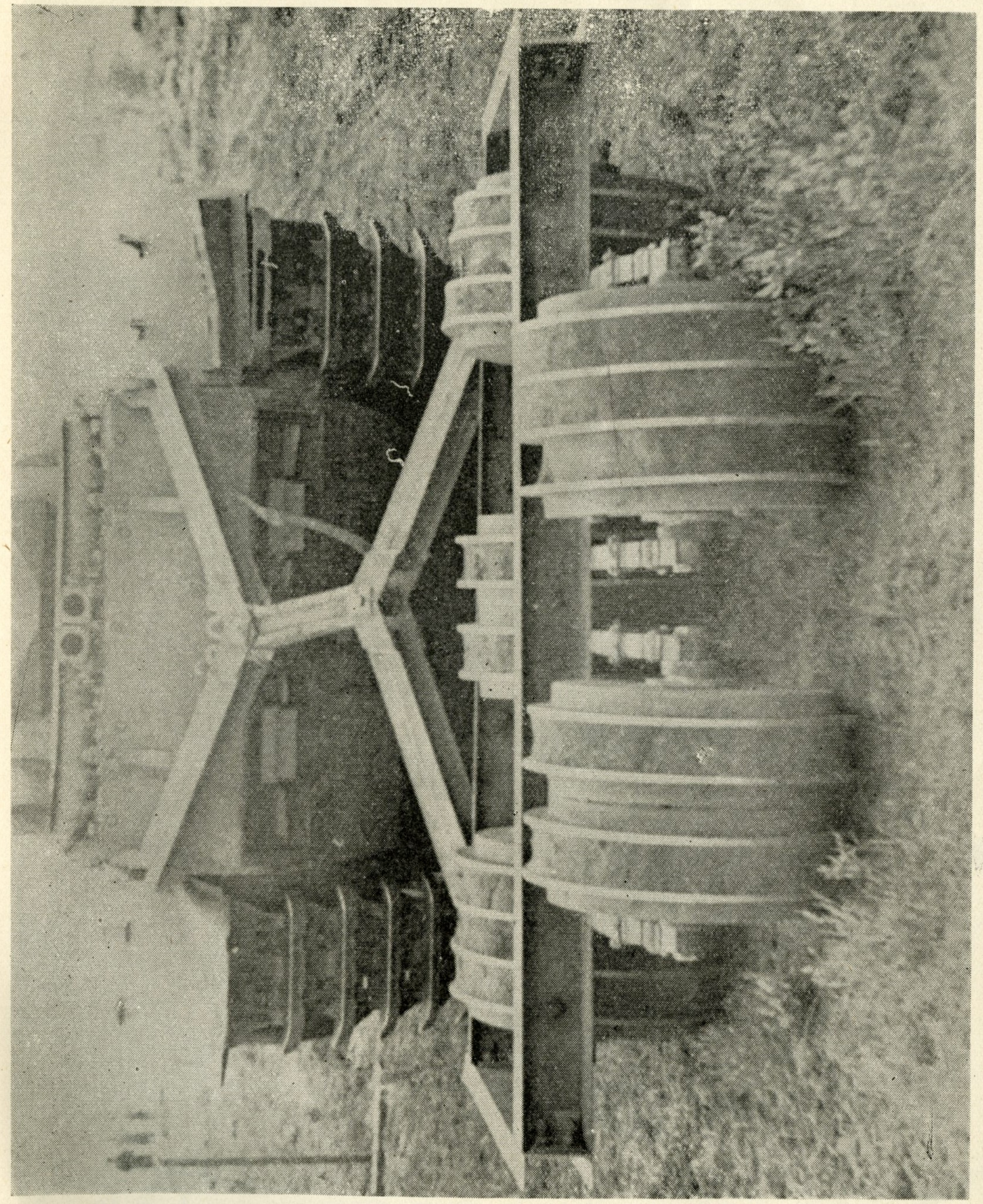

Figure X. Mine Clearance by Roller

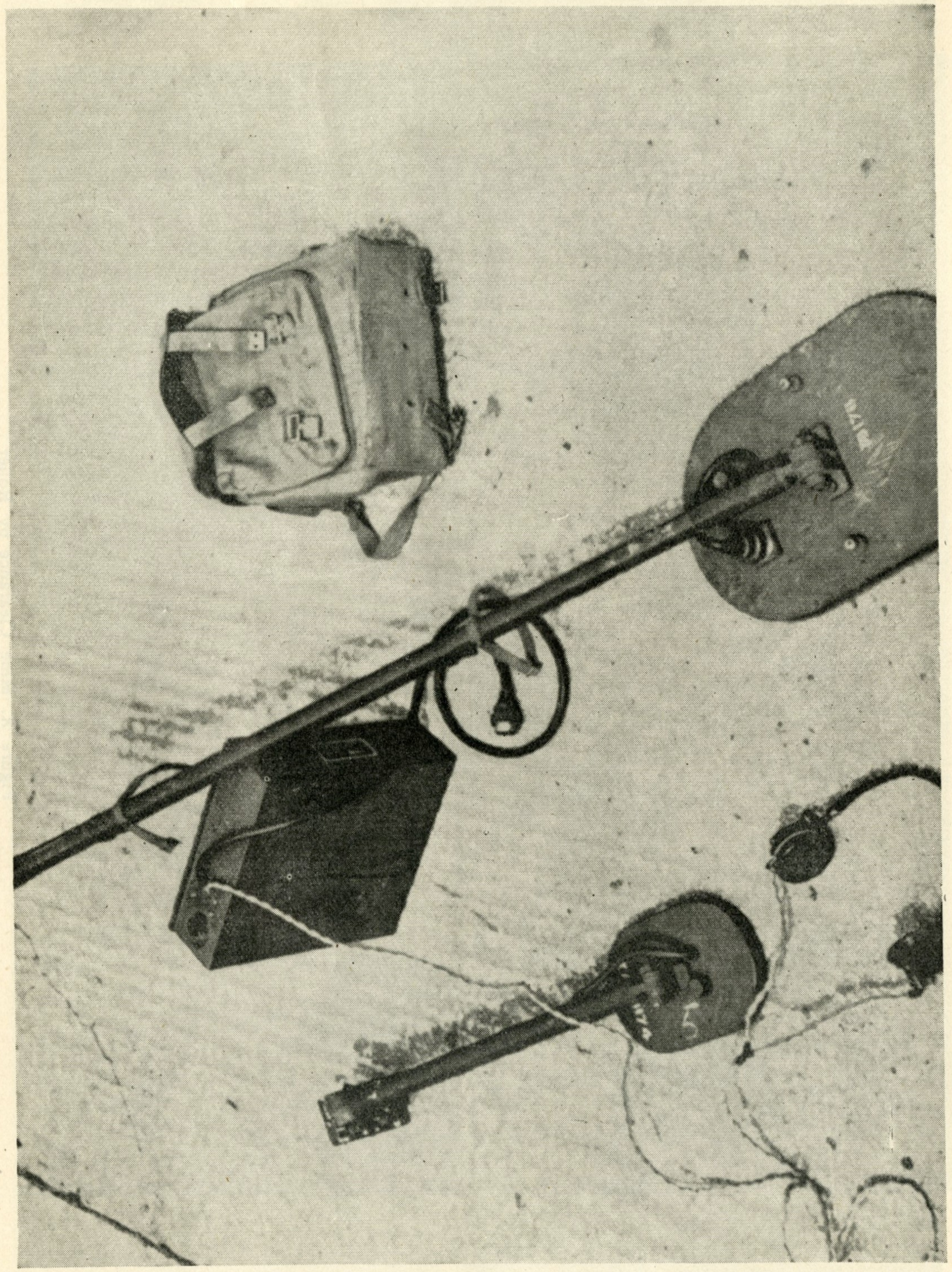

Figure XI. Mine Detector

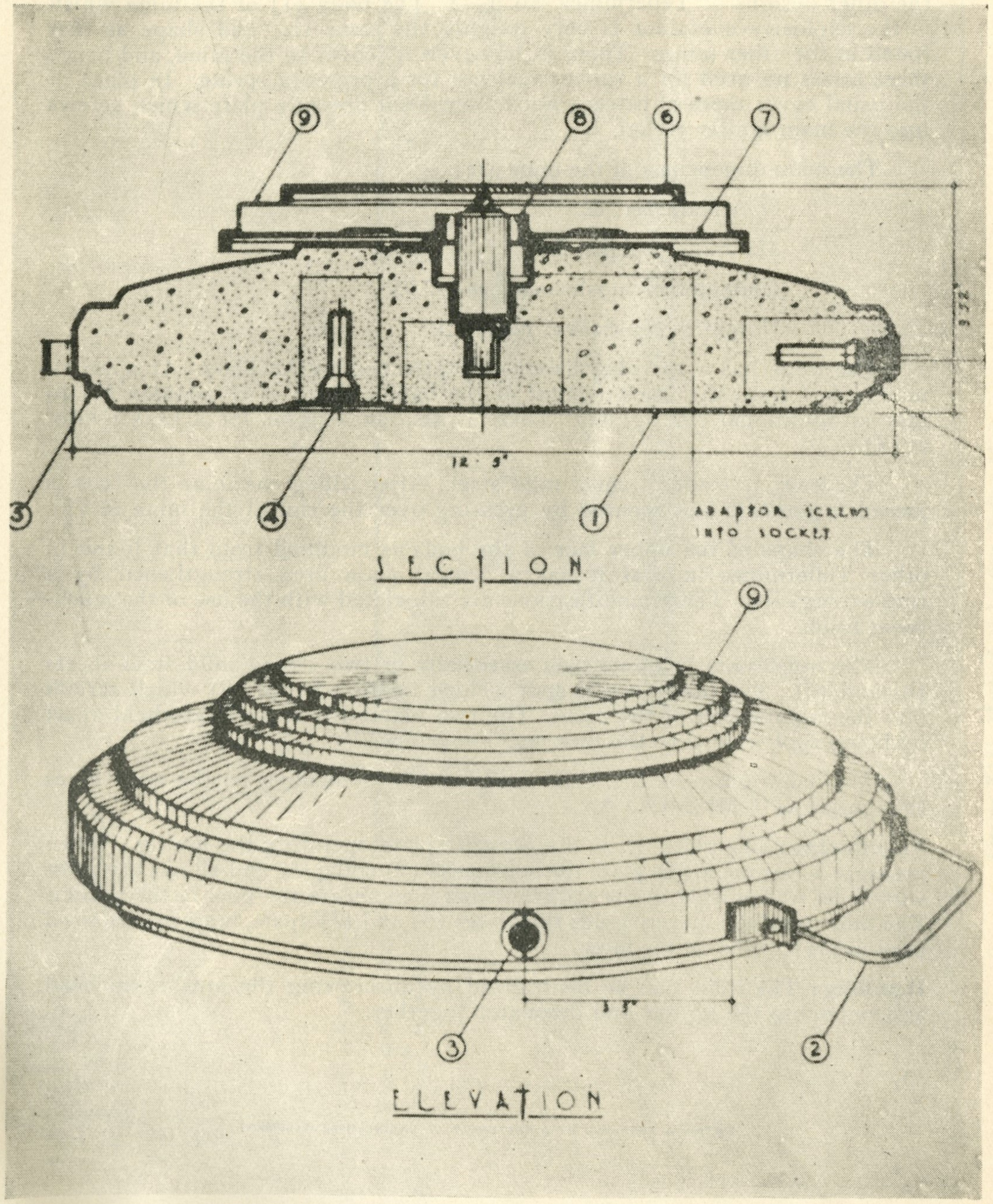

Figure XII. Teller Mine

GERMAN TELLERMINE No. 4 T-Mi-PILZ-43.

See Fig. XIII.

This mine represents a new departure from standard practice as seen in the other designs of Tellermines No. 1—3. The body (1) of the mine which is the explosive container is very roughly the same size and shape as that found in the other mines. There is, however, no cover to the mine, and hence there arises no need for a rubber seal nor for a pressure spring. In place of the usual cover there is fitted a mushroom head pressure plate which screws into the main igniter socket.

The main dimensions of the mine are:

O/A diameter, 12.5″.

Maximum height, 3.55″.

Diameter of mushroom head, 7.95″.

Height of mushroom head, 1.1″.

The mine has a carrying handle (2) attached to the body. At approximately 3.5″ from the nearest point of the handle there is an adaptor (3) to take an additional side igniter. There is also an adaptor for a base igniter at (4).

The body is made of sheet mild steel. After filling the mine the base is placed in position and secured by pressing over the rim of the mine at (5).

The shape of the upper face of the body is modified from that found in other Tellermines in that it has a central plain area strengthened by a ring corrugation. These modifications are associated with the use of the mushroom head.

The mushroom head consists essentially of two strong mild steel sheets (6) and (7). The lower one is spot welded to the adaptor (8) which screws into the main socket of the mine. The two plates (6) and (7) are held apart by being spot welded to the thin metal envelope (9).

The main igniter is the T-Mi-Z-42, and the stencilling on the mine gives the igniter as T-Mi-Z-4213-A.

Functioning: The plate (6) is the pressure plate operating the igniter. When pressure is put upon this plate the soft metal (9) collapses and allows the pressure to be transmitted to the striker which then shears the pins in the igniter. The thin metal (9) merely holds the plates (6) and (7) apart, until the required pressure is exerted on the mine.

Handling: The mine can be neutralized by unscrewing the mushroom head and removing the igniter and detonator together.

MATERIAL PREPARED BY DIRECTORATE OF ENGINEER DEVELOPMENT

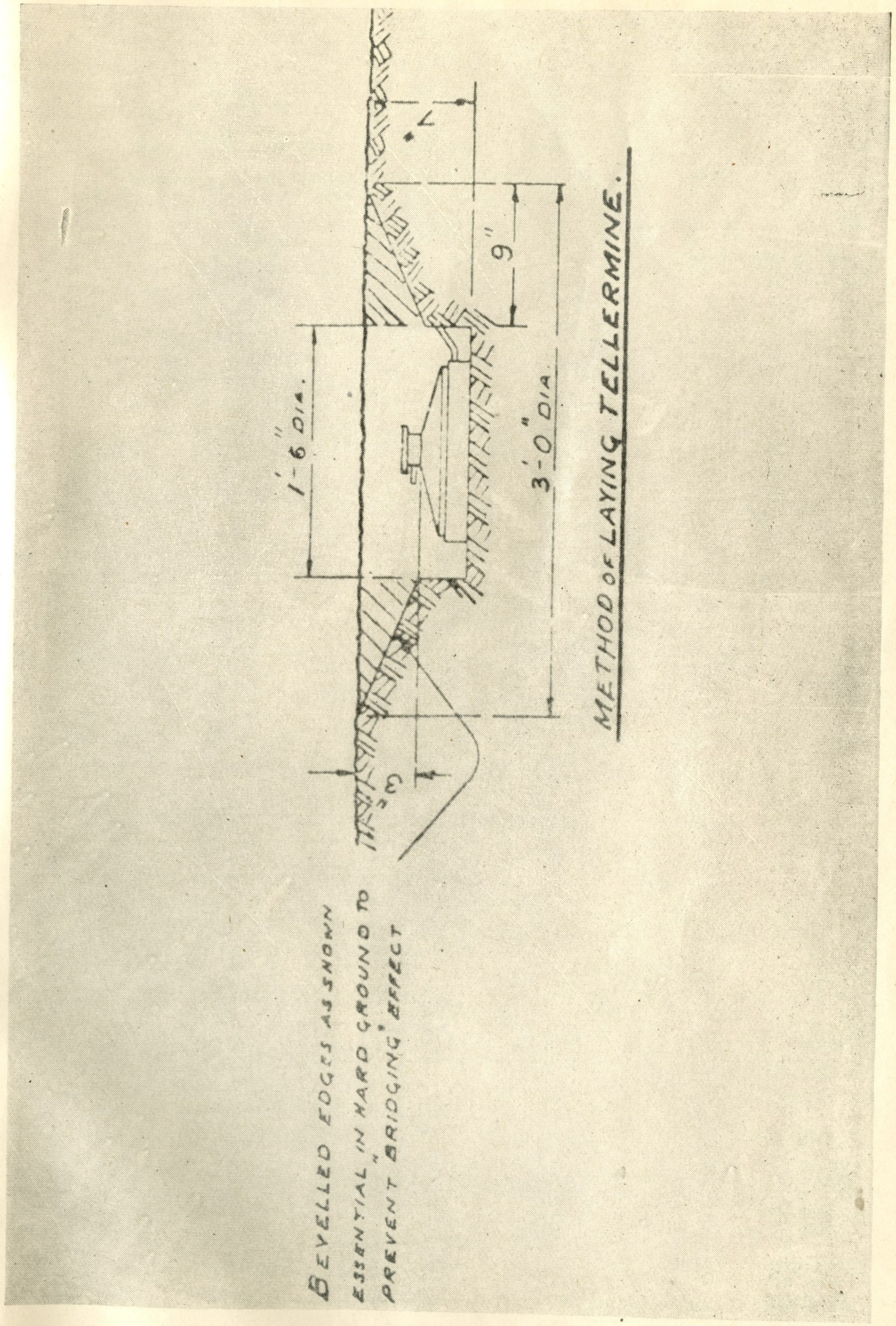

Figure XIII. Method of Laying Teller Mine