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GERMAN NAVY

(Naval Guns, Mountings, Sights and Table of Ordnance)

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Captain, U. S. Navy, Director of Naval Intelligence.

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C. B. 1182.

GERMAN NAVY.

PART IV.

SECTION I.

NAVAL GUNS, MOUNTINGS, SIGHTS, AND TABLE OF ORDNANCE.

Plates:—

at end of Part IV.

SECTION 1.

NAVAL GUNS, MOUNTINGS AND SIGHTS.

GUNS.

General Notes.

Classification of Guns.

German naval guns are classified as "heavy artillery," including all guns of 21 cm. and larger calibre, "medium artillery" comprising all guns from 10.5 cm. to 20 cm. in calibre, and "light artillery," which comprises all guns of smaller calibre than 10.5 cm.

All guns are denoted by the calibre in centimetres, and total length in calibres, as well as by the letters "K" (Kanone or B. L. gun), "SK" (Schnellade-Kanone or Q. F. gun); *e. g.*, 28 cm. K. L/40; 24 cm. SK L/40.

In these reports, for the sake of uniformity, the British nomenclature has been adopted, the calibre in inches, or, for smaller guns, pounds weight of projectile, being given, followed by the calibre in centimetres in brackets.

It must be borne in mind that the length of bore of Krupp guns is about 3 calibres less than the total length, owing to the wedge system of breech mechanism employed.

Types in Use.

All medium and light calibre guns introduced into the Service since 1889 have been of the Q. F. type. It was not, however, until 1895 that the Q. F. principle was applied to heavy calibre guns, the first of these to be introduced being the 8.2-in. (21 cm.) and 9.4-in. (24 cm.). Since that date guns of the heaviest calibre have been constructed with Q. F. breech mechanisms.

Some notes on the Krupp system of gun construction which, as far as known, apply equally to German naval ordnance, will be found in the German Coast Report, C. B. 1159.

It has been stated that the Germans, in order to obtain high ballistics from their guns, have adopted large chambers in which are employed heavy charges of slow-burning powder. The effect of this has been to produce very high forward pressures, and consequently excessive blast and flash.

Rifling.

Old reports state that an increasing twist of rifling is employed, the twist being generally uniform for a distance of about two calibres from the muzzle. The twist employed varies from 1 in 45 or 50 calibres to 1 in 25 or 20 calibres, according to the nature of the gun. In the 4.1-in. L/45 an increasing twist from 1 in 50 to 1 in 30 calibres and in the 4.1-in. L/40 and 22-pr. (8.8 cm.) L/30 from 1 in 45 to 1 in 25 calibres is known to be in use. The grooves are numerous, averaging about three to each centimetre of calibre.

The shape of the groove is very much the same as that in our later types of guns.

Life of Rifling.

There can be no doubt that the life of the rifling of Krupp guns is very great, and that great accuracy is maintained throughout the life of the gun.

According to the 1906 edition of the "Leitfaden für den Unterricht in der Artillerie, &c.," it is stated that no limits as to the permissible number of rounds to be fired from each calibre are laid down, but that the decision as to the condemning of a gun rests with the Admiralty.

Endurance tests were carried out at Meppen in 1907 with an 11-in. (28 cm.) L/45 and two 8.2-in. (21 cm.) L/45 guns.

From the 11-in. gun there were fired 138 rounds with a mean muzzle velocity of 2,821 ft.-secs., 33 rounds with a muzzle velocity of 2,690 ft.-secs., and 21 rounds below 2,624 ft.-secs., making a total of 192 rounds fired. The length of the chamber space was found to have been

increased by about one-third of the calibre; the limit of the life of the rifling had not been reached and there had been no sensible decrease in accuracy.

From the two 8.2-in. guns there were fired 390 and 500 rounds respectively. The first 350 rounds from No. 1 gun were fired with an average muzzle velocity of 2,789 ft.-secs., after which 36 rounds were fired with an average of 3,084 ft.-secs. The length of the chamber space was increased by 2.52 ins. after the firing. From No. 2 gun up to the 266th round fired the charges were generally chosen to give a muzzle velocity averaging 2,903 ft.-secs., and making a maximum of 3,018 ft.-secs.; rounds Nos. 267 to 344 were fired with reduced muzzle velocities; the endurance test was continued up to 500 rounds, and during the last series the accuracy was maintained. The wear was greater than that of No. 1 gun, but the exact amount was not reported.

At the calibration in 1913 of the ten 11-in. (28 cm.) L/40 Krupp guns, in the two old German battleships which were sold to Turkey and renamed "*Tourgood Reis*" and "*Barbarousse Haïreddine*," practically no wear was apparent in any of the bores, and the results were extraordinarily accurate. An average number of 155 rounds per gun, with a maximum of 192 and a minimum of 123, had been fired from these guns, but it is not certain that full charges were used in every case. The muzzle velocity with full charge is roughly 2,300 ft.-sec.

Relining Guns.

Owing probably to the very small number of full charges which appears to be fired from each naval gun per annum these guns are seldom returned to Krupp's works for relining.

According to the statement of a German officer in February 1910, a duplicate inner tube is kept ready for every heavy gun. This statement, however, contradicts one made by the Minister of Marine in the Reichstag about the same date, namely, that Germany was able to partially dispense with reserve tubes on account of the superiority of Krupp guns over those of other countries.

Reserve of Guns.

In 1905 it was reported that the proportion of reserve guns for heavy calibres was 25 per cent, but that the whole question of reserve guns was under consideration. At the same time it was stated that the above proportion had always been considered inadequate.

The reserve of guns at Wilhelmshaven Dockyard in January 1913 was stated to be 18—12-in. L/50, 22—11-in. L/45, and 60—5.9-in. L/45 and L/40. Although the information is meagre on the subject, it has been calculated that the reserve of heavy and medium guns in the German Navy is now about 40 per cent.

B. L. Guns.

The only B. L. guns of any importance now mounted afloat are the 11-in. (28 cm.) L/35 and L/40 and the 9.4-in. (24 cm.) L/35. The former calibre, both L/35 and L/40, form the main armament of the ships of the "*Brandenburg*" class, while the 9.4-in. guns are to be found in the vessels of the "*Siegfried*" and "*Aegir*" classes.

Q. F. Guns.

The Q. F. guns at present in use include the following calibres:—

12-in. (30.5 cm.) L/50.
11-in. (28 cm.) L/40, L/45 and L/50.
9.4-in. (24 cm.) L/40.
8.2-in. (21 cm.) L/40 and L/45.
6.7-in. (17 cm.) L/40.
5.9-in. (15 cm.) L/35, L/40 and L/45.
4.1-in. (10.5 cm.) L/35, L/40, L/45, L/50 and L/55.

In addition to these the latest battleships of the "*Bayern*" class carry 15-in. (38.1 cm.) guns. All the above guns are of the usual Krupp construction.

16-in. (40.64 cm.).

It is believed that a 16-in. (40.64 cm.) Krupp gun was under trial during 1913, but, so far as is known, there is no present intention of mounting this type of gun afloat.

15-in. (38.1 cm.).

The latest battleships, namely, the "*Bayern*" class, mount eight 15-in. (38.1 cm.) guns. The projected battle-cruisers will also carry this calibre of gun.

From photographs of the turrets it appears that these guns are about 45 calibres in length.

14-in. (35.5 cm.).

It is believed that Krupp experienced considerable difficulties in evolving a satisfactory 14-in. (35.56 cm.) gun, and mounting, but has, however, turned out a fair number of them. None are believed to be mounted afloat, but some may have been mounted in coast defences. The recovery of a shell base of this calibre and of naval design on the Somme Front indicates that these guns are being used for land service.

There are 72 grooves of rifling.

12-in. (30.5 cm.).

The 12-in. (30.5 cm.) L/50 is mounted in the "*Thüringen*," "*Kaiser*" and "*König*" classes. It is also mounted in the "*Derfflinger*," the first battle cruiser to carry a larger gun than 11-in.

11-in. (28 cm.).

The 11-in. (28 cm.) L/50 is mounted in the battle cruisers "*Moltke*," and "*Seydlitz*," and the 11-in. L/45 in the four battleships of the "*Nassau*" class and in the "*Von der Tann*." According to the range table for the latter, the 50 per cent. length, breadth, and height zones at 7,874 yards are 47 yards, 2.73 yards, and 5.69 yards respectively. The powder chamber is reported to be over 8 ft. long.

5.9-in. (15 cm.).

5.9-in. guns form the secondary armament of all battleships and battle cruisers.

It is believed that 50 calibre weapons are mounted in the latest ships.

4.1-in. (10.5 cm.).

The following information concerning the L/40 and L/45 guns is derived from Range Tables captured during the war:—

	4.1-in. (10.5 cm.) L/45.	4.1-in. (10.5 cm.) L/40.
Weight of gun and breech block	3,197 lbs.	Mod. 1897—3,858 lbs. Mod. 1904—4,233 lbs.
" " breech block	130 lbs.	174 lbs.
Number of layers of hoops	0	1
Length overall	4,725 mm.=186 ins.	4,200 mm.=165.4 ins.
" of bore	4,425 mm.=174.2 ins.	3,900 mm.=153.6 ins.
" " chamber	674 mm.=27.5 ins.	674 mm.=26.5 ins.
" " rifling	3,751 mm.=147.6 ins.	3,226 mm.=127.1 ins.
Calibre	105 mm.=4.134 ins.	105 mm.=4.134 ins.
Diameter of bore in grooves	107.5 mm.=4.233 ins.	107.5 mm.=4.233 ins.
" " conical cartridge chamber	115.6 mm.=4.552 ins.	115.6 mm.=4.552 ins.
	to	to
	111.6 mm.=4.394 ins.	111.6 mm.=4.394 ins.
	108.6 mm.=4.276 ins.	108.6 mm.=4.276 ins.
" " cylindrical projectile chamber	32	32
Number of grooves of rifling	1.25 mm.=.0492 in.	1.25 mm.=.0492 in.
Depth of grooves	6.8 mm.=.267 in.	6.8 mm.=.267 in.
Width of grooves	3.5 mm.=.137 in.	3.5 mm.=.137 in.
" " lands	1/50 to 1/30	1/45 to 1/25
Twist of rifling	12,700 metres (13,889 yds.)	12,200 metres (13,342 yds.)
Maximum range	2,329 f. s.	1,936
Muzzle velocity		

It has been reported that the 4.1-in. guns mounted in the later light cruisers, commencing with the "*Rostock*" (*see* Plate 1), are fitted with Krupp automatic mechanism.

The model 1915 gun of this calibre is said to be 55 calibres in length, and to have a range of 12,000 metres (13,100 yards). In this gun body rests for the gunlayer and sight setter are fitted. The gunlayer himself lays and trains the gun in good weather, but in bad weather the sight setter, who has his own elevating and training wheels, assists. Firing is by percussion only, and telescopic sights are fitted.

Part IV. Section 1. Guns.

Light Q. F. and Machine Guns.

The light Q. F. and machine guns at present in use comprise the following:—

3.5-in. 15-pr. (8.8 cm.) L/30 and L/35.
3.5-in. 22-pr. (8.8 cm.) L/30 and L/45.
3-in. (7.5 cm.) L/21.
7-pr. (6 cm.) L/21.
4-pr. (5.2 cm.) L/55.
4-pr. (5 cm.) L/40 and L/55.
1-pr. (3.7 cm.) Maxim automatic.
.31-in. (8 mm.) Maxim automatic.

The 3.5-in. 22-pr. (8.8 cm.) L/45 and 4-pr. (5.2 cm.) L/55 are fitted with semi-automatic breech mechanism. The latter was introduced to replace the 4-pr. (5 cm.) L/40 in the armaments of small cruisers, T. B. D.s, and T. B.s.

The 1-pr. (3.7 cm.) Maxim automatic guns are being withdrawn from ships' armaments, but are still supplied for landing purposes.

Rifle calibre Maxim automatic guns are supplied to ships for arming boats and landing purposes.

3.5-in. 22-pr. (8.8 cm.) L/30.

The following details are derived from the range tables taken from a prisoner of war, and are authentic:—

Maximum chamber pressure	(about) 15.4 tons.
Length of chamber	15.9-in. (404 mm.).
Maximum diameter of chamber	4.05-in. (103 mm.).
Weight of gun, including breech mechanism	1,091 lbs. (495 kg.).
Weight of breech mechanism	88 lbs. (40 kg.).
Maximum range	9,077 yards (8,300 metres).

There are 32 grooves of rifling, depth .036-in. (.9 mm.), the twist of which increases from 1 in 45 to 1 in 25.

The gun is believed to be made from a single ingot, and not reinforced with hoops.

This gun fires a projectile of 22 lbs. with a muzzle velocity of 1,936 ft. sec.

Details of the mounting as supplied to T. B.'s will be found on page 26.

Anti-T. B. Guns.

The 3.5-in. 15-pr. (8.8 cm.) Q. F. L/30 guns were recognised as the anti-T. B. armament in all battleships up to the "*Braunschweig*" class as well as in the earlier cruisers. In the "*Braunschweig*" and "*Deutschland*" classes of battleships and in the later 1st class cruisers, the anti-T. B. armament was composed of 3.5-in. 15-pr. (8.8 cm.) Q. F. L/35.

In the latest battleships and cruisers the 3.5-in. 22-pr. (8.8 cm.) L/45 semi-automatic was mounted for this purpose.

It appears probable that these guns have now been withdrawn from ships, and that a small number, varying from two to eight, of new guns of the same calibre, mounted on anti-aircraft mountings, have been supplied to the more modern ships, and that a few of the mountings for the guns in older ships have been converted for anti-aircraft fire, and either the original or new guns mounted on them.

This indicates that both the 5.9-in. and the 8.8 cm. guns are now considered to be the anti-T. B. armament in German ships, the latter calibre being also used as anti-aircraft guns.

Boat and Field Guns.

The boat and field guns in use at the present time are the 2.36-in. (6 cm.) B. L., and Q. F. L/21. So far as known the guns only differ as regards breech mechanism. The B. L. gun, complete with breech mechanism and fittings, weighs 238 lbs.

Rifle calibre machine guns are provided with field carriages, and the 1-pr. (3.7 cm.) can be mounted on the 2.36-in. (6 cm.) field carriage. In peace time all battleships carry two and cruisers one 2.36 in. (6 cm.) boat and field guns. It is believed that most of these guns have now been withdrawn for service in the field.

Part IV. Section 1. Guns.

T. B. and T. B. D. Guns.

The 3.5-in. 22-pr. (8.8 cm.) L/30 was the standard gun in all T. B. D's constructed from the 1908–9 programme up to the outbreak of war. During 1915 a new 4.1-in. (10.5 cm.) L/50 semi-automatic gun was introduced. This latter gun has been adopted as the standard gun for modern T. B. D's, and it is reported that earlier boats built during the war will be rearmed with it as soon as guns become available.

The machine guns in torpedo craft are mounted on a stand weighing about 90 lbs., which can be fixed to the deck in a few seconds by means of a screwed bolt.

From another source it is reported that the gun now being mounted in T. B. D's is the 4.1-in. (10.5 cm.) L/55 model 1915.

Submarines' Guns and Mountings.

With a few exceptions all recent large German submarines are armed with either one 4.1-in. (10.5 cm.) gun or two 22-pdr. (8.8 cm.) guns. These are mounted on fixed mountings. In addition a machine gun is carried which can be mounted on the conning tower.

It is possible that boats which at present carry 22-pdr. guns may be rearmed with a single 4.1-in. gun when guns are available, but it is believed that the extra weight of the 4.1-in. gun, which is a much longer and heavier gun than the 22-pdr., has proved to be an obstacle to its introduction in submarines.

It has been stated that the 4.1-in. gun mounted in the latest submarines is the L/55 model 1915 gun.

Anti-Aircraft Guns.

In February, 1914, the Secretary of the Navy stated in the Reichstag, that existing guns from the older stocks were being adapted and used as anti-aircraft guns, but that for new ships new guns had been ordered for that purpose. He mentioned particularly that the firm of Ehrhardt had some time ago been allowed to tender. All modern vessels are known to have been fitted with anti-aircraft guns during the war.

The 8.8 cm. gun has been adopted as the standard anti-aircraft gun, and although no verification has been received it is thought that the weapon used is the 22-pdr. 8.8 cm. gun.

Sub-Calibre Guns.

Sub-calibre guns are in use. The following details of the 1-pr. sub-calibre gun for use with the 4.1-in. L/45 are extracted from Range Tables captured during the war. The gun is secured in the parent gun by means of three rings. It is a 20-calibre 1.45-in. (3.7-cm.) rifle with 12 grooves of rifling of uniform twist 1 in 30 calibres. The muzzle velocity is 1,332 f. s., and the weight of the projectile 1 lb.

Breech Mechanisms.

Q. F. Guns.

The following types of Krupp wedge breech mechanism are to be found in the German Navy. The descriptions are arranged in chronological sequence, and accordingly represent the various improvements developed in this type of mechanism.

Old Q. F. wedge mechanism:—This mechanism, which is fitted to the 5.9 in. (15 cm.) L/35, 3.5 in. (8.8 cm.) L/30 (anti-T. B. gun), and 4-pr. (5 cm.) L/40, differs only in dimensions for the various calibres, except that the wedge for the 4-pr. (5 cm.) is flat and not cylindro-prismatic as for the other guns.

The wedge (*see* Plate 3. Figs. 1 and 2), which opens to the right, consists of the body, wedge plate, locking screw, hand lever, extractor, striker, cocking, firing and safety arrangements.

Action of mechanism:—To open the breech the hand lever is revolved to the rear until further movement is limited by a projection on the wedge plate. During this motion the threads on the locking screw disengage from the threads in the wedge slot, unlocking the wedge and giving it the first start to the right. At the same time the cocking band on the locking screw, travelling along the inclined plane in the cocking piece, revolves the latter about its axis pin, withdrawing the striker and compressing the main spring until the projection on the sear enters the cock notch on the cocking piece. Simultaneously the safety band on the locking screw engages outside the sear, thereby rendering firing impossible. The wedge is now pulled over to the right until its further movement is limited by the toe-pieces of the extractor taking against shoulders on the front face of the wedge, and the empty cylinder is ejected.

To close the breech, the wedge is pushed into the slot until the outer complete thread on the locking screw takes against the gun. The hand lever is then revolved to the front until the stud on the lever takes against a projection on the wedge plate.

Firing gear:—To the trigger sear is attached a plate with cam slot, through which passes the trigger. The latter is pivoted above the plate, and the lower end is furnished with an eye for the firing lanyard. On pulling the lanyard to the rear, the trigger is revolved and the trigger plate and sear moved outwards, thereby firing the gun. To make the gun safe when loaded the safety lever is revolved and the safety bolt takes against the outside of the sear, locking it. The 5.9 in. (15 cm.) and 4.1 in. (10.5 cm.) guns are provided with firing gear on the left as well as on the right, the former being cross-connected with the latter.

Flat wedge breech mechanism with "terminal pin" cocking arrangement:—

This type, which is only to be found in the 4.1 in. (10.5 cm.) L/40 mounted in the ships of the "*Gazelle*" class, opens to the right, the striker being cocked by the first movement of the locking screw. The parts of the mechanism are shown on Plate 4, Figs. 1 and 2. The wedge, of the flat type, is of steel and has guides which travel in grooves in the wedge slot. The front face is fitted with a removable steel plate, and has two grooves with shoulders for the extractor. The striker has on the right front portion a shoulder and notch for the trigger rod, and in rear an upward projecting cocking arm. The trigger rod, with spring, lies horizontally to the right of the striker, and to its outer end is screwed the plate, with cam slot for the trigger. At the right extremity of the locking screw, which in other respects resembles that for the earlier type, is the cocking plane, formed by cutting away a semi-cylindrical part. The safety arrangements are similar to those already described.

Action of mechanism:—To open the breech the locking screw is rotated through 180° to the rear, on completion of which the wedge is unlocked. During the first part of the movement, the cocking plane on the screw, bearing against the cocking arm of the striker, forces the latter to the rear, and the trigger rod, leaving its notch, engages in front of the shoulder, retaining the striker at full cock. Simultaneously the safety band engages outside the trigger plate and prevents it from moving outwards. The wedge is then pulled over to the right, ejecting the empty cylinder. To close the breech the above operations are reversed. The gun cannot be fired until the wedge is locked, as the safety band does not disengage from the trigger plate until this has taken place, and also because the coking plane has not reached its front position and consequently prevents the striker from going right forward.

Firing mechanism:—The firing mechanism is generally similar to that described for the earlier type, except that the trigger plate is connected to the trigger rod. The firing lanyard is led to the left side to enable No. 1 to fire.

Cylindro-prismatic wedge mechanism with traversing shaft:—

This mechanism is fitted to the following guns, viz.:—

9.4-in. (24 cm.) L/40 ("*Kaiser*" and "*Wittelsbach*" classes; "*Prinz Heinrich*," and "*Fürst Bismarck*").

8.2-in. (21 cm.) L/40 ("*Hertha*" class).

5.9-in. (15 cm.) L/40 ("*Kaiser*," "*Wittelsbach*," and "*Hertha*" classes; "*Prinz Heinrich*" and "*Fürst Bismarck*").

Mechanism for medium calibre guns:—The wedge (*see* Plate 4, Figs. 3, 4, 5, and 6) opens to the right, and its entry and withdrawal are effected by the continuous motion of the hand lever through 270°. The entire mechanism, with the exception of the traversing nut, which is of hardened bronze, is of steel. Mention is made of those parts only which differ essentially from the earlier patterns. The wedge is supported on rollers placed in recesses in the under surface of the wedge. On the right of the striker recess is pivoted the double-branched cocking piece, the front left arm of which terminates in a cocking toe, while the rear arm carries a vertical cocking pin engaging in the cocking groove on the traversing shaft. In rear of the cocking piece and in line with it is the trigger rod, which generally resembles that for the 4.1-in. (10.5 cm.) mechanism, except that it has a vertical safety arm which travels on the safety band of the traversing shaft, rendering firing impossible unless the wedge is properly locked; in the latter position the safety arm is opposite the cut-away portion of the band, and the trigger rod can move to the right.

The traversing shaft lies in a recess on the upper part of the wedge, and projects slightly above it. It has a threefold thread of very high pitch, which engages in the traversing nut secured to the gun. The parts of the shaft are: The rectangular end pin for the hand lever, cylindrical bearing collar, safety band, cocking groove, striking band, shaft, locking piece, and cylindrical end pin.

The safety band transmits the motion of the shaft to the wedge, and also prevents premature firing as already explained.

On closing the breech, the inner inclined surface of the striking band, which has the same pitch as the locking piece, takes against the outer inclined surface of the traversing nut, thereby limiting the speed of entry of the wedge into the wedge slot.

The locking piece extends round a quarter of the diameter of the shaft, and its side faces have a slight pitch; it engages in a similarly shaped recess in the upper part of the wedge slot. On opening the breech it gives the wedge its first movement of withdrawal, and on closing locks it in position.

Immediately to the left of the striking band the traversing shaft is recessed to take the lower part of the traversing nut when the breech is closed. The traversing threads on the shaft are disengaged from the nut when the breech is closed, all pressure on the block on firing being taken by the locking piece. The entry of the traversing threads of the shaft into the nut is effected by the striking thread on the right.

The wedge plate forms the right bearing surface for the traversing shaft.

The hand lever is fitted with a spring-retaining catch which engages in a recess in the gun.

Action of mechanism:—To open the breech the lever catch is disenagegd by being drawn to the right. The hand lever is then revolved to the rear until further movement of the wedge is checked by the toe pieces of the extractor. During the first part of the movement the locking piece leaves the inclined recess in the gun and loosens the wedge in the slot. The striking thread then takes against the outer inclined surface of the nut, causing the traversing threads on the shaft to enter the corresponding threads in the nut. The motion of the shaft is communicated by the safety band to the wedge, and, in consequence of the high pitch of the threads the latter is traversed quickly to the right. The shoulders on the wedge, taking against the toe-pieces on the extractor, eject the empty cylinder.

On the first movement of the hand lever, the cocking pin travelling in its groove on the shaft revolves the cocking piece, thereby withdrawing the striker and compressing the main-spring until the trigger rod has engaged with the shoulder on the striker. During the movement of the shaft the safety band takes against the outside of the trigger rod safety arm, rendering firing impossible.

To close the breech the above operations are reversed. The rotation of the lever to the front is limited by the striking piece of the locking piece taking against the upper surface of the wedge slot. During the final movement of the lever the cocking pin is carried to the left by its groove, causing the left branch of the cocking piece to travel forward and disengage from the striker.

Firing mechanism:—The firing mechanism is similar to that in the 4.1-in. (10.5 cm.) L/40 mechanism.

Mechanism for 9.4-in. (24 cm.) and 8.2 in (21 cm.) L/40 guns:—The mechanism for these guns (*see* Plate 5, Figs. 1 and 2) differs only in small details from that for the 5.9-in (15 cm.). The hand lever is double, the front arm being fitted with a spring-catch not shown on the Plate, but resembling that shown on Plate 7, Fig. 1. The mechanism for the 9.4-in. (24 cm.) requires 1¼ turns of the hand levers to open or close.

Both guns are fitted with electrical release in addition to the ordinary hand gear. This consists of an electro-magnet placed in a recess in the wedge below the trigger rod. The latter has a collar against which a projection on the armature of the magnet bears when the striker is in the cocked position. On completing the electric circuit the armature moves to the right, taking with it the trigger rod and firing the gun. The trigger rod spring then returns the rod and armature to their original position.

Flat wedge mechanism with traversing shaft:—This mechanism is fitted to the following calibres, viz.:—

11-in. (28 cm.) L/40 ("*Braunschweig*" and "*Deutschland*" classes).
8.2-in. (21 cm.) L/40 ("*Friedrich Carl*" and later armoured cruisers).
6.7-in. (17 cm.) L/40 ("*Braunschweig*" and "*Deutschland*" classes).
5.9-in. (15 cm.) L/40 ("*Friedrich Carl*").
4.1-in. (10.5 cm.) L/40 (in small cruisers).
3.5-in. 15-pdr. (8.8 cm.) L/35 (anti-T. B. gun in the later battleships).

The 5.9-in. (15-cm.) and heavier calibre guns are fitted with electrical release.

The 4.1-in. (10.5 cm.) was also fitted, but electrical release is not now used for this calibre.

Mechanism for medium and light calibre guns:—The mechanism (*see* Plate 6) generally resembles the cylindro-prismatic wedge mechanism already described.

To open and close the breech the hand lever is rotated through 300°.

The principal parts of the mechanism are:—Traversing shaft with lever and catch; striker with removable firing pin and spring; sear with closing cap and trigger rod; electrical release gear; and safety bolt with milled head and safety spring.

Cocking, trigger, and safety arrangements:—The striker recess in the wedge is closed in rear by a cap, having a forward projecting eye for the sear. The front arm of the sear has a cock notch, which, under the pressure of the main-spring engages with a stud on the underneath of the striker. The lower arm of the sear forms the safety arm which, when the wedge is locked, is opposite a slot in the gun, and, therefore, able to rotate to the rear. The trigger rod is an attachment to the sear, and at its outer extremity carries the trigger.

Immediately above and parallel to the trigger rod is the safety bolt, which, together with the milled head and spring, is secured in the wedge by a bayonet joint.

On the right of the wedge for medium calibre guns, in a longitudinal recess, lies the electro-magnetic trigger, which engages with a lug on the lower part of the trigger rod.

The traversing shaft consists of the hand lever with catch, the bearing collars, striking band, inclined groove, locking piece, cocking plane, groove for stop pin, and cylindrical end pin.

The cylindrical bearing collars take into corresponding grooves on the right side of the wedge. To the left of the collars is the striking band, which, on opening the breech, transmits the motion of the shaft to the wedge.

On the left of the locking piece the traversing threads on the shaft are interrupted and the cocking plane is cut, while further to the left is the cylindrical groove for the stop pin, which secures the traversing shaft to the wedge.

Action of mechanism:—To open the breech the hand lever is revolved counter-clockwise. During the first part of the movement, before the locking piece has disengaged from its recess in the gun, the cocking plane on the shaft presses the striker cocking arm to the rear, compressing the mainspring. As soon as the striker is fully cocked, the sear actuated by the main-spring engages with the stud on the striker. The cocking movement is completed before the wedge is fully unlocked. It is impossible to release the striker before the wedge is in the locked position, as during the movement of the wedge the safety arm of the sear slides along the rear face of the wedge slot and prevents the latter from being rotated. A further safety arrangement lies in the fact that the striker cannot go right forward until the shaft is in the locked position, as the slot in the shaft is opposite the cocking arm only in this position.

When the gun is at full cock, firing can be prevented by the safety bolt. This is effected by drawing the safety bolt outwards as far as possible, and then turning it to the rear until the word "*Sicher*" can be read. In this position the solid part of the safety bolt takes into the cut-away part of the trigger, locking it.

Firing mechanism:—The trigger is attached to the outer end of the trigger rod, and to its lower end is attached the firing lanyard. (N. B.—In the case of the 5.9-in (15 cm.) and 6.7-in. (17 cm.) electrical release is also provided, and is similar to that described below for the heavy guns.) The action of the mechanism can be seen from the Plate.

It is believed that all heavy and medium guns are fitted with electrical release for the percussion striker.

Mechanism for heavy calibre guns 8.2-in. (21 cm.) and above:—The mechanism (*see* Plate 7, Figs. 1 and 2) resembles that for the medium calibre guns, except in small details. To open and close the breech of the 11-in. (28 cm.) L/40 the hand lever is turned through 637°, this operation requiring about 3.7 seconds to perform. All the guns are fitted with electrical release. The electro-magnet is placed horizontally in a recess in the wedge parallel with the axis of the bore. The armature is fitted with a bolt, the rear end of which bears against a projection on the underneath of the trigger rod. On completing the electric circuit, the armature and bolt move to the rear, thereby rotating the trigger rod and firing the gun.

Semi-Automatic Guns.

The 2-in. (5.2 cm.) L/55 and 3.5-in. (8.8 cm.) L/45 are fitted with a semi-automatic vertical wedge breech mechanism, apparently somewhat resembling the Hotchkiss mechanism. The wedge is retained in the open position by the extractor, and is automatically closed by a spiral spring on the flange of the cartridge case forcing the extractor forward. A re-cocking-lever is provided.

Automatic Guns.

The 2-in. (5.2 cm.) and 3.5-in. 22 pdr. (8.8 cm.), and 4.1-in. (10.5 cm.) L/50 now under construction, and also, it is believed, a new type of 4.7-in. (12 cm.) are being fitted with Krupp automatic mechanism. Plate 8 shows the general appearance of the mechanism as applied to a 3.5-in. (8.8 cm.) L/35 gun, and Plate 9 the mechanism for a 4.1-in. (10.5 cm.) gun. The following description, though referring principally to the 3.5-in. (8.8 cm.), applies equally to all calibres up to and including the 4.7-in. (12 cm.), except in certain unimportant details.

The breech mechanism, of very simple design and construction, is of the horizontal wedge type, operated by means of a horizontal B. M. lever. The percussion firing gear is of the automatic cocking and release type, so that in case of a missfire a second trial of the primer can be made by simply operating the firing lever. The gear can be adjusted for automatic firing if so desired.

The magazine or hopper is attached to the cradle, and holds five or six cartridges, a sixth or seventh round being in the gun. The supply of ammunition to the magazine is usually effected by two men, one of whom places the cartridges on a small tray on the top of the magazine, while the other guides them down an incline into the magazine. These duties can both be performed by one number provided that a ready supply of ammunition is close to the gun.

To operate the gun automatically, a hand lever fitted on the exterior of the magazine is put to "Magazine Fire," and the first cartridge is inserted in the gun by hand. The action of the breech mechanism and magazine is then briefly as follows. The wedge is operated by a spring device connected to the B. M. lever, and contained in a cylindrical casing on the top of the cradle. This spring is compressed during recoil, and during counter-recoil opens the breech, ejecting the empty cylinder. The magazine is also actuated by a spring arrangement situated on the lower left side of the cradle, and compressed during recoil. The magazine spring is released by the ejected empty cylinder, and actuates a rammer. The latter at the commencement of its stroke causes the loading tray containing the lowest cartridge in the magazine to swing over to the right, thus bringing it into line with the bore. The further movement of the rammer inserts the cartridge in the chamber without shock. Directly the tray commences its movement to the right, two levers engage below the cartridges remaining in the magazine, and retain them in position. The breech is closed automatically whilst the loading tray returns to its initial position. Directly the latter reaches this position, the two supporting levers are withdrawn, and another cartridge falls into the tray. A slight shock, occurring on the completion of the loading movements, indicates to the gunlayer that the gun is in the "Ready" position.

A special contrivance is fitted, which, during "Magazine Fire," prevents the discharge of the last cartridge in the gun when the magazine is empty. This round can however be fired, if desired, by pressing a releasing button placed near the firing gear, and at the same time actuating the firing lever.

If it is not desired to employ "Magazine Fire," the hand lever on the magazine is put to "Ordinary Fire," thus preventing the two spring arrangements from being actuated by the recoil. In this case the action of the gun is that of an ordinary Q. F. To permit loading a "protection" plate, hinged to the top of the magazine, must be raised, which is also the case in

loading for the first round of "Magazine Fire." The magazine remains filled, so that by simply turning the lever this nature of fire can at once be reverted to if desired.

In the case of the occurrence of a missfire due to a defective primer, the breech is opened by hand, and the cartridge replaced by a fresh one, after which "Magazine Fire" can be resumed.

A hand-worked safety arrangement prevents the involuntary opening of the breech on firing. A locking bolt prevents the spontaneous opening of the breech on recoil.

Both mainspring and striker can, if necessary, be replaced with the breech closed.

A rate of fire of more than 40 aimed rounds per minute is stated to have been obtained with 3.5-in. (8.8 cm.) L/35 at Krupp's proof ranges, without undue fatigue to the gun's crew.

Gun Circuits.

Dynamo firing is employed in the "Moltke," and probably in the "Nassau" and later ships.

tables, and should therefore
n, *see* the table of ammuni-

Ballistics.			Remarks.
Muzzle Velocity.	Muzzle Energy.	Muzzle Penetration, W. I.	
f. s.	Ft.-Tons	Ins.	
2,780(?)	.....	.....	
2,800(?)	.....	.....	In "*Thüringen*" and "*Kaiser*" classes and "*Derfflinger.*"
2,247	18,520	28.0	
2,313	19,630	28.9	
2,700	.....	.....	
2,821	.....	.....	In "*Nassau*" class and "*Von der Tann.*"
.....	.....	.....	In "*Moltke*" and "*Seydlitz.*"
2,263	16,830	28.9	
2,739	16,090	31.1	
2,526	.....	.....	
.....	.....	.....	In "*Blucher*" only.
2,726	7,365	24.8	
2,231	3,038	15.4	
2,624	4,207	19.7	In "*Nassau,*" &c.
.....	.....	.....	
.....	.....	.....	
.....	.....	.....	
2,001	1,055	.....	
2,296	1,390	.....	
.....	.....	.....	In "*Breslau*" class.
.....	.....	.....	Automatic B. M.
.....	.....	.....	Latest T. B. D.'s and Submarines.
1,936	.....	1.97	New T. B. D. and submarines gun.
.....	.....	.....	Semi-automatic gun.
.....	.....	.....	T. B. and older T. B. D. gun.
2,461	.....	.....	
	Ft.-Tons	Ins.	
1,168	62	.....	Boat and field guns.
.....	.....	.....	
2,789	205	.....	
2,165	124	.....	
.....	.....	.....	
1,800	22	.....	
.....	.....	.....	Rifle calibre M. G.

Part IV. Section 1.

Mountings.

GUN MOUNTINGS.

General Notes.

Types Employed.

All mountings introduced since 1895 have been of the cradle type. These mountings are divided into three classes, viz., Drehscheibenlafetten or barbette mountings, Turmlafetten or turret mountings, and Mittelpivotlpivafetten or C. P. mountings. Barbette mountings and turret mountings for heavy calibre guns were formerly fitted with hydraulic control, but with the 11-in. (28 cm.) barbette mountings of the *"Braunschweig"* and *"Deutschland"* classes, electrical control has been introduced for heavy calibre guns. Turret and barbette mountings for medium calibre guns are provided with electrical control for the training gear. The C. P. mountings for medium and light Q. F. guns are of the usual type.

Until comparatively recently all mountings were as far as possible installed so as to permit the guns being fired at angles of elevation up to 30°.

The latest information, received from an authentic source, is to the effect that in the 12-inch turrets of the latest ships the maximum elevation obtainable is only about 15°, with a maximum depression of about 8°, and in the 5.9-in. batteries of these ships the maximum elevation is 20° with a maximum depression of about 40°.

All modern turret and barbette mountings revolve on ball races. The balls for 8.2-in. (21 cm.) mountings and above are 3.9-in. (10 cm.) in diameter. No case of the fracture of any of these balls has ever been reported. In the smaller calibre mountings the diameter of the balls varies with the calibre.

Williams-Janney Universal Speed Gear.

In May 1908 it was reported that the preliminary tests of this apparatus at the Wilhelmshaven dockyard had been so satisfactory that Messrs. Krupp had received instructions to fit the gear in the turret of a ship at Kiel. It was expected that the result of these trials would be the adoption of the apparatus in all new ships, but this at present lacks confirmation.

Improvement of Training Gear of Turrets.

A considerable sum of money was being spent in 1913 on the improvement of the training gear of heavy guns in both existing and new ships.

Improvement of Loading Gear.

A first instalment of 24,500*l*. out of a total of 112,500*l*., was voted in the estimates for 1914–15, for the replacement of handworked loading gear of heavy guns by hydraulic power.

Triple Turrets.

Exhaustive trials with triple turrets, which were unsatisfactory, are believed to have taken place at Essen during 1912. It has been reported that further trials took place early in 1914. Triple turrets have not been adopted.

Holes in the Rear Armour of Turrets.

These holes are used for two purposes: (i) for the ejection of empty cartridge cases, (ii) for the projection of the staff of the hand rammer. In ships having chain rammers the holes in the rear armour are closed by means of flaps.

15-in. (38.1 cm.) Turrets.

15-in. Barbette Mounting (38.1 cm. Drehscheibenlafette).

"Baden."

The gun-house of these turrets appears to be very large. Loading is at any angle of elevation, which represents a departure from previous types of mounting.

Part IV. Section 1. Mountings.

In the working chamber, projectiles and cartridges are transported from the trunk hoists to the loading hoists by means of endless belt transporters, as shown on Plates 10A and 10B.

The hoists to the guns are electric.

Projectile hoists deliver between the guns and the projectiles are pushed by hand onto a loading tray working on arms, which, by means of a lever, can be lowered against a returning spring into line with the breech. They are then rammed home by chain rammer.

Cartridges are delivered on the outside of the guns. Here they roll out into an inclined trough, along which they are pushed towards the breech by hand. They are then rolled into the loading tray. The front charge is pushed into the breech by hand, and the main charge is rammed home by the rammer.

An overhead rail in the gun-house enables projectiles to be supplied to both guns from either hoist.

Projectiles and cartridges can be whipped up from the working chamber to the gun-house by hand.

Ready Supply of Ammunition.

A ready supply of ammunition, consisting of three projectiles, is kept in the turret. The projectiles are stowed in the after end of the turret, horizontally.

Turret's Crew.

The gun-house crew consists of 18 men and an officer, with, in addition, two men for the rangefinder.

In the working chamber are 12 men and a petty officer.

The positions of the guns' crew are shown on Plate 10A.

General Remarks.

The arrangement in the gun-house, working chamber, and hoists for preventing the flash from burning charges passing down to the magazine are very thorough, flash doors being fitted at the top of all hoists in both the gun-house and the working chamber, and all necessary openings leading from the gun-house to the working chamber being made as small as possible.

The rate of fire is believed to be about the same as in the latest turrets in H. M. Service.

The general rule is for one gun to be fired at a time, but arrangements can be made for simultaneous firing.

Sighting Gear.

There are five sighting positions in the turret, one on the outside and one on the inside of each gun and a turret trainer's position between the guns. *See* Plate 10A.

The four gunlayers' positions are all fitted with periscopic sights, and the trainer's position with a direct telescopic sight.

The turret can be trained and the gun fired from either the centre or side positions.

There is also an officers' position, details of which are lacking.

A range finder is fitted in each turret.

12-in. Barbette Mounting (30.5 cm. Drehscheibenlafette).

"Derfflinger" Class.

The guns are mounted in turrets, the control of which is electric and hydraulic. The maximum elevation is 13½° and the maximum depression 8°.

Training and Elevating.—The training is electric and the elevating hydraulic. The compression pumps for the hydraulic elevating gear are fitted inside the barbette.

Ammunition Supply.—Loading is at a fixed angle of elevation

The ammunition hoists are electric and are capable of delivering 3½ rounds per gun per minute.

Part IV. Section 1. Mountings.

11-in. Barbette Mounting (28-cm. Drehscheibenlafette).

"*Moltke.*" (*See* Plate 12.)

The 11-in. L/50 guns are mounted in pairs in barbettes. The gun-houses are very large, the sides and roof are flat and not curved, the front face is rounded and sloping to the rear, and the rear face is slightly curved, with two large holes about 1 foot in diameter, cut in rear of each gun.

Training.—Electrically controlled from the central hood. Alternative hand. Very slow or very fast movements can be obtained with the electric gear.

Elevating.—Hydraulic motor, which is probably driven with pressure from a small pump, which is in turn electrically driven. It is understood that direct electrical gear was tried, but difficulty was experienced in supporting the extra weight of the gun when recoiling. Alternative hand gear.

Air blast.—This is actuated automatically on opening the breech, but does not have any effect until the cartridge case is extracted.

Firing Gear.—Electro-mechanical, somewhat similar to our sub-calibre apparatus. Dynamo circuits. Alternative, the same percussion gear, but actuated by rods instead of electro-magnets.

Working Chamber.—There is a small chamber encircling the central trunk in which are the switchboards and hand winches for training and elevating. There is no ammunition in this chamber, and the cages do not have any connection with it.

Loading Arrangements and Ammunition Supply.—All round loading at fixed elevation, hand ramming and electric ammunition hoists.

There is one large central trunk leading down to the magazines and shell-rooms. The projectiles come up horizontally in the centre of the turret, and the charges come up slightly canted at the sides of the turret, the hoists curving outwards from the centre before reaching the floor of the gun-house. The gun thus recoils between the projectile and the cartridge hoist.

In order to load, the gun is layed to the stop, the breech opened sideways by hand in the usual Krupp manner, by means of a horizontally sliding wedge actuated by a coarse thread; the hoists are raised electrically; the projectile is rolled onto a waiting tray, where it is held by stops which when removed allow the projectile to roll onto a tray, which is hinged horizontally at the bottom; this tray is canted over by hand until it is brought up in line with the bore by a stop; the projectile is rammed home by hand. The rammer is made of light tube steel with a head in the shape of a small lobster pot, and made of curved steel springs. The tray is then swung back.

The charge comes up on the outer side of each gun in two parts. The front charge is taken out of the hoist and inserted in the gun by hand; the main charge, is pushed down onto a tilting tray, from which it is tilted onto a horizontally-hinged tray. This tray is canted in a similar manner to the projectile tray until in line with the bore, when the cartridge is rammed home and the breech closed by hand.

On the gun being fired, the front charge volatilises. The cartridge case is started off its seat by an extractor and removed by hand, covered over and thrown through a hole in rear of the turret.

A ready supply of cartridges and projectiles is stowed vertically in racks in the gun-house.

Officers' Position.—This is situated directly in rear of the central hood. In this position is also fixed a Zeiss range-finder and several voice pipes.

Turret's Crew.—1 officer, 1 C.P.O., 9 L.S. or P.O.s, and 59 seamen—a total of 70, including magazine and shell-room parties.

Sighting Positions.—There are three sighting positions. The two side position sights are similar to our direct rocking sights, the telescope looking through a very small hole in the front wall of the turret. In the central position are three telescopes all in the same horizontal plane, the centre one being the trainer's telescope. This is mounted on a very solid sight, and is apparently not connected to either gun, but only to the structure of the turret. Immediately under this sight is a large tube, at the bottom of which the bearing is marked in degrees.

Part IV. Section 1. Mountings.

the entry of the piston-rods passes through the inclined channels into the space in the hollow air piston and lifting the non-return recoil valve enters the space in rear of the piston. The piston is thus forced to the front against the air pressure. During recoil, the recoil valve closes a series of radial holes communicating with an axial channel in the piston rod of the air piston. On completion of recoil, the recoil valve closes, and the compressed air returns the piston to the rear. The liquid in rear of the piston can now only return through the radial holes in the hollow piston-rod, and the flow can be regulated by means of the adjustable spigot. The liquid passes back into the recoil cylinders forcing the pistons and rods to the front and returning the gun to the firing position. A pressure gauge is attached to the rear end of the R. O. cylinder for use when charging the cylinder.

Steel clips bolted to the turntable engage under the outer lower edge of the lower ball path, and prevent the turntable from jumping on firing. The revolving trunk is fixed to the underneath of the turntable and pivots at its base about the central pivot pipe.

Training Gear.—Hydraulic alternative hand. The three-cylinder hydraulic turning engine is placed horizontally under the barbette floor on the right side of the turntable. The cylinders lie in one plane and are set at 120° to each other. The crank shaft carries at its upper extremity a pinion, which by means of toothed gearing is connected to the vertical shaft having the training pinion cast in one with it. The turning engine cannot be unclutched when the hand gear is in use, but revolves idly.

The hand gear, which is fitted with fast and slow speeds, has a separate train of gearing. Two training pinions on the left side of the turntable are driven by means of winches placed between the ammunition hoists. The motion of the winches is transmitted to the pinions by chains and sprocket wheel, and worm and worm wheel, gearing. The worm wheels are connected to their vertical shafts by frictional slip gear. Hydraulic and hand training brakes are provided.

Elevating Gear.—Hydraulic alternative hand. The hydraulic gear consists of the hydraulic cylinder placed vertically under the gun, the piston and piston-rod, crosshead, two toothed racks, two connecting rods, and a reversing valve, by which either end of the cylinder can be put to pressure and the other end to exhaust. To the upper end of the piston-rod is attached the crosshead which transmits the movement to the toothed racks. The latter at their lower ends are connected by the trunnion ring which slides up and down on the exterior of the cylinder. The connecting rods are pivoted about the trunnion ring and also about a similar ring screwed on to the front end of the R. O. cylinder.

The hand gear is provided with fast and slow speeds. The motion of the hand elevating wheel, on the outer side bracket of the carriage is transmitted by a train of gearing to a vertical worm driving two worm wheels, the shafts of which can be clutched to two horizontal shafts. The latter carry pinions gearing into the racks secured to the piston-rod of the hydraulic cylinder.

Maximum elevation + 30°, maximum depression − 4°.

Ammunition Supply.—The loading position is all round by hand only, with the gun horizontal. The hydraulic alternative hand hoists deliver ammunition in rear of each gun. Each cage consists of a rectangular framework carrying two trays, the uppper one for the projectile and the lower one for the cartridge. It is fitted with the usual safety gear. The cage is hoisted by means of a wire rope, both ends of which are secured to the hoisting drum, while the bight is led over rollers in the turret and on the cage. The drum is driven by means of gearing worked by a single acting hydraulic cylinder or by hand winches. A rack is attached to the end of the piston-rod of the cylinder, and gears with a pinion on the horizontal shaft which actuates the train of gearing. The hand winches are situated in a chamber in the central portion of the revolving trunk and drive the drums by means of chain and sprocket wheel gearing, a clutch being provided for connecting up the gear.

Two levers for working the hoist are provided. The one in the turret is only used for lowering the cage, and is attached to the outer bracket at the top of the trunk. The lower working lever on the revolving trunk is only employed for hoisting the cage. Cut-off gear is fitted to check the cage near the top and to bring it to rest in its place at the top and bottom of the trunk. This gear consists of a tappet rod connected to the lever working the hoist valve. To the rod near the top of the trunk is attached a tappet lever which is moved by the cage, and partially closes the hoist valve. At the top and bottom of the hoist, tappet levers are secured to the rod, which automatically close the valve and bring the cage to rest. A spring clip arrangement, which engages in a catch on the cage, holds the latter in place during the loading operations. The clip is released by means of a pedal lever.

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Mountings.

9.4-in Barbette Mounting Model 1899 (24 cm. Drehscheibenlafette C/99).

"Prinz Heinrich."

The guns are mounted singly (*see* Plate 15). As the carriage, cradle, elevating gear, and general arrangement of the gun-chamber are similar to those for the mountings already described, only points of difference are mentioned here.

Training Gear.—Hydraulic alternative hand. The hydraulic gear is situated under the floor of the turntable on the left side. The three cylinder turning engine is of the usual type and is placed horizontally. The hand gear is provided with fast and slow speeds and the winches are located in the upper hanging chamber under the turntable floor. The trains of gearing for hydraulic and hand power are entirely separate, and drive separate training pinions. The power transmission pinions on the vertical training shafts are connected to their shafts by clutches. These clutches are connected by a common system of rocking levers, so arranged that when the hydraulic clutch is in, the hand clutch is out, and *vice versâ*.

Ammunition Supply.—The loading position is all round by hand only with the gun horizontal. The spring clip hoist is generally similar to that already described for the 9.4-in. in the "*Wittelsbach*," except as regards the arrangements in the handing room for charging the hoist, and the method of stowing the ready supply of ammunition in the gun-chamber. The ammunition is delivered into the tilting loading tray L (*see* Plate 15), which, when containing a projectile, is brought into the horizontal loading position by means of a hand winch and worm gearing; when containing a cartridge, to replace it in the vertical position the tray is tilted by hand, and the friction clutch of the hand winch is thrown out of action.

The hydraulic and hand gear for working the hoist is similar to that already described for the 9.4-in. in the "*Wittelsbach*."

The arrangenent for charging the hoist in the handing room consists of a platform P, running on rollers, which can either be attached to the revolving trunk or moved independently of it. For the reception of ammunition the platform is provided with six semi-cylindrical charging trays Q, pivoted horizontally and vertically about pins and supported on rollers *i*. The pivot pins are so constructed that any movement of the trays towards the axis of the revolving trunk can only take place when the trays are opposite the charging hole. To charge the trays the open side is turned outwards and the cartridge or projectile inserted. The tray is then turned until the opening is towards the trunk. To place the loaded tray in position a spring catch is released and the revolving platform turned until the tray arrives opposite the charging hole, when the catch again engages and holds the platform in position. The tray is then inclined towards the trunk, closing the loading hole and placing the cartridge or projectile in position to be raised by the supply rod.

A runner with quick-acting differential purchase on a circular overhead rail R, bolted to the revolving trunk, is provided for placing the projectiles in the trays. The projectiles are brought on ordinary shot bogies from the shell rooms and are hoisted in special carriers. Cartridges are manhandled from the magazines to the trays.

In the turret in rear of the gun are two shot bogies K running on athwartship rails and each containing two ready projectiles in trays. The trays can be revolved about a horizontal axis. The upper projectile can be rammed straight through the loading tray into the gun when the bogie is in position. The lower projectile is then brought into the upper position by means of a hand winch and worm gearing.

The reserve hoist W is similar to that in the C/98 mounting.

8.2-in. 21 cm. Turrets.

8.2-in. Turret Mounting Model 1897 (21 cm. Turmlafette C/97).

"Hertha" Class.

The guns are mounted singly in turrets. The carriage, consisting of two sides and a front transom, is bolted to the turret floor. The cradle is similar to that for the 9.4-in. (24 cm.) Drehscheibenlafette C/98 except that the hollow controlling plungers are conical in shape, the smallest diameter being at the front, and that the external surface is smooth. The action of the recoil cylinders and hydro-pneumatic R.O. cylinder is identical with that described for the 9.4-in. turret of the "*Wittelsbach*." The revolving trunk is attached to the underneath of the turntable. The turntable is supported on the usual ball race.

sufficiently powerful to return the gun to the firing position at extreme elevation (30°). The running-out rods are attached to the breech ring of the gun.

Training Gear.—Electric alternative hand. The training motor is placed under the gun between the side brackets, and the shaft carries a worm meshing with a worm wheel on a vertical shaft to the lower end of which is attached the training pinion. The training lever is on the left, and the hand winch on the right side bracket. Automatic cut-off gear is fitted.

Elevating Gear.—Hand only. The worm elevating gear is on the left side bracket, and is shown on Plate 16.

Maximum elevation + 30°, maximum depression − 8°.

Ammunition Supply.—The loading position is all round by hand only. The electric alternative hand hoist is of the endless chain Paternoster (dredger) type. The motor, which is not reversible, and the hand winches are at the base of the revolving trunk in the handing room. The general arrangement of the hoist, ammunition conveyors, &c., are clearly shown in Fig. 2, Plate 16. In the turret the ammunition is delivered over a guide roller into a tray situated on the floor under the gun, whence it is manhandled. The rate of supply is about eight rounds per minute. Safety gear is fitted to prevent the fall of ammunition in case of fracture of the chains. Ammunition can be struck down by hand gear only. A mechanical tell-tale is provided from the turret to the handing room for controlling the supply of ammunition. A ready supply of six rounds is stowed in racks in the turret. Empty cylinders are ejected through a hole in the turret door, which also serves when loading for the rammer staff to pass through.

5.9-in. Turret Mounting, Model 1897–99 (15 cm. Turmlafette C/97–99).

"Wittelsbach" Class and *"Prinz Heinrich."*

This mounting is similar to the C/97 mounting, except that the revolving shaft only extends down to the main deck. In consequence of the short distance the ammunition has to be raised, the dredger pattern hoist is provided with hand gear only. The ammunition comes up the ordinary hoists in the central battery, and is there transferred by hand to the turret hoists.

Upper Deck, Battery, and Casemate Mountings.

6.7-in. C. P. Mounting, Model 1902–04 (17 cm. Mittelpivotlafette C/02 and C/02–04).

"Braunschweig" and *"Deutschland"* Classes.

The C/02 mounting is shown on Plate 17, Fig. 2, and is very similar in construction to that for the 5.9-in. (15-cm.) L/40 gun. Training gear is fitted on both sides of the mounting, and platforms for the gunlayer and training number are also provided. The maximum elevation is + 20° and maximum depression − 5°.

No information is available as to the modifications introduced into the C/02–04 mounting, which is the type installed in the *"Deutschland"* class.

5.9-in. C. P. Mounting, Model 1897 (15 cm. Mittelpivotlafette C/97).

"Kaiser" and *"Wittelsbach"* Classes and Armoured Cruisers.

In the C. P. mounting C/97 (*see* Plate 17, Fig. 1) the cradle consists of a recoiling sleeve and a non-recoiling portion. The sleeve, in which are cast the two rifled recoil cylinders, is secured to the gun by keys and key-ways and bolts. The non-recoiling portion consists of two side-pieces, connected by front and rear transoms. In front the side-pieces form semi-circular guides in which the recoil cylinders attached to the gun move, and at the rear end there are bearings for the R. O. spring cylinders. The recoil cylinders are of the usual type. The piston rods are attached to crossbars fitted at the front ends of the side-pieces. The telescopic R. O. spring cylinders are placed immediately in rear of the recoil cylinders, and each contains two spiral springs placed one within the other, and held in compression by a compressor rod. The rear ends of the cylinders rest in the bearings on the side-pieces. On recoil, the springs are compressed by the recoil cylinders, which carry the front portions of the

telescopic spring cylinders to the rear with them while the rear portions remain stationary. The springs are capable of retaining the gun in the firing position at extreme elevation (30°).

The carriage is of ordinary construction and consists of two side brackets connected by front, middle, and rear transoms. It rests on a ball race, supported on a cylindrical pedestal bolted to the deck, and is prevented from jumping on firing by front and rear clips. The pedestal contains an arrangement for raising the carriage sufficiently to enable an examination and removal of the balls to be carried out without dismounting the gun.

Worm training and elevating gears are fitted on the left side only, in the earlier mountings of this model, but in the later there is a training wheel on the right side also.

The mounting is fitted with a shield which completely closes the gun port, and a curved splinter shield is attached to the front end of the cradle.

Some of these mountings are provided with overhead dismounting gear, but this is only used when ships go into dock, &c., and the guns are not dismounted when going to sea.

5.9-in. C. P. Mounting, Model 1902 (15 cm. Mittelpivotlafette C/02).

This is a C. P. mounting, to be found in the *"Roon."* It is not known in what respects it differs from the C/97 mounting.

5.9-in. C. P. Mounting, Model 1902–6 (15 cm. Mittelpivotlafette C/02–06).

"Moltke." (*See* Plate 18.)

These guns are fitted with a 3-in. shield. The sights are worked off the trunnions and are kept unshipped. At the left sight the gunlayer looks through the telescope in the ordinary way, but lays his gun by means of a wheel placed across in front of his position. The trainer trains by means of a wheel situated in a similar position to our elevating wheel, and looks in at the same telescope as the gunlayer, but at a side eyepiece. The right sight is an open trunnion sight, the wheels being situated in the same way.

The platforms for gunlayer and trainer are large.

Round the pedestal is a toothed rack; fixed to the training portion of the mounting is a large drum, worked by means of rods and mitre wheels, and connected to a pinion which engages in the rack on the pedestal. As the gun is trained round, so the bearing is shown in large letters immediately under the gunlayer's and trainer's sight. This device is stated to be extremely simple and serviceable. The gun's crew consists of six men.

4.1-in C. P. Mounting, Model 1897 and 1904 (10.5 cm. Mittlepivotlafette C/97 and C/04), (Small Cruisers).

The 4.1-in. (10.5 cm.) C. P. mounting C/97 is to be found in the *"Berlin"* and all the older small cruisers, while the C/04 pattern is used in the *"Lubeck"* and later cruisers. The C/97 pattern is identical with the 5.9-in. (15 cm.) C/97 mounting except as regards dimensions.

The following are the main points of interest in the 4.1-in. model, 1904 mounting, salved from the *"Emden."*

The gun can be elevated to 30 degrees. This high angle of elevation is obtained by using a "Y" bracket with longer arms than is customary in H. M. Service, and to some extent by using a short recoil cylinder. The recoil cylinder is attached to the gun, not to the mounting, the object being to increase the weight of the recoiling parts, and so to reduce the velocity of recoil.

The training and elevating gear are both fitted to the left side of the mounting. The elevating handwheel moves in the reverse to the conventional direction.

Percussion firing gear only is fitted, the lever being attached to the cradle. This lever is out of reach of the gun layer at high elevations, when it is operated by a lanyard, convenience and utility having been sacrificed to simplicity of detail.

Sights are fitted on both sides of the mounting but not cross-connected. The left sight is fitted with both telescopic and open sights—the right sight is open only.

The training worm can be thrown out of gear by a lever and eccentric bushes, on lines somewhat similar to our 4-in. "K" class mounting, so that the gun can be trained by shoulder if required.

It is interesting to note that steel castings are used for the pedestal, carriage, side bars, and cradle, the cassings being machined on surfaces in contact only.

Part IV. Section 1.

Mountings.

The following details of mountings for the 4.1-in. L/40 and L/45 guns have been obtained from Range Tables captured during the war:—

Mounting.	Gun for which used.	Maximum Elevation.	Total Weight of Mountings without Shield.	Weight of Shield.	Maximum Recoil.	Average Recoil.	Remarks.
		Degrees.	Lbs.	Lbs.	Inches.	Inches.	
4.1-in. C. P. Mounting, Model 1897. (10.5-cm., M. P. L., C/97.)	4.1-in., L/40.	30	4, 829	4, 255	8.3	7.5	
4.1-in. C. P. Mounting, Model 1904. (10.5-cm., M. P. L., C/1904.)	4.1-in., L/40.	30	4, 938	4, 883	8.3	7.9	Mounted in "*München*" and "*Lübeck*."
4.1-in. C. P. Mounting, Model 1904. (10.5-cm., M. P. L., C/1904.)	4.1-in., L/40.	30	5, 225	5, 004	8.3	7.9	Mounted in "*Leipzig*," "*Fuchs*," "*Danzig*," and later.
4.1-in. C. P. Mounting, Model 1906. (10.5-cm., M. P. L., C/1906.)	4.1-in., L/45.	30	5, 566	5, 896	9	7.9	
4.1-in. C. P. Mounting, Model 1912. (10.5-cm., M. P. L.,	4.1-in., L/45.	30	6, 834	6, 106	13	12.2	

Part IV. Section 1. Sights.

consisting of a frame with cross-wires, is pivoted about the same axis pin as the carrier arm, and projects through the turret roof. The lower extremity of the tangent sight is securely connected to the foresight by a rod, so as to maintain a constant sight radius.

In the 5.9-in. (15 cm.) turret mounting (Turmlafette) C/97 and C/97–99 the sights are of the direct rocking motion pattern. A rocking arm is bolted to the left trunnion of the cradle, and near its rear end travels on an arc-shaped guide secured to the side bracket. Ordinary fore and tangent sights are suitably attached to the rocking arm.

Non-Automatic Pattern Sights.

In the 9.4-in. (24 cm.) barbette mounting (Drehscheibenlafette) C/97 and C/98, and 8.2-in. (21 cm.) Drehscheibenlafette C/01, the turret sights are of the "*Hero*" or non-automatic pattern, and appear to be somewhat similar to the sights of this type supplied by Krupp to the Dutch Navy (*see under* Dutch Naval Ordnance). The following remarks refer to the 8.2-in. (21 cm.) turret sights, seen on board the "*Friedrich Carl.*"

The telescopic sights are enclosed in a brass box on a carrier mounted on a horizontal shaft extending across the turret above the guns, and having a sight pointer, about 2½ feet in length, at each end on the outer sides of the guns. At each gun there is a second or gun pointer pivoted concentrically with the sight pointer, and worked by a sliding block traveling in a cam groove on the cradle. The range is engraved spirally on a drum, which by gearing communicates the elevation to the sights and also, by means of the rod, moves the sight pointers at the guns. A second hand wheel is fitted in the sighting position, by means of which the gunlayer can bring the sights on to the target without altering the angle of the elevation already given to the sight. The elevating number at the gun makes the gun and sight pointers coincide by working the elevating gear, and the gun is then correctly laid for elevation. A system of electric control lamps is provided, the circuit of which is so arranged that the lamps can only burn when the pointers coincide.

It is believed that this pattern turret sight has been abandoned.

Sights in the 12-in. Turrets "Kaiser" and "König" Class.

The sights in these ships are periscopic. Full details of the sighting gear are lacking.

The drums on the sights are circular with spiral groove, probably for ranges.

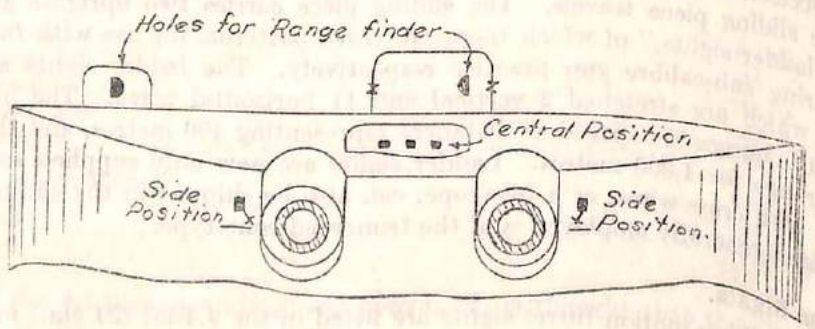
The inner sighting telescopes are not fixed to the guns and remain horizontal when loading.

Wooden boxes, thought to contain spare drums (possible for ¾ charges, &c.), are fitted in the turrets.

Sights of 11-in. (28 cm.) L/50 Turrets ("Moltke").

There are three sighting positions. The side position sights are similar to our direct rocking sights, the telescope looking through a very small hole in the front wall of the turret. From the outside there appear to be two telescopes fixed vertically one over the other.

It is understood that this embodies one of the Zeiss principles.



In the central position there are three telescopes all in the same horizontal plane, the centre one being the trainer's telescope, which is mounted on a very solid-looking sight, and is apparently not connected to either gun, but only to the structure of the turret. The other two telescopes in the central hood are the gunlayers' telescopes mounted on direct-rocking sights. The two gunlayers at these sights sit facing each other, and look down eyepieces which are at right angles to the line of sight. The sightsetter sits down below the gunlayer and sets his sights from an electrical receiver.

Training Gear:—Hydraulic, with a maximum speed of 3° per second. Two hydraulic training engines are fitted. Auxiliary electric training gear is fitted, which gives a maximum speed of 1° per second.

The training gear automatically cuts off at extreme training. A dial and pointer is fitted to show the bearing on which the turret is trained.

Elevating gear:—Hydraulic, alternative hand. The gear is automatically disconnected at the maximum elevation of +20°, or at the maximum depression of −4°.

The two elevating controls may be connected, so that both guns can be worked by one wheel for simultaneous firing.

The hand elevating gear is worked by two men, and has two speeds.

Ammunition Supply.

The main ammunition hoists are arranged direct from the magazines and shell-rooms to the guns, and are worked by hydraulic presses.

Auxiliary hoists are fitted to work by electric motors, two upper and two lower. The lower ones lift the ammunition to the transfer chamber, and the upper ones from the transfer chamber to the guns.

For the main supply the shell are lifted and traversed by electric crabs on rails, and are dropped on trucks which rest on circular stages which revolve about the bottom of the trunk. This stage can be fixed to the ship's structure or to the trunk, as in the English bogie system. When the cage descends, the trucks and the shell in them are pushed into the trunk. The cage on rising picks up the shell, leaving the empty truck.

The charges are in two halves, and are transported by hand on overhead runners, and then lowered into troughs on the trunk. When the cage is at the bottom, the charges are pushed through openings into skeleton trays in the trunk.

The cage rises slowly with the projectile, picks up the charges, and then rises quickly to the breech of the gun. The projectile is rammed home, the cartridges are then dropped into the lower tray and rammed home in turn, the limit of travel of the rammer being automatically regulated for the charges.

The speed of loading by the main system is 2.2 rounds per gun per minute.

For the secondary supply, the electric motor crabs bring the shell to the hoist, whence they are hooked on to overhead rails and lowered into tilting trays, whence they are tilted into auxiliary cages in the revolving part of the trunk. The charges on the deck above are treated in a similar fashion; electric hoists then raise them to the transfer chamber, where the ammunition is removed by similar appliances to those in the magazine and shell rooms; they are then placed in the gun-loading cages. These upper secondary cages are combined cages for projectile and cartridges, the lower ones being separate vertical cages for shell and cartridges. All the secondary cages are electric.

The transfer chamber contains all the hoist machinery. Arrangements are made so that should the magazines or shell rooms of an adjacent turret be flooded, the transfer chamber of this turret may receive ammunition from the magazine or shell rooms of another turret by the auxiliary hoists.

A central pivot below the trunk forms a connection between the ship and turret hydraulic for pipes, electric cables, and voice-pipes.

The turret's crew, including the magazine and shell-room parties, consist of 1 officer and 47 P.O.'s and men. 10 additional men are required if hand gear be in use.

Sights.

1 trainer's sight built into the turret in the central hood.

1 elevating sight on the outside of each gun.

1 trainer's telescope on the outside of each gun, built into the turret structure.

1 observation telescope in between the guns for the officer of the turret, fitted with a device for indicating the position of the target and allowing for deflection.

Illuminating lamps are fitted to all telescopes and sight dials.

The elevating sights are direct trunnion sights, in the form of a horizontal periscope projecting through a hole in the side armour, the axis of the telescope being a continuation of the axis of the trunnion. These sights appear to be solid, simple, and not likely to get out of order. Suitable conical gearing is fitted for setting the elevation in such a way that the graduations on the dial are large and far apart. The same principle is used for the deflection setting.

The trainer's sights are similarly fitted, but they are built into the turret a few feet in rear of the elevating sights, and project from the side wall at a different level.

Rangefinder.

One, 6½-metre (21.3-ft.) base rangefinder is built into the turret under the roof across the top of both guns and projects from the side wall on each side.

Voice pipes are fitted between all parts of the turret.

26349—17——5

Attention is called to the penalties attaching to any infraction of the Official Secrets Act.

C.B. 1182.

GERMAN NAVY.

PART IV.

SECTION 2.

AMMUNITION AND SMALL ARMS.

SECTION 2.

AMMUNITION AND SMALL ARMS.

AMMUNITION.

Powder.

Black powder is only used for blank and saluting charges, as bursters for common shell, and for igniters, &c.

Smokeless Powder.

Two types of smokeless powder are in use in the German navy, a nitro-cellulose powder being employed in small arms and .314-inch (8-mm.) machine guns, and a nitro-glycerine powder in all other guns.

Small-Arm Powder.

The composition of the small-arm powder is as follows:—

Nitro-cellulose and graphite	97.51 per cent.
Camphor	0.93 "
Diphenylamine	0.25 "
Volatile matter	1.31 "

The camphor is probably added to facilitate gelatinisation, and the diphenylamine for the purpose of improving the stability of the powder.

Nitro-Glycerine Powders.

The nitro-glycerine powders now in use are R. P. (Röhrenpulver) C/00, C/06, and C/12. An older form of powder, W. P. C/07 (cubical powder) was in use until recently, but is believed to be no longer used.

R.P. C/00.

This is practically identical with the M. D. cordite in use in H. M. Service excepting that the nitrogen content of the nitro-cellulose is slightly lower. The powder is of slate-grey colour, owing to the use of .5 per cent. of graphite for smoothing the surface. This powder is no longer being manufactured and the stock is being used up for practice ammunition.

R. P. C/06.

This powder was first manufactured in 1900, but was not adopted until early in 1906, after having been under trial during the whole period.

It is of practically the same composition as C. S. P_2. The following are some details of this powder as used in 1913 in the 5.9-in. (15-cm.) L/40 gun:—

The powder is in the form of a tube with a smooth surface and a dark grey-brown colour.

External diameter	.295 inch.
Internal "	.165 inch.
Annulus	.065 inch.
Analysis:—	
Nitro-glycerine	21.95 per cent.
Nitro-cellulose	71.50 "
Mineral jelly	4.50 "
Sodium bicarbonate	0.95 "
Graphite	trace "
Volatile matter	1.10 "
	100

The nitro-cellulose is soluble in ether alcohol to about 60 per cent. An oily substance, ..mounting to about 0.5 per cent., was obtained, but the sample was too small to determine its nature.

An analysis of a sample of powder which the Germans were credited with having tried in their 12-in. experimental gun in 1911 showed the following composition:—

Nitro-glycerine	22.03 per cent.
Nitro-cellulose	70.26 "
Mineral jelly	4.28 "
Sodium bicarbonate	1.40 "
Volatile matter	1.53 "
Graphite	0.50 "
Ash	Nil
	100

Examination of nitro-cellulose:—

Soluble in ether alcohol	45.22 per cent.
Insoluble in acetone	—— "
Nitrogen	12.08 "

Measurements of sample:—

External diameter	23.5 mm. (.925-in.)
Internal diameter	11.1 mm. (.437-in.)
Annulus	6.1 mm. (.240-in.)

R. P. C/12.

In the German Ammunition Handbook, which has been captured during the war, mention is made of R. P. C/12 as the powder for charges of some guns. This powder is not yet in general use in the naval service. Its composition is not known.

Form and Size of Powder.

The S. A. smokeless powder is in the form of graphited flakes, the dimensions of which are approximately 1.3 mm. by .3 mm. (.051 by .011 inch).

The nitro-glycerine powder is of the tubular type, the tubes being generally somewhat oval in shape. The powder is denoted by the model year and by the dimensions of the tubes in millimetres, *e. g.*, R. P. C/06 ($550 \times 12\frac{1}{2}/4\frac{1}{2}$), the figures in brackets indicating the length, outer and inner diameters of the tube respectively in millimetres.

A good idea of the sizes in which the tubular powders are made will be obtained by a study of the table of ammunition on page 14.

Where the charge does not completely fill the length of the brass cartridge case a cylin- drical powder filling piece, held central by a millboard disc, is inserted.

Dished discs (*Fahnenhüte genannt*) with central holes, resembling D...

Cartridges for B. L. Guns.

Smokeless powder cartridges for the old B. L. guns are enclosed in silk cloth bags, and the

The cartridges for the 6-pr. (6 cm.) Q. F. boat and field gun are supplied in a wood-lined zinc case, containing 50 cartridges.

The burster consists of either F. P. C/02 or Grf. C/88 described on page 5, all the later and larger calibres having the F. P. C/02 burster. The burster, which is in all cases exploded through the medium of a gaine, is contained in a millboard container.

In the case of shell with internal fuzes the hardened steel nose can be unscrewed in order to insert the fuze and gaine.

As in the case of A. P. shell, lead washers are used to seal the flanges of the base closing plug and gaine container.

Details of the fuzes and gaines in use with each type and calibre of shell will be found in the table of ammunition on page 13.

C. I. Common Shell (Granate). (Plate 21, Fig. 4.)

Cast-iron common shell are supplied for all guns. The projectiles for the 5.9-in. (15 cm.) and smaller Q. F. guns are nose-fuzed, while those for larger calibres have base fuzes.

The interiors of the shells are lacquered, and the bursters of large-grained shell powder are enclosed in flannel burster bags.

These shell are now mainly supplied for practice purposes and contain generally a small powder practice burster. In some cases the practice burster is of H. E., and a smoke producer of pitch is inserted. The general arrangement of the shell is similar as regards fuze, gaine, &c., to H. E. shell.

Shrapnel Shell. (Plate 21, Fig. 6.)

Pressed steel shrapnel shell with base bursters are supplied to the 4.1-in. (10.5 cm.), 5.9-in. (15 cm.), and 6.7-in. (17 cm.) Q. F. guns, excepting the 5.9-in. L/45. The projectiles for the 5.9-in. (15 cm.) and 6.7-in. (17 cm.) have an eye-bolt screwed into the base, in order to facilitate the withdrawal of the projectile from the gun if necessary. The bullets are of antimony and lead and weigh about 1 oz.

The shell is identical in principle with that in use in H. M. Service excepting that the flash from the fuze is reinforced by the magazine ring. The T. and P. fuze (Doppelzünder C/92.99) is always used with these shell.

Experimental Shell.

Experiments are said to have been carried out with the combined shrapnel and H. E. shell made by Krupp and Ehrhardt. The Krupp projectile in exterior appearance resembles an ordinary shrapnel shell and consists of two portions. The front portion is composed of the shrapnel shell of usual type with base burster and time fuze. The H. E. shell is formed by a cylindrical prolongation, projecting from the base of the front portion, and a screwed base which carries the driving band. The cavity contains a percussion fuze and detonator, a small H. E. burster, as well as some smoke-producing substance. If the projectile is used as an ordinary shrapnel shell, the explosion of the shrapnel burster causes the percussion fuze to act and the H. E. shell to detonate. If, however, the shell is burst on impact, it is split up for its entire length and a very large number of fragments are dispersed laterally in a wide cone.

The Ehrhardt projectile differs widely from the Krupp pattern. The steel head of the projectile, in addition to carrying the time fuze for the shrapnel portion, also contains the H. E. burster, percussion fuze, and smoke-producing compound. If the projectile is burst by time fuze, the two portions do not act simultaneously in the air, but the head continues in flight and detonates on impact. The shrapnel portion has a base-opening charge.

The tests carried out by the naval authorities are said to have been very satisfactory, but it is not thought that this type of projectile has been adopted.

Tracer Shell.

It has been reported that tracer shells are used by German T. B. D.'s when firing at night from their 4.1-inch guns.

Star Shells.

The star shell consists of a steel body, closed by a domed head, containing an illuminating "star" and parachute. The illuminating composition is contained in a thin steel cylinder to which a parachute is attached.

A small bursting charge in the base and head of the shell is ignited by means of a time fuze, the flash from the charge in the head being conducted to the base burster through a circular channel. The bursting of the shell discharges the star and parachute and the flash ignites four quick match fuzes leading to the illuminating composition of the star.

The parachute is made of holland and is octagonal in shape. In the case of the 4.1-inch shell it is just over two feet in diameter. The holland is reinforced by flexible steel wires, and the cylinder containing the illuminating composition is supported by wires from each corner and from the centre of the parachute, leading to a swivel piece at the head of the cylinder.

The illuminating composition is composed of sulphur, barium nitrate and magnesium in the respective proportions of 19, 47 and 34 per cent. approximately. It burns with an intensely brilliant flare, illuminating a considerable area.

It has been reported that star shells are supplied to 5.9-inch, 4.1-inch, and 22-pdr. guns in all ships.

When firing star shells a charge of 2 lbs. 5 ozs. R. P. C. powder (approximately one-third of the service charge) is used.

Coloured Star Shells.

It has been observed by our airmen on active service that the Germans use star shell with red stars in their anti-aircraft guns ashore. It is not known whether similar shell are supplied to ships.

Caps.

Caps of the shapes shown in Plate 22 were in use in 1914. These are soldered on to the point of the projectiles.

An 11-in. shell recovered at Hartlepool after the bombardment was found to have a cap of the Firth's hollow pattern.

Marking of Projectiles.

The marking of projectiles is as follows:—

Steel shot.—Painted light blue.

A. P. shell.—Painted yellow up to the central swell. The part in rear of the black shoulder band and the base are painted light blue.

C. I. Common.—Painted red. When with a practice burster a yellow band is painted round the shoulders.

H. E. shell.—Painted light yellow. In fixed ammunition that part, excepting the base, in rear of the driving band is black.

Shrapnel.—Painted blue.

Star Shell.—Painted green with a black head.

Practice shell.—Painted red, with 1.2-in. yellow band round shoulder.

Substitute A. P. shell.—Painted yellow. When with practice burster a black band in front of foremost driving band.

All shell have the central swell coated with black lacquer varnish.

A black point indicates that the shell is fuzed.

Drill projectiles are painted black.

Driving Bands.

Copper driving bands are employed. For the 4-in. (10.5 cm.) and smaller guns only one band is used. For the 5.9-in. (15 cm.) guns and above there are two bands, each about one-sixth of the calibre in width. The front edge of the upper band is bevelled off at a steep slope and is smooth, while the rear portion is almost cylindrical. The lower band is cylindrical, but the front edge is slightly bevelled.

One of the driving bands is serrated on the after part.

Driving bands are pressed into under-cut grooves which have plain interrupted ribs for ensuring the grip.

Primers.

Percussion primers only are used and are of the ordinary Krupp pattern. The primer used in the heavy and medium calibre Q. F. guns is known as the Primer C/12, and consists of a short brass body, threaded on the exterior to screw into the cartridge case. The head is solid and has three semi-circular slots to take the key for inserting or removing the primer from the case. The interior is bored out cylindrically, leaving a central boss, which is also bored out and threaded to receive the percussion cap and brass anvil with central fire-hole.

The body is filled with fine-grain powder and a compressed powder pellet with central fire-hole. The primer is closed by a brass washer and a disc shellacked in place.

The old pattern primer C/95 is still in use for firing practice and saluting charges.

When screwed in, the primer is flush with the base of the cartridge case.

Fuzes.

The following fuzes are in use. The type of projectile in which each is used may be seen from the table of ammunition on page 13:—

Nose Fuzes.

Nose Fuze C/89. (Granatzünder C/89.)
Nose Fuze C/98. (Granatzünder C/98.)
H. E. Nose Fuze. (Kopfzünder für Sprenggranaten.)
Time and Percussion Fuze C/92.99. (Doppelzünder C/92.99.)
Steel precussion (specimen recovered).

Internal Fuzes.

Internal Delay Action Fuze. (Granatzünder mit Verzögerung.)

Base Fuzes.

Base Fuze C/98. (Bodenzünder C/98.)
Base Fuze C/00. (Bodenzünder C/00).
H. E. Base Fuze. (Bodenzünder für Sprenggranaten.)
Delay Action Base Fuze. (Bodenzünder mit Verzögerung.)
Delay Action Base Fuze with safety shutters (specimen recovered).

Nose Fuze C/89. (Plate 23, Fig. 1.)

This fuze is used in the nose-fuzed common shell for the 4-pr. (5 cm.) and 3.5-in. (8.8 cm.) Q. F. guns and also for the 5-pr. (6 cm.) B. L. and Q. F. boat and field guns. It consists of a brass body (*a*), the upper part of which is threaded to screw into a fuze adapter. The body is bored out cylindrically, and the upper part is threaded to receive the screwed plug (*f*) containing the detonating cap (*g*). The base of the fuze body has a central fire-hole. In the lower part is the needle pellet (*b*) with steel needle and central fire-hole, which is retained in place by a brass plate stirrup spring (*c*) and a safety collar (*d*). A brass spiral rebound spring (*e*) is placed between the pellet and the detonating cap.

Action.—Before firing, the safety collar resting on the arms of the stirrup spring holds all parts rigid. Two inspection holes (*j*) cut in the side of the body of the fuze enable the correctness and safety of the fuze to be ascertained by inspection. On the gun firing, the shock of discharge forces the safety collar over the springy arms of the stirrup spring and so firmly on to the conical part of the needle pellet. This exposes the head of the needle. The rebound spring now holds the needle pellet to the rear until, on impact, the weight of the needle pellet, reinforced by the safety collar, overcomes the tension of this spring and the needle strikes the detonating cap and fires the fuze, the flash passing through the fire-hole through the centre of the needle pellet.

Nose Fuze C/98. (Plate 23, Fig. 2.)

This fuze is used in the common shell for the 4.1-in. (10.5 cm.) and 5.9-in. (15 cm.) L/35 Q. F. guns. The fuze is generally similar in principle to the C/89 fuze, but is of larger dimensions and differs in the following points. A lead rebound washer is placed in the base of the fuze body, the central part of the needle pellet is conical, and the interior of the safety collar is also conical in shape. All parts are clearly shown in the Plate.

Action.—On shock of discharge the safety collar straightens out the two arms of the safety stirrup spring, sets back on to the conical part of the needle pellet, leaving the latter free to fly forward on impact. The rebound of the pellet on firing is prevented by the lead washer and spiral spring.

Inspection holes are pierced through the body of the fuze as in the C/89 fuze.

H. E. Nose Fuze.

This fuze is used for the H. E. nose-fuzed shell for the 4.1-in., 5.9-in., and 6.7-in. guns, and for cast-iron common in the 5.9-in. and 6.7-in. guns.

The action is identical with that of the nose fuze C/98.

Steel Percussion Nose Fuze. (*See* Plate 23A.)

A specimen of this type of fuze has been recovered which had been fired from a 5.9-inch gun. It is believed that this is the newest type of nose percussion fuze, as the mark on the recovered fuze showed the date 1916.

The body of the fuze is made of steel.

The action of the fuze can be seen from the Plate. On the gun firing the grooved ferrule (*a*) sets back over the arms of the spring safety clip (*b*). This allows the centrifugal shutters (*c*) to move outwards, turning on their brass axis pins (*g*), freeing the detonator pellet (*d*) which can now fly forward, forcing the detonator (*f*) on to the needle (*e*) on impact.

Internal Delay Action Fuze. (Plate 23, Fig. 3.)

This fuze is used in the 4.1-in. and 3.5-in. H.E. internal fuzed shell.

The action is exactly similar to that of the nose fuzes described above.

The delay action is brought about through the flash from the fuze being passed through a tortuous passage in the base of the fuze.

Base Fuze C/98. (Plate 23, Fig. 4.)

The only shell mentioned in the German Ammunition Handbook in which this fuze is used is the base-fuzed common for the 9.45-in. (24 cm.) L/40. It is probably also used in some of the older ammunition.

The fuze consists of the following parts:—Body (*a*) with lead disc (*b*); lighting pellet (*c*) with detonating cap (*d*) and closing screw (*e*); stirrup spring (*f*); spiral spring (*g*); and screwed cap (*h*) with needle. The brass body is bored out cylindrically and at the top is threaded to receive the screwed cap. On the exterior the lower part is threaded to screw into the shell, and on the solid base there is a rectangular boss to take the fuze key. From the base to the threaded portion the exterior of the body is cone-shaped, in order to form a gas-tight joint with the fuze hole in the shell. Two cylindrical inspection holes are drilled through the unthreaded walls of the body to enable the correctness of the fuse, and therefore the safety, to be ascertained by inspection. The brass lighting pellet is cylindrical in front, but the rear part is conical; it is bored out longitudinally, the rear portion being threaded to receive the stop screw which retains the detonating cap in position. The stirrup spring and safety collar are of usual type, the interior of the latter being coned. A spiral spring of hardened brass wire, .04 inch in thickness, is placed between the lighting pellet and the screwed cap. The fuze is closed by the screwed cap which carries the steel needle and has a central fire-hole.

Action.—The action of the fuze is similar in all respects to those already described.

Base Fuze C/00.

This fuze only differs from the Base Fuze C/98 in the base of the lighting pellet being made of lead, and the lead disc being abolished.

It is used in the base-fuzed C.I. common shell for the 6.7-in. (17 cm.) and the 11-in. (28 cm.) L/40 guns.

H.E. Base Fuze. (Plate 23, Fig. 5, and Plate 24.)

This fuze is used in all H.E. shell with base fuzes from 5.9-in. to 11-in. It is also used in C.I. common shell 8.2-in. (21 cm.) and above which have a H.E. *practice* burster.

The fuze is identical in principle with those already described. Details can be seen in the Plate. The only difference in this fuze is that the flash from the detonating cap is augmented by a powder pellet which is contained in the closing plug of the fuze. The body of the fuze is marked "spgr."

Delay Action Base Fuze. (Plate 23, Fig. 6.)

This fuze is used in all A.P. shell and also in the 12-in. (30.5 cm.) H.E. shell. The fuze is identical in shape and in detail with the H.E. base fuze, excepting that in the place of the powder pellet a delay action device is inserted. This consists in causing the flash from the percussion pellet to pass through a tortuous channel to the magazine of the fuze.

Delay Action Base Fuze with Safety Shutters. (*See* Plate 23A.)

Specimens of this type of fuze fired from 11-inch and 12-inch guns were recovered at Lowestoft. The date on these fuzes, 1915, tends to show that they are the latest form of delay action base fuze.

The action of the fuze is as follows (*vide* Plate). On the gun firing the brass detent (*a*) straightens out the stirrup (*b*) and is set to the rear. This frees the centrifugal shutters (*c*) leaving the detonator pellet (*d*) free to fly forward on impact. The delay action is secured in the same way as in the ordinary base fuze, by the flash passing through a tortuous channel.

Time and Percussion C/92–99. (Plate 23, Figs. 7 and 8.)

The time portion of the fuze consists of the following parts:—

Magazine ring, *a*, with annular ring, *b*, of powder forming magazine and six fire holes, *c*.
The annular ring is closed by a screwed ring, *s*, which forms a cover plate.
The lower time ring, *d*, carries an annular ring of timing composition interrupted at one place.
A similar and interrupted ring of timing composition is carried by the upper time ring, *e*, which is fixed and forms the body of the fuze. These parts are held together by the locking ring, *f*.
g is a needle pellet, *i* the detonating pellet carried in the detonating plunger, *h*, which is held by means of the safety pin through the upper time ring.
k is a safety spring which keeps the needle clear of the detonating pellet until the gun is fired.
The nose of the fuze is closed by the closing plug, *l*.

The percussion portion of the fuze consists of:—

The needle, *m*, fixed in the wall of the upper time ring casing.
The percussion pellet, *n*, with elongated slot through which the needle, *m*, passes; this is held in place by the four arms of the safety cylinder, *p*, pressed over it.
The detonator, *o*.
The safety cylinder, *p*, with four arms of flexible metal, holding the pellet, *n*.
The closing plug, *q*, screwed into the upper time ring casing.
The granulated powder pellet, *r*, between the percussion pellet and time needle pellet, holding the former fixed.

ACTION.

Only the lower time ring can turn, and the time rings are so arranged that for a given time of flight the upper ring passes the flash to the lower ring after *half* that time. On firing, the safety spring, *k*, is pressed in by the impact of the detonating plunger, *h*, which is freed by the removal of the safety pin. The detonator strikes the needle and is fired. This ignites the upper time ring, and simultaneously the granulated powder pellet, *r*, which burns away and leaves the percussion gear free to act.

The triangular mark on the magazine plate marks the point at which the firehole leads from the lower time ring to the magazine.

Time Position.

If the indicating mark is set to any range or time, on the gun firing the upper time ring is ignited and burns to the right for half the time. At this point the flash is carried to the lower time ring, which burns to the left until it reaches a point abreast of the triangular mark, where the flash passes down the channel (filled with powder) to the magazine. The flash from the magazine passes through six fireholes to the magazine ring C/92.

The maximum burning time is 26 seconds.

Percussion Position.

When the mark † on the lower time ring coincides with the mark on the magazine plate, the fire-hole from the upper to the lower time ring is blank flanged; the lower time ring is not therefore ignited and only the percussion arrangement can act.

If the fuze does not act owing to the time arrangment, it will act as follows on impact. The powder pellet, *v*, having burnt away, the percussion pellet will on impact fly forward. The detonator, *o*, will strike the needle, *m*, and the flash will pass through the fire holes of the magazine ring C/92.

Gaines. (*See* Plates 22 and 24.)

The gaines (Zündladung) in use in the various types of projectiles are as follows:—The large and small C/98, and the C/08 and long C/08. The projectiles in which each is used will be seen in the table of ammunition on page 13.

In addition to the above, a magazine ring (Ringkapsel C/92) is in use in conjunction with the time and percussion fuze (Doppelzünder) in shrapnel. This serves to reinforce the flash of the fuze.

In some powder-filled cast-iron projectiles a reinforcing powder pellet (Zündschlag C/91 and C/98) is used to convey the flash of the fuze to the burster.

Gaine C/98. (Plate 22, Fig. 1.)

The C/98, small and large, differ only in size. Each consists of a tinned sheet brass container with about half an ounce of picric powder, *a*. At the opening of the container is an explosive pellet, *b*, and some delaying composition, *c*. There is a leather washer, *d*, at the top, and the base of the fuze bears against this when the fuze is in place.

Gaine C/08. (Plate 22, Fig. 2.)

The C/08 gaine is similar in principle and construction to the C/98. These gaines are, however, especially designed for use with shell with delay action base fuzes and are impervious to shock.

Plate 24 shows the gaine and fuze from a recovered 11-in. A. P. shell.

Magazine Ring (Ringkapsel C/92). (Plate 22, Fig. 3.)

This is made of strong sheet copper and filled with granulated powder. Its shape can be seen in the plate.

Allowance of Ammunition.

The following table shows the pre-war allowance of ammunition to ships, so far as this is known.

Class.	Round per Gun supplied.		Remarks.
	Heavy Gun Armament.	Medium Calibre Armament.	
"Brandenburg"	60	?	
"Kaiser Friedrich III."	80	150	
"Nassau"	80	180	½ H. E.
"Kaiser"	98	200	½ H. E. A. P. capped.
"König"	96	?	30—12″ H. E.
"Von der Tan"	80	180	66—12″ H. E. A. P. capped.
"Moltke"	96 centre line turrets, 81 side turrets.	160	
"Seydlitz"	96 centre line turrets, 81 side turrets.	160	
"Derfflinger"	90	100	
"Hertha"	80	100	
"Gazelle"	None	100	
"Stuttgart"	None	100	
"Strassburg"	None	150	

The amount of ammunition carried by submarines varies according to the nature of service upon which they are employed. In the U 66–70 class as much as 750 rounds of 22-pdr. ammunition has been carried. It is therefore probable that large sea-going submarines carry at least 400 rounds of 4.1-inch ammunition.

The normal storage of 22-pdr. ammunition in later U.C. class submarines is reported to be 120 rounds, but it is known that on service double this number is at times carried.

Table of Ammunition.

The information contained in this table has been extracted from the German Ammunition Handbook captured during the War. It may therefore be taken as authentic. Descriptions of the projectiles, types of powder, fuzes, &c., will be found in the letterpress of this report.

Gun.	Nature of Projectile supplied.	Length in Calibres.	Composition of Burster.	Weight of Burster.	Fuze.*	Gaine.	Total Weight of Projectile.	Full (Action) Charge.	Practice Charge.	Remarks.
3.5-in. 15-pr. (8.8-cm.) Q. F. L/30 and L/35.	H. E. (Nose Fuze).	2.6	F. P. C/02 or Grf. C/88	Lbs. .926	Nose Fuze C/89	Small C/98	Lbs. 15.4	L/30 guns with M. V. 2,021 f. s. 2.53 lbs. R. P. C/00 or C/06 (290×5/2½). L/30 guns with M. V. 2,198 f 2.78 lbs. R. P. C/00 or C/06 (290×5/2½). L/35 guns. 3.68 lbs. R. P. C/00 or C/06 (290×6/2½).	1.05 lbs. W. P. C/89 or C/07.	
	H. E. (Internal Fuze).	2.8	" "	.853	Internal Delay Action.	"				
	C. I. Common (Nose Fuze).	2.6	Black powder.	.485	Nose Fuze C/89	"				
	Practice Shell	2.6	Sand and sawdust	.....	" "	.....				
3.5-in. 22-pr. (8.8-cm.) Q. F. L/45.	H. E. (Nose Fuze).	3.6	F. P. C/02 or Grf. C/88	1.40	Nose Fuze C/89	Small C/98	22.0	5.13 lbs. R. P. C/06 (470×9/4) or R. P. C/12 (470×6½/3).	2.31 lbs. R. P. C/00 or C/06 (290×5/2½).	
	H. E. (Internal Fuze).	3.8	" "	1.41	Internal Delay Action.	"				
	Practice Shell	3.6	Sand and sawdust	(Adjustable)	Nose Fuze C/89	Large C/98				
4.1-in. (10.5-cm.) Q. F. L/35, L/40, and L/45.	H. E. (Nose Fuze).	3.4	F. P. C/02 or Grf. C/88	1.97	H. E. (Nose Fuze).	Large C/98	38.4	L/35 guns. 6.24 lbs. R. P. C/00 or C/06 (544×11/6). L/40 guns. 7 lbs. R. P. C/00 (544×11/6). L/40 and L/45 guns. 6.83 lbs. R. P. C/06 (544×11/6), or 7 lbs. R. P. C/12 (544×7¼/4). 2 lbs. 5 oz. R. P. C. (213×4¼×2½).	3.04 lbs. R. P. C/00 or C/06 (263×4½/2½).	
	H. E. (Internal Fuze).	3.8	" "	2.58	Internal Delay Action.	Small C/98				
	C. I. Common (Nose Fuze).	3.7	Coarse-grained powder	.771	Nose Fuze C/98	Small Zundschlag C/91.				
	Shrapnel	3.0	Black powder	.374	T. & P. C/92.99	Magazine ring C/92.				
	Practice Shell	3.4	Nil	Nil	Nose Fuze C/98	Large C/98				
	Star Shell†	.....	F. G. Powder	About 3 oz.	.....	.....	.....			
5.9-in. (15-cm.) Q. F. L/40.	H. E. (Nose Fuze).	2.9	F. P. C/02 Grf. C/88	4.41	H. E. (Nose Fuze).	Large C/98	.....	M. V. 2,460 f. s. guns. 20.16 lbs. R. P. C/00 or C/06 (550×11½/4½). M. V. 2,625 f. s. guns 21.82 lbs. R. P. C/00 or C/06. (550×11½/4½).	7.71 lbs. R. P. C/00 or C/06 $\left(\frac{290}{260}\times 5/2\frac{1}{2}\right)$.	
	H. E. (Base Fuze).	3	" "	3.57	H. E. (Base Fuze).	"	.....			
	A. P. Shell	2.9	F. P. C/02	1.91	Delay Action (Base Fuze).	C/08	.....			
	C. I. Common (Nose Fuze).	2.9	F. P. C/02 and pitch	(Practice) .264.	H. E. (Nose Fuze).	Large C/98	.....			
	Shrapnel	2.6	Black Powder	.992	T. & P. C/92.99	Magazine ring C/92.	.....			
	Practice Shot	2.7 2.6	Nil	Nil	.....	.....	.....			
	H. E. (Nose Fuze).	3.1	F. P. C/02 Grf. C/88	6.61	H. E. (Nose Fuze).	Large C/98	.....			
5.9-in (15-cm.) Q. F. L/45.	H. E. (Nose Fuze).	3.5	F. P. C/02	8.37	H. E. (Nose Fuze).	Large C/98	99	29.2 lbs. R. P. C/06 $\left(\frac{275}{550}\times 11\frac{1}{2}/4\frac{1}{2}\right)$. or 30.2 lbs. R. P. C/12 (825×10/4).	11.8 lbs. R. P. C/06 $\left(\frac{290}{290}\times 6/2\frac{1}{2}\right)$.	
	"	3.3	"	5.51	"	"				
	H. E. (Base Fuze).	3.4	"	5.54	H. E. (Base Fuze).	Long C/08				
	A. P. Shell	3.2	"	2.19	Delay Action (Base Fuze).	"				
	C. I. Common (Nose Fuze).	3.3	"	(Practice) .308	H. E. (Nose Fuze).	Large C/98				
6.7-in. (17-cm.) Q. F. L/40.	H. E. (Nose Fuze).	3.0	F. P. C/02 or Grf. C/88	7.71	H. E. (Nose Fuze).	Large C/98	141	51.8 lbs. R. P. C/00 or C/06 (1040×17/7) or 50.7 lbs. R. P. C/12 (1040×12/5).	16.5 lbs. R. P. C/00 or C/06 $\left(\frac{290}{290}\times 5/2\frac{1}{2}\right)$.	
	A. P. Shell	3.0	F. P. C/02	3.96	Delay Action (Base Fuze).	C/08				
	C. I. Common (Nose Fuze).	3.0	"	(Practice) 330.	H. E. (Nose Fuze).	Large C/98				
	C. I. Common (Base Fuze).	3.3	C. G. bursting powder	3.74	Base Fuze C/00	Zundschlag C/98.				
	Shrapnel	2.7	Black powder	1.54	T. & P. C/92.99	Magazine ring C/92.				
	Practice Shot	2.7	Sand and sawdust	(Adjustable)	.....	.....				
8.2-in. (21-cm.) Q. F. L/40 and L/45.	H. E. (Base Fuze).	3.1	F. P. C/02	15.18	H. E. (Base Fuze).	Long C/08	238	L/40 guns. 65 lbs. R. P. C/00 or C/06 (845×17/7). L/45 guns. Main 65 lbs. R. P. C/06 $\left(\frac{422}{845}\times\frac{17}{7}\right)$ ditto. Fore 12.3 lbs. Total 77.3 lbs.	29.1 lbs. R. P. C/00 or C/06 $\left(\frac{290}{290}\times 6/2\frac{1}{2}\right)$.	Full charge in two parts, *see* p. 6.
	A. P. Shell	2.9	"	7.67	Delay Action (Base Fuze).	C/08				
	C. I. Common (Base Fuze).	2.9	F. P. C/02 and pitch	(Practice) 1.07	H. E. (Base Fuze).	Long C/08				
	Practice Shot	2.6	Sand and sawdust	(Adjustable)	.....	.....				
9.45-in. (24-cm.) Q. F. L/40.	A. P. Shell	2.6	F. P. C/02	6.75	Delay Action (Base Fuze).	C/08	309	94.3 lbs. R. P. C/00 or C/06 (1040×17/7).	38.8 lbs. R. P. C/00 or C/06 (544×11/6).	
	C. I. Common (Base Fuze).	2.6	"	(Practice) .727.	H. E. (Base Fuze).	Large C/98				
	C. I. Common (Base Fuze).	2.8	C. G. bursting powder	6.35	Base Fuze C/98	Zundschlag C/98				
	Practice Shot	2.3 2.4	Sand and sawdust	(Adjustable)	.....	.....				
11-in. (28-cm.) Q. F. L/40.	H. E. (Base Fuze).	2.9	F. P. C/02	35.59	H. E. (Base Fuze).	Large C/98	529	145.5 lbs. R. P. C/00 or C/06 (1230×17/7).	51.8 R. P. C/00 or C/06 $\left(\frac{544}{\frac{142}{544}\times 11/6}\right)$	
	A. P. Shell	2.6	"	11.02	Delay Action (Base Fuze).	C/08				
	C. I. Common (Base Fuze).	2.9	C. G. bursting powder	11.64	Base Fuze C/00	Zundschlag C/98.				
	" "	2.6	F. P. C/02	(Practice) .992.	H. E. (Base Fuze).	Large C/98				
	Practice Shot	2.4	Sand and sawdust	(Adjustable)	.....	.....				

* These are the fuzes mentioned in the German Ammunition Handbook. In a few cases specimens of later types of fuzes have been recovered, *vide* pages 10 and 11.
† The source of this information is a recovered round of ammunition.

TABLE OF AMMUNITION—*continued.*

Gun.	Nature of Projectile supplied.	Length in Calibres.	Composition of Burster.	Weight of Burster.	Fuze.*	Gaine.	Total Weight of Projectile.	Full (Action) Charge.	Practice Charge.	Remarks.
11-in. (28-cm.) Q. F. L/45 and L/50.	A. P. Shell	3.2	F. P. C/02	Lbs. 19.74	Delay Action (Base Fuze).	Long C/08	672	Main 165.3 lbs. R. P. C/06 $\left(\frac{615}{1230}\times 28/13\right)$.	Main 86 lbs. R. P. C/00 or C/06 $\left(\frac{550}{130}\times 11\frac{1}{4}/4\frac{1}{2}\right)$.	Full charge in two parts, *see* p. 6.
	Substitute A. P. Shell.	3.2	"	(Practice)	" "	"	672			
	C. I. Common (Base Fuse).	3.2	"	1.65 " "	H. E. (Base Fuze).	"	507	Fore 52.9 lbs. ditto.	Fore 41.9 lbs. ditto.	
	Practice Shot	3	Sand and sawdust	(Adjustable)	.....	.....	672	Total 218.2 lbs.	Total 127.9 lbs.	
12-in. (30.5-cm.) Q. F. L/50.	H. E. (Base Fuze).	3.8	F. P. C/02	59.08	Delay Action (Base Fuze).	Long C/08	893	Main 201 lbs. R. P. C/12 (1230×18/8)	Main 98 lbs. R. P. C/00. $\left(\frac{550}{130}\times 11\frac{1}{4}/4\frac{1}{2}\right)$.	Full charge in two parts, *see* p. 6.
	A. P. Shell	3.4	"	25.4	" "	"	893	Fore 76 lbs. ditto.	Fore 52 lbs. ditto.	
	Substitute A. P.	3.4	F. P. C/02 and pitch	(Practice) 1.65 " "	" "	.....	893	Total 277 lbs.	Total 150 lbs.	
	C. I. Common (Base Fuze.)	3.4	F. P. C/02		H. E. (Base Fuze).	Long C/08	694			

* These are the fuzes mentioned in the German Ammunition Handbook. In a few cases specimens of later types of fuzes have been recovered, *vide* pages 10 and 11.

The maximum rate of fire with ammunition in readiness is about 100 rounds per minute The barrel has six grooves of right-handed rifling, the twist being half a turn in the length of the barrel.

Details of Small Arms.

Rifle.	Calibre.		Weight.		Total length.		Cartridge.		Muzzle Velocity.
	Mm.	Ins.	With Bayonet.	Without Bayonet.	With Bayonet.	Without Bayonet.	Charge.	Bullet.	
			Lbs.	Lbs.	Ft. Ins.	Ft. Ins.	Grs.	Grs.	f.s.
Mauser, Mod. 1898	7.9	.311	9.87	9.0	5 9.75	4 1.4	40.75	227	2093*
Automatic pistol, Mod. 1904	9.0	.354	.....	2.02	.....	.....	49.38	1.543	2820†
								123.4	

* Old bullet. † S. bullet.

Bayonet.

The bayonet is unusually long; it is provided with a straight rib which forms the back for two-thirds of its length, but for the remainder of its length the blade extends on both sides of the rib, and is double edged. There is no cross-piece on the side of the hilt next the barrel.

Cutlass.

The cutlass supplied to ratings not armed with rifles is a short broad-sword; the blade is curved and about 2 ft. in length, but the back is almost straight. The greatest width of the blade, 2 ins., is some 8 or 9 ins. from the point. The guard is large and efficient, and the weapon is strong and well balanced.

Supply of Small Arms to Ships.

Each seaman is supplied with his own rifle, which he takes with him wherever he goes.

Rifles have in some cases been withdrawn from the men of the Second Torpedo Division, and automatic pistols, model 1904, with removable shoulder pieces, issued in their stead.

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C. B. 1182.

GERMAN NAVY.

PART IV.

SECTION 3.

TORPEDOES, MINES, ETC.

Part IV. Section 3.

Torpedoes.

SECTION 3.

TORPEDOES, MINES, ETC.

TORPEDOES.

Government Torpedoes.

General Notes.

The Torpedo Service (Torpedo-Abteilung) is said to be the most sought-after branch of the German Navy and to contain some of their smartest officers.

There is little doubt that a great deal of reliance has been placed on the work of the torpedo flotillas, and that during hostilities with any but the greatest Naval Power very great things would be expected of them. The training in this branch has been most thorough and a great deal of it is carried out in very bad weather.

Types in Use.

The following table shows the main features of torpedoes which are known to be in use in the German Navy:—

Size. Ins.	Type.	Date.	Heater.	Range on Counter. Metres.	Estimated Speed to this Range. Knots.	Charge. Lbs.	Charge. Nature.	Remarks.
17.7-in. (45 cm.).....	Bronze	1895–8	None.	2,400	18	250	Wet G.C.	*See* page 3.
17.7-in. (45 cm.).....	"Emden"	1907	Dry	4,000	24–25	300	Wet G.C.	" " 4.
17.7-in. (45 cm.).....	Improved "Emden."	.....	Dry	4,000	.....	.....	.....	" " 5.
17.7-in. (45 cm.).....	Fiume	Ordered 1913 for Brazil.	Dry	4,000	29	351	Hexanite	" " 8.
17.7-in. (45 cm.).....	Fiume	Ordered for Italy.	Armstrong Whitehead Wet.	6,000	.....	.....	.....	
19.7-in. (50 cm.).....	"G" and "K" improved "Emden" type, enlarged.	1911	Dry	6,000	30 Perhaps also 20 kn. for 12,000 m.	357	Hexanite	" " 5.
19.7-in. (50 cm.).....	.....	1913	Wet	12,000	.....	.....	.....	

In addition to the above it is considered possible that 21.6-inch (55 cm.) and 23.6-inch (60 cm.) torpedoes may be in use. There appears to be but little doubt that trials have been carried out with these. Details are not known.

Samples of the 17.7-inch bronze "Emden," improved "Emden," and Fiume (Brazilian) and 19.7-in. G s/m have been recovered, and a study of these makes the following progressive sequence of manufacture and development appear probable.

The original design was very similar to the normal Fiume cold torpedo. The "Emden" torpedo showed signs of having been a conversion of a development of this type to a Dry Heater.

The next stage of development appears to be the 17.7-inch recovered by the Russians in the Baltic, and the 19.7-inch ex U.B. 26 is simply an enlargement of this design.

The latest torpedo so far recovered, the 19·7-inch No. "K" 7460, is a very slight improvement on the U.B. 26 torpedo.

A fragment of shell of a German torpedo recovered has the word "Wasser" on it, the position of which tends to indicate that only a small water bottle is used and that the torpedo was

Depth-keeping Mechanism.

The depth-keeping mechanism is situated in the engine room. The connections of the weight and valve to the servomotor are very similar to those in the R. G. F. torpedoes.

The valve is under the weight.

There is a small auxiliary weight secured to the weight, and adjustable for position on the weight, the object being to enable adjustment of the turning angles for different weights of head.

Controlling Gear.

This is of a very unusual design. Besides the usual adjustments for distance and amount of rudders the gear can be set for a quick or a slow release, presumably for use from submerged or above-water tubes respectively. The maximum distance is 110 metres (120 yards). A sinking hook is fitted.

Valves, &c.

The charging valve is in the same casting as the starting valve, abaft it. There is no stop valve.

The reducer is similar to the early R. G. F. bucket type.

Engines.

The engines are 3-cylinder, and are entirely of phosphor-bronze.

The cylinders exhaust through exhaust ports in the walls at the end of the expansion stroke and through gudgeon exhaust ports on the return stroke.

The diameter of the cylinders is 3.79 inches, and the stroke 3.45 inches.

Gyroscope.

The gyroscope is of the ordinary spring drive rotary valve type, with a few modifications. There is no angling gear.

The air is cut off the gyroscope if the torpedo is fired uncocked, and the rudders are then locked central.

The extreme difficulty with which the gyroscope is entered and removed from the torpedo points to its having been added later.

Tail.

This is of the Woolwich type with very large square-shaped fins and large horizontal rudders. Both the horizontal and vertical rudders are let into the fins.

The tail is screwed to the after body. Two-bladed propellers are fitted.

General Remarks.

As a weapon this torpedo is about equivalent to our 18-inch R. G. F. Mark III or IV. The date of the torpedo is thought to be between 1895 and 1898.

The workmanship throughout is excellent.

"Emden's" 17.7-inch (45 c. m.) Torpedo No. 3352.

A fuller and more technical description of this torpedo will be found in the Annual Report of the Torpedo School, 1915, pages 91 *et seqq.*

The following are the general features and dimensions of this torpedo:—

Diameter	45 cm. (17.7 inches).
Length over all	16 feet 11 inches.
Capacity of air vessel	10 cub. ft. (estimated).
Working air pressure	150 kg. per cm.^{2} = 2,150 lbs. per square inch.
Total weight uncharged	1,410 lbs.
Weight of head, empty	59¾ lbs.
Weight of guncotton	300 lbs. (estimated).
Maximum range on counter	4,000 metres.
Discharge fittings	Hook brackets.
Heater	Dry.
Engines	3-cylinder.
Propellers	3-bladed.

This torpedo is a development of the Fiume design. The body is of steel and working parts of bronze.

The warhead and pistol are similar to those of the old bronze torpedo described on pages 3 and 4, but the head is bluffer.

Maximum range on counter	6,000 metres.
Estimated speed to this range	30 knots.
Discharge fittings	Top suspension.
Heater	Dry.
Engines	4-cylinder.
Propellers	3-bladed.
Tail	Woolwich type.

Warhead.

The warhead has a case of thin high-per-cent. nickel steel, and is closed at the rear end by a tin door with screwed rivets sweated and soldered. There is no air space and no vent plug is fitted. The use of steel for the casing allows a large reduction in the weight of the shell.

The charge, which is covered with oiled silk, is a mixture of trotyl and hexanitrodiphenylamine (hexanite). This mixture has a rate of detonation slightly less than that of trotyl or amatol.

The contour of the head is identical with that of the exercising head shown on Plate 24*b*.

Pistol.

The pistol is similar to that described under the bronze torpedo on page 3, but external lugs are fitted to take the net cutter.

Net Cutter.

The net cutter recovered in the U. B. 26 is believed to be the latest pattern.

The cutter is an explosive one, and is shown on Plate 24*c*.

It consists of a metal case A, containing a charge of 3.8 oz. (109 grammes) of an explosive, the composition of which is trotyl 40 per cent., hexanitrodiphenylamine 60 per cent., with a primer of 11 grammes of tetryl surrounding one detonator, which is similar to the second detonator in the warhead primer. Another detonator similar to the one in the German pistol is screwed into the cap which forms the base of the case containing the charge.

To the case are secured four blades or whiskers, B, B, two of which are longer than, the other two the same length as, those on the pistol. The reason for this difference in length is not clear.

The points of the whiskers are of similar shape to those of the pistol whiskers, and their rear edges are formed to a cutting edge.

The case A fits into a brass casting C, and is secured to it by eight copper shearing pins which pass through lugs on the casting and through the whiskers.

The shearing pins are arranged in pairs and pass through slots in the whiskers, formed so that the first pair shear immediately on striking and the other three pairs shear in succession with a slight delay action between each operation.

The whiskers work in slots between the lugs of the casting C, which slots allow the required movement to the rear.

Into the rear end of C is screwed a steel striker which remains opposite the detonator in the cap of A, and through slots in C just in rear of this cap passes a safety pin D, to which is secured a long lanyard E. This lanyard is of such a size and length that it ensures that the safety pin is not forgotten.

To other lugs F, F, on the casting C are pivoted four light steel rods G, G, about 18 inches in length, passing through steel tubes. This method of construction is apparently for the purpose of combining lightness with strength.

These rods are threaded at their rear ends and secure the cutter to lugs H, H, formed on the pistol body.

One of the tubes surrounding the rods G has an enlarged part J to which is pivoted a stop K which fits between a lug L on the head of the pistol striker and the pistol body. This prevents the striker going home.

With the cutter are supplied propeller guards which secure to the vertical tail fins and to the horizontal tail fins.

The action of the cutter is as follows:—

On the torpedo striking a net the whiskers B, B are caught in the grommets and forced to the rear, shearing the shearing pins. Owing to the delay arrangements of the shearing pins the net is bunched round the whiskers by the time the striker enters the detonator.

The charge of explosive is then detonated and blows the case A, casting C, &c. to pieces, the knife edges on the back of the whiskers presumably increasing the destructive effect on the net. The charge is far enough away from the warhead to prevent sympathetic detonation.

At the same time the rods G, G are blown away, and the stop K should thus be withdrawn from under the head of the pistol striker leaving it free to function when the torpedo strikes the ship.

If the ship is not protected by nets the action is similar, as the cutter must fire before the pistol can fire.

Air Vessel.

This is of very large capacity. The ends are hemisperical. The great capacity is necessary in order to obtain a long range with a dry heater. No drain screw is fitted.

After Body.

The after body is divided into three compartments, viz., the engine room buoyancy chamber, and the air box for the hydrostatic valve gear.

Depth-keeping Mechanism.

There is no separate balance chamber, the depth mechanism being fitted in the engine room. The valve is a piston valve working in a cylinder inclined to the vertical. The depth index is just outside the opening and is very difficult to read. The maximum setting is for 12 metres (39.4 feet).

The servomotor is considerably larger than our own, and all connections are very stoutly built.

In torpedo No. "G" 5955 ex U. B. 26, a vertical weight is fitted, the object of which is not quite clear. It is thought that its object is to reverse the rudders in case of a roll of over 90°.

The same device is fitted in the 17.7-inch torpedo recovered by the Russians, but no such fitting appears in No. "K" 7460.

Counter, Controlling Gear, Valves.

The charging valve, starting valve, air delay valve, counter controlling gear, and reducer are all fitted in the engine room, and are similar in all essentials to those in the "Emden" torpedo described on page 5.

No sinking gear is fitted.

Engines.

The engines are generally similar to those of the "Emden" torpedo described on page 5, but differ in the following respects:—

They have four cylinders with gudgeon exhaust. The exhaust through the cylinder walls is also provided, but in the two lower cylinders only.

In No. "G" 5955 all parts are made of bronze, but in No. "K" 7460 the crank propeller and shaft are of steel.

Heater.

The heater system is situated in the buoyancy chamber, and is similar in all essentials to that of the "Emden" torpedo described on page 5.

In No. "G" 5955 the igniters can only be inserted by removing a door in the shell; in No. "K" 7460 a pocket is formed in the shell, and the igniter can be inserted from outside.

The ignition piston has two strikers and the igniter two caps.

The fuel used is methylated spirit.

There is no provision for any change in the speed setting.

Gyroscope.

The gyroscope is slightly different to that fitted in the "Emden" torpedo. The exhaust air from the steering piston is used for an air drive.

The gyroscope can be angled in steps of 15° up to 90° right or left. It is cocked from the outside of the shell, and can be angled from outside the tube.

Safety gear, similar to that in the "Emden" torpedo, is fitted, which locks the gyro and rudders if the torpedo is fired uncocked

Tail.

The tail is of the Woolwich type, and is generally similar to that of the "Emden" torpedo.

The propellers are three-bladed.

General Remarks.

Torpedo "K" 7460 generally resembles the G. 5955, but is evidently a later mark. The following are the principal differences between these two types.

In G. 5955 there is a small watertight space round the dome of the after end of the air vessel, to give greater buoyancy. This is omitted in "K" 7460, and the space is open to the sea, ballast weights being placed round the lower half of the hemisphere.

The vertical weight for reversing the rudders if the torpedo rolls over 90° is omitted in "K" 7460.

There are small differences in the generator mentioned on page 7 under "heater." Also there is a separate disc reducer for the gyroscope in "K" 7460.

Top suspension brackets are fitted, but the discharge fittings are suitable for end-on or above-water discharge only.

17.7-inch (45 cm.) Fiume Torpedo No. 11582.

This torpedo, which is of Whitehead Fiume manufacture, was originally ordered for Brazil and transferred to Germany. The following are the general features and dimensions so far as they are known:—

Diameter	45 cm. (17.7 inch).
Length over all	17 feet (approximately).
Length of air vessel	6 feet 10¾ inches.
Working pressure of air vessel	2,100 lbs. (probably).
Capacity of air vessel	11.5 cubic feet (approximately).
Total weight uncharged	1,500 lbs.
Weight of warhead without pistol and primer	488½ lbs.
Weight of pistol and primer	8 lbs.
Weight of explosive (hexanite)	351¼ lbs.
Maximum range on counter	4,000 metres.
Discharge fittings	T suspension.
Engines	4-cylinder Fiume.
Propellers	4-bladed.
Tail	Fiume.

Warhead.

The case is of steel, and the door was made tight by studs and nuts and a washer, as in our own torpedoes.

The head was fitted to take the Fiume ring net cutter (described on page 13), but no cutter was in place.

Pistol.

The pistol is of the Fiume inertia type, described on page 13.

Air Vessel.

The air vessel is made of nickel steel, and is fitted with a T suspension bracket at the centre of gravity of the torpedo and a guide stud on the foremost flange. The ends are hemisperical. No test and drain screw is fitted.

Balance Chamber and Depth-keeping Mechanism.

The shell is of thin sheet steel, and the door of bronze. Besides the depth-keeping mechanism, which is of Uhlan type, the balance chamber contains the stop valve and charging valve.

Counter, Controlling Gear, Servomotor, &c.

These are of normal Fiume type. The maximum range on the counter is 4,000 metres. The sinking valve is worked by the counter, as in our Fiume Mark III torpedoes.

The reducer is of the usual Fiume oil delay type.

Engines.

The engines are of normal Fiume 4-cylinder type, except that of the slide valves and water-relief valves are made of steel.

Heater.

The heater is exactly similar to our Weymouth Mark I torpedoes, except that the generator and fuel bottles are joined by a casting which contains the air and fuel leads. Hammer ignition is fitted, and the fuel used is methylated spirit.

Buoyancy Chamber.

The buoyancy chamber contains only the gyroscope, which is of the usual Fiume type, namely, air operated with a heavy wheel which is spun by a small air turbine. The gyroscope is an angled gyroscope, but *not* fitted with angling gear.

Tail.

The tail is of the Fiume type, with rudders abaft the propellers, which are 4-bladed.

17.7-inch (45 cm.) Fiume Torpedo, No. 13555, fired from Seaplane.

The following are the principal weights and dimensions of a Fiume torpedo recently used by a German seaplane off the coast. This is practically a standard Fiume torpedo.

Diameter	17.7 ins. (45 cm.).
Length overall	17 ft. 7 ins.
Tail	Fiume type.
Weight of head	420 lbs.
Weight of charge	350 lbs. (estimated).
Weight of torpedo, all on	1,681 lbs. (approx.).
Range on counter	6,000 metres.

The pistol is generally similar to the specimens of German make, but all parts are of bronze, and the striker is screwed to the rear by a small fan attached to a fork as in our own A. W. pistols. The air vessel is of approximately the same capacity as that of the R.N.T.F. Mk. VIII. torpedo.

All parts of the engine, excepting the slide valves, are made of bronze.

The torpedo is a heater weapon, the bronze fuel and water bottles containing approximately 6 lbs. and 54 lbs. respectively.

Sizes of Torpedoes carried in more modern Ships.

The "Nassau" and earlier battleships carry 45-cm. (17.7-inch) torpedoes.

It is believed that all later battleships carry 50-cm. (19.7-inch) torpedoes.

Of the battle cruisers, the "Von der Tann" carries 17.7-inch, and the remainder, up to and including the "Seydlitz," carry 19.7-inch torpedoes.

T.B.D.'s up to and including those of the 1908–9 programme (V 162, S. 165, &c.) carry 17.7-in. and later boats 19.7-inch torpedoes.

Submarines up to U 20 carry 17.7-inch and later submarines 19.7-inch torpedoes. For full information in this respect, *see* Part III. of this Report. It is possible that the latest submarines have larger torpedoes but there is no evidence at present to support this.

Conversion of Older Torpedoes.

In the estimates for 1913–14 it was stated that the conversion of older torpedoes, which was commenced in 1912, had proved so successful that the whole stock of older torpedoes would be similarly converted at a total cost of 93,000*l.*

It is probable that owing to the extensive use of torpedoes in the submarine warfare against merchantmen, the greater part of the older torpedoes has now been expended.

Schwartzkopff Torpedoes.

(*See* Plate 25.)

So f[illegible]rally made for the German Navy.

The following are some details of the latest Schwartzkopff torpedoes:—

21-in. (53.3-cm.) Schwartzkopff Torpedo.

		Speeds (at 77° F.).		
Explosive charge	397 lbs. T. N. T.			
Air vessel	Krupp nickel steel.			
Working pressure	2,205 lbs. per sq. in.	42	knots for	2,200 yards
Fuel	Benzine.	38	" "	4,400 "
Heater	Gesztesy.	32	" "	6,600 "
Buoyancy	207 lbs.	20.5	" "	10,900 "

Bronze and not steel is used in the engines. At trials $\frac{1}{10}$th of the torpedoes are run 8,750 yards at a speed of not less than 29½ knots, and $\frac{1}{10}$th to 11,000 at a speed which is not stated.

17.7-inch (45-cm.) Schwartzkopff Torpedo.

The latest type of 17.7-inch (45-cm.) Schwartzkopff torpedo is a water heater weapon and is fitted with an angled gyroscope. The following are the details, so far as is known:—

War Head.

The charge consists of either 200 lbs. of guncotton or 225 lbs. of T. N. T.

Exercising Head.

This is of ordinary type and is shown on Plate 25. There is a central tube for an indicator light holder.

Pistol.

There is nothing very remarkable about this. It is secured into the head by radial screws through the nose. The whiskers are short and strong as is usual in German pistols. There is no safety fan.

Air Vessel.

Length, 6 feet 11 inches, with hemispherical ends. Fitted with T-shaped top suspension.

Balance Chamber.

Length, 2 feet 3 inches. This contains the depth gear, water bottle, and charging valves.

Depth Gear.

This is practically standard pattern, *i. e.*, the weight and the valve act separately. The servomotor is in general design the same as our own.

After Body.

The valve group is of modified Fiume pattern. The air delay valve is of Fiume type and worked by both top and bottom flaps.

Stopping is effected by a strong spring, which is released by a stud on the range wheel and which pulls the air lever forward. The sinking valve is operated by the action of the air lever going forward.

Reducer.

This is of the ordinary Fiume type.

Engine.

This is a four-cylinder radial Fiume machine of ordinary type with Fiume valve gear.

Generator.

This is practically the same in principle as that in R. G. F. torpedoes. The capacity of the water bottle is 200 ozs. and that of the fuel bottle 40 ozs.

Gyroscope.

Fitted in the buoyancy chamber is what is believed to be a Kasielovski gyroscope. This gyroscope is air *spun* but not air *driven*. The angling is up to *about* 45° each way.

Tail.

The tail is of R. G. F. type, the rudders being before the propellers. These latter are four-bladed.

Range.

The maximum range on the counter is 4,000 metres (4,375 yards).

Speed.

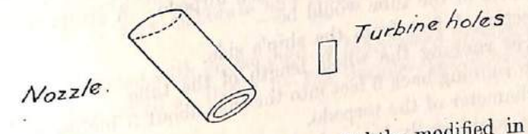
The speed has been reported to be 37.5 knots for 2,200 yards and 32 knots for 3,300 yards.

Schwartzkopff Gyroscopes.

The gyroscope is as much an integral part of the torpedo as are the main engines. It is adjusted at the torpedo depôt for its own torpedo, it is kept in the torpedo, and if any damage is done to it, the whole torpedo is returned to the depôt.

In a certain navy, Schwartzkopff torpedoes which have been in a destroyer for a year without any alteration of adjustment, or any verification beyond the usual swinging of the torpedo test before running, have in every case run absolutely straight.

The air-drive is supplied by two fixed pipes which play tangentially on the wheel; the nozzle is large and the turbine holes of the wheel are rather broad, but of the same shaped section as those in our service.



It is believed that this arrangement has been slightly modified in the latest pattern gyroscope.

There are two releases, one actuated by the air lever on the outer gymbal, and similar to our hand clutch, and one delay action on the inner gymbal. The delay is obtained by an air bottle which is filled slowly from a small pipe. When the pressure is sufficient, a spring is forced in and the clutch withdrawn. The adjustment is such that time is given to the gyroscope to attain its full speed before release. The air is admitted through a valve, actuated by a bell-crank, which is pressed down by the top of the tube. When the valve closes on its leaving the torpedo tube, the gyroscope cannot again be locked until the air lever goes forward, when the two clutches again automatically lock the torpedo.

The gyroscope has a slide and not a rotary valve.

Results obtained with this gyroscope are excellent, and wandering never occurs.

General Notes on Schwartzkopff Torpedoes.

It has been reported that Schwartzkoff torpedoes do not run well in cold weather.

Early in 1913 Schwartzkopff had only two trial 21-inch torpedoes with a maximum range of 6,000 metres.

Leon's Automatically-steered Torpedo.

It was reported, in July 1909 that Messrs. Siemens and Halske had received a contract to manufacture a torpedo of this description. The invention consists of microphone receivers, fitted each side of the head of the torpedo, connected by relays to a servomotor which works the vertical rudders. It is claimed that if the torpedo is within 200 to 300 metres of a vessel, the sound waves emitted from the propellers act on the microphone in such a manner as to attract the torpedo to it.

The apparatus is said to have been tried by the German Admiralty, with what result is not known, but an inventor was told by the German Government, in 1912, that they had no use for a dirigible torpedo.

Methods of Discharge.

Submerged Tubes in Battleships and Cruisers.

Stem Tube.—It is believed that a stem tube is fitted in all battleships, battle cruisers, and armoured cruisers.

In the "Thüringen" class the tube is placed underneath the ram at 19 feet 8 inches below the water line.

Broadside Tube.—Both Whitehead's and Kasielovski's systems of broadside tubes have been experimented with, but the type actually adopted is stated to be more like that in use in our Service, the bar being run out before the torpedo is discharged. The tubes in the older ships are said to be always fixed on the same bearing, viz., about 15° before the beam. The torpedoes have two attachments to the bar, consisting of a T-piece in rear and two hook pieces in front.

In later ships the broadside tubes are said to be on a bearing of about 20° before the beam and are fitted with gyro angling gear which is capable of angling the torpedo in steps of 15° from 30° before to 60° abaft the line of the tube. This angling gear can be adjusted from outside the tube.

All battleships carry four broadside tubes, two on each side; in the "Thüringen" these are 13 feet 1½ inches below the water line forward and 11 feet 6 inches aft. All battle and armoured cruisers carry two broadside tubes, one on each side, except the "Fürst Bismarck" which carries two on each side.

"Emden's" Broadside Submerged Tube:—The only information which has been obtained in connection with submerged tubes in big ships, from war experience, has been derived from a study of the fittings on the "Emden's" 17.7-inch torpedo. A study of these tends to show that the leading features of the tube would be—

(*a*) A bar projecting 5 feet from the ship's side.
(*b*) Guide grooves running the whole length of the tube.
(*c*) A bell mouth running back 6 feet into the tube about 5 inches wider on the after side than the diameter of the torpedo.
(*d*) Such a tube could easily be made side-loading and the torpedo could be fired with the ship steaming at 25 knots.

Stern Tube:—All battleships and armoured cruisers up to, but not including, the "Kaiser" class carry a stern tube. In older ships it is fitted under the port quarter, the outer end being slightly abaft the centre propeller. It is located from 5 to 6 feet below the water line and is far enough from the center line to be well clear of the rudder. The wash of the screws does not seem to have much effect on the torpedo when fired. With the introduction of double rudders it is now, in the "Nassau" and the later classes, placed in the centre of the stern. In the "Thüringen," the stern tube is 4 feet 11 inches below the water line.

No form of bar is used in the stern tubes. The grooves for the side lugs of the torpedo are placed about an inch above the greatest diameter of the tube.

The above-water stern tubes in the older ships, although still retained, are no longer used.

T. B.'s and T. B. D.'s.

The destroyers of the 1909–10 programme, and onwards, carry either four or six 19.7-inch tubes. It has been reported that the tubes of the later boats are made of aluminium. Details of the tubes in destroyers carrying 19.7-inch torpedoes are not known. It is, however, reported that torpedoes are usually fired from the bridge.

All T. B. D.'s up to the 1908–9 programme carry three 17.7-inch single revolving A. W. tubes. There is no carriage, shield, or training gear, but in 1904 it was reported that cogged racer training gear was to be introduced in future manufacture. The tubes are very much lighter and thinner than those formerly fitted in our T. B. D.'s before the adoption of the light 18-inch pattern. The racer is very light, and the fore end of the tube, which is supported by a roller running on the racer, is fitted with a spring stop engaging in slots cut in the racer rim. There is also a roller under the after part of the tube. The pivot is very slight.

The door of the tube is easily opened and closed, being secured with a link over a strengthening arm, which forms the hinge and carries the door, and which is then jammed by an eccentric.

The firing gear, which is mechanical, cannot be released unless the door is properly secured. It is actuated by means of a press knob on the top of the tube, a spiral spring arrangement then performing the operations of withdrawing the stop in front of the top suspension of the torpedo, and striking the percussion cap of the cartridge inserted in a pocket near the top of the door. The firing gear extends to the rear of the tube, and is there supported by a right angle bracket capable of being revolved to clear the door when opening, by simply removing a plain pin.

The tube is never without its cover on at the fore end, the cover being laced tightly on and extending abaft the lip, so that the head of the torpedo cannot be seen.

Collision Heads.

Collision heads used to be made of copper, with 20 very thin brass discs, each about 2 inches in diameter, let in. They were filled with water.

It was reported in 1909 that collision heads had been discarded, and that exercising heads were used, torpedoes being set to run at 10 metres (32.8 feet) depth, when fired against ships as targets.

Net Cutters.

Two types of net cutters are known to be in use, the standard Fiume explosive type and the outrigger explosive type, which is believed to be of German naval design.

Fiume Explosive Cutter.

The cutter consists of a hardened steel knife edge ring, A (*see* Plate 25*a*), secured to the nose of the warhead, B, which is specially shaped to receive it.

Screwed to the base of this ring is a copper charge ring, C, containing 3 oz. of fine-grained powder, D. In the charge ring are six percussion caps, E. A cover ring, G, in rear of the charge ring carries six strikers, H, each opposite their own percussion cap. The cutting ring and charge ring are held clear of the strikers by means of shearing pins, J. When the torpedo strikes a net the shearing pins, J, are sheared, and the ring is driven back against the strikers, which, striking the percussion caps, fire the charge. This throws the cutting ring violently forward and it cuts the net. This cutter will not penetrate our latest harbour defence nets.

Fiume Inertia Pistol.

In conjunction with this cutter an inertia pistol is used. This pistol consists of a pendulum capable of movement either athwartships or fore and aft in the torpedo. The pendulum is locked before firing and released during the first 25 yards of the run by the action of a small paddle wheel. The pendulum is then steadied by springs which prevent its movement excepting when a considerable shock is given to the torpedo. On impact either nose on or obliquely the steadying springs are overcome and the pendulum swings in either a fore and aft or athwartships direction. This frees the toe of a bell crank lever, which in turn releases the striker, which flies forward and strikes the detonator.

When recovering a torpedo fitted with this pistol it should be remembered that the pistol is in a dangerous state and that any severe blow to the body of the torpedo in any direction may fire the pistol.

German Naval Design.

A description of the net cutter of German naval design recovered from the U. B. 26, which is believed to be the latest German cutter, will be found on page 6 under the description of the 19.7-inch torpedo. This cutter will not penetrate our latest harbour defence nets.

The cutter is shown on Plate 24*c*.

Heaters.

Descriptions of the heaters of recovered torpedoes will be found on pages 5, 7, and 9. They are generally similar to the Weymouth Mark I* heater in H. M. Service. It is believed that a "wet" heater or "steam" heater is in use in long-range torpedoes, but no details of this are known. Heater torpedoes are known as Anwärmevorrichtung A.V. torpedoes.

Gyroscopes.

Descriptions of gyroscopes from recovered torpedoes will be found on pages 4, 5, and 7. In all cases safety gear is fitted which locks the gyroscope and rudders in the event of the torpedo being fired uncocked.

The latest design is air-driven and can be angled in steps of 15° up to 90° either way.

After experiment, the manufacturing rights for the Obry gyroscope were purchased by Germany. In 1904 it was reported that the gyroscope had been improved, and, though spun by a spring, required no cocking. At the same time, it was stated that it was fitted with a very efficient form of safety gear, and that, no matter what went wrong with the gyroscope, the rudders were immediately centred.

In 1906 it was reported that the German Admiralty had, pending the settlement of the purchase price, temporarily taken over the patent relating to a modification to the Obry gyroscope, proposed by a Dr. Anschütz. The improvement consists of an electrical arrangement by means of which the gyroscope is kept spinning at maximum speed for a considerable period.

The item for torpedo exercises, &c., in the 1910 Navy Estimates was nearly double the amount voted in the previous year; it was remarked that torpedo warfare had undergone great development, and that a prize had been introduced for good torpedo shooting.

According to a report received, new regulations were introduced in 1913, regarding the practices carried out by torpedo flotillas, the chief features of which were said to be as follows:—

(1) Each torpedo carried must run at least once every two months. (Previous reports stated that three torpedoes were kept for practice purposes and that the remainder were *not* usually run.)
(2) Practice was to take place more frequently, especially in rough weather.
(3) The maximum range was increased to 5,000 metres. (Previously it had been 2,000 metres.)

Squadron Firing.

It is known that squadron firing with torpedoes was carried out by four light cruisers in October 1913.

Torpedo Directors.

In the "König" the torpedoes are fired from the foremost compartment of the conning tower, where the directors, &c., are fitted. It is not known whether they can also be fired from other positions.

In the "Braunschweig" class there are 10 torpedo directors, viz.:—

3 in the fore conning tower.
3 " after " "
1 at the fore end of each battery.
1 " after " "

Each broadside tube has three director positions. A torpedo in the starboard foremost tube, for instance, can be fired either from the director position in the fore or after conning towers or from the director at the foremost end of the starboard battery.

The positions of the directors in the batteries can be seen by the slits in the armour, as shown in the photographs of most of the battleships.

The senior Lieutenant (T) is stationed at the directors in the fore conning tower and the junior Lieutenant (T) in the after director tower. These officers have no other duties in a day action. The officers of quarters in the batteries work the directors in the batteries if those in the conning tower become disabled.

The course and speed of the enemy are judged by the director officer.

In older T. B. D.'s the director is of the circular type and fits on a spill at the rear end of the tube. A similar spill with director, raised above the bridge rails, is fitted on the bridge on each side to enable the Commanding Officer to check the aim or, if necessary, to fire by signal to the tube.

In the latest T. B. D.'s torpedoes are fired electrically from the bridge, where a director is fitted on either side.

Communications from Directors.

In each conning tower, alongside each director, is a combined incandescent lamp transmitter to, and receiver from, the tube. In addition, two voice-pipes on each side are fitted to the broadside, and one to the bow or stern, submerged flats.

Torpedo Adjusting Ranges.

Wilhelmshave .

There is a torpedo adjusting range in the Ausrustungshafen at Wilhelmshaven.

Strande Bay

The torpedo testing and adjusting station for Kiel is situated on the west side of the entrance to the harbour in Strande Bay, close to the village of Schilksee. The range is from 4,000 metres (4,374 yards) to 5,000 metres (5,468 yards) in length, and is absolutely free from all interference by shipping, &c. The firing pier is 330 metres (361 yards) in length, and the establishment includes dwellings, workshops, and coal store.

In January 1909 it was reported that the furthest target stage on the range was at a distance of 3,500 yards from the firing station.

Friedrichsort.

There is also an old range at Friedrichsort, where at the end of 1908 two ranges of 1,000 metres (1,094 yards) and 2,000 metres (2,187 yards) in length, respectively, were seen in use. The shorter range had three targets and the longer two. The firing pier is a very rough structure and the range is managed on the same lines as our own.

Eckenförde Bay.

The new torpedo range at Eckenförde Bay, which is about 20 miles from Kiel, was opened in 1913. It is said to be nearly 14,000 yards in length. The buildings to accommodate the technical staff, together with the shops and practice pontoons, are situated near the village of Altenhof, on the south side of Eckenförde Bay. This range was constructed as the two existing ranges at Friedrichsort and Strander Bay were not sufficiently long for modern torpedoes.

Distance Controlled Explosive Boat.

Experiments have been carried out with a motor boat controlled from a distance and carrying an explosive charge. This weapon has been brought to a certain degree of efficiency, and consists of a high-speed motor boat (speed about 30 knots) carrying in the bow a considerable quantity (said to be about 1 ton) of explosive. The boat is driven by an internal combustion engine and steered by means of electrical controls operated through an insulated wire which is carried on a drum in the boat.

The length of wire carried is said to be about 65 miles and this is paid out through the stern of the boat as it progresses on its course. The explosive in the head is detonated on impact.

The boat is "conned" by an observer in an accompanying aircraft, who transmits directions by W/T to the controlling station. It has been stated that boats of this nature are now carried in some battleships.

Outrigger Torpedoes.

Outrigger torpedoes are not used in the German Navy.

TORPEDO NET DEFENCE.

Information has been received that after the Jutland action all torpedo nets were removed and that they are no longer carried.

Previously to this they had been re-introduced into the German Navy, commencing with the battleships of the "Nassau" class and the "Von der Tann." All subsequent battleships and battle cruisers up to and including the "Kaiser" class and the "Derfflinger" were fitted with nets. It was reported that they were hung double and half a metre apart.

It is believed that the nets were made by Messrs. Felton Guillaume of Düsseldorf. They are roughly F type nets, with double corrugated 2½-inch gromets, 15 gauge. The breaking strain of the wire is 125 tons per square inch. In the specification for wire no torsional test is required and the wire is therefore probably more brittle than that used in our F nets.

The booms are generally 10 metres (32.8 feet) apart, and the foremost boom is believed to be used as an outrigger and to have no nets attached.

Torpedo Protection Bulkheads.

Torpedo protection bulkheads are fitted in the "Thüringen" class and in later battleships and battle cruisers.

Naval Mines, Types I. to VI. (Plates 26 to 30).

The six known types are tabulated hereunder:—

Type.	Charge.	Probable Use.
Type I.	180 lbs.* Wet G. C.	An early type known to have been laid in the Scarborough operations and off the coast of Ireland in the early part of the War.
Type II.	290 lbs.* Wet G. C.	A large type with high buoyancy owing to its size is likely to be used only from minelayers. Used for more recent operations.
Type II. small	54 lbs. Hexanite	For use from above-water minelayers.
Type III.	220 lbs. T. N. T.	This type is a later design probably intended to replace Type I. and perhaps also Type II.
Type IV	220 lbs. T. N. T.	This is the Type III. mine adapted for laying from submarines.
Type V.	361 lbs. T. N. T.	As for Type IV.
Type VI.	Not known.	Ditto.

* Weight of the guncotton as extracted from the mines.

In the absence of direct evidence, it is at present considered probable that if these mines have taken up their depth after a delay of days, it has been due to accident rather than to design.

The effect, however, is the same, and there is no doubt that minefields laid by submarines have proved more difficult to clear than other minefields.

(*d*) The following point also requires emphasis:—

Types I. and II. mines have external wires leading to the detonator and can be rendered safe by cutting these wires.

In Types III., IV., and V. these wires are carried internally, and these types can best be made safe by withdrawing the detonator.

Nothing in this report should be taken as advocating the recovery of German mines by any but those who have had previous experience.

Table of Dimensions.

Type.	Total weight.	Weight of charge.	Buoyancy.	Length of shell.	Diameter, Maximum.
		Lbs.		Inches.	Inches.
Type I.	560	180	250	42	31½
Type II.	710	290	320	46	31½
Type II. small.	324	54	.....	37	25
Types III. and IV. 1st Design.	620	220	200	37	34
Type IV. "U.C. 5" Design.	.....	.....	.....	41¾	34
Type V.	835	361	281	46	34
Type VI.	.....	.....	.....	.....	.....

Mine Case and Charge Chamber.

All mine cases are of welded steel .2 inches thick.

In Types I. and II. a charge chamber is formed by a watertight platform, built across the lower part of the interior.

In Types III., IV., V., and VI. a cylindrical charge chamber is built into the lower part of the shell.

Brass bushes are screwed and sweated into bosses on the shell of the mine to take the horns, safety gear, and lower mouthpiece.

Lifting eyes and lugs are welded on as necessary for transport and for carrying mooring attachments.

The interior of the cases is distempered or whitewashed, probably with the intention of absorbing moisture. In the Type V. mine recovered the interior of the case was galvanised.

Loading the Charge Chamber.

Types I. and II.

The charge is built up of hexagonal discs of wet guncotton of about 12 ounces in weight.

A medium of hard wood packing is used to hold the charge in place and to fill the space left by the discs. The operation of loading or unloading is performed through a hole in the bottom of the mine case.

Unloading is a simple operation.

Types III., IV., and V.

The light cylindrical charge case is filled with cast T. N. T. through the loading hole in the bottom of the mine.

There is a primer of compressed T. N. T. inseparable from the cast T. N. T. and surrounding the primer.

There is nothing interposed between the compressed T. N. T. primer and the primer proper and but little clearance.

The T. N. T. cannot be unloaded from these mines by any ordinary means, and can only be undertaken by an Explosive Factory with the necessary melting plant.

Primers and Primer Cases.

All primers are contained in solid drawn brass cases, closed with a lid soldered on after filling. They are of stout material and should last when exposed to water not less than six months. (*See* Plate 32.)

Type I.

This is a hexagonal primer case containing three discs, presumably of dry guncotton, of the same size as the wet discs of the main charge.

The total weight of explosive is about 1 lb. 11 ozs.

Type II.

This is a cylindrical primer case containing what is believed to be a more violent explosive than dry guncotton.

The weight of the explosive is about 12 ozs. and is small in comparison with Type I.

The space surrounding the lower part of the detonator tube is filled with a disc of asbestos to admit of the joint being soldered.

Types III. and IV.

This is also a cylindrical primer case containing presumably tetryl or some similar priming explosive.

Types V. and VI.

Details of the primers in these mines have not been received.

Detonator.

This is identical for all types of mines, and contains approximately 80 to 90 grains of fulminate of mercury.

The case is of copper and is of stout construction. It is secured to the detonator carrier as shown in Plate .

Priming the Mine.

This operation is performed variously in the different types.

Type I. (*See* Plate 26.)

The lower mouthpiece is removed by unscrewing the screwed washer, the primer is then inserted, the mouthpiece replaced, and the screwed washer screwed hard up.

Type II. (Plate 27.)

Priming in this case is effected by removing the safety gear (D) and placing the primer in the top of the primer tube.

The safety gear is then replaced and the detonator inserted as for Type I.

Types III. and IV. (Plates 28 and 29.)

The lower mouthpiece is removed sufficiently to enable the primer to be secured to it by means of the bayonet joint.

The spring for the joint is obtained by means of a thick rubber washer. The mouthpiece and primer are then replaced and the screwed washer screwed up.

Inserting the primer will probably be completed some time before the operation of laying is likely to take place.

The final operation of inserting the detonator is a short operation probably deferred till the last moment.

It is probable that a testing adapter is inserted before this is done in order to be certain that the circuit is not incorrectly joined up.

The detonator is permanently wired to the detonator carrier.

A feather on the detonator carrier ensures that the detonator is inserted correctly.

By screwing up the ring of the carrier the thick rubber washer is expanded and holds the detonator in place, while at the same time it can be withdrawn by a pull.

The Horns and Batteries.

A Type I. horn is shown on Plate 33.

A later pattern in use on Type II., III., IV., and V. is shown on Plate 34.

The modifications of the latter pattern were probably introduced to increase the sensitiveness of the mine.

Type I. horns bent to an angle of 30 degrees have been recovered with the glass tube intact.

The horns of some of the mines recovered in the Baltic have a metal extension fitted to increase the length of the horn, which renders the breaking of the glass container by a ship striking the mine more certain. This horn extension is only used on mines laid from above-water minelayers. *See* Plate 34*a*, Fig. 3.

Firing will be instantaneous with the breaking of a glass tube; there is no delay action.

Experiments have shown that with the buoyancy chamber of any type full of sea-water and with the whole of the safety gear, batteries, and leads immersed, the mine will fire if a glass tube is then broken, even if the battery itself is already full of water.

The details of the horns and battery will be clearly seen in the Plates 33 and 34.

The holes through the base of the battery are probably intended to allow the acid to run through into the mine-case should a horn be broken while the safety-gear is still at safe, *i. e.*, on laying.

By this means, and provided that the lead horn is not actually pierced, the mine will remain active but with one horn short.

But for this provision the mine would probably fire as soon as the safety gear had ceased to be operative.

Types I., II., and III. mines have five horns. In Type IV. and V. mines the hole for the top horn is closed, in Type IV. by means of a brass plug and in Type V. by means of welding which leaves the surface of the mine perfectly flush.

The base of the top horn differs from other horns in being deeper and having two tapped holes usually plugged with a brass screw.

Occasionally, however, a mine is recovered with the attachments shown on Plate 34 in place. These would at first sight appear to be time-sinking devices, the short tube being filled with a suitable compound, but this is open to doubt, and a definite opinion cannot yet be given. It is, however, known that the German Navy has a sinking device for mines.

Inertia Firing Gear.

In the Type VI. mine no horns are fitted, but a form of inertia firing gear is fitted instead. This mechanism is shown on Plate 34*a*, Figs. 1 and 2. Like most mechanisms of this type, it probably requires extremely careful workmanship and has the objection usual to this type that the firing spring is always in compression.

Reports have been received from Russian sources that this form of inertia firing gear is sometimes used *in addition* to the usual horns. It is thought that this is intended to cope with a submarine which may foul the mine moorings.

In this gear the pistol is situated in the upper part of the mine and a part of it projects through a large opening in the top of the mine for a distance of about 5 inches.

No central horn is fitted.

The pistol depends upon a pendulum weight for its action.

On receiving a considerable blow or being heeled over to 30° the pendulum releases a trigger which permits a compressed spring to force a glass tube on to a striker.

This tube contains the usual battery solution, which falls into a battery of the ordinary type and fires the mine.

Safety when laying is assured—

(*a*) by a soluble plug,

(*b*) by the wires from the battery passing through the usual safety switch.

Any mines which are seen to have this gear fitted should be treated with extreme caution.

As far as is known, however, they have not been found outside the Baltic and are not likely to be used in tidal waters.

The Safety Gear.

Types I. and II. (*See* Plates 26, 27, and 35.)

This disconnects both leads to the detonator until a soluble plug has dissolved.

The Plate is self-explanatory.

Type III. may also be fitted with this type of safety gear or may be fitted with the mechanically operated gear shown in Plate 28.

Types IV. and V. are known to be fitted with safety gear operated by a rod attached to the sinker. (*See* Plate 29.) Under perfect conditions this mine should remain safe from 10 to 15 minutes after laying.

When this gear is used the mine becomes dangerous as soon as it leaves its sinker, and owing to defective design the mine is actually dangerous to lay.

Primer Safety Gear.

This is fitted only in Type II. (*see* Plate 27).

The primer is held at the top of the primer tube by a toe which is itself kept entered in the tube by a spring.

As soon as the spring of the safety gear has been released by the soluble plug the toe is withdrawn and the primer falls into place.

The Mooring Gear and Sinker.

The general arrangement of a Type I. mine and sinker when moored is shown in Plate.

In all cases on being laid the mine and sinker go to the bottom together.

In the Types I., II., and III., which are laid from above water, the mine is released from the sinker by a soluble plug device.

In the Types IV., V., and VI. the device is usually operated by a dashpot with thick oil or glycerine in place of the soluble plug.

There may be variations of the method of release of Type IV. mines, but there is no direct evidence of any other device but the dashpot already referred to.

The depth-taking is hydrostatically operated and is believed to be accurate.

The hydrostatic depth gear is shown on Plate 37 and requires no detailed description.

All types of mines have a nearly identical design of depth gear, and the only differences noted have been in the metal used and in the arrangement for adjusting for depth.

The function of the brake (E) is described later.

Sinkers, General Explanation.

From various sources of information it appears certain that there is a standard design of sinker for all types of mines, and that sinkers differ only in the size and shape of the wood blocks on which the mine rests.

The sinker, as used with Types I., II., or III. mines, is described separately from that adapted for submarine laying

The Standard Sinker.

This is shown in Plate 28 with a Type III. mine just having left it.

The drawing shows clearly the general arrangement.

The weight of the mine in the sinker is taken on the spring supports (G), evidently with a view to absorbing the shock on the mine and sinker striking the bottom.

The mine is held down in the sinker by the releasing gear.

The jaws of the releasing gear are held closed by the device (M), which is probably operated by a soluble plug.

The release may also be effected by filling the device (M) with thick oil or glycerine and allowing it to act as a dashpot, but this is probably only done in the case of the Type IV., V., and VI. mines.

In sinkers recovered glycerine was in use in the dashpot. With this liquid the time of release is probably about half an hour.

The lead of the mooring rope will be seen in the drawing.

The drum contains 55 fathoms of 1⅝-inch special wire. In mines recovered during the last year the mooring wire is 1⅜-inch. The eye of the standing part is formed with a specially-designed device. The other end of the wire (in the sinkers actually examined) is half-hitched inside the drum. The mine could, therefore, not have been laid in water much deeper than 28 fathoms. If this end had been free it appears that the mine could then have been laid in twice that depth if desired.

The mines laid by a German raider off Aden had moorings consisting of 118 fathoms of ¼-in. steel wire. The ¼-in. wire was 1⅜-in. wire, to the end of which was attached 80 fathoms of ¼-in. steel wire. The ¼-in. wire was apparently fitted to enable the mines to be laid to the full depth of the main mooring wire, holding the end of this wire whilst the mine was rising to its set depth and preventing it from winding round the standing part, thus preventing the mine rising to the desired depth.

(E) will not ride down the mooring rope, and unless the riding part unreeves through the hydrostatic depth gear the chain cannot tauten.

If the riding part does unreeve through the depth gear and *if* the drum of the sinker does not revolve too easily the non-riding part has to resist the buoyancy of the mine; the chain will then take the strain and the detonator will be withdrawn.

Probably the drum of the sinker will be more or less clogged with sand or mud, and provided that the riding part unreeves the safety gear will operate correctly.

Two things are, however, likely to happen, particularly after any length of immersion:—

(*a*) The moving parts of the hydrostatic depth gear may be so rusted that they will not yield and allow the mooring wire to unreeve, or

(*b*) The wire may be so jagged or kinked where it has parted that it will jam in the depth gear even though the latter would allow a clean cut wire to unreeve. (This applies only when the wire is cut within 12 inches of the depth gear.)

In both these cases, therefore, and even if the chain is in place, it is extremely unlikely that the gear will operate. Moreover, if the drum is not clogged it is quite possible that the mine will come to the surface unreeling wire from the drum as it rises.

It, therefore, reaches the surface in an active condition, although the detonator may ultimately be withdrawn when the mooring wire is all hauled off.

This, again, will not happen if the end of the mooring wire is not secured.

Action of Mines, Types I. to V.

When laid, the mine and its sinker go to the bottom together. After a period, probably 10 to 20 minutes, a soluble plug will have dissolved and released the mine, which then rises by its buoyancy.* The hydrostatic depth gear is held unlocked until the mine leaves its sinker; it then comes into play and, on the mine reaching its set depth, grips and holds the mooring rope. Once it has thus operated it does not again come into action and cannot subsequently release the wire.

The safety gear is only operative so long as a soluble plug (or in some cases a safety pin) is in place. As soon as the soluble plug has dissolved or the safety pin has been removed the mine becomes active.

On one or more of the horns being bent the glass tube of acid is broken, the acid flows to the bichromate battery and energises it. The current passes to the detonator and explodes the mine.

It has been found that as long as the mine is active detonation is simultaneous with the breaking of one of the glass tubes. *There is no delay action.*

Notes on the handling of Recovered Naval Mines.

All floating mines must be treated as active and mines washed ashore may also be active.

Floating mines should always be sunk by shell fire from a minimum distance of 200 yards.

A mine with only one horn left may still be active.

There is no means of telling whether a floating mine is active or not unless it is evident that all horns are completely crushed.

Mines washed ashore should be inspected as follows:—

Examine the lower mouthpiece if accessible and see if the detonator is in place.

If it is in place:—

In types I. and II.—Cut the external wires.

In types III., IV., and V.—Remove the detonator carrier by unscrewing the ring and withdrawing.

In ty[illegible]emove the detonator until the external wires have been cut.

[illegible]extract the primer.

Detonator.

The detonator can be removed from the carrier by cutting the leads. This requires care.

Primer Case.

It is not recommended that any attempt should be made to open a primer case.

Nothing in these notes should be taken as advocating the handling of German Naval Mines by any but those who have had previous experience or who are thoroughly acquainted with the details.

The Carbonit Mine.

(*See* Plates 38 and 39.)

The following is a description of the latest mine made by the Carbonit Co. of Hamburg, which *may possibly* be in use:—

The mine case is in two distinct parts, the buoyancy chamber and the charge chamber. In the buoyancy chamber is contained the firing, gear consisting of five uncharged batteries connected in parallel to the detonators in the charge chamber. On top of the mine are five lead horns, each containing a glass tube filled with acid (Eonin solution). On one or more of these horns being broken by impact the acid flows into the battery, energising it and thus firing the detonators.

The charge chamber contains 220 lbs. of cast T. N. T. exploded by two Tetryl detonators in parallel and a primer of 2.2 lbs. of lightly compressed T. N. T. The charge chamber is attached under the buoyancy chamber by means of clamps.

In this mine the mooring-rope drum and depth-regulating mechanism are attached by two strong springs to the bottom of the charge chamber, instead of being contained in the sinker as is usually the case. When the mine is dropped it goes to the bottom with the sinker, being secured to it by a slipping arrangement which, by means of a soluble plug, is locked for about 15 to 20 minutes, after which the mine should rise to its set depth. The mooring rope passes out of the drum cover and through a checking mechanism, which, when held open, permits the cable to run out freely; but which grips the mooring rope, and so holds the mine, on being released by a hydrostatic valve which can be set to operate at any desired depth as the mine rises. An adjustable brake is provided to prevent the cable paying out too quickly. This gear is claimed to be very accurate, and this claim was certainly borne out by the results of the trials. The mooring wire is exceedingly flexible and of good quality, the breaking strain being about 4½ tons.

The sinker is an iron plate, fitted with rollers to engage in the mine-rails which are laid on the deck. On board the minelayer the mine rests in a framework on the sinker and is rigidly attached to it by the slipping arrangement before mentioned. The mooring rope is attached to the sinker by a stopper. If the mines are being used as defence mines the mooring rope is attached at some distance from its end, the end being secured to a small drum on which the slack cable is reeled up. In this case also each sinker is connected to its neighbour by a wire, the slack of which reels up on another drum, which when pulled upon frees the stopper and allows the mine to come to the surface. This arrangement is to facilitate weighing. If the mines are to be used as blockade mines the connecting wire is not utilised and the end of the mooring wire is secured to the sinker.

Safety Arrangement.

Attached to the drum cover is a chopper contact, contained in a watertight box, through which the firing circuit is led, and which keeps the circuit broken unless the two strong springs supporting the drum cover are extended, which only occurs if the mine is properly moored by its sinker. This renders the mine safe should it break adrift from its moorings.

The batteries can only remain energised for 6 to 10 minutes, after which the elements become oxidised. The soluble plug prevents the mine from rising to its depth until 15 to 20 minutes after laying. Consequently, should a glass tube be accidentally broken while laying, the mine will not fire on arriving at its depth. Furthermore, the unbroken tubes are still capable of firing the mine on impacts as the resistence of the flooded battery is sufficiently high to prevent short-circuiting the detonators.

(3) The drum with the mooring wire is attached to the sinker, and not to the mine case.
(4) The depth is obtained by a hydrostatic valve similar to that in the Type I. mine, but which in this case puts a "jam" brake on to the wire, revolving round the wheel on the mine case.
(5) The device, for use in releasing the mine when used for defensive purposes, is the same as in the Type I. mine.
(6) The safety arrangements and firing horns are the same as the Type I. mine.
(7) There are four horns. A central and smaller brass horn, when unscrewed, exposes the electric wires leading to the charge. When weighing this horn is unscrewed and the wire cut, thus rendering the mine safe.

Possible (Experimental) Government Mine.

The following notice concerning a lost mine appeared in the German press in 1913:

"The mining ship 'Arcona' has during exercise lost a mine near Borkum. The mine case has not up to the present been recovered. It must be understood that this mine offers no danger, even to vessels of heavy draught. But there is danger if the case, getting adrift from its anchor, is cast ashore and the detonator is handled by officious people. The mine case is of iron, coloured red, of cylindrical form, about half a metre (1.6 feet) in diameter and about 1 metre (3.3 feet) in height. About one-half contains explosive, and there is a live electric detonator in the middle of the base. It is anchored in 75.5 feet of water, and is about 30 feet below the level of mean spring tide."

As the "Arcona" was at the time a mining experimental ship, the mine described need not necessarily have been of a type in use in the German Navy.

Leon Torpedo Mine.

(*See* Plates 41 and 42.)

Several Leon Torpedo Mines have been recovered near the coast during the war. These have all been fitted with guide strips which make them suitable for discharge from a torpedo tube. It is believed that they were discharged from submarines. These mines only differ from those described in the Annual Report of the Torpedo School, 1914, in small details. They have a screw plug with lifting eyebolt in place of the firing whiskers, and are fitted with inertia firing gear only. It is, however, possible that if these mines are dropped from ships being chased the whisker firing gear may also be fitted.

Plate 41 shows a diagrammatic drawing of the inside of the mine, and Plate 42 an external view of a mine fitted with firing horns.

It will be observed from Plate that the mine is primed through a door in the side of the charge chamber. The priming arrangements are similar in principle to those of the German naval mine.

The mines are cylindrical and are made in two parts. The upper part contains the pistol, primer tube, and charge, which consists of about 250 lbs. of T. N. T.; the lower part contains the depth-keeping mechanism.

The action of the mine is as follows:—On being launched the mine remains on the surface until the ballast chamber is flooded and then sinks, due to its negative buoyancy. On sinking below its set depth the pressure forces in the hydrostatic valve against a spring (the compression of which is adjustable outside the mine); this completes the motor circuit through the starter and the propeller revolves, raising the mine. As it again reaches its set depth the valve is forced out by the spring and the circuit broken. The amplitude of the oscillation is about 5 feet and the hydrostatic valve may be adjusted for depths of from 5 to 30 feet. When the ballast chamber is flooded the mine floats with its axis at an angle of about 20 to the vertical.

These mines require no special launching apparatus, but can be dropped overboard or launched out of a torpedo tube.

When the battery power is exhausted the mine can be set to sink or float. The batteries remain active for about eight hours.

The mines recovered on the coast have been set to sink at the end of their period of oscillation, and have been set to a depth of about $4\frac{3}{4}$ metres ($15\frac{1}{2}$ feet).

These mines being unmoored will drift about with the tide. They will probably be picked up by drift nets, but cannot be picked up with the ordinary mine sweep.

It is expected that they will be used by a ship being chased, consequently it is dangerous to cross the wake of enemy ships.

MINING VESSELS.

In addition to the three minelayers "Pelikan," "Nautilus," and "Albatross," Germany possesses a large number of other mining vessels, viz.:—

Sixty M class mine sweepers and layers.
A large proportion of light cruisers fitted as minelayers.
The light cruiser "Arcona," which is used as a mining experimental ship, is believed to carry about 450 mines.
A large number of T. B. D.'s.
Special mine-laying submarines.
A few merchant vessels and sixteen tugs fitted as minelayers.
Twenty-one mining launches for harbour duty, also trawlers.

Destroyers carry mines only when they are detailed for that particular purpose, and whilst carrying them are considered to be precluded from undertaking other offensive operations, in view of their dangerous cargo, and are usually provided with an escort.

When detailed for mining, each destroyer carries 12 mines, six on either side amidships, lashed as convenient. There are no special fittings for them, except in a few of the older boats. Rollers are fitted on the under side of the sinkers to facilitate moving about the deck. The mines are laid at a speed of about 15 knots. They are simply pushed overboard, alternately from starboard and port side.

German mine-laying submarines carry their mines in tubes running through the boat in the fore part. In the small type of submarine these tubes are at a slope of about 16° aft. Each tube carries two, or in later boats three, Type IV. mines. The tubes are loaded from above. Stops are fitted inside each tube to hold the mines. These stops can be placed in three different positions, "load," "secure," or "release," and are fitted with interlocking gear, which ensures that the stop of the upper mine cannot be placed in the position of "release" until the lower mine has been let go. Indicators inside the submarine show the position of the stops, and these can be locked with a bolt in any particular position.

MINE-SWEEPING AND SEEKING.

It has been reported that experiments to discover the position of submerged mines by aerial observation have taken place.

In October 1912 it was reported that the German Navy had 2,000 sets of mine-finders.

A cutting sweep is said to be in use, but no confirmation of this report has been received.

It is not *known* whether the mine-finder made by the Carbonit Company of Hamburg, and described below, is in use in the German service, but a recent report tends to indicate that a sweep of this nature is used by torpedo craft when sweeping.

Carbonit Mine Finder (*see* Plate 43).

The following is believed to be a fairly accurate description of the Carbonit mine finder. It is in reality a rather elaborate system of rapid sweeping. The mine finder is towed between two tugs, each of which is provided with a windlass, on one side of which the buoy ropes MM_1 are wound, and on the other side the tow lines NN_1. The buoy ropes are attached to the buoys AA_1 and the tow lines to the weights DD_1, which in their turn are supported by the buoys AA_1 by means of the ropes KK_1.

When searching for a mine the grapnel G is attached to the weight D by means of a short strop L, the connection being made by a spring clip F. From the strop L a thin wire P is led to a reel on the weight D.

The charge, which is of T. N. T., is contained in the grapnel. A line O leads from the grapnel to the buoy A. The weight of this line is taken by a small buoy B and the connection with A is made by a spring clip S.

By means of a strop the grapnel is secured to the search line H which leads to the weight D_1. On the buoy A is an incandescent lamp which will be switched on by the disconnecting of O from the spring clip S. The current is supplied by means of a battery in the buoy A.

The action of the sweep is as follows. When the moorings of a mine are caught by the search line H the strain on H disconnects the strop L from the spring clip on the weight D. The wire P will unreel from the weight D and after a while the line O will become taut. This will, when the strain is sufficient, break the contact at S and switch on the lamp. The lighting up of this lamp, therefore, indicates that a mine is in the sweep.

The search line H will render round the moorings of the mine until the grapnel grips the mooring rope. When the strain on H becomes sufficiently great a percussion device in the grapnel will be released and the charge fired. By regulating the pressure at which the firing device is released the charge can be made to either fire when the grapnel grips the moorings or when it has ridden up the mooring wire to the mine itself.

Explosive Sweeps.

Automatic explosive sweeps have been reported to be in use, but this is not confirmed, and too great reliance should not therefore be placed on this report. These sweeps are said to carry a cutter which can be actuated by an explosive charge when it engages the mooring rope of a mine. Each cutter is said to have 100 such charges.

Kite Sweep.

It is believed that a sweep is in use, the depth of which is regulated by means of one or more kites. The nature of the sweep itself is not known; it is towed between two ships.

Double Wire Sweep.

Recent information shows that a double wire sweep was used successfully in the Baltic to overcome the anti-sweeping device, probably of the nature of a star wheel, used by the Russians with their mines. The double wire sweep is said to have defeated the anti-sweeping device on all occasions, causing it to jamb.

Fleet Sweepers.

It has been reported that some of the larger German torpedo boats are fitted with a sweeping arrangement which will enable them to lead a squadron, clearing a channel for the ships of heavier draught following them.

Torpedo Boats and T. B. D.'s.

A considerable number of destroyers, including some of the most recent types, are fitted for mine-sweeping. A large double fairlead is fitted aft. Mine-sweeping is carried out by half-flotillas in line abreast, the two ends of each sweep being towed by adjacent destroyers. A kite is fitted midway along the sweep, which is of 1½-in. to 2-in. wire. The destroyers are 164 yards apart.

All torpedo boats, except those few which are used as despatch boats and tenders, are fitted for mine-sweeping, and in war time are principally employed on mine-sweeping duties.

M Class Minesweepers.

There are 60 of these vessels (described in Part III.) which are primarily for mine-sweeping purposes, but which are also used as minelayers.

ANTI-SUBMARINE DEVICES.

General.

The devices used in the German Navy against submarines are—

1. Steel wire nets.
2. Depth charges.
3. Submarine explosive kites.

In addition, hydrophones are used to detect the presence of submarines.

They have nothing in the nature of indicator nets, mined nets, or quick-shooting nets.

Steel Wire Nets.

These are used either towed or moored. In either case the net is of 12-foot mesh, made of 1½-inch wire rope, with a head rope and foot rope of about 3-inch wire. Buoys are shackled on to the head rope at intervals of about 33 feet.

In the case of towed nets it is said that a certain proportion of the buoys carry lights.

Towed nets are about 6,560 feet in length, and from 46 to 52 feet in depth. Moored nets are of sufficient length to close the required channel, and are said to extend to the vicinity of the bottom.

The towed nets are towed by trawlers whose ordinary speed is about 7 to 8 knots. When towing they make good about 1 knot in ordinary weather. The net is towed by means of a towing span of 3-inch wire, from either quarter, attached to the head rope. The only indication of the presence of a submarine in the net would be the additional strain on the tow and possibly the submergence of some of the buoys. The submarine, being held in the net, is attacked by means of depth charges.

Depth Charges.

The depth charges used are cylindrical in form, about 4 feet in height and about 1 foot in diameter. The general shape is shown in Sketch A, Plate 43*a*. It is not known why the cylinder is made in two portions, but the upper and larger portion undoubtedly contains the explosive charge. Two men are always employed to lift the charges.

Only the one size of depth charge is supplied. They are used up to a depth of 33 fathoms, possibly more.

Mine-sweeping and net trawlers carry four of these charges, one in a shoot on either quarter, lashed, but otherwise in readiness to be pushed overboard; the other two spare, stowed upright, one on either side. Torpedo boats and destroyers carry six depth charges. Apparently they are not used by light cruisers or larger vessels.

Submarine Kite.

This is a wooden kite, about 4 feet in length and 2 feet across, containing an explosive charge. The general shape is shown in Sketch B, Plate 43*a*. The hole near the foremost end of kite is the position from which the safety arrangement is adjusted. The towing wire is kept wound on a reel abaft the funnel in trawlers and T. B.'s, and is led through a block at the top of a hinged derrick fitted right aft. It is always towed at the full speed of the trawlers, *i. e.*, 7 to 8 knots. It is said to maintain its depth steadily, and explodes on impact only. Great care has, of course, to be exercised in getting the kite inboard, and the safety arrangement is reinserted whilst the kite is at the derrick head.

These kites are carried by mine-sweeping and net trawlers, T. B.'s and destroyers.

Submarine kites are used when searching for a submarine which has been reported or sighted in the neighbourhood and has dived.

Groups of trawlers usually tow their kites in line abreast, the trawlers being about 33 feet apart. The torpedo boat acting as Group Leader steams ahead of the group, also towing a kite. Sometimes two groups tow together in line abreast.

The kite is used up to a depth of 22 fathoms, possibly more.

Both the kites and the depth charges are regarded as highly secret articles, and are always kept carefully covered up in harbour.

The following is the system of arrangement of the forward lights in the "Moltke":—

The four forward lights are divided into two groups of two each. The lights in each group are situated one vertically over the other. The port group is situated the port side forward of the funnel, and the starboard group on the starboard side aft of the funnel, *i. e.*, they are diagonally disposed.

Each group of two lights can sweep through a complete arc of 225° or more. There is only one very slight obstruction to the starboard lights when sweeping aft across the after funnel to the port side, and practically no obstruction to the port lights when sweeping on the starboard bow. The arcs are as follows:—

Port group, 45° starboard to 0° and round to 180° port.

Starboard group, 0° to 180° starboard and on across the stern to 135° port.

There is strong reason to believe that the system of placing (and controlling) the searchlights in all modern vessels is similar to that in the "Goeben."

Light cruisers carry four projectors, which are placed on the same principle and at about the same height above the guns.

Control of Searchlights.

In the battle cruiser "Goeben" the searchlight control platform is situated before the lights and at a lower level. It is completely roofed in both from the weather and from the rays of the lights. There are four electrical controllers, one for each light on the fore funnel. The levers which train the lights appear to move round graduated arcs, so that by putting the lever opposite a certain bearing the light automatically stops there also. The searchlights have bearing arcs also graduated round their pedestals. Large voice-pipes lead from the controllers to each light.

It has been reported that great trouble has been experienced in the German navy with eletrical control, and that it is to be abandoned. This report is to a certain degree confirmed by a recent report which states that the searchlights in the "König" are controlled by hand, orders being transmitted by telephone from the control station.

Arrangements for Striking Down.

In most modern ships, including the "König," special arrangements are made for striking down the searchlights on the superstructure. In the "Braunschweig" class special hatchways are provided for this purpose, the projectors being stowed in closed recesses on the main deck.

The arrangements for striking down are as follows in the battle cruiser "Goeben":—The platform of the upper light forms the roof over the lower light. Under this roof is fitted a rail with a traveller, which plumbs the light. Each light is fitted with a special lifting bolt and band. The light and pedestal complete are lifted by a tackle, run along the rail, and lowered down to a position behind armour. Similar convenient arrangements are fitted for lowering the upper lights and the lights round the foot of the mainmast.

Attention is called to the penalties attaching to any infraction of the Official Secrets Act.

C. B. 1182 A.

GERMAN NAVY.

PART IV.
SECTION 4.

TARGET PRACTICE, RANGE-FINDERS AND CONTROL OF FIRE.

SECTION 4.

TARGET PRACTICE, RANGE-FINDERS, AND CONTROL OF FIRE.

TARGET PRACTICE.

General Notes.

A noticeable feature is the frequent use of old battlships and cruisers as targets by day and old torpedo boats by night.

Awards for Good Shooting.

The German Emperor presents a *Kaiserpreis* annually to the best shooting ship in each squadron. There were five *Kaiserpreise* in 1913, which were awarded as follows:—

1st Squadron	"*Ostfriesland.*"
2nd "	"*Schleswig-Holstein.*"
3rd "	"*Friedrich der Grosse.*"
Large Cruisers	"*Moltke.*"
Small "	"*Coln.*"

The ships' companies of the winning ships are entitled to wear a special badge for the ensuing year.

A new section was introduced in the Navy Estimates, 1910–11, dealing with expenditure on various shooting exercises, prizes being instituted for guns' crews, searchlight men, rangetakers, &c., for proficiency in their particular callings. About 73,000*l.* was then devoted to this purpose. For 1913–14 the vote was increased to 83,000*l.*

It is not known what percentage of this amount is expended in awards.

Prizes are also given for proficiency in the use of instructional appliances, loader, dotter, &c.

Weather Conditions during Firing.

In the Navy Estimates for 1911–12 an increased vote was asked for in view of the anticipated increased loss of targets, owing to gunnery practice being carried out in the North Sea. Prior to this date, gunnery practice, for the most part, had taken place in the Baltic, under good weather conditions; but, since then, firing in the North Sea (known as High Sea firing) under rough weather conditions has frequently taken place.

In April 1912 it was reported that the battleship "*Elsass*" and the armoured cruiser "*Blücher*" carried out High Sea firing near the Faroe Islands, this locality being selected so as to get really bad weather.

From the report on page 10, it is evident that "unfavorable weather conditions" during German Target Practice are hardly what would be so designated in H. M. Service.

Calibration.

All reports agree that the Germans do not calibrate. Certain experiments were reported in January 1910 to have been carried out by one of the ships of the "*Brandenburg*" class, when the differences in the fall of shot with charges at various temperatures were noted.

Instructional Appliances.

Dotters, deflection-teachers, and loading-teachers are in use, and frequent drills are carried out with these appliances. The deflection-teacher is very similar to that in use in our ships.

Loading drill is carried out at the loader for medium calibre guns, and arrangements are made by which exercise in loading can be practiced in the 11-inch and 12-inch turrets in modern ships. Special projectiles, which are covered with "soft metal," similar to very wide driving bands, or with strong leather, and charges in brass cases are supplied. The projectiles and charges are loaded in the ordinary way, each successive round pushing the former ones along the bore in front of it. A recent report, however, stated that when loading drill was carried out in the *"Friedrick der Grosse"* the projectiles were not entered into the gun. The best performances at turret loading in the *"König"* in 1916 was 2½ rounds per gun per minute, and with the 5.9-inch loader 17 rounds per minute. This latter was the record of the squadron.

The sub-calibre gun in use is a 3.5-inch (8.8-cm.) L/40 gun. In all cases it extends forward from the face of the wedge, the breech portion being reinforced by a brass block, which accurately fits the powder chamber of the gun. The cartridge is kept in position by the wedge of the parent gun.

Annual Allowance of Ammunition.

The ammunition expended by the various ships of the German Navy during gunnery practices in 1912–13 can be seen from a reference to I. D. 973.

The following is the average expenditure per ship of the 1st Squadron during that gunnery year:—

Long Range Firings by Day.	T.B. Defence Firings by Day.	Night Firings.	Test Firings.
Heavy guns, 136 rounds..... Medium guns, 159 rounds....	Heavy guns, 35 rounds.... Medium guns, 78 rounds... Light guns, 32 rounds.....	Heavy guns, 17 rounds.... Medium guns, 51 rounds... Light guns, 79 rounds.....	Heavy guns, 20 rounds. Medium guns, 35 rounds. Light guns, 212 rounds.

The totals for the year's firings of all natures for each ship averaged—approximately:—

Heavy guns 207 rounds (about 17 rounds per gun).
Medium guns 323 rounds (about 25 rounds per gun).
Light guns 324 rounds (about 22 rounds per gun).

The annual allowance of aiming rifle and sub-calibre gun ammunition was reported in an old report to be as follows:—

.314-inch (8-mm.) aiming rifle	300–400 rounds per rifle.
1-pr. (37-mm.) sub-calibre gun	60–127 rounds per gun.
4-pr. (5-cm.) and 3.5 inch (8.8-cm.) sub-calibre guns	50 " "

H.E. shell with full charges are said to be used for some of the long range practices, but practice charges and plugged or practice shell are used for the other firings.

Since 1910 there has been a steady increase in the vote for target practice, and it is believed that the allowance of ammunition has undergone a similar increase during this period.

Training of Gunlayers.

The following information concerning firing exercises and the training of gunlayers was received towards the end of 1909 from a very reliable source.

Three gunlayers (*Geschützführer*) are allowed to heavy calibre guns and two to other guns; the first gunlayer performs the laying and the second the training. Each turret has an officer (*Turmkommandeur*) and a captain of turret (*Stückmaister*). Gunlayers are divided into three classes—1st class for heavy guns, 2nd class for medium guns, and 3rd class for light guns.

Method of Selection and Courses of Instruction.

Courses for gunlayers, 1st and 2nd class, take place annually on board the *"Schwaben"* (since replaced by the *"Wettin"*); the men put through these courses are selected from qualified gunlayers holding the qualification next below, *i.e.*, the men for the 1st class gunlayers' course must be qualified 2nd class gunlayers, and the men for the 2nd class course must be qualified 3rd class gunlayers. They must also engage to serve for two years after the completion of their course.

For gunlayers, 3rd class, four courses are held each year, two on the *"Undine"* (since replaced by the *"Danzig"*) and two in the *"Stüttgart."*

Some 110 to 120 men are told off to attend each course, the men being selected according to the length of time they will be available for the navy, *i. e.*, the men who have engaged for 12 years are given the preference, and then those engaged for six, five, and four years respectively.

The first four to six weeks are passed in the Gunnery School at Sonderburg, and the time is spent in drilling on board the *"Prinz Heinrich"* (afterwards replaced by the *"Prinz Adalbert"*) and in carrying out sub-calibre practice on board the gunnery tenders. Considerable practice with the dotter is also carried out during this period, at the completion of which some 20 of the men who have obtained the worst results in the practices are sent back, the remainder being embarked on one of the cruisers *"Undine"* (since replaced by the *"Danzig"*) or *"Stüttgart."* Here 15 firing practices are carried out. Eight of these, four by day and four by night, are carried out with 1-pr. (3.7-cm.) sub-calibre ammunition. The first four sub-calibre practices are carried out at an anchored target; the next three sub-calibre practices and the first three practices with service ammunition (3.5-inch) are carried out at a towed target. In all the above each man fires at a separate target, the ranges being 1,500 metres for the earlier and 2,400 to 2,800 metres for the subsequent practices.

One practice with sub-calibre and one with service ammunition are fired by two men at one target. The target used in all these practices is the torpedo-boat target, measuring 20×2.5 metres (65×8.2 feet). Then follow the sub-calibre and service practices with the 4.1-inch (10.5-cm.) gun. The target used is the battle practice target, measuring 40×6 metres (131¼ ×19.69 feet), and the range 4,500 yards. Five men are told off to fire at each target. Finally follows a sub-calibre practice in the *"Schwaben"* (now replaced by the *"Wettin"*) with the 5.9-inch gun.

Throughout the course the men work in couples, the one not firing acting as sightsetter. Thorough instruction is given in everything relating to gun parts, sights, ammunition, &c., and the knowledge of the men in these matters is tested at the completion of the cruise. A record is kept of all the practices, upon the results of which depends the man's qualification to act as No. 1 or No. 2 at a light gun.

Firings from 1910 to 1912.

The following are accounts of some firing practices carried out since 1909; it is not known definitely, but it was reported in November 1911, from a fairly reliable source, that in the firings carried out in the spring of that year ricochets were counted as hits.

I. It was reported in July 1910 that the German Fleet had carried out their exercises with heavy guns at ranges up to 10,000 yards, and that the system of obtaining 25 per cent. of short shots had been adopted.

II. The following are particulars of a demonstration firing which was carried out in the latter part of 1910 by the battleships *"Nassau"* and *"Westfalen"* before certain Chilian officers. The conditions under which firing took place are believed to have been simplified in order to obtain the best possible results. These ships fired singly at ranges varying between 7,400 yards and 7,850 yards at a target 131 feet by 26 feet, which was towed slowly. The speed of the firing ship was about 12 knots and there was an alteration of course made. Salvo firing was principally employed, but this was not carried out by director, each gun being laid independently. The weather conditions were fine and the Chilian officers were told that the *"Westfalen"* obtained 38 per cent. of hits.

III. The following are particulars of a demonstration firing which was carried out in March 1911 by the battleship *"Rheinland"* before certain Turkish officers. The target, which was 196.8 feet long and 26.2 feet high, was towed on a straight course by a tug, against tide and wind, at an estimated speed of 6 knots. The speed of the ship was 12 knots, on a practically parallel course, and the range varied from 8,500 to 8,700 yards; the time of firing was five minutes, and the weather conditions were excellent.

On one run the turrets fired by ripple, and on the other by salvoes.

The 6-inch fired all by salvoes, alternately with the turrets.

All orders to fire were given by fire-gongs. Reduced charges were used.

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Part IV. Section 4. Target Practice.

The officers claimed 24.5 per cent. of hits with 11-inch and 32.0 per cent. with 5.9-inch guns. The rate of fire from 11-inch guns was about three rounds per minute, but on the completion of the firing the crew were observed to be very exhausted, and it is considered doubtful if this rate of fire could have been maintained.

IV. Spring Firing, 1911:—In a report of this firing, it is stated that the "*Mecklenburg*," which was the best ship that had fired up to April, scored 70 (?) per cent. hits (all guns). Ricochets were counted as hits. The targets were towed faster than was the custom in our navy at that time.

V. Spring Firing, 1912:—The following is reported to be a description of the Spring Firing carried out by the 1st Battle Squadron in June 1912:—

Fire was opened at about 10.900 yards, the guns of an 11-inch or 12-inch turret being used to find the range.

The secondary armament opened fire at about 8,700 yards, and at 3,300 yards every gun on board came into action. The main armament was still firing when the range was only 2,200 yards.

Firing Practices, 1912–13.

A study of I. D. 973, Germany, Results of Firing Practices, 1912–13, will give a very good idea of the firings carried out in that year. The following notes are compiled entirely from that report.

In the absence of knowledge of the conditions under which the firings were carried out criticism and comparison with the firings in H. M. Service have been avoided.

The following practices were carried out in 1912–13 by the 1st Battle Squadron:—

Day Firings.

(1) Long-range firing by heavy and medium guns, easy conditions.
(2) Long-range firing by heavy and medium guns, difficult conditions.
(3) Long-range firing by heavy and medium guns, difficult conditions, at ship targets:—
  (*a*) With full charges.
  (*b*) With practice charges.
(4) Long-range firing by heavy and medium guns, squadron firing.
(5) Torpedo-boat defence practice in sub-divisional formation, medium and light guns.
(6) Torpedo-boat defence in divisional formation, heavy and medium guns:—
  (*a*) Heavy guns at ship targets.
  (*b*) Heavy guns at T. B. targets.
  (*c*) Medium guns at T. B. targets.

Night Firings for T. B. Defence.

(7) Heavy, medium, and light guns. (Single ships.)
(8) Heavy, medium, and light guns in sub-divisional formation.
(9) Heavy, medium, and light guns in sub-divisional formation. Both sides engaged.
(10) Heavy, medium, and light guns. (Single ships.)
  (*a*) Cruiser target.
  (*b*) T. B. target.

Test Firings.

(11) Heavy guns.
(12) Medium guns.
(13) Light guns.

Composition of the Squadron.

The following ships took part in these firings, and formed the 1st Battle Squadron:—

"*Ostfriesland*"	1st Division.	"*Posen*"	2nd Division.
"*Thüringen*"		"*Rheinland*"	
"*Helgoland*"		"*Nassau*"	
"*Oldenburg*"		"*Westfalen*"	

Day Firings.

(1) *Long Range Firing by Heavy and Medium Guns, under Easy Conditions.*

This practice was carried out at ranges varying from 7,800 metres (8,530 yards) to 5,200 metres (5,637 yards), the average range for the squadron being 7,300 metres (8,016 yards).

The two calibres fired together, one ship firing at a time. In the case of two ships, the two calibres fired separately. The firing ship steamed on a fixed course at 12 knots, and the target was towed at 5 to 6 knots on a course nearly parallel to the ship and in the same direction, usually slightly convergent.

Weather conditions appear to have been very good. The target in all cases measured 8×60 metres (26.2×196.9 feet).

Ships fired an average of 31.3 rounds of heavy and 38 rounds of medium calibre ammunition. The best firing with heavy guns gave six hits out of 31 rounds with a speed of hitting of .23 hits per gun per minute for 12-inch.

The average was 31.3 rounds, 4.5 hits (14.4 per cent) with a speed of .14 hits per gun per minute.

With medium calibre guns the average results were 3.2 hits out of 38 rounds, or 8.4 per cent. and .1 hits per gun per minute.

This firing was carried out by most of the squadron in October 1912.

(2) *Long Range Firing by Heavy and Medium Guns, under Difficult Conditions.*

This practice was carried out by most of the squadron in January and February 1913. The weather conditions were good. Each ship (or in some cases *pair* of *ships*) fired on a different scheme.

Thus, the "*Ostfriesland*" firing at a towed target did a two point turn during firing, and the target also altered course.

The "*Thüringen*" and "*Helgoland*" fired together, in conjunction with the 12-inch guns on Helgoland Island.

The "*Oldenburg*" fired simultaneously from both sides, and did a one point turn during firing.

The "*Posen*" and "*Rheinland,*" firing together, concentrated on one target and (probably) changed target during the firing.

The average range for heavy guns was 6,150 metres (7,120 yards), and for medium calibre guns 6,410 metres (7,010 yards).

The target was 8×60 metres (26.2×196.9 feet), towed at 4 or 5 knots, and the speed of the firing ship 14 knots.

The average results were:—

Heavy guns—37.7 rounds, 5.2 hits (13.8 per cent.) and .14 hits per gun per minute.

Medium guns—48.3 rounds, 5.4 hits (11.8 per cent.), and .17 hits per gun per minute.

The conditions, so far as one can gather from the data contained in the tabulated results were not such as would be considered difficult in H. M. Service.

(3) *Long Range Firing by Heavy and Medium Guns, Difficult Conditions, at Ship Targets.*

In this firing the ship or ships firing manœuvred as units of a fleet in regular formation. It corresponds closely with our battle practice. The practice was carried out by half of the squadron with full charges and by the remainder with reduced charges.

Heavy and medium guns took part in both practices. Each ship's or pair of ships' practice consisted of a different scheme of firing, concentration on one ship by two firing ships, division of one ship's armament between two targets, change of target, &c. being practised.

Weather conditions appear to have been very good.

In the case of firing with full charges the range varied from 14,600 metres (15,967 yards), to 11,600 metres (12,686 yards), and with reduced charges from 10,700 metres (11,702 yards) to 5,800 metres (6,343 yards).

The targets were anchored. It is not clear from the report whether these were actually disused ships, but this is probably the case, as the Germans have made frequent use of old ships as targets in the past.

Firing ships steamed at 12 to 16 knots. The percentage of hits for heavy and medium guns in these practices combined were 8.3 and 7.7 respectively.

This firing was carried out in April, 1913.

(4) *Long Range Firing, Squadron Firing.*

In this firing the whole squadron fires together, each ship firing at its own target. On this occasion, the firing was carried out in quarter line at a line of moored targets, 8×40 metres, approximately on the beam.

The weather conditions were good. The fleet steamed at 12 knots during the firing.

The ranges varied from 8,000 to 6,200 metres (8,749 to 6,780 yards), the average for heavy guns being 7,180 metres (7,852 yards), and that for medium guns 7,000 metres (7,655 yards). The average percentage of hits for the squadron was 8.2 for both natures of guns, the best ship with heavy guns, the "*Helgoland*," obtaining 20 per cent., and with medium guns the "*Posen*" obtaining 19.4 per cent. of hits.

The firing was carried out in August, 1913.

(5) *Torpedo Boat Defence Practice in Sub-Divisional Formation, Medium and Light Guns.*

This practice was carried out by pairs of ships in line ahead. The targets in this case consisted of two groups of three targets 3×30 metres (9.8×98 feet) towed separately on parallel courses at about 5 knots. The ship steamed at 14 knots on a converging course, closing the target.

The average range at which the firing was carried out was 4,500 to 3,700 metres (4,921 to 4,046 yards) for heavy guns, and 3,660 to 2,840 metres (4,000 to 3,100 yards) for light guns. The medium and light guns fired separately.

The average percentages of hits for medium and light guns were 18.6 and 42.8 respectively, but it is not clear from the tabulated results whether these percentages are of actual hits on the 30×3 metre target, or assumed hits on a target 8 metres high.

These firings were carried out in the Baltic in November 1912, the weather conditions being extremely good.

(6) *Torpedo Boat Defence Practice in Divisional Formation, Heavy and Medium Guns.*

(*a*) Against ship targets; (*b*) against T. B. targets.

This practice was carried out by divisions of four ships, the heavy and medium guns firing separately. The ships steamed in quarter line at 15 knots, and did a small turn together during the firing. The targets were towed at about 4 knots on a course converging with that of the firing ships at about 45 degrees.

The heavy guns fired at ship targets at an average range of 6,280 metres (6,868 yards), and against T. B. targets at an average range of 5,230 metres (5,720 yards).

The medium guns fired at T. B. targets only at an average range of 4,990 metres (5,457 yards).

The percentage of hits by heavy guns against ship targets was 20.4, and against T. B. targets 24.4, and that of the medium guns against T. B targets was 11.6.

These firings were carried out in the North Sea at the end of May, 1913. Weather conditions were good.

Night Firings.

T. B. Defence, Heavy, Medium and Light Guns (Single Ships).

In this practice the ships steamed at 12 knots, the targets being towed at speeds varying from 2 to 8 knots.

The ships were on a course parallel and in the opposite direction to the targets and in most cases did a four-point turn away from the targets during firing. The targets used were 3×30 metres (9.8×98 feet) three being towed in line ahead.

All guns fired together at an average range of 1,430 metres (1,563 yards). The average percentage of hits were 37.5, 21.6, and 27.5 respectively for heavy, medium and light guns.

This practice was carried out in the North Sea between October and December 1912.

(8) *T. B. Defence, Heavy, Medium and Light Guns, in Sub-Divisional Formation.*

In this practice the ships fired in pairs, all calibres of guns firing together. The ships in line ahead steamed at 12 to 14 knots on a course parallel and opposite to that of the targets.

The targets consisted of two groups of three and two targets 3×30 metres (9.8×98 feet) towed at 4 or 5 knots.

In the case of one ship "Searchlight interference" was introduced. The average range at which this practice was carried out was 1,470 metres (1,607 yards) and the percentages of hits were 28.6, 14.2, and 16.9 for the heavy, medium and light guns respectively.

This firing was carried out between January and March, 1913.

(9) *T. B. Defence, Heavy, Medium and Light Guns, in Sub-Divisional Formation, both sides engaged.*

This practice was carried out by ships in pairs steaming in line ahead at 14 knots, all guns firing at once.

It appears from the diagrams in I.D. 973 that divided fire was exercised. Both sides were firing simultaneously at groups of three 3×30 metre (9.8×98 feet) targets at anchor.

The average range was 1,400 metres (1,531 yards) and the percentages of hits for heavy, medium and light guns were 14.3, 26.3, and 25.8 respectively. This firing was carried out in April, 1913.

The weather conditions were on the whole fair.

(10) *T. B. Defence, Heavy, Medium, and Light Guns, Single Ships, (a) against Cruiser Targets (b) against T. B. Targets.*

In these firings only the heavy and medium guns fired against cruiser targets and all calibres against T. B. targets.

The targets were in each case towed at 5 knots on a parallel course to the firing ship and in the opposite direction. The firing ship steamed at 12 knots and did a turn away from the targets during firing.

The average range against cruiser targets was about 2,100 metres (2,297 yards) and that against T. B. targets 1,640 metres (1,794 yards). These firings were carried out between June and August, 1913, under good weather conditions.

Test Firings.

These three firings were purely test firings for the gunlayers of the different calibres of guns.

In all cases one gun fired at a time at short range at an anchored target 4×4 metres (13.1×13.1 feet), the ship steaming slowly past it parallel to the target.

The allowance of ammunition was as follows:—

Heavy Guns, 20 rounds per ship, 4 gunlayers firing.

Medium Guns, 35 or 28 rounds per ship, 5 or 4 gunlayers firing.

Light Guns, 11 rounds per gunlayer firing, the maximum number of gunlayers firing being 16 in the "*Posen*."

Firing Practices, 1913–14.

The following is a translation of the substance of a German official report on the long range firing by heavy and medium guns under difficult conditions, carried out by the 1st Squadron during 1913–14.

The substance of the report is shown in italics, criticisms and remarks being shown in ordinary type in brackets. Although some portions of this report appear to be unintelligible and superfluous it is reproduced in extenso, as it is thought that the full report will convey a better idea of general systems of control, &c., than could be gleaned from an abbreviated narrative.

Remarks by the Squadron Commander, 1st Squadron, on the 3rd Day Firing Practice, 1913–14.*

1. *The problems ordered to be carried out by the Fleet were divided among the ships as follows:—*

"*Ostfriesland*" . . . . . *A passing fight.*

"*Thüringen*" . . . . . *Running fight from the weather position.*

* See N.I.D. 973. This practice is long-range firing by heavy and medium guns under difficult conditions.

Part IV. Section 4.

Target Practice.

"*Helgoland*" ..... *Fighting on both sides. From one side simultaneous firing.*
[This is believed to mean actually mechanically connecting the two gun slides together, so that they move as one in elevation. It has no reference to director firing.]

"*Oldenburg*" ..... *Halving fire.*
[This is thought to mean dividing the armament between two targets.]

"*Posen*" ..... *Shooting at high speed, and large alteration of course.*

"*Rheinland*" ..... *Running fight, range increasing; firing with tracer shell.*

"*Nassau*" .....
"*Westfalen*" ..... } *Combined firing at one target, and change of target.*

2. *The firings were carried out under unfavourable weather conditions, except those of the "Posen" and "Helgoland." Ships were rolling about 3° each way, and pitching about 1°.* [These would hardly be designated difficult conditions in our Service.]

The "Thüringen" had to check her firing, as she could not see the target.

The "Rheinland" fired under exceptionally unfavourable conditions, as the visibility was only just enough to allow the target to be recognised, and a part of her practice could only be carried out at a small portion of the target, the rest having been shot away.

3. *The ranging was carried out by all ships with the range clock. The advantage of this method was brought out, and it must be considered wrong not to range with the clock when the range is fairly reliably known.*

When ranging with the clock one must of course, when firing the next salvo, use the clock range and not fire again with the uncorrected range. ("*Rheinland.*")

Even if the time for ranging has improved since last year, still on the whole the speed with which the battery can be brought to bear on the target cannot yet be considered sufficiently fast. The following points are to be noted:—

(*a*) *Considerable importance must be attached to range-finding, and every possible opportunity is to be taken to train the range-finder operators. Since ships have been fitted with the range-transmitter, they now possess an excellent instrument for testing the capabilities of the range-takers. The apparatus is also suited for controlling the alertness of the operators.*

(*b*) *The proper use of the "error of the day" tables is necessary. Even if in the cases of the practices of the "Ostfriesland," "Thüringen" and "Oldenburg" the tables did not give accurate results, yet it is to be expected that from the use of the tables better data will be obtained.*

Wind has the greatest influence on the range correction. The ascertaining of this factor from the tables takes too much time, and it is therefore often now not sufficiently accurately carried out. It is therefore recommended that tables be made out whereby the range correction for wind can be directly read off.

Strength of Wind.	*Range.*	*60 h. m.*					*70 h. m.*
	Angle between Wind and Line of Fire.	*Points.*					
		0.	*2.*	*4.*	*6.*	*8*	
1							
2							
3							
&c.							

[NOTE.—60 h. m. equals 6,560 yards.]

(*c*) *The method of making use of assistant observations still varies too much and stricter rules are required.*

When salvoes fall over, the distance over is not to be given in metres, and salvoes falling to the right or left of the target are not to be indicated as short or over unless the splash clearly passes in front of or behind the target.

this check is made easier. If the curve showing the actual gun ranges is compared with a curve based on plotting the run, the source of error will be clearly seen,

Such curves are to be included with the returns at Target-Ship Practice this year.

6. *The medium artillery only partly succeeded in distinguishing their own salvoes, so that the results are not equally satisfactory.*

The tables in one case ("Helgoland") gave the corrections the wrong way. I would propose that in future, instead of as formerly using a slow alteration of the calibre difference, a bracket be used for ranging. At the end of the shooting year, I would request a short report of the experiences obtained.

In any case a suitable method must shortly be found to bring together both calibres when firing, and I request that, when experience has been gained, suitable suggestions for experiments be made.

[This refers to the difficulty of making two different calibres range alike.]

On the other hand I trust that such missfires [? mistakes] *as occurred with the medium artillery of the "Helgoland" will not occur again.*

7. *The simultaneous firing* [with pairs of guns mechanically locked] *does not give rise to any special remarks.*

8. *Firing on both sides could not be carried out as intended owing to continuous interruption caused by steamers, sailing vessels, and by thick weather.*

After a long delay, the targets had to be fired at one after the other, but the principal side continued to be controlled.

Owing to unfavorable means of transmitting orders, difficulties were experienced in controlling the medium guns from the side tower.

9. *In the "Thüringen" the guns were loaded from the ready racks, which with salvoes at intervals of every 20 seconds, occasioned no difficulties.*

[It is not clear whether turret guns or secondary armament are referred to.]

10. *During the firing of the "Helgoland" and "Posen" signals were made from the extendable pole. With the deflection and elevation at which the firing was carried out, the signal only once carried away.*

11. *The breakdowns ordered were made good in the proper manner.*

Although the training of the 15-cm. guns with the handspike produced no noticeable results as regards dispersion ("Nassau," "Westfalen" and "Thüringen"), the danger that the fire commander may be influenced to take the wrong measures owing to a stray shot is so great that for the present I forbid guns to take part in the firing which can only be trained by means of handspikes. An alteration in the drill instructions has been requested.

[This presumably refers to intentional breakdown of hand-worked guns.]

12. *Observation from the side* [presumably by rake] *is in general satisfactory. It is unfortunate that owing to the seaway a part of the firings only could be photographically recorded.*

The side observation records of the "Westfalen" and "Nassau" are insufficient.

13. *The general result of the firing is satisfactory. In comparison with the results of the previous year it is true that only an inconsiderable improvement can be noted, but in the present year the weather conditions were less favourable. The ships rolled considerably. Some of the exercises were more difficult, and the fact that the method of calculating the results was slightly different made this year's results appear unfavourable.*

The results of the medium artillery have in an unfortunate manner been reduced by the bad firing of the "Helgoland."

Military Decisions.

"Ostfriesland."

I concur with the criticism of the commanding officer, and express my approbation to the gunnery officer, as regards the control of fire.

The exercise was well carried out.

"Thüringen."

1. *The range clock has on the whole proved satisfactory, but in the course of the firing account must be taken of the increase or decrease of rate as ascertained by means of the instruments. Had this been done, the battery would have kept on the target better in the middle of the firing. During the firing it was not possible to obtain the condition of no rate of change.*

2. *As this firing was carried out from the windward position, a few remarks on smoke hindrance would have been in place.*

3. *In spite of the short ranges the exercise has been correctly carried out in view of the increased difficulties of the firing caused by the motion of the ship.*

"Oldenburg."

Heavy guns.—Firing was in every respect satisfactory, and I express my approval to the gunnery officer.

Medium Guns.—I concur in general with the remarks of the commanding officer, although it does not necessarily follow that a bracket for ascertaining the calibre difference would have enabled the target to be picked up quicker.

In this firing there also occurred a case which has scarcely ever happened before, namely, that the actual and calculated calibre difference lie so far apart.

The heavy and the medium guns carried out this exercise well.

[It is thought that calibre difference means the difference in ranging between guns of different calibres.]

"Helgoland."

Primary Target.

Heavy Guns.—The exercise was satisfactorily carried out.

Medium Guns.—I concur with the commanding officer's opinion. Success cannot be obtained by theory, when the fire commander (control officer) acts with so little decision on actual observation.

Secondary Target.

Heavy Guns.—The fire commander (control officer) carried out the firing irrespective of the regulations. I expect the firing regulations to be carried out exactly. In the case of such an inexperienced gunnery officer, any deviation from the firing regulations cannot be permitted.

Medium Guns.—I concur with the opinion of the commanding officer. The exercise, so far as the secondary target is concerned, has not been properly carried out.

"Posen."

Heavy Guns.—I concur with the opinion of the commanding officer. Even if the fire commander (control officer) has recognised his mistakes, I must put it on record that similar mistakes were made at previous firings controlled by him. The alterations of the rate were made so suddenly, that the fire commander (control officer) concluded that in such cases independent firing would be better. It is possible however also to carry out such firing very satisfactorily with the clock, although on the other hand it is the duty of the fire commander to cease using the range clock when the latter can no longer follow.

Medium Guns.—I concur with the opinion of the commanding officer.

In spite of five hits, the exercise, so far as the heavy guns are concerned, was not well carried out.

"Rheinland."

The firing took place under very unfavourable weather conditions.

The good shooting of the gunlayers was especially noticeable.

The criticism of the commanding officer regarding the control of the fire is concurred in.

The exercise was well carried out by the heavy guns: but even after allowing for the unfavourable conditions, that of the medium guns was only partially successful.

"Nassau."

The salvo + 75, + 50, − 75 which became fatal to the success of the whole firing of both ships belonged, according to the observations by rake, to the "Nassau," but unfortunately the rake observer, even at the first salvo, had already mixed up the firing ships. It is therefore impossible to say to which ship this salvo belonged.

*The "Nassau" in any case fired over the target. If the assistant observation had been made use of, the gunnery officer would have been in doubt concerning his "cocksure" observation + − * at the fourth salvo, seeing that the next salvo was again +, and a reduction of the rate at salvo 6 would then have had a good influence on the firing.*

When the medium guns fired alone, the battery should have been brought on to the target by larger and increasing corrections. Sufficient attention has not been paid to the target passing the beam and to the consequent increase of range.

The choice of the opening range cannot be concurred in. The ranges taken by the range-finders in the after side control position should not have been taken into account.

"Westfalen."

The shots went over the target. The spotting of wide shots has already been forbidden by me from next firing onwards, after the failures of this year. The shooting of the "Nassau"-"Westfalen" shows that such assistant observations must be forbidden.

The opinion of the commanding officer is concurred in.

The 4th sub-division (i. e., "Nassau"-"Westfalen") has not carried out the exercise satisfactorily.

Practice Firings carried out during the War.

According to reports from a reliable source the usual firing practices have been carried out periodically by the German Fleet during the war. It appears that ships do firing practices at least once in every six months, and possibly more frequently, generally in the Baltic.

Battle practice, night firing, and torpedo firing are, if possible, carried out on the same day, or within a few days of each other.

Sub-calibre and aiming-rifle practice is also frequently carried out.

It has been reported that, as a result of the experience gained during the Jutland action the range at which battle practice is carried out has been considerably increased.

Method of Firing during Action.

In the Jutland action the "*Konig*" opened fire with a few rounds of H. E. shell, after which only A. P. shell was used.

Salvo firing, either instantaneous or by ripple, was used, and it is believed that until such time as a ship is damaged, and so forced to go into independent fire, salvoes are to be anticipated as the rule.

It was observed in the Jutland action that the fourth salvo from a German ship was fired after 1½ minutes. This shows that a system of ranging by rapid salvoes is in use.

Ranging salvoes with a reduced number of guns are believed to have been used by some ships.

Concentration of the fire of several ships on one ship was practised during the action, the point of concentration being in certain cases the turning point when an enemy line was turning in succession.

First fire was very rapid, and accurate for range, but frequently bad for direction.

Little use was made by the Germans during the Jutland action of the secondary armament, excepting against light cruisers and destroyers.

Light cruisers are believed to have fired by director.

Method of Firing by T. B. D.'s during Action.

Salvo firing is always used in T. B. D.'s as long as the control remains intact, and salvo firing by half flotillas appears to be practised considerably.

* German method of showing a hit.

Part IV. Section 4.

Range-finders.

Range-finders on the Sextant Principle.

Two sizes of this type of range-finder, both made by Zeiss, are employed, viz.:—

(*a*) Single observer hand instruments.

(*b*) Large instruments requiring two operators, a range-taker, and a range-reader.

Both instruments depend upon the knowledge of the height of the masts or funnels of the ship of which it is desired to find the range, but the large instruments can also be used for obtaining the range by the horizon method.

(*a*) Hand Instrument (*Hand-Gerät*).—The instrument is provided with a drum graduated to read ranges from 15 to 250 times the vertical base employed. It is about 18 inches in length and weighs some 5 lbs. The instrument cannot be used for the horizon method, and is intended principally for use during local control by officers of quarters.

(*b*) Large Instrument (*Stand-Gerät*).—This instrument is provided with three eyepieces, having powers of 10, 15, and 20 magnification respectively. A range and a depression drum are fitted, the former being graduated to read ranges between 100 and 1,000 times the vertical base employed. With the horizon method, ranges between 3,000 and 5,000 metres (3,281 and 5,468 yards) only can be taken. The pointer on the range drum can be moved independently of the instrument in order to allow spotting corrections to be applied directly to the instrument. The second operator reads the range off the drum on the range-taker calling out "*Null.*"

Coloured glass shades—red, green, and grey—are fitted to the telescope for use in bright lights.

Stereoscopic Range-finders (Basis-Gerät).

The following details refer to the 1½ and 3-metre (5 and 9.8-feet) base instruments, the tubes of which are 8 inches in diameter. Details of the larger instruments believed to be now fitted are not known, but in the latest ships the range-finder has a base of about 9 meters (29.5 feet).

The tubes are of aluminium. One range-finder operator suffices for the short base range-finders, but it is believed that two operators are required for the latest long base instruments. The operator must be possessed of stereoscopic vision. The principle of the instrument is the artificial increase of the distance between the human eyes. Within the instrument is an index which can be shifted by means of a drum outside. When taking a range, the index has to be brought exactly over the object, when the range can be read on the drum. This drum can be turned forwards or backwards, and the index then appears to move further out to approach the eye. A fixed mark then shows the range on the drum. The small instrument, with 1½-metre base, takes ranges up to 9,000 metres (9,842 yards); the larger, with 3-metre base, is accurate up to 12,000 metres (13,100 yards) and even further. These instruments are easily transportable, accurate, and do not require the height of the target to be known. The target need not be fully visible, as the smallest portion, such as the top of a mast, or cloud of smoke from the funnel, is sufficient to range upon. It is said that even by night the range can be accurately taken, while this is hardly possible with other instruments. The objections to it are: difficulty of training the men, since every man cannot use it; the great strain on the eyes, and the liability of the range-finder to get out of adjustment. The instrument must be brought to the place where it is to be used at least two hours beforehand, in order that it may acquire the same temperature as the surrounding objects.

When these range-finders are fitted in the control tower, the operator is completely under cover; the range-finder is made to revolve round a complete circle on its central pivot, the arms sweeping over the control tower. The eyepieces are down below armour. When fitted in a turret the range-finder is fixed and revolves with the turret.

Divided Image Range-finders (Invert-Gerät).

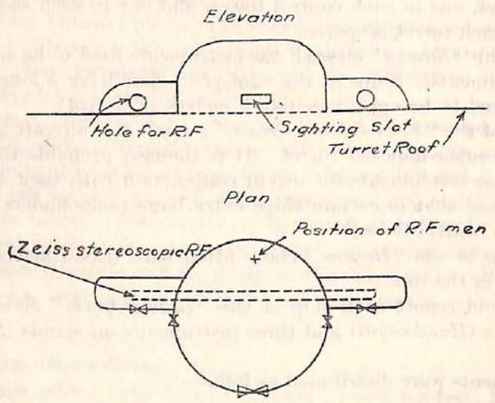
The range-finder carried in torpedo craft is the Invert-Gerät, known to the German *personnel* as the "I. G." This instrument works on the Divided Image principle, the upper image being inverted. There is only one eye-piece, into the field of which the range-scale, graduated up to 10,000 metres, is introduced.

It is said that ranges are taken only with great difficulty in bad weather. The instrument has a base of about one metre, and is mounted on a stand.

Range-finder Positions.

Turret Range-finder Position.

For mounting range-finders in the turrets of some of the older ships wings have been added to sighting hoods in certain turrets, as shown in the accompanying rough sketch. The range-finder is not capable of any training independently of the turret, but can be rotated about its horizontal axis only.



In the "*Nassau*" and "*Westfalen*" long hoods are erected in rear on top of the gun shields of certain of the turrets. The accompanying sketch, Fig. 1, shows the general appearance looking from front of turret.

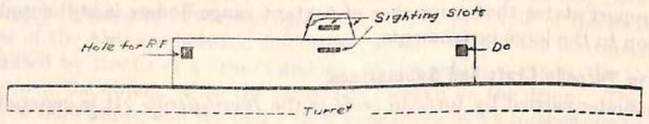


Fig. 1

All the turrets of the "*Rheinland*," "*Posen*," and later battleships and battle-cruisers up to and including the "*König*" class and the "*Seydlitz*," contain a range-finder; hoods on the roof contain the object-glasses.

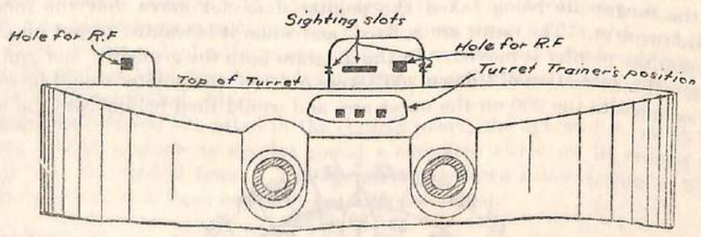


Fig. 2.

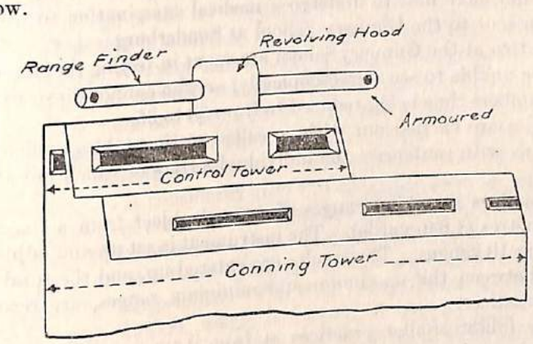
In the latest battleships carrying 15-inch guns the range-finders are placed well to the front of the turret passing through the front armour; the object glasses are protected by screens.

Conning Tower Range-finder Position.

The large sextant principle range-finder (in battleships launched between about 1900 and 1904) is mounted on an adjustable frame, traveling on rails fixed to the walls of the conning towers below the sighting slots.

In these older ships the Zeiss stereoscopic range-finder is mounted in a kind of cradle traveling on rails suspended from the roof of the conning tower.

In the "*Schlesien*" and later ships, range-finders are mounted above the roof of the control tower and the after control tower; the ends of the range-finders project through a revolving hood as shown below.



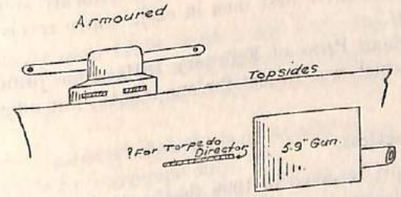
Broadside Range-finder Position.

In all modern ships a special armoured position for the range-finder is provided on each broadside for use with the secondary armament. This consists usually of a small revolving hood, with sighting slot supported on a ring of rollers and rotated by means of hand-training gear. The range-finder is attached to, and revolves with, the hood, the range-taker being seated on a stool with revolving seat. The range-reader stands alongside the range-taker on a small fixed platfrom. A third operator works the training gear and is provided with a telescope with cross-wires to enable him to keep the training on.

In ships of the "*Thüringen*" and "*Kaiser*" classes, and the "*Moltke*" and "*Seydlitz*," the range-finder is made to revolve round in a complete circle on its central pivot, the arms sweeping over the tower, as shown in the sketch.

RANGE-FINDER.

ARMOURED.



The range-finders in these broadside positions are used for the secondary armaments, but no control instruments are fitted in the tower.

Range-finders are possibly mounted aloft in some of the latest ships. A report has been received that a range-finder has been fitted experimentally in the top of the "*Kronprinz*."

Range-Takers and Range-Finding.

The following information is derived from a reliable report received in October 1909.

Ten specially trained range-takers (*Entfernungsmesser*, *Distanzmesser*) are carried per ship. An outline of the qualifying course for this rating is given below.

Range-takers are taught the general appearance of ships of the English and French navies, and are required to know the masthead heights and heights of funnels of each class.

As regards accuracy, it is stated that an experienced range-taker, using the large sextant principle instrument (*Stand-Gerät*), will take ranges up to 8,000 metres (8,749 yards) with little or no decrease in accuracy.

Range-finding exercises are carried out daily, both at sea and in harbour, and the instruments are adjusted each day by their own range-takers. A record of each instrument is kept in a special log.

Range-takers are selected from the 12-year gunnery personnel.

Part IV. Section 4.

Range-finders.

Course of Instruction in the Zeiss Stereoscopic Range-finder.

Four courses, each lasting eight weeks, take place every year. Some 45 or 50 men are told off for each course, and have first to undergo a medical examination to test the sight of both eyes. They are then sent to the Gunnery School at Sonderburg.

The first day or two at the Gunnery School are spent in testing the stereoscopic sight of the men. Those who are unable to see stereoscopically, or who cannot do so to a sufficient extent, are sent back, the numbers thus being reduced to from 30 to 35.

The first exercises are carried out with so-called testing tables, which consist of a small stereoscopic apparatus with sentences, the individual letters of which are at varying distances from the eye.

Then follow practices in taking ranges of a fixed object from a fixed observing station at a range of 1,500 metres (1,640 yards). The instrument is set up and adjusted by the instructor, each pupil taking 10 ranges. The results are entered up, and the total and average error, and the difference between the maximum and minimum ranges, are recorded. Each pupil undergoes 60 such practices.

After this stage follow similar practices at from 2,500 to 3,500 metres (2,734 to 3,827 yards). The average error must not exceed 1 per cent.

Now follow practices from a fixed observing position on a moving target at ranges up to 3,500 metres (3,827 yards). The target, a steamer, moves in a given direction at a uniform speed. Every 20 seconds the orders "*Achtung*" (Stand by!) and "*Null*" (Stop!) are given and then the ranges are noted. The results should consequently give a uniform increase or decrease of range. Each pupil undergoes 60 such practices.

The subsequent practices are from a moving observation station on fixed and on moving targets, the ranges being gradually increased up to 5,000 and 6,000 metres. (5,468 and 6,562 yards).

Finally, range-taking is done by time at both fixed and moving targets; for instance, 10 ranges in 25 seconds on a fixed target, so as to practice the men in rapidly picking up the target. The ranges of a moving target are read off and noted every 5 seconds, so that during the whole of the practice the range-taker must keep the target exactly under the large wedge.

The whole of the ranges taken by each individual pupil are entered up and calculated out. Each, on completion of the course, receives a certificate showing his qualification for employment in his ship. The three best men in each course receive money prizes of 50, 35, and 20 marks (2*l.* 10*s.* to 1*l.*).

According to the German Press of February 1910, some junior officers were appointed to a range-finding course which was to last for one month, but officers are not used as range-takers.

Squadron Range-taking Practices.

It appears from a report received in 1909 that several squadron exercises for the trained range-takers take place each year.

The method of carrying out the practice is as follows:—The two squadrons in quarter line steam away from each other at equal speeds. Every 10 seconds the ranges are read off and noted. In clear weather the practice is continued up to a range of 9,500 metres (10,389 yards). Then the same is repeated with the squadrons approaching one another.

After the completion of the practice the instruments are adjusted, and any adjustment found necessary is noted.

The best range-taker in the ship receives a money prize of 40–20 marks, the best range-taker of each squadron a further prize of 50 marks.

COMMUNICATIONS AND CONTROL OF FIRE.

General System of Control.

It is considered that the following conclusions regarding fire control can be drawn from the remarks of the Squadron Commander of the 1st Squadron on the long-range firing carried out in 1913–14. The report in question appears on page 9.

Part IV. Section 4.

Communications and Control of Fire.

The system of control in force in the German Navy up to a comparatively recent date was based on the principal Control Officer transmitting ranges direct to the guns, the ranges being based on range-finder readings with the necessary prediction superimposed.

They have recently (since the latter part of 1912) adopted some form of range clock, which from this report is evidently intended to be used up to the moment the first salvo is fired, and, provided the clock is able to compete with the rate and alterations in the ship's course, should be used from then on, more especially during "Effective fire," *i. e.*, when hitting.

That, in 1914, they were not very expert in the use of this clock is fairly evident from the report; further, it appears they had only just commenced to make use of the results of all their range-finders, the range-transmitters so frequently spoken of being somewhat of a novelty.

Generally speaking, it is considered that the Germans were, in 1914, considerably behind us as regards their system of control, and were then experiencing the difficulties which we had met with in regard to clock control two years or more previously.

It is believed that in the latest German battleships, battle and other modern cruisers, the range is obtained by range-finder. The main range-finder is stated to be on top of the *Kommandostand* (Control Tower), which is usually in the after part of the conning tower. From there the range is communicated to a transmitting station between decks. The latter is situated below the armoured deck and is looked upon as a very safe place, but was actually put out of action by the first hit on "*Blücher*" in the engagement in January 1915.

Plotting is carried out, but it is believed that it is not relied on to the same extent as is the range-finder. The following account of the methods in use is believed to be substantially correct.

An instrument almost exactly like our Dumaresq is in use for finding the rate of change of range and the deflection angle. It is an instrument with a system of lines and cross lines on it like ours, and a bearing plate.

Both the rate of change of range and deflection are worked out on the virtual system, *i. e.*, imagining the enemy to be stationary; the angle of deflection is read off in divisions, marked in sixteenths of a degree from zero.

The speed of the wind relative to the observer's own ship is found by anemometer, then converted into angular form, and applied to the angular deflection found by the Dumaresq. The result is then passed to the guns.

Spotting.

Before 1913, spotting used to be carried out from the conning towers. During 1912, however, small unprotected platforms were fitted at the junctions of the topmasts with the main and fore masts in most of the battleships and cruisers, and were used during 1913 as spotting positions.

For a day action it is believed that the spotter only is posted here, and is in communication with the control tower by voice-pipe only.

The following extract is from a reliable report received in 1913:—

"After the Russo-Japanese war the German fleet gave up all ideas of using 'spotting' as the primary method of hitting the target at long ranges. The range-finder is relied on primarily for this purpose, and spotting is looked upon as an auxiliary only. It is not considered possible to spot in action, whereas it is considered possible to continue to take ranges so long as it is possible to direct the guns. There is good reason to believe that the errors which creep in when finding the gun range have been reduced to a minimum."

In a photograph of the newest battleship, the "*Bayern*," extensive accommodation is shown aloft, at the top of the tripod mast, for fire control. It would, therefore, appear probable that as a result of experience gained during the war, control and spotting from aloft is being introduced.

Control Towers and Transmitting Stations.

In all the more modern ships the conning tower is situated on the fore shelter deck and the fore control tower (*Kommandostand*) is the after part of the conning tower, from which it is separated by a bulkhead.

Immediately below this in the "*König*" class and "*Kaisers*" is the upper transmitting station, the two compartments being separated by the floor gratings of the control tower.

The after control tower is the torpedo control position.

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