

The Schwartzkopff Torpedo, U.S.N.: Descriptions, Nomenclatures, and Plates, 1903

In the collection of the
U.S. Naval Undersea Museum

NMNW.2015.023.009



THE
SCHWARTZKOPFF TORPEDO,
U. S. N.



Descriptions, Nomenclatures,
and Plates.

1903.

V850
.S3
1903

Faint, illegible text at the top right of the page.

NON-CLASSIFIED



**Naval Ordnance Systems Command
Technical Library
Dept. of the Navy
Washington, D. C. 20360**

NMWW. 2015.023.009

Chief Gunner
Herbert Campbell
U.S. Navy

No.

To be returned to the Bureau of Ordnance when called for.

THE
SCHWARTZKOPFF TORPEDO,

U. S. N.
NON-CLASSIFIED

ERRATA.

Page 11, line 30, last word should be "branch."
Page 14, line 13, reference number should be 21, instead of 2.
Page 17, line 5, last word should be "flask."
Page 17, line 10, third word should be "medium."
Page 19, line 18, instead of "spindle" should read "pinion."
Page 21, line 29, instead of "unlocking" should read "uncocking."

PREPARED AT THE NAVAL TORPEDO STATION

BY DIRECTION OF THE

BUREAU OF ORDNANCE.

N. T. S. P.
1903

NAVY
BUREAU OF ORDNANCE
TECHNICAL LIBRARY
WASHINGTON 25, D.C.

V
850
N32
C.1

Chief Gunner
Robert Campbell
U.S. Navy

No.

To be returned to the Bureau of Ordnance when called for.

THE
SCHWARTZKOPFF TORPEDO,

Unclassified

U. S. N.
NON-CLASSIFIED



PREPARED AT THE NAVAL TORPEDO STATION

BY DIRECTION OF THE

BUREAU OF ORDNANCE.

N. T. S. P.
1903

NAVY
BUREAU OF ORDNANCE
TECHNICAL LIBRARY
WASHINGTON 25, D.C.

V
850
1432
C.1

The Schwartzkopff Torpedo.

Plate I.

The Schwartzkopff torpedo is constructed in eight sections, but is ordinarily dismantled and assembled in four principal parts: 1, 2, the Head, 3, the Immersion Chamber, 4, the Air-flask, and 5, 6, 7, 8, the After-body. The after-body carries the tail, 8, the bevel gear box, 7, and the engine room, 5, and all sections, are of bronze, the air flask being of a special grade manufactured to stand the internal pressure of 90 atmospheres per sq. in.

The principal dimensions of this torpedo are as follows:

Extreme length.....	15 ft. 1 in.
Greatest diameter.....	14 in.
Weight of air in flask charged to 90 atmospheres	32 lbs.
Exercise head complete.....	149.9 lbs.
War head complete.....	149.9 lbs.
Weight of wet gun-cotton charge	125.4 lbs.
Weight of dry primer	21.8 ozs.
Weight of Torpedo ready for launching.....	728.4 lbs.
Buoyancy in sea water.....	2.9 lbs.

The head, 2, is attached to the forward end of the immersion chamber by three equidistant locks, forming a bayonet joint, and fifteen counter-sunk screws.

The immersion chamber is secured to a short sleeve on the forward end of the air flask, and is held in place by thirty screws.

The after-body is secured to the air-flask by thirty counter-sunk screws.

Screwed to the after part of the after-body, 6, is the bevel-gear box, 7, held in place by four set screws. The tail, 8, is screwed to the bevel-gear box and is also held in place by four set screws.

THE HEADS.

Plates II and III.

There are two interchangeable heads supplied with each torpedo, the war-head, and the exercise-head.

THE WAR-HEAD.

Plate II.

The war-head, of sheet bronze, is charged with 125 lbs. of wet gun-cotton, and is closed at its base by a bronze bulkhead, 9, against a bulkhead ring, by 20 screws. The interior of the war-head and the bulkhead are tinned over. In the center of the bulkhead is a moisture tap, 10, through which distilled or rain water may be poured to make up possible loss of weight in the charge by evaporation. The stowage weight of the war-head is stamped on the bulkhead near the moisture tap.

Soldered in the forward end of the war-head is the primer case pocket, 7, of bronze, in which is inserted the dry gun-cotton primer case, 6. The forward end of the primer case, 6, is threaded on its outside to receive the war-nose, 1, and on its inside for the reception of the inner exploder holder, 5.

THE WAR-NOSE.

Plate IV.

The war-nose is screwed on the forward end of the primer case, 12, and is attached to the forward end of the war-head by a bayonet joint. The body of the war-

nose, 7, is of bronze, the firing pin and striker, 1, of steel. The firing pin screws into the rear end of the striker. A shearing disc, 2, between the firing pin and striker, 1, prevents the firing pin from moving aft to strike the cap of the outer exploder until it is sheared by the striker on impact of the torpedo with the target.

The striker is shaped at its forward end like the screw-fan of the Whitehead war nose except that the surfaces of the blades are not shaped to make it revolve. Four guides in the forward end of the war-nose body, 7, prevent the blades from turning, and allow the firing pin and striker to move aft on impact. A safety pin, 4, is put in place abaft the firing pin to prevent its being driven in accidentally; this pin must be removed before firing the torpedo. The inside of the war-nose body, 7, is threaded for the reception of a bronze disc, 5, which acts as a holder for the forward exploder, 6, which screws into its centre. This exploder is unlike the one in the primer case, 12. It consists of a heavy bronze stock capped at its forward end with a percussion cap, and filled with 14 grains of fulminate of mercury, its after end being closed by a piece of tinfoil. The inner exploder, 11, is a bronze case filled with 26 grains of fulminate of mercury; it is closed at its forward end, by a thin disc of copper, 10, held in place by the exploder holder, which screws in against a leather washer. The war-nose is kept attached to the primer case, so that the primer and war-nose can be attached to the war-head together. The action of the war-nose is as follows. On impact of the torpedo with the target, the striker, 1, shears the shearing disc, 2, the firing pin strikes the cap on forward exploder, the flame from this exploder penetrates the copper disc, 10, which covers the inner exploder, 11, in the primer case, 12, and this in turn detonates the dry

primer. Leather washers are placed under the head of the bronze disc, 5, and the forward exploder, 6, and prevent water from coming in contact with the exploders. Holes in the body of the war-nose in rear of the firing pin prevent water-cushioning. A leather washer is placed between the war-nose body and the flange of the primer case. A leather washer is also placed between a shoulder on the war-nose and the forward end of the war-head.

EXERCISE - HEAD.

Plate III.

The exercise-head is ballasted for exercise by filling it with fresh water and is closed at its base by a bronze bulkhead secured by studs and nuts to a bulkhead ring against a rubber washer, 7. On the forward side of the bulkhead is a trimming tank, 4, which is to be kept empty if the torpedo is to be fired in fresh water, but if fired in sea water, it receives the additional fresh water needed to make the total weight of exercise head and nose 149.9 lbs. In the bulkhead of the tank is a filling hole and a vent hole closed by screw plugs, 5 and 6.

Encircling the interior of the head is a leaden ballast ring, 2.

The head is filled through a filling hole, 3, through the upper surface of the shell close to the bulkhead, and this hole is closed by screw-plug against a leather washer.

Soldered in the forward end of the head is a primer case pocket similar to that in the war-head; it is closed by the exercise-nose which is in one with the dummy primer case; the object of this case is to have the trim of the war and exercise heads alike. The exercise-nose, 1, Plate III or 14, Plate IV, is attached to the head by a bayonet joint and is held in place by a set-screw.

A hole passes through the body of the nose for a dis-

mounting-tool, and also for the nose line used in towing the torpedo.

THE IMMERSION CHAMBER.

Plate V.

The immersion chamber, 3, Plate I, containing the immersion mechanism, is secured to the forward end of the air-flask, 4, Plate I, by thirty counter-sunk screws; it is a short bronze cylinder closed at its after end by a water-tight bulkhead held against a bulkhead ring by studs and nuts and at its forward end by a bulkhead permanently secured in place.

The immersion chamber, Plate V, is strengthened by two interior strengthening rings, and at the ends by the joint rings.

The immersion mechanism consists mainly of the hydrostatic piston, 15, and pendulum, 4.

The hydrostatic piston governs the immersion of the torpedo during its run, and can be set for any depth within the limit shown on the depth index.

The pendulum acts to maintain the axis of the torpedo in the horizontal plane.

The combined action of the hydrostatic piston and pendulum is transmitted, by a system of levers and connecting-rods, to the steering engine, and thence to the rudder, to steer the torpedo to its set depth and to maintain it in the horizontal plane at that depth.

Through the bottom of the forward immersion chamber joint rings are a number of large holes, corresponding with similar holes in the bulkhead ring of the head, which permit the free access of water to the forward side of the hydrostatic piston. Through one of these holes can be inserted the hook for testing the hydrostatic piston, and also the dismounting-tool for head.

THE HYDROSTATIC PISTON.

Plate V.

The hydrostatic piston is a metal disc contained in a shallow circular recess, or box, 16, in the centre of the forward bulkhead of the immersion chamber.

The forward side of the recess is closed by a thin copper diaphragm, 13, which being flexible, permits water pressure to act on the forward side of the hydrostatic piston. The rim of the diaphragm is clamped, air and water tight, against the forward side of the bulkhead, by a bronze ring, against a leather washer secured by screw-bolts and nuts.

Across the forward face of the diaphragm is secured a bracket, 12, in which is pivoted the testing-lever, 11, which, when moved up, will, by the pitch of a coarse thread, give the full in-throw to the piston.

Secured to the after side of the piston is a sleeve into which fits a spindle, 17, threaded at its after end, which carries a spur gear. The threaded part of the spindle abaft the spur gear passes through a bracket, 18, which has three radial arms, to which are secured the after ends of the three hydrostatic piston springs, 19, the forward ends of these springs being secured to the after side of the piston box, 16. Secured to the after face of the piston box are two brackets, 25, in which revolves an adjusting spindle, 24. On the threaded part of this spindle is a sleeve, which, when the adjusting spindle is turned, moves up or down, and which is kept from revolving by a guide.

The depth-index, 26, is a T shaped socket wrench graduated in metres and half metres, over which loosely slides a bronze sleeve, the function of which is to bear against the sleeve on the adjusting spindle. When the spindle is turned to set for immersion, the sleeve will be given

vertical motion which is transmitted to the sleeve around the index until the upper edge of the index-sleeve is in line with a mark showing the desired immersion, in metres and half metres.

Rigidly secured to the lower end of the adjusting spindle is a bevel gear, 22, which engages a bevel gear secured to the forward end of the gear spindle, 20. The gear spindle also carries a spur wheel engaging the spur wheel on the threaded spindle, 17. The after end of the gear spindle passes through and acts as a guide for the bracket of the hydrostatic piston springs.

The hydrostatic piston springs are of steel, (electro-plated) spiral in shape and three in number.

To set for immersion the depth-index is shipped over the square head of the adjusting spindle, which, if turned to the right, will transmit rotary motion to the gear spindle, and through the medium of its spur gear will cause the threaded spindle to be revolved, moving the bracket for hydrostatic piston springs aft; this distends the springs, causing a greater forward pull on the bracket. The more the bracket is moved aft, the greater will be the distension of the springs, tending to force the threaded spindle, and consequently the hydrostatic piston forward. The greater the tension of the springs on the threaded spindle, the greater will be the immersion of the torpedo before the hydrostatic piston will be in equilibrium between the pressure of the water on its forward face, and the push of the threaded spindle on its after face.

The area of the piston is such that it takes a water-pressure of about 38 pounds to balance or equal the tension of the hydrostatic piston springs, when set for a depth of 1.5 metres.

On the after face of the hydrostatic piston is secured a boss, which passes through the piston box, 16. Secured

to this boss is the forward end of the double spring rod, 1. The function of this rod is to transmit the piston stroke to the lower arm of the cross-lever, 2, which pivots about a pin on the port pendulum rod, 6. This rod, 1, is provided with a spring which permits it to lengthen or shorten in absorbing the combined effort of piston and pendulum.

The pendulum, 4, hangs on knife-edge bearings near the after end of the immersion chamber, and swings in the vertical fore and aft plane. Its movement being eased and regulated by spring buffers, 5, and arrested by stops. Leading from the upper arm of the cross-lever, 2, is a rod, 7, which connects by a claw at its after end with the arm of a rock shaft, 9, working in a stuffing-box on the after bulkhead of the immersion chamber.

When, in disassembling, it is desired to remove the bulkhead, a hanger, 8, suspended in the shell of the torpedo is run up and the claw is thus disconnected from the rock-shaft arm. In assembling be very careful not to injure the rock-shaft arm when making the claw connection.

The pendulum buffer springs when properly adjusted, should allow the pendulum to make its extreme forward throw when the axis of the torpedo is inclined $2^{\circ} 18'$; and its extreme throw aft, when inclined $2^{\circ} 36'$.

THE AIR - FLASK.

Plate I.

The air-flask, 4, Plate I, is a hollow bronze cylinder with dome-shaped heads, strong enough to withstand an air-pressure of 1350 pounds per sq. in., or 90 atmospheres. Throughout the length of the air-flask, between the two heads, runs a tube or casing for the steering engine valve rod. From the after head of the air-flask projects a

charging pipe through which the air-flask is charged when the after body is in place.

THE ENGINE - ROOM

Plate XI.

The engine-room, 5, Plate I, is situated between the after end of the air-flask and the after body. It contains the main and steering engines with their connections, the locking and distance mechanisms, the charging and stop valves, the cocking and starting levers, the reducing valve group with regulator, 3, the retarding mechanism, the oil cup, 4, and the sinking valve, 17, with its mechanisms. The charging and stop valves are connected to the air-flask by a copper tube.

THE ENGINE.

Plate XII.

The engine is of the three cylinder, single acting, type, the body of bronze comprising in one casting, three cylinders, three valve chests and the crank case. The after end of the crank case is open, but when in place is kept water-tight against the engine-room bulkhead, by a ground joint, the body of the engine being held in place by six studs and nuts.

The three cylinders radiate from the crank case with their axes 120° apart. On the forward side of each cylinder is cast its slide valve chest, 3, with its axis parallel to that of the cylinder. The crank case is closed at its forward end by the crank case cover, a bronze screw plate which takes the thrust of the forward end of the crank shaft, 14, abutting, in a socket in the centre of the crank case cover, against three or more friction discs, 13. The crank case cover is kept from jarring off by a set screw, held in a bracket cast with the crank case.

Cast in the centre of the crank case is a spider frame

forming a bearing for the crank shaft, forward of the crank. The shaft has a third bearing just abaft the engine bulkhead in the forward end of the shaft tube, and another bearing in the after end of the shaft tube.

The main shaft, 16, is a hollow bronze tube carrying the after propeller whose pitch is left handed. The forward propeller, which is right handed, is carried on an outer shaft of bronze surrounding the after end of the main shaft, and is geared to it by the gears in the gear box.

Each crank pin brass embraces the crank pin, 15, for about 90° of arc, and is held in place in an annular groove, cut in each web of the crank, concentric with the crank pin, the ends of the brasses being furnished with tongues to fit the grooves. The bearing surfaces of the brasses are babbited to decrease friction. A gate cut in the forward arm of the crank permits sliding the brasses on, or off, the crank pin, and this gate is closed by a removable piece held in place by a flat-headed screw.

Each piston has a double slide valve, inner valve, 5, and outer valve, 4, worked by eccentrics keyed to the crank shaft. Around the eccentrics are the eccentric straps, 9, to which are secured the inner ends of the slide valve rods. Each double valve slides in its chest which is cast on the forward side of its respective cylinder. The outer slide valve has an annular space or span formed between two valve faces, around which is a constant air pressure. When the valve is moved on through the medium of its eccentric, the air in this space around the outer slide valve is brought in line with the port in the cylinder; air will then get in rear of the piston and force it towards the centre of the crank case until the direct exhaust port, 21, on the piston is clear of the cylinder, at which time the air which has been behind the piston will exhaust into the crank case

and out through the main shaft. Just before the end of the piston stroke the valve receiving motion from its eccentric, has moved, so that one of its faces covers the pressure port thus cutting the air off from the cylinder. The air expanding in the cylinder completes the stroke. On the return stroke of the piston the direct exhaust ports are closed and the air remaining in the cylinder exhausts through four radial exhaust ports on the outer slide valve previously uncovered by the inner slide valve. A pipe connecting to the outer end of the valve chests admits the exhaust air to the crank case. Each main valve has a relief valve, 23, kept seated by a spiral spring, and in case of excessive cushioning on the outward stroke of the piston, the relief valve is lifted, opening another channel to the crank case.

Secured by two studs on the forward face of the eccentric, is a worm which meshes into a worm wheel secured near the lower end of a vertical shaft, by which means the necessary power is transmitted for operating the locking and distance mechanism.

The outer ends of each cylinder are closed by screw plugs, screwed in and then soldered.

Holes in the outer ends of the valve chests permit the removal of the valves from the outside for cleaning or changing. These holes are closed by screw plugs screwed in against rubber washers.

Air from the reducing valve passes through an admission pipe, 1, running around the forward face of the crank case; the ends of this pipe are connected to the forward face of two of the valve chests, and a branch from the admission pipe admits air to the third valve chest.

Air from the admission pipe also flows through a small

bent pipe, 25, which is connected to the valve chest of the steering engine.

THE STEERING - ENGINE.

Plate VI.

The steering engine is situated on the port lower side of the engine room, and is secured to the engine room bulkhead by three holding bolts and nuts, 25; it is operated by air at the working pressure of the main engine and transmits the action of the immersion mechanism with increased power to the steering rod, and thence to the horizontal rudders.

The steering engine is entirely of bronze, and consists of the following parts: the cylinder, 19, the piston, 18, and its rod, 16, to which is secured the forward end of the steering rod, 15, the piston spring, 17, the slide valve rod, 4, the counter weight, 21, and the slide valve lever, 10. The slide valve chest, 23, to which air is admitted from the main engine admission pipe, is cast in one with the cylinder and contains the inner slide valve, 11, and the outer slide valve, 12.

The forward end of the cylinder of the steering engine is closed by a cylinder cover, 20, screwed in against a paper washer; the after end of the cylinder is closed by a cylinder cover, 20, in the centre of which is a stuffing box, through which passes the piston rod, worsted packing being used in the stuffing box.

The piston, 18, of the steering engine is a partially hollow cylinder, and fits neatly in the cylinder of the steering engine; the piston rod projects aft from the hollow part of the piston and is surrounded by a stiff spiral spring, held in a state of compression between the piston and the after cylinder cover; the object of this spring is to push the piston forward when the torpedo

has travelled the desired distance and the air is shut off from the engine and steering engine, thus giving up rudder, and causing the torpedo to come to the surface. Around the outer surface of the piston are six annular grooves, for the oil circulation used in packing the piston.

The action of the steering engine is, as follows: The movement of the immersion mechanism, transmitted to the inner slide valve of the steering engine through a system of levers, causes the valve to move, and to uncover two air channels, thus admitting pressure to one end of the cylinder, which acts on one end of the piston and causes it to move forward or aft, giving up or down rudder. Secured to after end of the outer slide valve is the outer slide valve rod, 13, to which is pivoted one end of the double lever, 14, the other end of the double lever being pivoted to the forward end of the steering rod. The function of the double lever is to transmit the motion of the piston and steering rod to the outer slide valve; this causes the air to be cut off from the steering engine when the piston has moved sufficient to give the intended throw of the rudder.

When the inner slide valve gets motion in the opposite direction, the air channels admitting air to the opposite end of the piston are uncovered and the piston is moved in the new direction. The exhaust air passes through a channel in the cylinder, out to the slidevalve chest, through a port in the outer slide valve and finally escapes through five radial holes near the end of the outer slide valve. The inner and outer slide valves constitute a following valve.

The movement of the hydrostatic piston or pendulum, or both, is transmitted to the inner slide valve by the rod extending through the tube in the air-flask.

To the after end of this rod, just abaft the air-flask, is

pinned the upper arm of a bell-crank, 28; this bell-crank pivots about a pin passing through a bracket secured on the after head of the air-flask; the lower arm of this bell-crank pivots in an eye, 1, in the slide valve rod. The lower end of the slide valve rod screws into a bracket, 8, and a part of its threaded portion, extending through the bracket receives a securing nut, 5. This bracket also carries the valve adjusting screws, by which the setting of the inner slide valve is accomplished. When the proper valve adjustment is obtained, a securing nut, 6, prevents possible change of this adjustment.

To the lower part of the bracket, 8, is pivoted a lever carrying a counter-weight, 2, capable of adjustment by being moved along the lever and held in the desired position by a set-screw. The function of the counter-weight is to balance the weight of the slide valve rod and bracket. The counter-weight lever has a square socket, into which ships the square end of the slide valve lever, 10.

The upper end of the slide valve rod, 4, is threaded to receive the locking spool, 2, with its holding plate 3.

REDUCING VALVE GROUP AND WATER-TRIPPER
CONNECTIONS.

Plate X.

The body of the reducing valve, 15, is a peculiar shaped bronze casting comprising the water-tripper piston cylinder, reducing valve cylinder, and engine oil cup; it is secured to the starboard forward side of the engine bulkhead. The reducing valve admission port, 2, which extends through the engine bulkhead, is threaded for the reception of a securing nut which secures the reducing valve body to the engine bulkhead. Air passes from the charging and stop valves to the reducing valve

body through a pipe behind the engine bulkhead. Inside the reducing valve body is the reducing valve, 1, and the controller, 3.

The reducing valve is a hollow bronze cylinder perforated with forty tapered holes; pivoted to the centre of its forward face is the controller; against the forward face of the controller is the controller spring, 4, which keeps the reducing valve lifted against the pressure of air on its after end tending to seat it. The controller spring is contained in the controller spring box, 6, which is a hollow bronze cylinder screwing on the forward end of the reducing valve body; the controller spring box is threaded on its outer surface to receive the bevel gear and sleeve, 7, for adjusting the reducing valve controller spring.

Over the bevel gear sleeve slides, another bronze sleeve to which is secured the bracket forming a bearing for an adjusting spindle, 29, having on its inner end a small bevel gear. When the adjusting spindle is turned it causes the bevel gear sleeve to be rotated thus compressing or extending the controller spring. The greater the compression of this spring, the greater will be the opening of the reducing valve and consequently the greater the pressure of air admitted to the engine.

On the starboard side of the after body is the reducing valve controller index, 28, graduated in millimetres up to 25. In making the controlling adjustment, a socket wrench is shipped over the square end of the adjusting spindle which, when turned, causes the bracket adjusting, spindle and the bevel gear sleeve, to be moved, thus compressing the controller spring. The reference mark of this adjustment is on the outer end of the bracket, and as it moves along the controller index, the compression of the spring is indicated. When the adjustment is made, the adjusting spindle is kept from turning by a locking

piece, 30, which is pivoted in the bracket and fits over the square head of the spindle; this piece is kept from jarring off the end of the spindle by a flat bronze spring, 31, held on the bracket by two screws.

Inside the reducing valve body a cylinder is permanently secured, over which the reducing valve slides; this cylinder is perforated with holes which coincide with the holes in the reducing valve when the latter is lifted, allowing the air to pass through into the water tripper piston cylinder, and thence to the engine. The air from the flask entering the reducing valve body, constantly tends to seat the valve, while the controller spring tends to lift it; the lift of the valve due to controller spring, must be sufficient, when the air-flask is charged to 90 atmospheres, to allow a pressure of 30 atmospheres to pass to the engine. As the pressure from the air-flask diminishes, the push of the controller spring against the controller causes the valve to lift higher, allows a greater flow of air to pass and thus maintains the required uniform pressure in the engine. The working pressure of the engine is 450 lbs. approximately. Oil flows around the reducing valve and controller for lubrication and packing.

THE RETARDING GEAR.

Just below, and in one with the reducing valve body, is the water tripper piston cylinder, containing the water tripper piston, 12, and the water tripper piston spring, 13. The object of the water tripper piston is to retard the passage of air from the reducing valve to the engine from the instant of launching until the torpedo strikes the water; this is the retarding device, and the engine will turn slowly only until the water tripper is thrown down or back.

The water tripper piston cylinder is a bronze casting having two ports, one leading from the body of the reducing valve, and the other leading to the admission pipe of the engine. A small air pipe, 26, leading into the oil-cup, 10, permits the entrance of air at flank pressure forcing the oil through its various exits. Oil flows through a small pipe to the water-tripper piston valve, 20, and is there arrested until the water-tripper is thrown down, at which time the slide valve is moved through the medium of the slide-valve lever, 21, thus allowing the oil from the oil cup to flow through the longitudinal channel, 16, in the water-tripper piston cylinder, to the rear of the water-tripper piston, forcing it forward against the tension of its springs, and allowing the air to pass from the reducing valve to the admission pipe of the engine.

The water-tripper piston is spool shaped and hollowed out at its forward end for the reception of its spring. Around the after part of the forward valve face are six annular cuts, 34, which allow the air to pass to the engine at a moderate pressure, during the passage of the torpedo from the tube to the water, or, while the water-tripper is raised. The engine is thus prevented from racing before the torpedo enters the water.

The water-tripper slide valve chest, 24, is a small bronze cylinder secured to the reducing valve body by two screws; it is hollowed out for the reception of the slide valve, 20, which has a recess at its forward end for the reception of a small stud on the water-tripper slide valve lever, 21. Raising or lowering the water-tripper gives motion to the slide valve through the medium of its connecting rod, 22. The water-tripper piston and slide valve have annular channels for the distribution of oil used in packing them.

THE OIL CUP.

The oil cup, 10, is a cylindrical shaped casting, secured to the reducing valve body, which carries a supply of oil for lubricating and packing purposes. On the under side of the oil cup is cast the oil cup regulator, 18, carrying the oil regulating screw, 25, capable of adjustment, by which means the flow of oil from the oil cup is governed. The oil cup is filled through a pipe leading from the body of the oil cup and accessible through a hole in the starboard side of the engine room. This pipe is closed by a screw plug against a leather washer.

THE LOCKING AND DISTANCE GEAR.

Plate VII.

The locking and distance gear is situated on top of the crank case, and is operated by the worm, 4, secured to the forward face of the eccentric on the crank shaft of the engine.

THE LOCKING GEAR.

When the torpedo is launched, the inertia of the pendulum causes it to lag to the rear, the effect of which, if unchecked, would be to put the rudder down and to give the torpedo a deep initial dive, which in shallow water might cause the torpedo to come in contact with the bottom. This lag of the pendulum continues while the torpedo gathers speed immediately after launching, and until the speed is uniform, when the pendulum recovers its plumb position and exercises its normal function. To prevent this deep initial dive, the locking gear locks the slide valve rod of the steering engine in a desired position until a sufficient time shall have elapsed to allow the pendulum to operate independently of its inertia, at which time the slide valve rod is automatically unlocked and

the steering engine is free to be controlled by the immersion mechanism.

The locking gear, made wholly of bronze, consists of the following principal parts: the locking spindle, 10, with spur gear, 9, the locking index, 12, the one-tooth pinion, 11, the locking arm, 26, the locking stud, 17, and the unlocking stud, 18.

The locking spindle is a small bronze shaft pivoted at its lower end in a bracket secured to the forward upper part of the crank case; near its lower end and machined on it, is the spur gear, 9, which is held in engagement with the spur gear pinion, 8, by a spiral spring, the spur gear pinion being secured to the upper end of the worm gear spindle, 7, by a through pin. The locking spindle, near its upper end, has another bearing in the forward end of a bracket secured to the shell of the torpedo; below this bracket, and rigidly secured to the locking spindle is the one-tooth spindle, 11, which operates the distance gear.

The locking arm is pivoted at its centre in the locking arm brackets, 27. On one side the locking arm has a clutch which, when the slide valve of the steering engine is locked, engages the spool on the slide valve rod, and thus prevents the rod from having vertical motion; the other end of the locking arm is fork shaped and permits the studs on the spur gear, as it revolves, to operate the other end of the locking arm, engaging the clutch for the spool on the slide valve rod, if the locking spindle is revolved by hand in locking, or disengaging the same clutch if the locking spindle is revolved, automatically, as in unlocking.

The locking index is secured to the upper end of the locking spindle and is graduated on its upper face from 0 to 75, each number representing 0.7 of a metre. The

upper end of the locking spindle projects through the index and is squared to receive the adjusting tool.

To lock the slide valve of the steering engine for duration, the adjusting tool is shipped over the square head of the locking spindle. Pressing down against the distance spindle spring and turning the locking index to the right, will cause the locking stud on the lower side of the spur gear to come in contact with the lower prong of the fork of the locking arm, and move it about its pivot. This causes the clutch on its other end to engage the locking spool on the slide valve rod.

When this adjustment is completed, the locking spindle, 10, will be moved up by its spiral spring and its spur gear, 9, will engage with the spur gear pinion, 8, on the worm gear spindle, 7. This will cause the locking spindle, 10, and its spur gear, 9, in unlocking automatically, to be rotated in the opposite direction from that in which they were turned when the adjustment was being made. This rotation of the locking spindle, 10, and its spur gear, 9, will continue until the locking stud, 18, on the upper side of the spur gear, 9, comes in contact with the upper prong of the locking arm about its pivot, and causes the other end to become disengaged from the locking spool, thus allowing the steering engine to come under the control of the immersion mechanism.

The locking spool also furnishes means by which the steering engine slide valve rod may be locked in such a position as to maintain the rudder during the period of locking, either horizontal, slightly up, or slightly down, so that the torpedo at the beginning of its run, before coming under the control of the immersion mechanism, may be prevented from making too deep a dive or coming so near the surface as to endanger broaching.

The locking spool is screwed on the upper end of the

slide valve rod, which is threaded for a portion of its length. When it is desired to lock the slide valve of the steering engine for position, the locking spool is turned, and if held against vertical motion by the clutch on the locking-arm it will cause the slide valve rod to be moved up or down. Turning the locking spool to the right will raise the slide valve rod and cause the slide valve of the steering engine to be moved aft, thus admitting air to the after end of the steering engine piston, pushing it forward and putting the rudder up. Turning the locking spool to the left will lower the slide valve rod and cause the slide valve to be moved forward, admitting air to the forward end of the steering engine piston, pushing it aft and giving down rudder.

After this adjustment is made, the locking spool is held rigid by a locking piece slipped over the upper end of the slide valve rod. This locking piece engages the locking spool by means of two studs on its under side. Before making this adjustment the locking piece must be lifted out with a tool provided for the purpose.

DISTANCE GEAR.

Plate VII.

The object of the distance gear is to shut off the air from the engine, and stop the torpedo at the end of a predetermined run.

The distance gear is situated on top of the crank case of the main engine, and consists of the following principal parts:—the distance spindle, 14; the distance wheel, 13; the unlocking spindle, 21; the pawl connecting rod, 23; the pawl, 24; the pawl spring, 25; the uncocking arm, 20; the distance index, 15; the uncocking stud, 19; the distance spindle spring, 16; the spur-gear pinion, 8; the pawl connecting rod lever, 22, and the cocking spring box, 31.

The distance spindle is a short vertical shaft resting in a socket on the upper end of the worm gear spindle and supported at its upper end by a bracket which also supports the locking spindle. Machined in one with the distance spindle is a distance wheel having eighteen notches cut around its periphery, with which the one-toothed pinion on the locking spindle engages. On the under side of the distance wheel is the uncocking stud; and on the upper end of the distance spindle is secured the distance index, graduated up to 18, each graduation representing a run of fifty metres. Just abaft the distance spindle is a short vertical shaft carrying on its upper end the uncocking arm, and near its lower end the pawl connecting rod lever. Pivoted in the forward end of the pawl connecting rod lever is the forward end of the pawl connecting rod which is secured near its after end, to an arm of the pawl by a pin. The pawl is pivoted on the side of the cocking spring box which is rigidly secured on top of the crank case by four studs and nuts.

To set the torpedo to run a certain distance, the adjusting tool is shipped over the square end of the distance spindle and is pressed down against the tension of a small spiral spring which bears against the pivot of the distance spindle and a small shoulder on the spindle. The adjusting spindle is then turned to the left until the desired graduation on the index coincides with the reference mark on the shell of the torpedo. When the adjustment is made and the pressure released, the spiral spring raises the distance spindle and causes the distance wheel to become engaged with the one-toothed pinion on the locking spindle.

The operation of the distance gear in shutting off the air is, as follows:—when the torpedo is launched and the engine started, the worm revolving on the forward end of

the crank shaft revolves the worm gear and spindle. The revolution of the spindle causes the spur gear, the locking spindle, and the one-toothed pinion which engages the notches on the distance wheel, to turn the latter to the right (slowly) until the uncocking stud, 19, on the bottom of the distance wheel comes in contact with the uncocking arm on the upper end of the uncocking spindle, 21, moving it about its pivot. This will draw the pawl connecting rod forward and cause the pawl to be disengaged from the spring piston, which, on returning to its normal position, will, through a system of levers, cause the starting lever to be pulled forward, thus closing the stop valve and stopping the engine.

COCKING MECHANISM.

Plate IX.

The cocking mechanism situated on top of the crank case of the main engine, consists of the following parts:—the cocking lever, 1, the cocking spring, 6, the spring piston link, 7, the spring piston, 8, the cocking pawl, 10, the cocking pawl spring, 11, the cocking pawl connecting rod, 12, and the starting lever, 13.

The cocking lever, which has two arms, is pivoted to a stud, 5, cast in one with the body of the valve group; and is connected by its link, 2, to a stud, 3, which is secured to the side of the cocking spring piston. The spring box is a hollow bronze casting, cylindrical in shape, containing the spring piston and the cocking spring; the spring piston slides inside of the spring box, and is hollowed out for the reception of the cocking spring. The piston link is secured to the forward face of the spring piston and the spring is held in a state of compression by a bonnet, secured to the forward end of the spring box by a bayonet joint and kept from unlocking by a set screw.

Before the torpedo is entered in the tube, the cocking

lever is pushed down by means of a screw driver inserted in a slot on its upper end. This causes the spring piston to move forward and compress the cocking spring. The spring piston is held in this forward position by the pawl on the side of the spring box until the latter is disengaged by the action of the distance gear at the end of the run. Thus the cocking mechanism insures the starting lever being pulled forward at the end of the run and so cuts off the supply of air to the engine.

VALVE GROUP CHARGING AND STARTING VALVES.

Plate VIII.

The body containing the starting valve, 7, and charging valve, 2, is an irregular shaped bronze casting secured to the upper part of the engine room bulkhead.

The charging valve body, through which the air flask is charged, contains the charging valve, 2, the charging valve spring, 3, and is closed at its lower end by the charging valve cover, 4, screwed in against a leather washer. After the air-flask is charged the upper end of the charging valve body is closed by the charging valve plug, 1. Inside the charging valve body the charging valve is forced into its seat by the spiral spring and the air pressure from the air-flask, after the air-flask is charged, and the charging pipe is removed.

In charging the air-flask, the charging valve plug is removed and the charging pipe, fitted with valve end and wing nut, is screwed down in its place. The air pressure on the charging valve unseats it and allows the air to pass into the air-flask. The air in passing presses on the forward end of the starting valve, seats it and thus cuts itself off from the engine.

The starting valve body is a hollow cylinder running at right angles to the body of the charging valve, and

is connected to the after end of the reducing valve body by a pipe abaft the engine room bulkhead. Inside the body of the starting valve is a valve seat for the starting valve, 7, habitually kept seated by its spring, 8, which bears against the forward face of the valve and is held in a state of compression by the starting valve cover, 9, screwed into the forward end of the starting valve body against a leather washer. Projecting from the port side of the starting valve body is the starting lever cam shaft, 10, held in place by its cover, 14. The cam, by which the starting valve is lifted, is a part of the cam shaft and is also inside the starting valve body. The free end of the starting lever cam shaft is squared to receive the lower end of the starting lever, 11, the upper end of which projects through a slot in the shell of the torpedo. When the starting lever is thrown to the rear, the starting lever cam shaft is revolved, and the cam bearing against the after side of the starting valve, lifts it from its seat, and allows the air to pass through to the reducing valve.

In the centre of the starting lever is a stud on which is pivoted one end of the starting lever connecting arm, 12, the other end of the starting lever connecting arm being connected to another lever, secured to the forward end of the piston link of the cocking mechanism.

When the torpedo has reached the end of its run, the spring piston is released by the action of the distance gear, causing the starting lever connecting arm to pull the starting lever forward, thus revolving the starting lever cam shaft, withdrawing the cam from engagement with the after face of the starting valve, and allowing the valve to be seated by the action of its compressed spring and the pressure of air behind it. This shuts the air off from the engine.

Extending from the starboard side of the starting valve

body is a small pipe through which passes enough air to force the oil through the oil cup to oil the engine and to operate the retarding mechanism.

THE SINKING GEAR.

Plate XI.

The sinking gear operates by opening a hole through the engine room bulkhead allowing water to fill the after body and thus to sink the torpedo. It consists of the following parts:—the sinking valve, 17, the sinking valve spring, the sinking valve rod, 18, and the sinking lever, 19. A stem on the after side of the sinking valve projects into the after compartment of the after body, and the valve, ground water-tight, is firmly held to its seat in the engine room bulkhead by the compression spring, which encircles the stem between a nut on the after end of the stem and the after side of the sinking valve seat. On the forward side of the sinking valve is an eye into which hooks the after end of the sinking valve rod, movable in a fore and aft direction. The sinking valve rod after passing through an eye on the lower end of the sinking lever is pinned at its forward end to the rocker arm, 23. The sinking lever is pivoted on the outer end of the starting lever cam shaft and projects through, and is capable of fore and aft movement, in a slot in the shell of the torpedo. When the sinking lever is in the forward end of its slot, the eye at its lower end will keep the hook on the after end of the sinking valve rod disengaged from the eye on the forward end of the sinking valve when it is not desired to sink the torpedo at the end of its run. The sinking lever is held in its forward position by a strip of brass soldered in place abaft the lever.

In preparing the torpedo for a war shot, the soldered strip is removed, and the sinking lever pushed aft until

held by an offset in the after end of its slot. This will cause the guide on the sinking lever to lower the hook on the after end of the sinking valve rod, so that it will engage the eye on the forward side of the sinking valve. At the end of an unsuccessful war shot, the sinking valve is pulled forward by the sinking valve rod, through the medium of the rocker arm, which is actuated by the cocking mechanism, thus allowing water from the engine compartment to flow into the after body, sinking the torpedo, and removing it as a source of danger to friendly vessels, or preventing its falling into the hands of the enemy.

THE WATER TRIPPER.

Plate XIII.

The water tripper, 4, with its mechanism, is contained in a recess on the bottom of the after body, and is connected to the retarding gear by the water tripper rod, 2, passing through the water tripper rod tube, 3.

The water tripper is a thin plate of bronze, shaped to conform with the curved surface of the after body; it is secured at its centre to the lower end of a lever, pivoted between two arms on a screw threaded cylinder, in which slides the water tripper spring barrel, 6; this cylinder screws into the recess in the after body and is kept from turning by a set screw; the water tripper spring barrel is hollowed out for the reception of the water tripper spring, 5, which, when the screw threaded cylinder is in place, is held in a state of compression between the bottom of the recess, and the lower end of the water tripper lever spring barrel pressing against the upper end of the water tripper lever.

The upper end of the water tripper lever has a triangular shaped head, filed flat on two sides. Before the

torpedo is shoved in the tube, the water tripper is thrown forward, being held in this position by the spring barrel bearing against the forward side of this head, the spring barrel being forced down by the water tripper spring. When the torpedo strikes the water, the water tripper is thrown back into place, transmitting motion to the water tripper slide valve through the medium of the water tripper rod, which is connected to the water tripper lever.

THE AFTER BODY.

The after body is a truncated cone of sheet bronze, joined to the after end of the air flask by thirty counter-sunk screws. It is strengthened at its forward end by a stout joint ring, and at its after end by a bronze bulkhead, riveted and soldered in place. The after flange of this bulkhead is threaded for the reception of the bevel gear box, and the centre of this bulkhead supports the after end of the shaft tube. Interposed between the forward face of this bulkhead and a shoulder on the shaft, is a rubber washer inside of a nut which screws on a threaded portion of the shaft tube. Screwing up on this nut forces the washer against the forward face of the bulkhead and thus keeps the after body water tight.

The after body is also strengthened internally by six strengthening rings and by a bulkhead ring to which the engine room bulkhead is secured.

The shaft tube, having a bearing at each end for the main shaft, extends from the after bulkhead to the engine room bulkhead where it is secured watertight. The tubes through which pass the steering rod and the water tripper rod are also secured, inside of the after body, to brackets, in such a way as to maintain the watertightness of the after body.

The shell over the engine room, in the forward end of

the after body, is pierced with a number of holes to allow the free circulation of water, the insertion of tools for making the various adjustments and the removal of the slide valves of the main engine.

The guide stud is rigidly secured to the top of the engine cage, above the shell of the after body, and considerably abaft the centre of gravity of the torpedo. This permits the torpedo to be given a flat initial dive, with a comparatively short length of spoon.

THE TAIL.

Plate XIV.

The tail of the torpedo is that portion abaft the after body, comprising the bevel gear box, 1, the outer shaft, 11, the forward and after cones, the tail frame, the vertical and horizontal blades, the propellers, the rudders and the rudder connections. The bevel gear box screws on the after end of the after body with a left handed thread and, when in place, is kept from turning by four counter-sunk screws. It contains the forward bevel gear, 2, keyed to the main shaft, the intermediate gears, 3 and 4, mounted on a crosshead, 6, and the after gear, 5, which is a part of the outer shaft, 11. The after end of the gear box has a bearing for the outer shaft, 12, which is lubricated through a short pipe projecting through the shell of the torpedo. This oil pipe is closed by a screw plug. The after end of the steering rod passes through the lower part of the gear box.

The after end of the gear box is threaded for the reception of the forward cone, and the after part of the forward cone has a bearing, 13, for the after end of the outer shaft. Two pairs of flat blades are secured to the tail cone by flanges on its outer surface, one pair in the

vertical plane, and the other pair in the horizontal plane, the latter forming frames abaft the propellers, for the horizontal rudders. The vertical blades are designated top and bottom blades, and the horizontal blades are called side blades.

The forward and after top and bottom blades are joined by flat rails, above and below the propellers, held together by screws, and each rail carries a guide, 27. The forward and after side blades are joined together by the rudder frame on each side of the propellers, each arm of the frame after passing through a sleeve on the corresponding forward side blade being secured by a conical nut, 15.

The forward end of the forward cone is threaded, and screws on the after end of the bevel gear box, and it is kept in place by four countersunk screws.

The bronze propellers are mounted between the forward and after cones, the forward propeller, 17, being right handed and keyed to the outer shaft, the after propeller, 19, being left handed and keyed to the main shaft.

The horizontal rudders are mounted, one on each side of the after cone. Each has two bearings, one in the side of the after cone, and one in its corresponding rudder frame. A lever is secured to the inner end of each rudder. The forward ends of these levers are bent downward over the edge of the rudder frame, and connected to a crosshead on the upper end of the after steering gear rod connection by the adjusting screws, 24. Each rudder adjusting screw has two nuts, one bearing on each side of the crosshead of the after steering rod connection, and the throw of the rudder is changed by slacking up on one pair of nuts and setting up on the other.

The lower end of the after steering rod connection is secured to the after end of the balance connection which is pivoted at its centre in the bottom rail. The forward end of the balance connection is secured to the lower end of the forward steering rod connection, the upper end of which is secured to one arm of a bell crank in the after end of the forward tail cone. The other arm of the bell crank is secured to the after end of a link, the forward end of which is secured to the after end of the steering rod by the connecting pin, 28.

The forward bevel gear, 2, is keyed to the main shaft in the forward end of the bevel gear box, and is held in place by two set screws. The intermediate gears, 3, are mounted on the crosshead, 6, which has a short sleeve, forming a bearing for the main shaft. This sleeve has an oil cup on top and the oil cup, closed by a screw plug, 26, is accessible through a hole in the shell of the torpedo.

Three bronze friction rings, 8, between the forward gear and the sleeve of the crosshead and three more, 8, between the sleeve of the crosshead and the after gear, decrease friction between the sleeve and the forward and after gears.

The forward propeller is secured to the outer shaft by the propeller nut, 18, which screws on abaft the propeller and is kept from turning by a set screw. The after propeller is similarly secured to the main shaft by the propeller nut, 20.

The main shaft, the after propeller and the forward bevel gear turn to the left and, through the medium of the intermediate gears, this causes the after bevel gear, the outer shaft and the forward propeller to turn to the right.

The vertical vanes, 14, are small stiff plates of bronze,

mounted on the forward side blades of the tail. They are pivoted at their forward ends and can be swung on their pivots, the starboard vane to starboard, or the port vane to port, to give a permanent rudder effect for correcting any permanent deflection, to right or to left, in the run of the torpedo. Each vane is made in two parts, one above and one below the side blades of the tail, the two parts being secured at the forward end by the screw which constitutes the pivot, and at the after end by a clamp screw which holds the vane firmly in place after it is set. The clamp screws by which the vanes are clamped in desired fixed position, pass through slots in the forward side blades.

The rear ends of the vanes have pointers, referring to scales divided in arc, in twenty divisions, each division representing one degree of arc.

A plus adjustment of the vertical vanes indicates that the starboard vane is to be set to the right the number of divisions directed, the port vane remaining at zero, and a minus adjustment, that the port vane is to be set in the position directed, with the starboard vane at zero.

Plates.

PLATE I.
SCHWARTZKOPFF TORPEDO.

- | | |
|-----------------------|--------------------|
| 1. War nose. | 5. Engine room |
| 2. War head. | 6. After body. |
| 3. Immersion chamber. | 7. Bevel gear box. |
| 4. Air flask. | 8. Tail. |

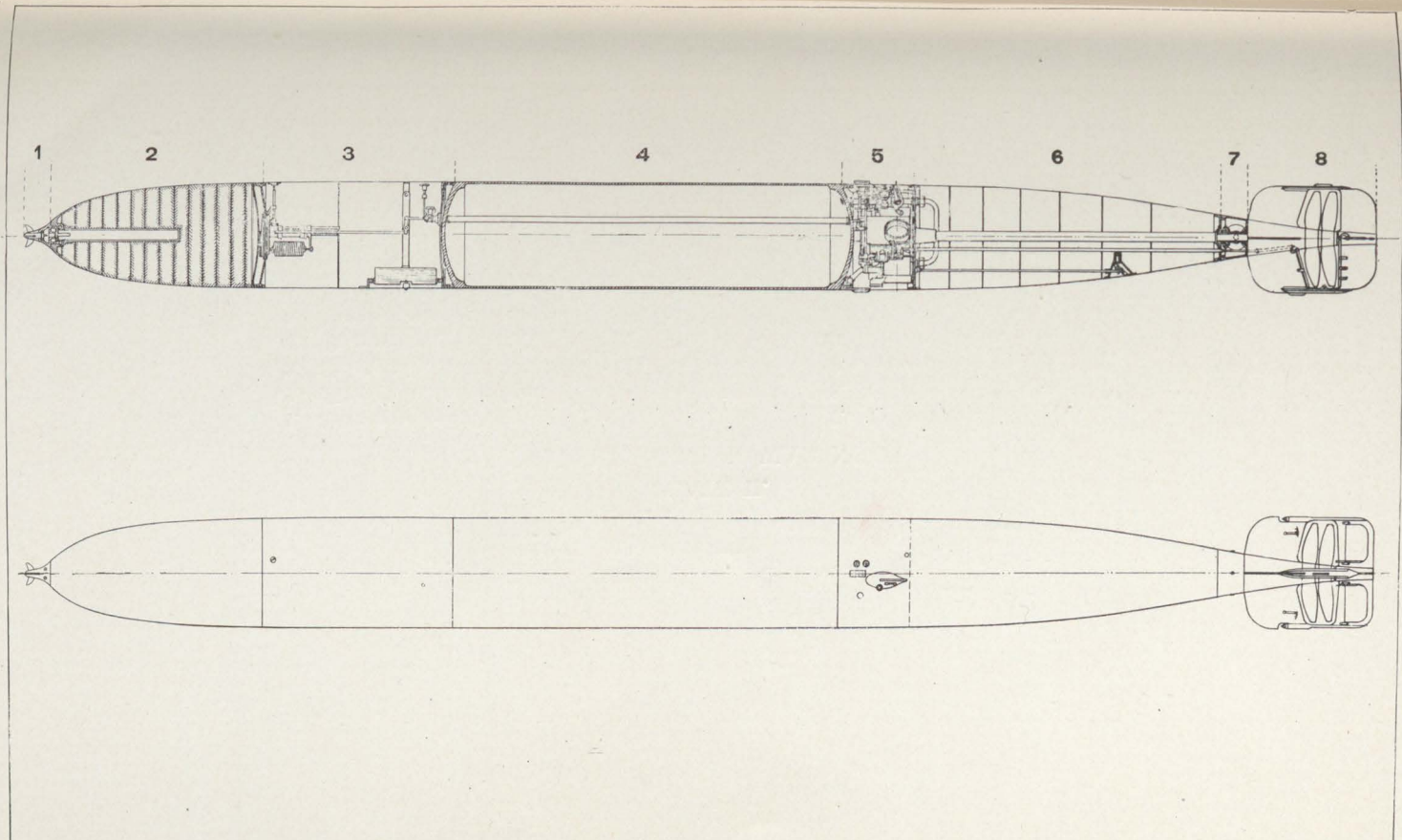


PLATE II.
WAR HEAD WITH WAR NOSE.

- | | |
|----------------------------|------------------------------|
| 1. War nose body. | 7. Primer case pocket. |
| 2. Firing pin and striker. | 8. Charge of wet gun-cotton. |
| 3. Safety pin. | 9. After bulkhead. |
| 4. Forward exploder. | 10. Moisture tap. |
| 5. Inner exploder holder. | 11. Immersion chamber. |
| 6. Primer case. | |

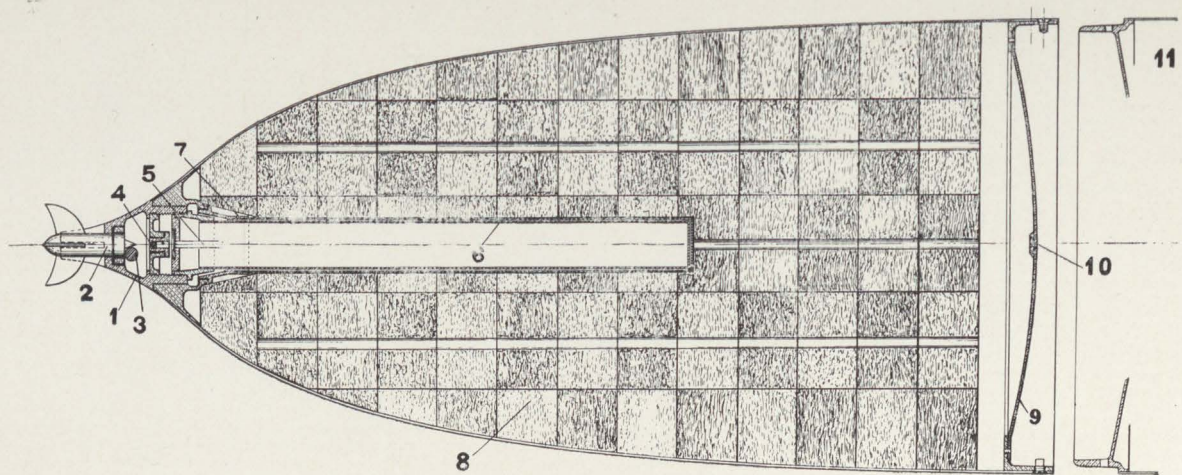


PLATE III.

EXERCISE HEAD WITH NOSE.

- | | |
|------------------------|----------------------------------|
| 1. Exercise nose. | 5. Vent hole and plug. |
| 2. Lead ballast rings. | 6. Filling hole and plug. |
| 3. Filling hole. | 7. Rubber washer under bulkhead. |
| 4. Trimming tank | 8. Immersion chamber. |

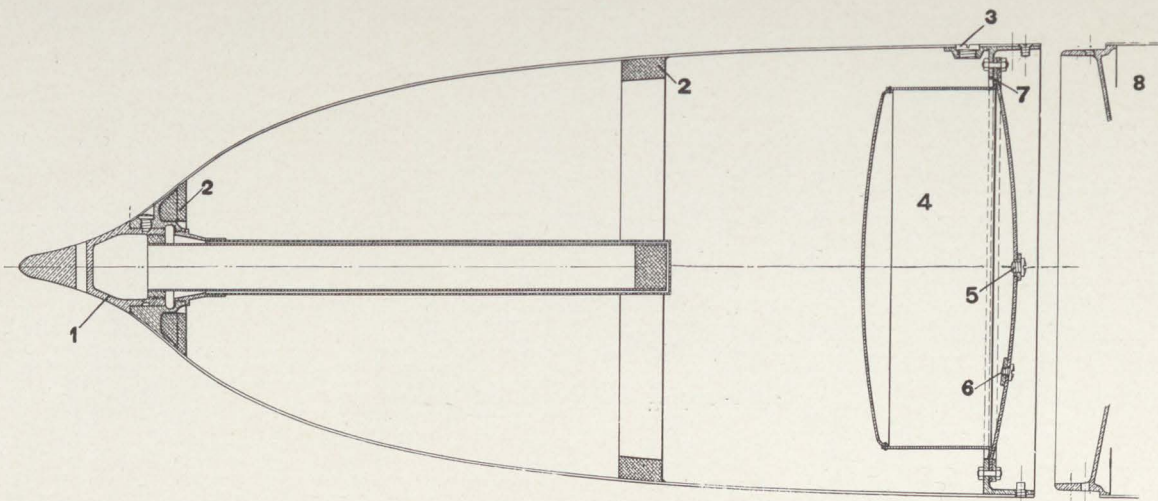


PLATE IV.

WAR NOSE.

1. Firing pin and striker.
2. Shearing disc.
3. Shearing disc rut.
4. Safety pin.
5. Bronze disc.
6. Forward exploder.
7. War nose body.
8. Primer case base.
9. Inner exploder nut.
10. Copper disc.
11. Inner exploder.
12. Primer case.
13. Primer case pocket.
14. EXERCISE NOSE.

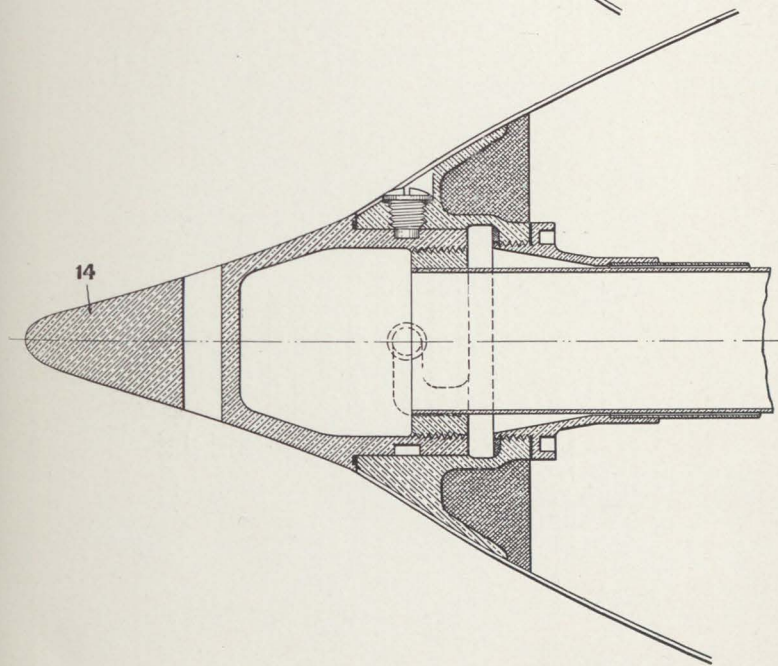
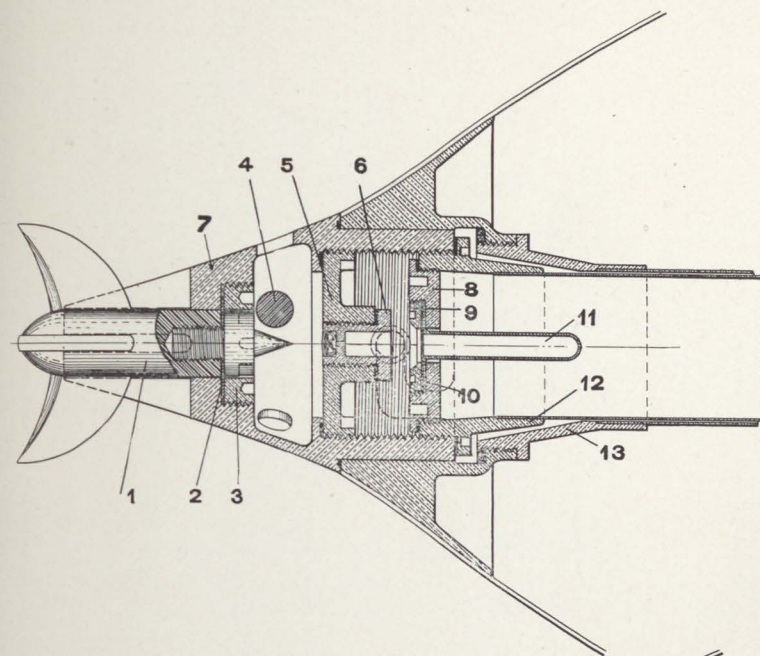


PLATE V.
IMMERSION CHAMBER.

- | | |
|----------------------------------|---|
| 1. Double spring rod. | 14. Copper diaphragm clamping ring. |
| 2. Cross lever. | 15. Hydrostatic piston. |
| 3. Pendulum rod brackets. | 16. Hydrostatic piston box. |
| 4. Pendulum. | 17. Hydrostatic piston spindle. |
| 5. Spring buffers. | 18. Hydrostatic piston spindle bracket. |
| 6. Pendulum rod. | 19. Hydrostatic piston springs. |
| 7. Connecting rod. | 20. Gear spindle. |
| 8. Connecting rod hanger. | 21. Adjusting spur gears. |
| 9. Rock shaft. | 22. Adjusting bevel gears. |
| 10. Connecting rod hanger screw. | 23. Gear spindle brackets. |
| 11. Testing lever. | 24. Adjusting spindle. |
| 12. Testing lever bracket. | 25. Adjusting spindle brackets. |
| 13. Copper diaphragm. | 26. Depth index. |

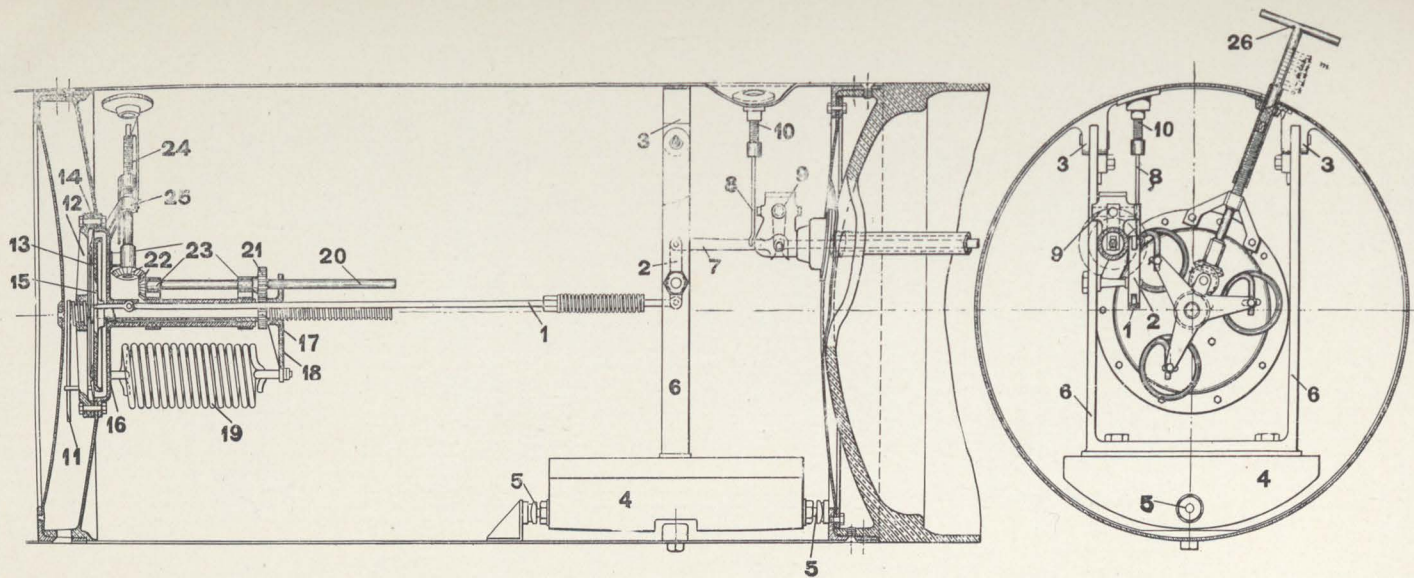


PLATE VI.

STEERING ENGINE.

1. Bell crank pivot eye.
2. Locking spool.
3. Locking spool holding plate.
4. Slide valve rod.
5. Slide valve rod securing nut.
6. Valve adjusting screw securing nut.
7. Valve adjusting screws.
8. Valve rod adjusting bracket.
9. Valve rod adjusting bracket pin.
10. Slide valve lever.
11. Inner slide valve.
12. Outer slide valve.
13. Outer slide valve rod.
14. Double lever.
15. Steering rod.
16. Piston rod.
17. Piston spring.
18. Piston.
19. Cylinder.
20. Cylinder covers.
21. Counter weight.
22. Air admission pipe.
23. Slide valve chest.
24. Slide valve lever pivot frame.
25. Holding bolts and nuts.
26. Engine room bulkhead.
27. Steering rod tube.
28. Bell crank.

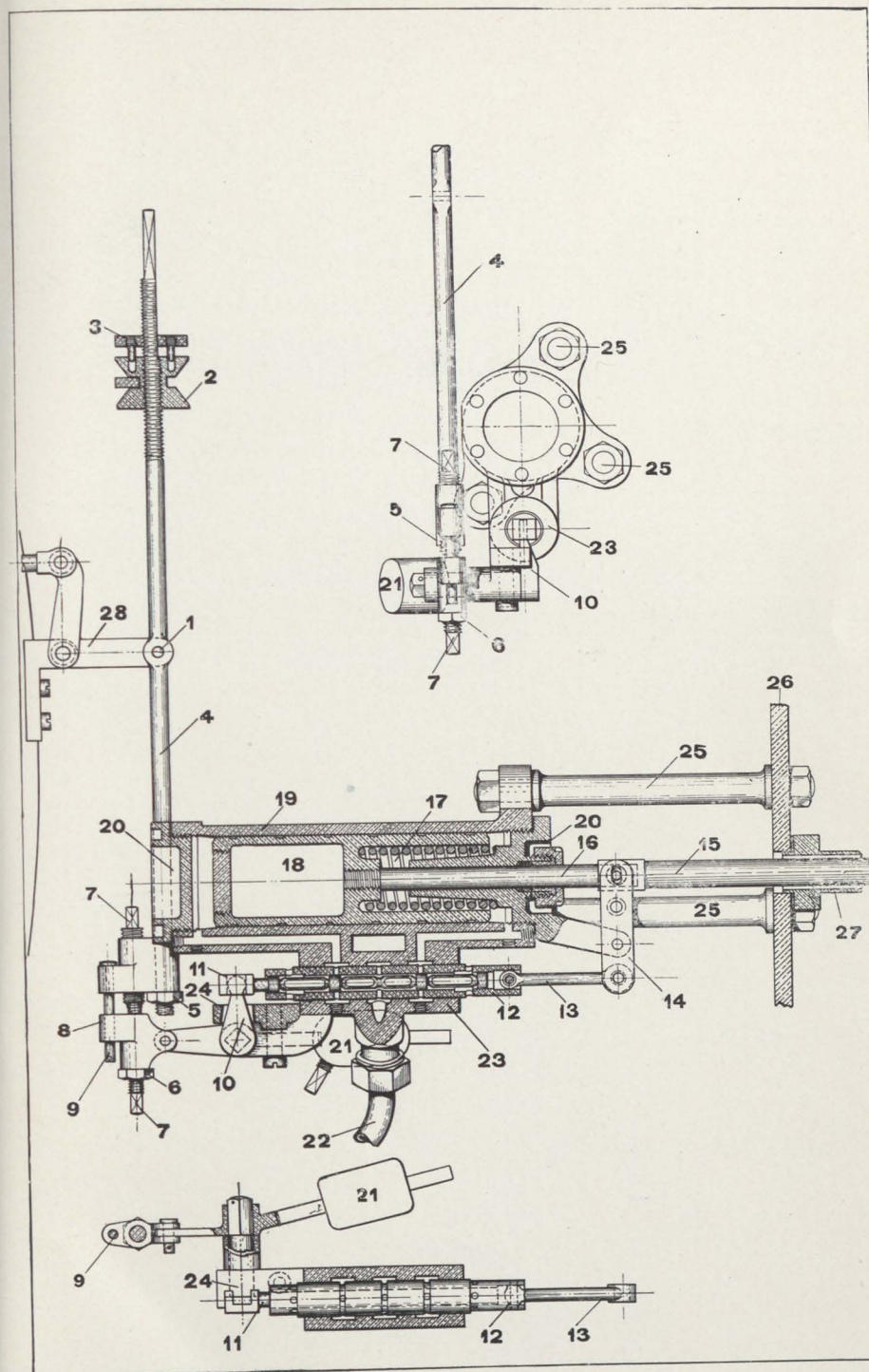


PLATE VII.

LOCKING AND DISTANCE GEAR.

1. Support for crank case cover with securing screw.
2. Crank case cover.
3. Crank shaft friction discs.
4. Worm.
5. Crank shaft.
6. Worm wheel.
7. Worm gear spindle.
8. Spur gear pinion.
9. Spur gear.
10. Locking spindle.
11. One-tooth pinion.
12. Locking index.
13. Distance wheel.
14. Distance spindle.
15. Distance index.
16. Locking spindle spring.
17. Locking stud.
18. Unlocking stud.
19. Uncocking stud.
20. Uncocking arm.
21. Uncocking spindle.
22. Pawl connecting rod lever.
23. Pawl connecting rod.
24. Pawl.
25. Pawl spring.
26. Locking arm.
27. Locking arm brackets.
28. Locking arm guide.
29. Valve rod bracket.
30. Guide stud.
31. Cocking spring box.

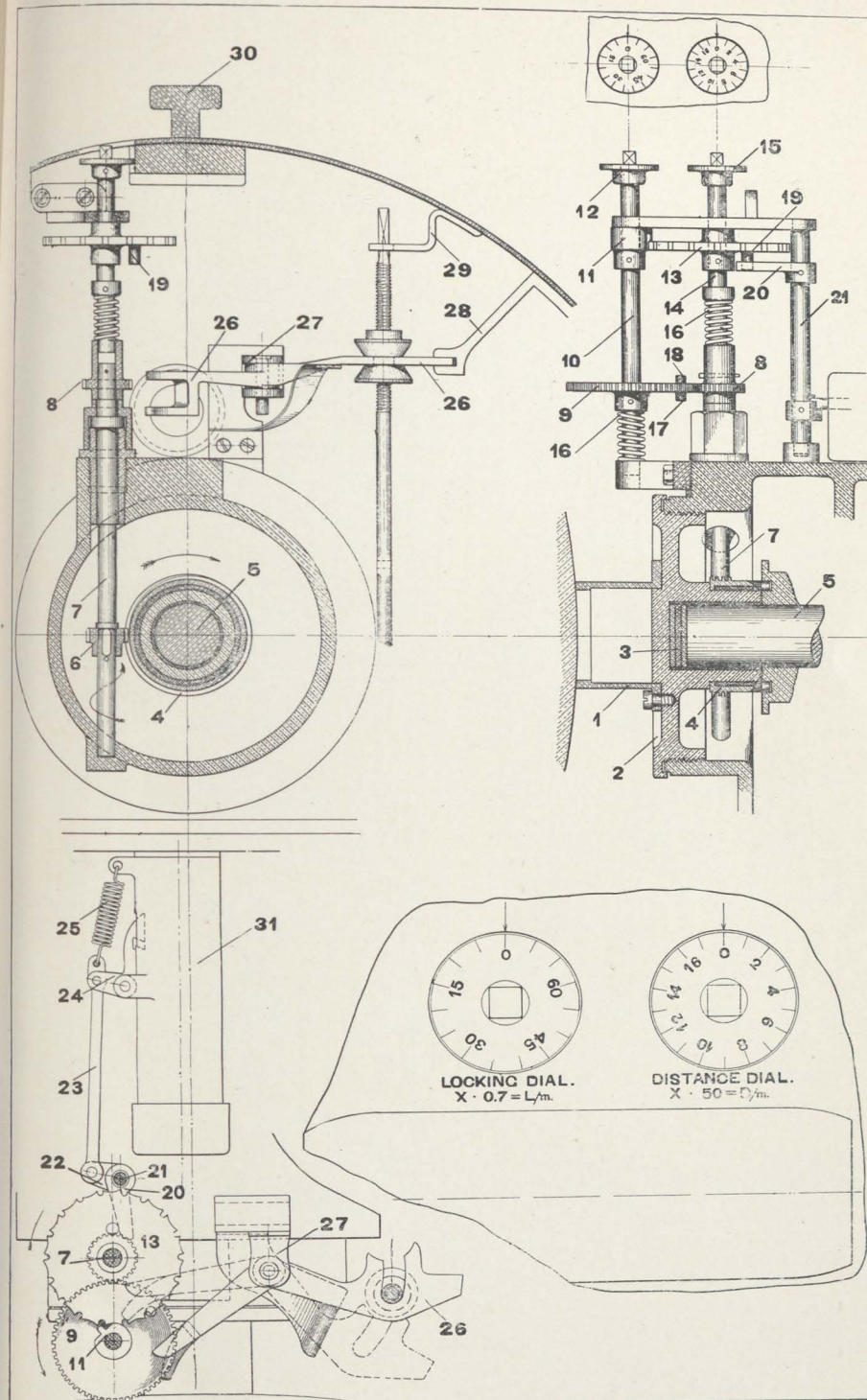


PLATE VIII.

VALVE GROUP, CHARGING AND STARTING VALVES.

- | | |
|---------------------------------|-------------------------------------|
| 1. Charging valve plug. | 9. Starting valve cover. |
| 2. Charging valve. | 10. Starting lever cam shaft. |
| 3. Charging valve spring. | 11. Starting lever. |
| 4. Charging valve spring cover. | 12. Starting lever connecting arm. |
| 5. Starting valve body. | 13. Air pipe to oil cup. |
| 6. Air pipe connecting screws. | 14. Starting lever cam shaft cover. |
| 7. Starting valve. | 15. Engine room bulkhead. |
| 8. Starting valve spring. | 16. Air pipe from flask. |

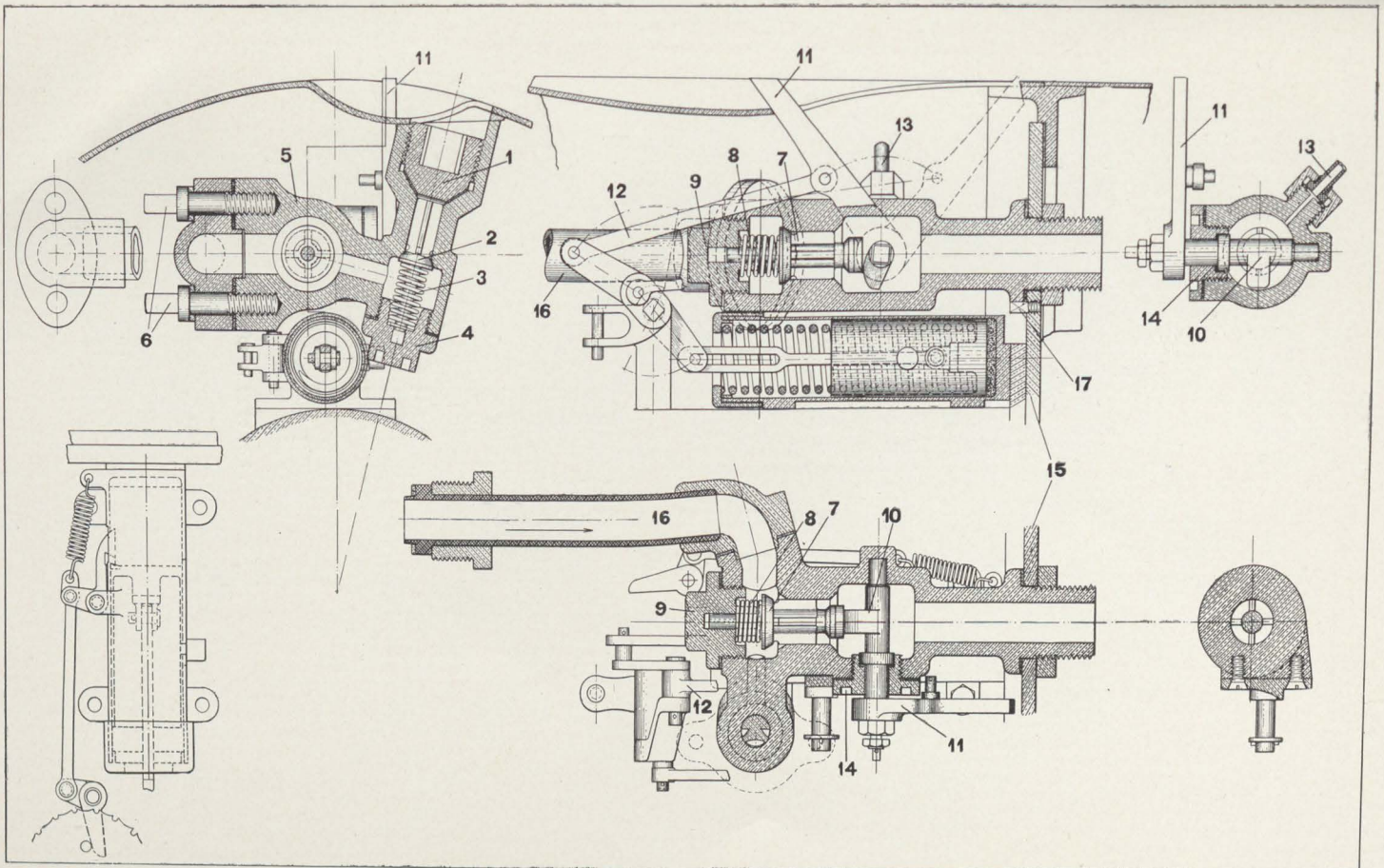


PLATE IX.
COCKING MECHANISM.

- | | |
|---|--|
| <ul style="list-style-type: none"> 1. Cocking lever. 2. Link. 3. Stud for link, 2, on cocking lever. 4. Stud for link, 2, on spring piston. 5. Cocking lever stud pivot. 6. Cocking spring. 7. Spring piston link. | <ul style="list-style-type: none"> 8. Spring piston. 9. Spring piston buffer. 10. Cocking pawl. 11. Cocking pawl spring. 12. Cocking pawl connecting rod. 13. Starting lever. 14. Charging and starting valve bodies. |
|---|--|

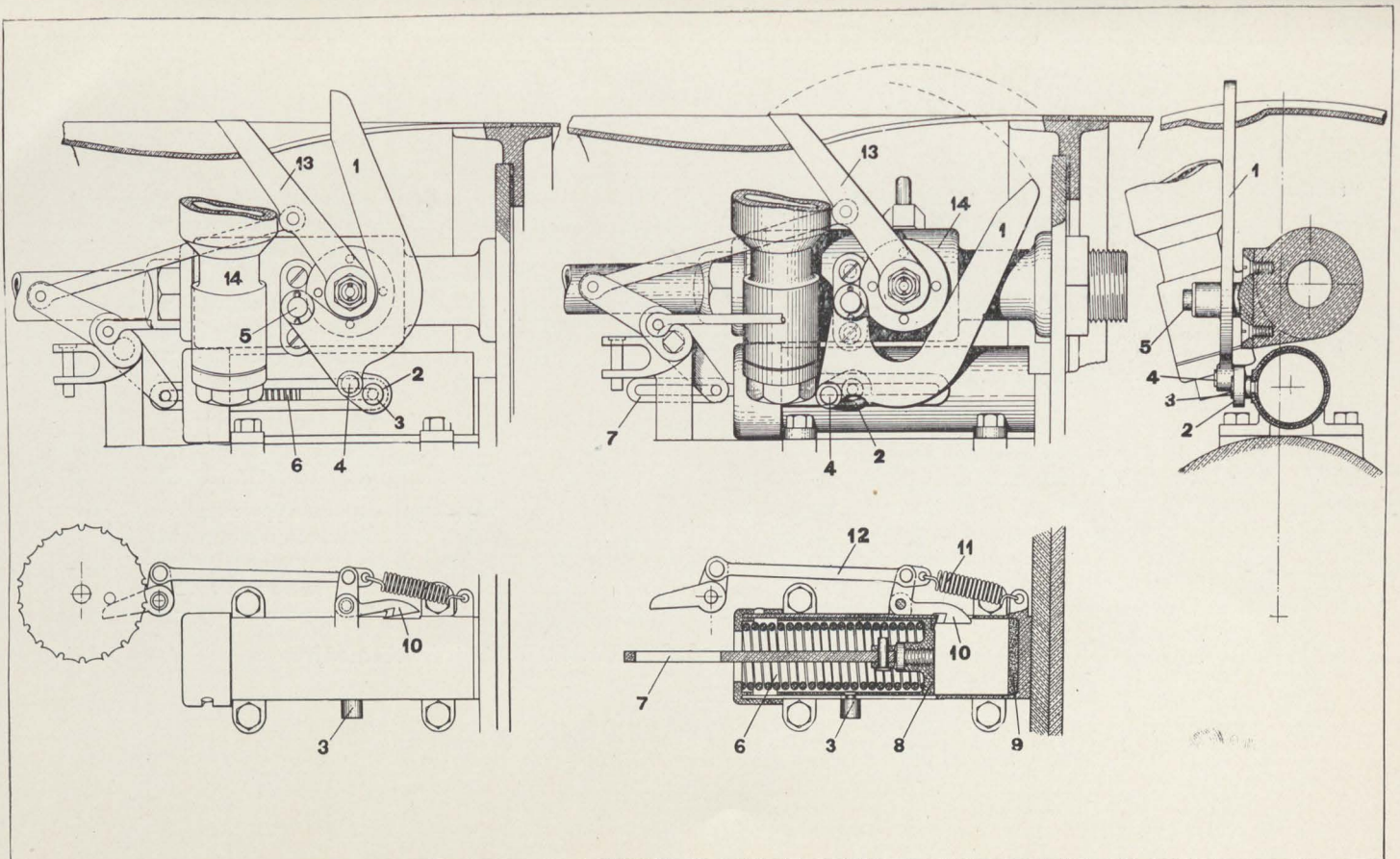


PLATE X.

REDUCING VALVE GROUP AND WATER TRIPPER CONNECTIONS.

- | | |
|--|---|
| 1. Reducing valve. | 19. Oil pipe from oil cups to water tripper piston valve. |
| 2. Reducing valve admission port. | 20. Water tripper piston valve. |
| 3. Reducing valve controller. | 21. Slide valve lever. |
| 4. Controller spring. | 22. Water tripper rod extension. |
| 5. End of controller spring box. | 23. Water tripper piston valve lever pivot and bracket. |
| 6. Controller spring box. | 24. Water tripper piston valve body. |
| 7. Bevel gear and sleeve. | 25. Oil cup adjusting screw. |
| 8. } Oil ducts. | 26. Air pipe to oil cup. |
| 9. } | 27. Oil cup filling plug. |
| 10. Oil cups. | 28. Reducing valve controller index. |
| 11. Oil cup filling pipe. | 29. Adjusting spindle. |
| 12. Water tripper piston. | 30. Adjusting spindle locking piece. |
| 13. Water tripper piston spring. | 31. Adjusting spindle locking piece spring. |
| 14. Water tripper piston spring cap. | 32. Engine room bulkhead. |
| 15. Reducing valve body. | 33. Air pipe to engine. |
| 16. Channel to water-tripper cylinder. | 34. Grooves in retarding valve. |
| 17. Oil pipe from valve to water-tripper cylinder. | 35. Oil cup for main shaft bearing at engine room bulkhead. |

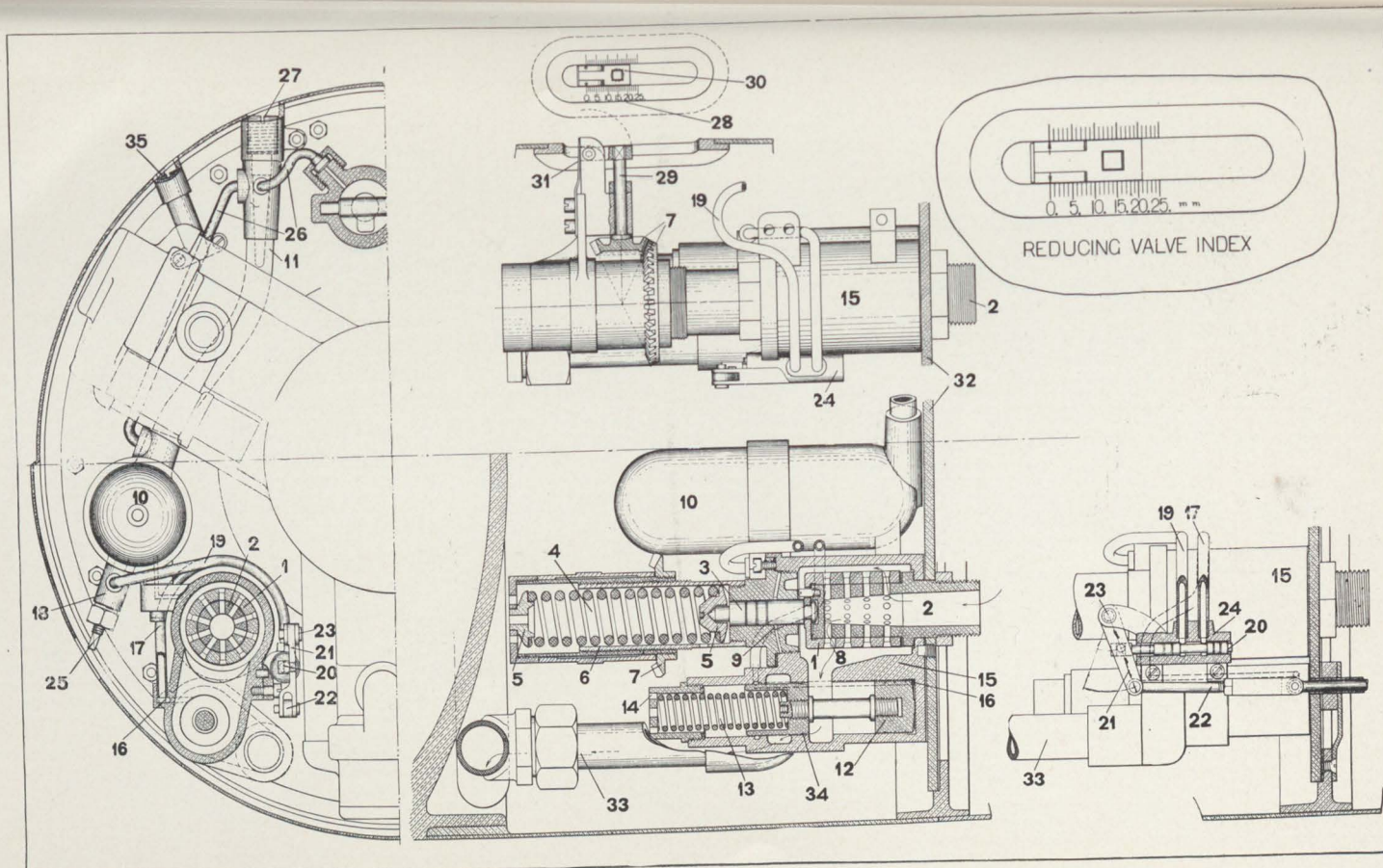


PLATE XI.
ENGINE ROOM.

- | | |
|--|--------------------------------------|
| 1. Crank case and cylinders. | 16. Locking spool. |
| 2. Steering engine. | 17. Sinking valve. |
| 3. Reducing valve. | 18. Sinking valve rod. |
| 4. Oil cup. | 19. Sinking lever. |
| 5. Air distributing pipe. | 20. Cocking lever. |
| 6. Air pipe to steering engine. | 21. Starting lever. |
| 7. Water tripper piston valve lever. | 22. Starting lever connecting arm. |
| 8. Oil pipe to water tripper piston valve. | 23. Rocker arm. |
| 9. Oil pipe to water tripper piston. | 24. Starting valve cover. |
| 10. Cocking spring box. | 25. Immersion mechanism bell crank. |
| 11. Uncocking arm. | 26. Main air pipe to reducing valve. |
| 12. Distance wheel. | 27. Main air pipe from flask. |
| 13. One-tooth pinion. | 28. Steering rod and tube. |
| 14. Unlocking spur gear. | 29. Water tripper rod and tube. |
| 15. Locking arm. | |

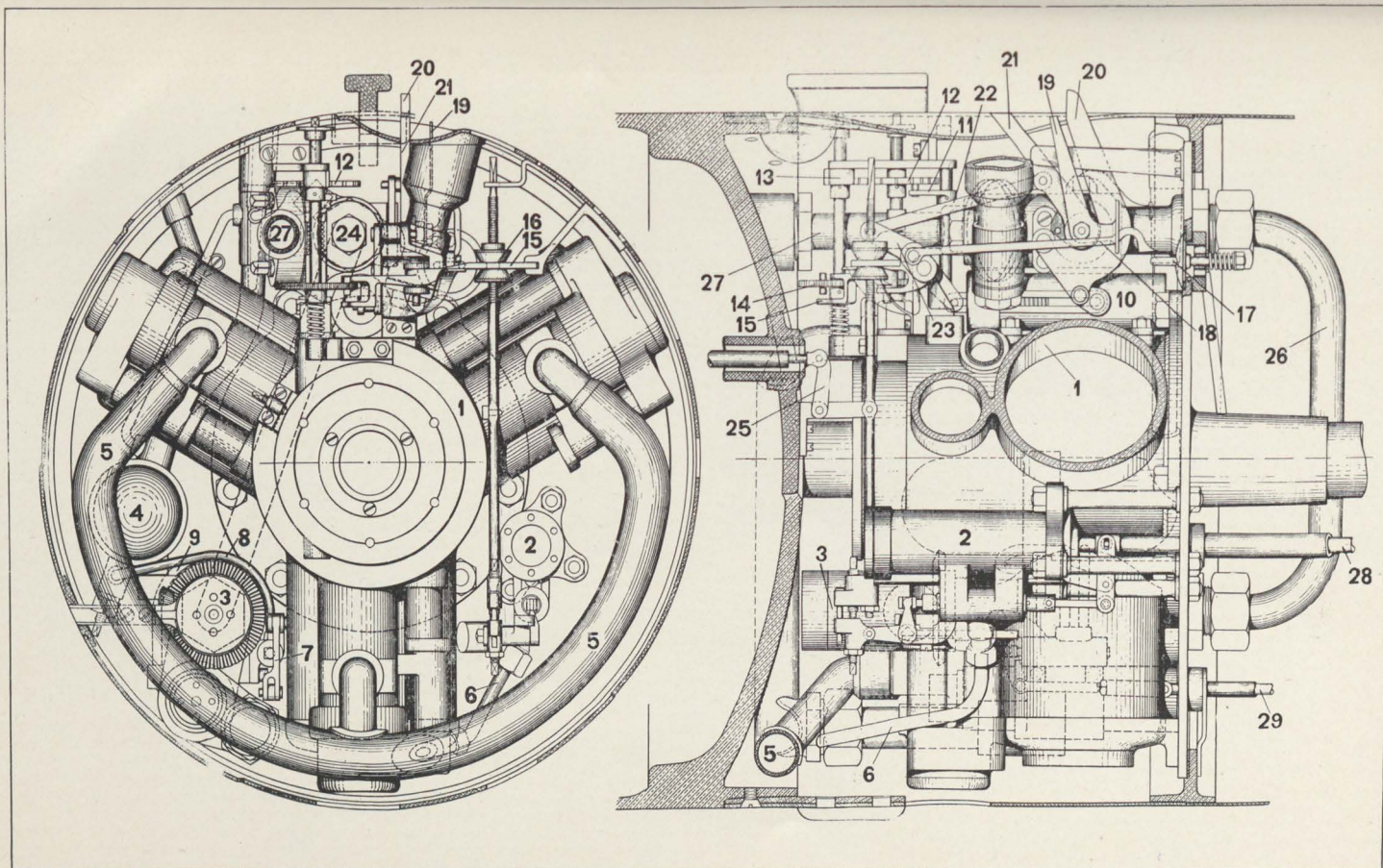


PLATE XII.

ENGINE.

- | | |
|--------------------------------|---|
| 1. Air admission pipe. | 15. Crank pin. |
| 2. Engine bed plate. | 16. Main shaft. |
| 3. Slide valve chest. | 17. Crank pin brasses. |
| 4. Outer valve. | 18. Piston rod. |
| 5. Inner valve. | 19. Ball and socket joint. |
| 6. Inner valve connecting rod. | 20. Piston. |
| 7. Outer valve connecting rod. | 21. Direct exhaust port. |
| 8. Eccentric. | 22. Engine room bulkhead. |
| 9. Eccentric strap. | 23. Relief valve. |
| 10. Eccentric strap. | 25. Air pipe to steering engine. |
| 11. Eccentric strap. | 26. Holes for steering engine bolts. |
| 12. Eccentric key. | 27. Screws securing steering rod tube. |
| 13. Friction discs. | 28. Exhaust passages. |
| 14. Crank shaft. | 29. Oil cup for forward main shaft bearing. |

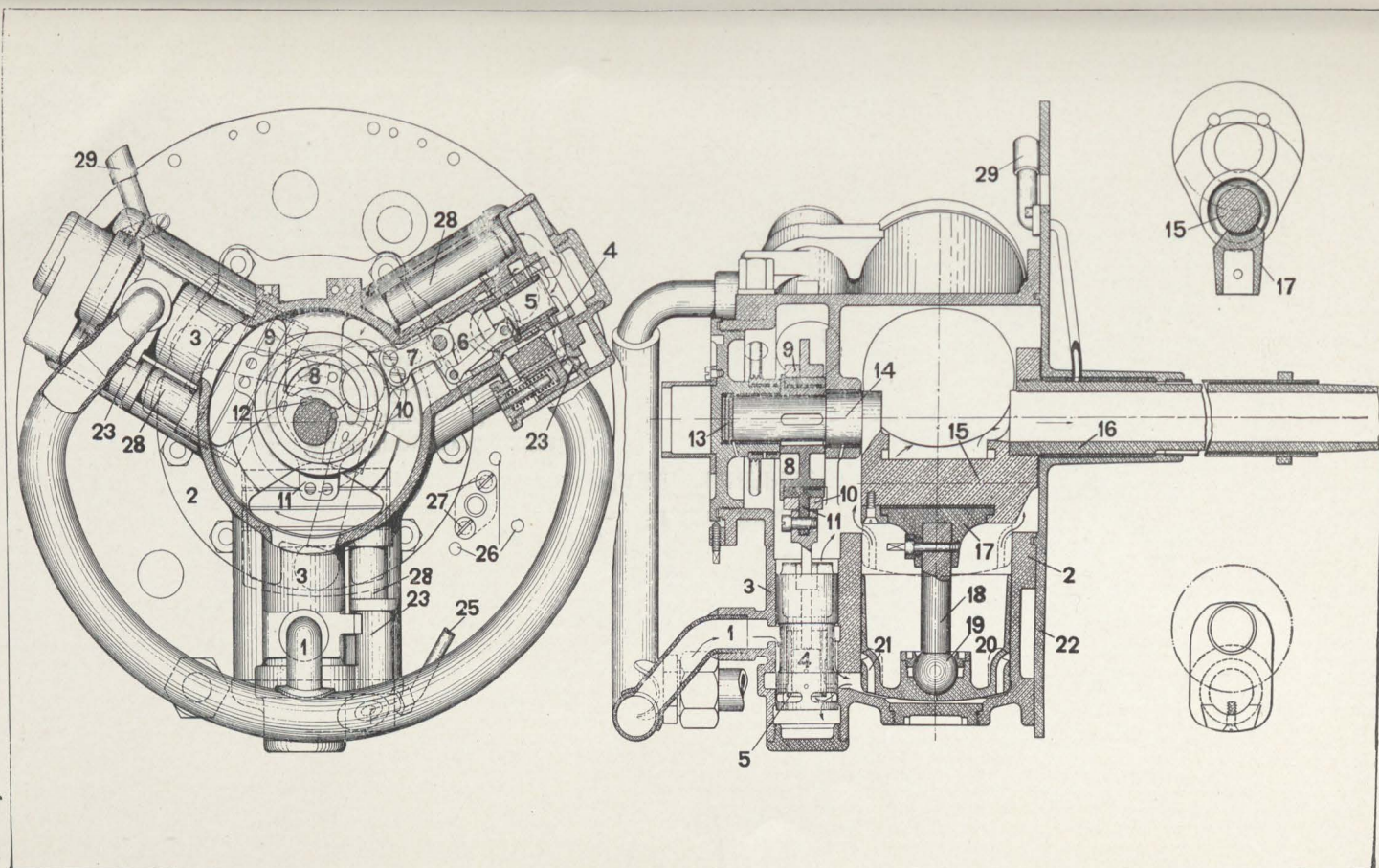


PLATE XIII.
WATER TRIPPER.

- | | |
|---------------------------------|------------------------------------|
| 1. Water tripper rod extension. | 6. Water tripper spring barrel. |
| 2. Water tripper rod. | 7. After body. |
| 3. Water tripper tube. | 8. Strengthening ring. |
| 4. Water tripper. | 9. Reducing valve body. |
| 5. Water tripper spring. | 10. Water tripper piston cylinder. |

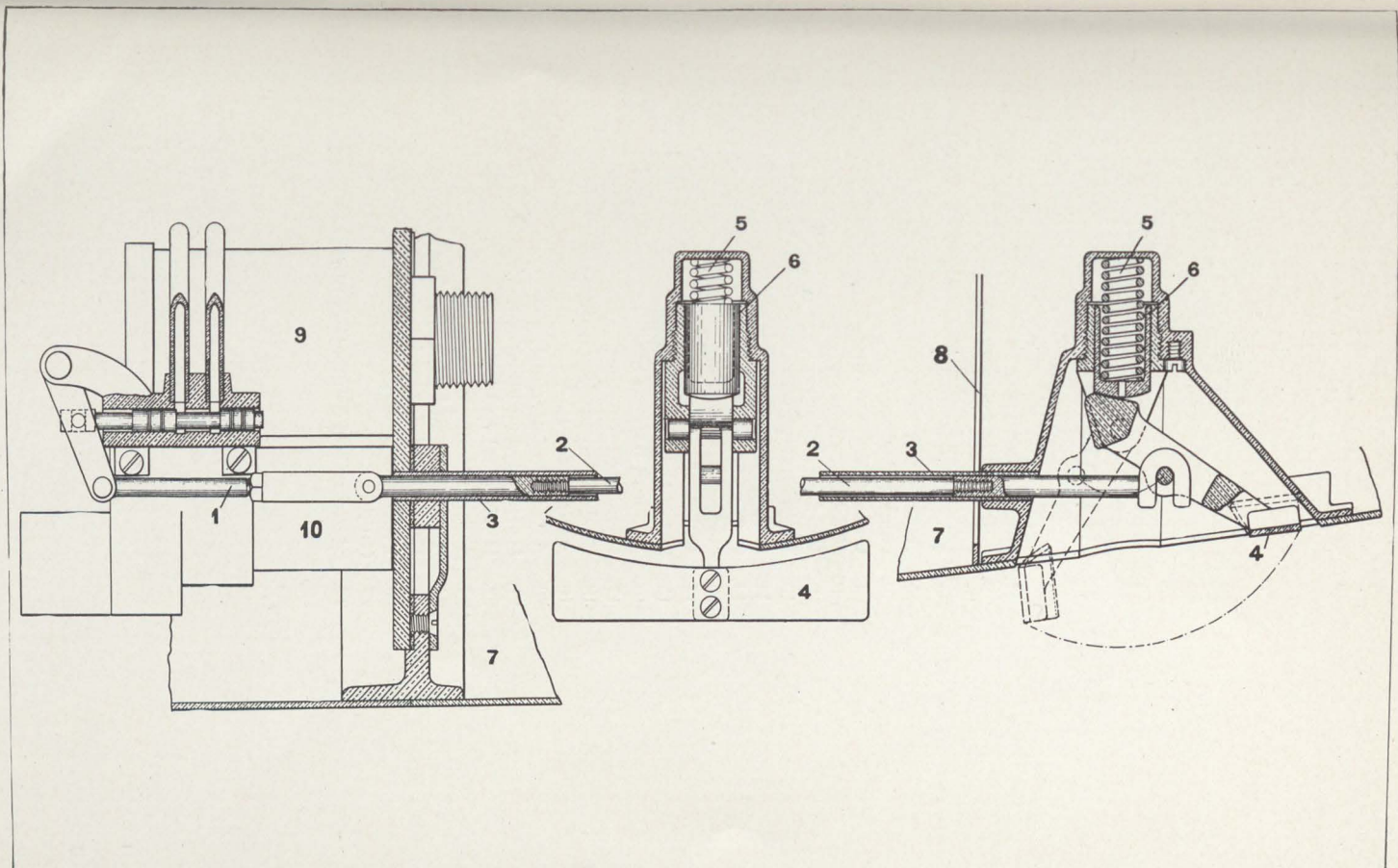


PLATE XIV.

TAIL.

1. Bevel gear box
2. Forward bevel gear.
3. Intermediate gear.
4. Intermediate gear.
5. After gear.
6. Gear crosshead.
7. Gear crosshead nuts.
8. Friction washers.
9. Rubber gasket.
10. Main shaft.
11. Outer shaft.
12. Outer shaft bearing.
13. Outer shaft bearing.
14. Vertical vanes.
15. Side blade conical nuts.
16. Top and bottom blades.
17. Forward propeller.
18. Forward propeller nut.
19. After propeller.
20. After propeller nut.
21. Horizontal rudder frames.
22. Horizontal rudders.
23. Steering rod connections.
24. Horizontal rudder adjusting screws.
25. Horizontal rudder bearings.
26. Plugs for gear oil holes.
27. Guides.
28. Steering rod connecting pin.

