THE HOWELL TORPEDO: 14.2 INCHES, MARK I: GENERAL DESCRIPTION

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The Howell Torpedo.

U. S. NAVY,

14.2 INCHES, MARK I.

GENERAL DESCRIPTION.

PREPARED AT THE NAVAL TORPEDO STATION,

BY DIRECTION OF THE

BUREAU OF ORDNANCE.

NAVAL TORPEDO STATION PRINT.
1896.

This description of the Howell Torpedo, U. S. N., 14.2 inches, Mark I, prepared at the Naval Torpedo Station by order of the Bureau of Ordnance, is approved for use in the Navy.

W. T. Sampson,
Chief of Bureau.

Bureau of Ordnance,
September 1, 1896.

The Howell Torpedo.

U. S. NAVY, 14.2 INCHES, MARK I.

GENERAL DESCRIPTION.

Plates I and II.

The Howell Torpedo consists of a cylindrical middle-body, D, to which is attached an ogival head, A, and an ogival after-body, M, bearing the tail, S.

The principal dimensions of the model, U. S. Navy, 14.2 inch, Mark I, are:—

Extreme length	11	ft.	$1\frac{3}{4}$	in.
Greatest diameter			14.2	"
Weight of charge in war-head, 82 lbs. 12 oz. dry gun-cotton plus 20% water [approx.]	99	lbs.	4	oz.
Weight of dry gun-cotton primer	1	"	6	"
Displacement of torpedo immersed in sea-water, sp. gr. 1.026, at 62° F. [approx.]	528	"	4	"
Weight of torpedo with war-head filled and primed, ready for launching [approx.]	518	"	0	"
Reserve buoyancy of ditto in sea-water [approx.]	10	"	4	"
Weight of torpedo with exercise-head ballasted with fresh water, ready for launching [approx.]	518	"	0	"
Reserve buoyancy of ditto [approx.]	10	"	4	"

The head may be either the war-head, containing the explosive charge, for use in action, or the exercise-head, containing fresh water ballast and lead balance-weights, for use in exercise.

The middle-body contains the depth-register pocket, B; the calcium-phosphide pocket, C; and the fly-wheel, F, whose stored-up energy, when set in motion by a motor situated outside the tube from which the torpedo is launched and clutched to the fly-wheel shaft by the clutches, G, is transmitted to the propellers, Y Y, by gears, H H, gear-shafts, I I, and propeller-shafts, R R, and whose gyroscopic influence tends strongly to stiffen the torpedo, laterally, in its course.

The after-body contains the hydrostatic-piston, E, and horizontal-rudder pendulum, J, the action of each of which is transmitted, through the impulse-mechanism, L, to the horizontal-rudder, Z, by the horizontal-rudder tiller-rod, N; the vertical-rudder pendulum, K, whose action is transmitted, through the impulse-mechanism, L, to the vertical-rudder, X, by the vertical-rudder tiller-rod, P; the locking-mechanism, O; unlocking-rod, Q; and the propeller-shafts, R R.

The frame of the tail comprises the tail-cone, U; the side-blades, V V; and the top and bottom-blades, W W; and in the tail are the vertical-rudder, X; the horizontal-rudder, Z; the propellers, Y Y; and the speed-regulator, T.

The torpedo is launched by indirect gunpowder impulse from a tube above or below the water-line, with the fly-wheel revolving at a speed of ten thousand revolutions per minute, the clutch of the motor being disengaged from the intermediate-clutch, connecting it with the fly-wheel shaft at the moment before launching.

The shell of the torpedo is of hard-rolled brass, $\frac{1}{16}$ in.

in thickness, strengthened at various points by interior strengthening-rings and reinforced, at the junctions of the middle-body with the head and with the after-body, by stout joint-rings, brazed in. The fly-wheel is supported by a stout wheel-frame. The interior parts of the torpedo are of bronze, aluminum bronze and a few easily accessible parts of steel.

THE HEADS.

Plates III and IV.

There are two interchangeable heads supplied with each torpedo, the war-head and exercise-head, for use in war and in exercise, respectively. Their external appearance is the same.

The head is attached to the forward end of the middle-body by a bayonet-joint with four equidistant locks and is secured in place by a set-screw.

THE WAR-HEAD.

Plate IV.

The war-head, habitually attached to the torpedo in time of war, is stiffened and strengthened by the nose-ring, A, and by a joint-ring at its after end. The joint-ring is fitted with the studs of a bayonet-joint for attaching the head to the forward end of the middle-body, a set-screw passing through the joint-rings of the head and of the middle-body keeping it from unlocking, when shipped. The war-head is divided into two water-tight compartments, L and Q, by two bulkheads, P and R, which are secured by nuts against flat rubber washers, to screw-studs in bulkhead-rings brazed in the shell of the head. Reinforce-rings, one for each bulkhead, are shipped over the screw-studs and serve to take the thrust of the nuts and to stiffen the edges of the bulkheads. The after compart-

ment formed by these two bulkheads is a buoyancy chamber. In the forward compartment is compactly stowed the charge of wet gun-cotton, weighing approximately 99 lbs. 4 oz.

In the center of each bulkhead is a boss in which is tapped a screw-thread for the lifting-screw used in removing the bulkheads.

The primer-case, K, in which is inserted the dry gun-cotton primer when priming the torpedo, has at its forward end a flange, E, which seats on the nose-ring, A, and is brazed to it, thus forming a fixed part of the war-head. In the flange are two holes, one, F, a moisture-tap and the other, G, a vent hole, communicating with the interior of the head, closed ordinarily by screw-plugs. Should the charge lose moisture by evaporation, distilled or rain water may be poured through the moisture-tap to make up loss of weight.

The stowage weight of the war-head, that is, the weight of the shell and contained charge of wet gun-cotton only, is stamped on the after bulkhead of the war-head near the center of the bulkhead.

The after end of the primer-case is supported in the primer-case rest, N, a short socket soldered to the forward side of the bulkhead, P. In the primer-case is soldered the diaphragm, M, which constitutes the after end of the space in the primer-case actually filled with dry gun-cotton in priming.

The forward end of the primer-case is closed water-tight, after priming, by the primer-case cover, D, which is clamped tight against a flat rubber washer by the primer-case clamp-ring, B, screwed down on a boss on the primer-case flange. In the primer-case cover are two small holes, H H, closed by soluble plugs of soap, protected by patches of paper pasted over them, which dissolve at

the end of an unsuccessful war shot, admitting water to the dry primer and drowning it.

The primer-case cover, D, carries the exploder-pocket, I, brazed to its after side and forming part of it. The exploder-pocket is closed at its after end and open at its forward end for the reception of the exploder, J, which is held in place by a spring-latch, C, on the forward side of the primer-case cover.

The exploder is a closed copper tube, painted red, containing thirty-five grains, (approximately), of fulminate of mercury, primed with four grains of dry long staple gun-cotton, and capped at its forward end by a percussion cap.

The nose-ring, A, of the war-head is threaded internally for the reception of the war-nose.

THE WAR-NOSE.

Plate V.

The war-nose, screwed in the nose-ring of the war-head, consists of the mechanism for firing the exploder on impact of the torpedo with the target, and the safety-mechanism by which the firing-mechanism is rendered inactive until, after launching, the torpedo shall have traveled through the water a safe distance from the point of launching.

The construction of the war-nose is as follows: — in the forward end of the body, K, of the war-nose is screwed the cap, E, which is kept from unscrewing by the cap lock-screw, F, and which is bored out axially for the reception of the sleeve, G. The sleeve is capable of longitudinal motion within the cap but is prevented from turning by its guide-pin, I, which enters the guide-slot, J, in the cap. The sleeve is bored out axially for the reception of the firing-pin, H, which has longitudinal motion within the sleeve. The movement of the firing-

pin is limited in its travel aft by the head, C, which brings up against an interior shoulder in the sleeve, and the movement forward is restrained by the firing-spring, M, which encircles the after end of the firing-pin, the forward end of the spring bearing against an interior shoulder in the sleeve, and the after end against a collar, P, screwed on the after end of the firing-pin. The collar is kept from unscrewing by a lock-pin, and the head of the firing-pin is slotted for convenience in assembling.

A bent sear-spring, L, of steel, secured to the cap by two screws, catches over the collar on the after end of the firing-pin when the war-nose is cocked, as shown in the plate.

The safety-mechanism consists of the screw-fan, B, and the shearing-pin, D. The screw-fan, four-bladed, of steel, works on a screw-thread cut on a portion of the forward projecting end of the sleeve and can be run aft, to the safety position, until it bears on the cap, E, as shown in dotted lines in the plate, in which position it locks the sleeve, preventing it from being driven in to actuate the firing-pin; or it can be run forward, to the firing position, shown in full lines in the plate. The point, A, screwed in the forward end of the sleeve and kept from unscrewing by a lock-pin, prevents the screw-fan from running completely off the sleeve. The shoulder of a slot cut in the after side of the hub of the screw-fan brings up against a stud on the forward end of the cap, when the screw-fan is run aft, and prevents jamming on the thread.

To insure against explosion by an accidental blow, the screw-fan must always be kept, in store and while being handled, in its position of safety, with the screw-fan run aft on the end of the sleeve until stopped by the shoulder of the slot in the screw-fan bringing up against the stud on the cap.

The shearing-pin, D, of lead, passes through holes in the cap and in the sleeve and holds the latter in position against light forces tending to displace it when the screw-fan is in its firing position.

The action of the war-nose is as follows:—during the passage of the torpedo through the water, after launching, the screw-fan is revolved and run forward on the sleeve to its firing position. The extreme forward end of the sleeve is cut blank so that, when the screw-fan is in its firing position, it will have run clear of the screw-thread and will revolve freely, without opposing undue resistance in the water. On impact with the target, the sleeve is driven aft within the cap, shearing the shearing-pin and compressing the firing-spring between the after end of the sleeve and the collar on the after end of the firing-pin, until the after end of the sleeve trips the sear-spring and releases the firing-pin, which is then projected aft by the compressed firing-spring against the percussion cap of the exploder, firing it.

Holes, NN, in the body of the war-nose, admit water to the soluble plugs in the primer-case cover in the event of an unsuccessful shot.

The range necessary to run the screw-fan forward far enough to fire is from thirty to forty yards.

THE EXERCISE-HEAD.

Plate III.

The exercise-head, habitually attached to the torpedo in time of peace, is stiffened and strengthened by the nose-ring, A, and by a joint-ring at its after end. The joint-ring is fitted with the studs of a bayonet-joint for attaching the head to the middle-body, a set-screw passing through the joint-rings of the head and of the middle-body keeping it from unlocking, when shipped. The exercise-head is

divided into two water-tight compartments, L and P, by two bulkheads, M and R, which are secured by nuts against flat rubber washers to screw-studs in bulkhead-rings brazed in the shell of the head. Reinforce-rings, one for each bulkhead, are shipped over the screw-studs and serve to take the thrust of the nuts and to stiffen the edges of the bulkheads. The after compartment formed by these two bulkheads is a buoyancy chamber. The forward compartment is filled, for exercise, with fresh water which serves to ballast the torpedo to the same trim as that which would obtain were the war-head shipped in place. In the center of the after bulkhead is a boss in which is tapped a screw-thread for the lifting-screw used in removing the bulkhead.

A balance-weight, K, capable of longitudinal adjustment within the balance-weight tube, G, permits correction of slight errors in trim.

The balance-weight tube, extending through the entire length of the head, has at its forward end a flange, E, which butts against the inner face of the nose-ring, A, and is clamped in place by the following-ring, C, which screws on a thread cut on the forward end of the flange. After the following-ring is set up the flange of the balance-weight tube is soldered in place. The after end of the balance-weight tube is supported in the balance-weight tube-rest, N, a cylinder soldered to the after side of the bulkhead, M. A feather, H, is attached to the upper inner side of the balance-weight tube and extends throughout its length.

The balance-weight, K, is composed of a number of lead discs held between two followers, JJ. The discs and followers are slotted on their upper edges, the feather in the balance-weight tube entering the slots. The followers are cut, axially, with a screw-thread through which

threads the balance-weight rod, I, the ends of which are supported, free to revolve, by the sockets, F and Q. A slot in the forward end of the balance-weight rod permits turning the rod, with a screw driver, to move the balance-weight forward or aft, as required to correct the trim of the torpedo. The socket, Q, is soldered in the after end of the tube. The socket, F, is slipped in the forward end of the tube, after adjustment of the balance-weight, a score in the upper edge fitting the feather, H. The socket, F, has a flange which rests on the end of the balance-weight tube, with a flat rubber washer interposed, and the tube is closed water-tight by screwing down the clamp-ring, B, against the flange.

In filling the compartment, L, with water the bulkheads, M and R, are removed, being replaced after the compartment is full. Any small deficiency of water may be made up through the filling-holes, DD, which are ordinarily kept closed by screw-plugs.

The nose-ring, A, of the exercise-head is threaded internally for the reception of the exercise-nose.

THE EXERCISE-NOSE.

Plate V.

The exercise-nose, screwed in the nose-ring of the exercise-head, is similar in external form and equal in weight to the war-nose, with the view of making the conditions of trim of the torpedo and resistance to the water the same in an exercise run as in those that obtain in a war shot.

In the forward end of the body, **f**, is screwed the cap, **d**, which terminates in a spindle, **b**, threaded for a portion of its length and left blank at its forward end. The cap is kept from unscrewing by a cap lock-screw, **e**. On the spindle ships the screw-fan, **c**, four-bladed, of steel,

similar to the screw-fan of the war-nose. The point, a, screwed in the forward end of the spindle and kept from unscrewing by a lock-pin, prevents the screw-fan from running completely off the spindle. The shoulder of a slot cut in the after side of the hub of the screw-fan brings up against a stud on the forward end of the cap, when the screw-fan is run aft, and prevents jamming on the thread.

Before launching the torpedo the screw-fan is run aft. After launching, the screw-fan is revolved during the passage of the torpedo through the water and is run forward, revolving freely on the thread and on the blank of the spindle, when it has reached its forward position, without opposing undue resistance in the water. The possible effect of the screw-fan during a run is thus the same, in exercise, as in a war shot.

THE MIDDLE-BODY.

Plate VI.

The middle-body, D, cylindrical in shape, is stiffened and strengthened by two joint-rings, one at either end, two interior strengthening-rings, J J, soldered in, and the fly-wheel frame.

The forward joint-ring is fitted with a sleeve in which are the slots of a bayonet-joint for attaching the head, and the forward end of the middle-body is closed water-tight by a bulkhead, which is secured by nuts, against a flat rubber washer, to screw-studs in the joint-ring. A reinforce-ring is shipped over the screw-studs and serves to take the thrust of the nuts and to stiffen the edge of the bulkhead.

The after joint-ring is fitted with a sleeve over which ships the forward end of the after-body against a solid rubber gasket of circular cross-section let in the angle of the joint-ring. The after-body is held in place by eighteen steel joint-screws at its junction with the middle-body.

Guide-studs, E E, of steel, are secured, one on each side of the torpedo, with their after ends near the center of gravity of the torpedo and somewhat above it. They are soldered to the shell and bolted to interior strengthening-plates riveted and soldered to the shell and to the fly-wheel frame. The guide-studs support the torpedo in guide-slots in the launching-tube. The starboard guide-stud has a notch in which fits the stop-pin of the launching-tube when the torpedo is in the right position for the engagement of the motor-clutch.

The middle-body contains the depth-register pocket, B; the calcium-phosphide pocket, C; the fly-wheel, F, with its gears, L L, and gear-shafts, I I; and the clutches, G.

THE DEPTH-REGISTER AND POCKET.

Plates VII and VIII.

The depth-register pocket, B, is a brass tube supported transversely in the torpedo by flanges at each end soldered inside the shell. It is closed at the port end and open at the starboard end for the reception of the depth-register, through a hole in the shell of the torpedo, when that instrument is used for obtaining a curve of the depth maintained during the run.

When the depth-register is not used the depth-register pocket is closed water-tight by a cover held in against a solid rubber gasket of circular cross-section by a clamp-ring which screws in a thread cut in the flange of the pocket. The outer surface of the cover conforms to the curve of the shell, the correct placing of the cover being insured by the engagement of a locating-pin in the flange of the pocket with a slot in the rim of the cover.

The depth-register is employed in exercise runs to record the depth to which the torpedo descends below the surface of the water when launched and at which it travels

throughout its run. The principal features are shown in Plate VII., the details of the piston in Plate VIII.

The two supporting-stays, I, carry at the outer end a bronze cylinder, E′, terminating outside in a flange, K′, which seats on a solid rubber gasket of cylindrical cross-section, O, Plate VIII, against the shoulder of the flange, F′, of the depth-register pocket, B, and held in place by the clamp-ring, G′. On the inner end of the supporting-stays is mounted a music-box movement actuating a winding drum, F, which takes paper from an unwinding drum, G. At the extreme inner end is the counterpoise, H. The piston-rod, A, has two bearings, one at the inner end of the bronze cylinder at D, cast in one with it, the other at K. The outer end of the piston-rod carries the piston, H′.

The inner end of the piston-rod carries a pencil, L, which traces a depth-curve on the moving paper slip. A base-line is traced by a fixed pencil.

The piston moves its rod, A, against the tension of a spring, E, one end of which is secured to the rod and the other to the cylinder. Underneath the platform on which the drums are mounted is pivoted an arm, one end of which catches on a stop on the piston-rod and the other ends in a detent which checks the regulator of the music-box movement, thus preventing movement of the drums until the torpedo has gained a certain depth. The piston is permitted free movement in the cylinder by the flexible rubber diaphragm, D′. A ring, L′, holds the diaphragm in place by means of a friction-plate, N, and follower, I′. The diaphragm is secured to the piston by the cap, J, held in place by a washer and nut.

Encircling the stays and the piston-rod, is a middle spring-bearing of brass, the ends of which are locked previous to inserting the depth-register and unlocked before pushing it home. Four brass feathers are soldered to the

bottom and forward side of the cylinder to form an outer bearing for the depth-register. The depth-register is properly placed by the locating-pin in the after side of the depth-register pocket.

THE CALCIUM-PHOSPHIDE POCKET.

Plate VII.

The calcium-phosphide pocket, C, is a brass tube, closed at the lower end and open at the top, supported vertically in the torpedo by a flange at its upper end soldered inside the shell, around a hole through the shell of the torpedo. It is stiffened in position by a stay of sheet brass connecting its lower end to the depth-register pocket.

Prior to an exercise run of the torpedo a sealed can of calcium-phosphide is put in the pocket, holes having first been punched through each end of the can to admit water to its interior. The can is secured in the pocket by a flat strip of spring brass, slightly longer than the diameter of the pocket, sprung into nicks in opposite sides of the mouth of the pocket.

When the torpedo is immersed, the action of water on the chemical generates hydrogen-phosphide which burns at the surface of the water with dense white fumes, thus indicating the position of the torpedo. These fumes last about ten minutes, giving sufficient time to buoy the torpedo, in case it sinks, marking the spot for subsequent dragging.

In war service the calcium-phosphide pocket is left empty, its mouth being closed by a flat cork.

THE FLY-WHEEL.

Plate IX.

The fly-wheel, F, revolving in the longitudinal vertical plane of the torpedo, furnishes the motive power by

which the torpedo is propelled through the water. The stored-up energy of the fly-wheel when set in motion prior to launching, by a motor situated outside the tube from which the torpedo is launched and detachable at the moment before launching, is transmitted to the propellers by the fly-wheel gears, L L, the shaft-gears, H H, the gear-shafts, I I, and the propeller-shafts. The energy of the fly-wheel is also utilized, by power taken from the propeller-shafts, to operate the horizontal and vertical-rudders, the speed-regulator and the unlocking-mechanism.

The gyroscopic effect of the fly-wheel is such as to stiffen the torpedo laterally in its run, causing it to roll, rather than yield to any force tending to deflect it from its course, the roll of the torpedo being immediately corrected by the action of the vertical-rudder in response to the swing of the vertical-rudder pendulum. The fly-wheel, looked at from the starboard side, that on which the motor is situated, revolves from right to left, or against the sun. The standard fly-wheel speed for launching is ten thousand revolutions per minute, but the propeller speed is geared down by the fly-wheel gears and shaft-gears in the ratio of eight to ten of the fly-wheel speed.

The fly-wheel, F, of forged steel, weighs 131 lbs. It is secured by two keys and by two set-screws to the fly-wheel shaft, G, the ends of which are mounted in roller-bearings, J J, carried in the wheel-boxes, K K, within the bearings, N N, of the fly-wheel frame, O. The fly-wheel frame is rigidly constructed and is secured firmly in place by screws passing through the shell of the torpedo; it is soldered to the shell of the torpedo and the screws holding the frame are sweated in the shell, water-tight. Each roller-bearing of the fly-wheel shaft has eight cylindrical steel rolls, P, which are held in place in the wheel-boxes by the steel washers, Q. Ball-bearings, R R, composed

of steel balls let into grooves in the outer faces of the fly-wheel gears and the inner faces of the wheel-boxes, take the thrust of the fly-wheel, when the torpedo rolls, and prevent excessive friction.

The fly-wheel gears, L L, of steel, are bevel gears slipped over the ends of the fly-wheel shaft, one on either side, and keyed in place, thus being when assembled, practically in one with the fly-wheel and its shaft. With the fly-wheel gears engage the shaft-gears, H H, of bronze, which slip over the forward ends of the gear-shafts, I I, and are rigidly secured to them by set-screws.

The gear-shafts are carried in Babbitt metal bearings, S, one on either side, in the after part of the fly-wheel frame. The after ends of the gear-shafts are squared, and over them ship the couplings, M, of steel, which are secured to the gear-shafts by taper-pins. The couplings are cut axially throughout their length with a square hole and in the after ends of the couplings slip the squared forward ends of the propeller-shafts, when the after-body is shipped in place.

Two steel washers, T T, are slipped on each gear-shaft, one between the shaft-gear and a square shoulder on the shaft, and the other between a collar on the shaft and the coupling.

The fly-wheel is spun up, prior to launching, by a motor situated outside the launching-tube, on the starboard side of the tube, the motion of the motor being transmitted to the fly-wheel through the motor-clutch, the intermediate-clutches, U U′, and the fly-wheel clutch, V. The details of the clutches are given in the following section and illustrated in Plate X.

Oil is supplied to the bearings of the fly-wheel shaft and of the gear-shaft, and to the intermediate-clutch shaft stuffing-box by oil-pipes, which are filled from outside the

shell through oil-holes, and are kept closed by screw-plugs.

A light screen of sheet brass, not shown in the plate, secured by screws to the after side of the fly-wheel frame, shields the rubber diaphragm of the hydrostatic-piston from oil thrown off by the fly-wheel when in motion.

DETAILS OF THE CLUTCHES.

Plate X.

The motor-clutch is put in engagement with the outer intermediate-clutch, U′, and withdrawn from engagement with it, by the action of a cam operated by the firing-bar on the launching-tube, not shown in the plate. The firing-bar is so constructed that, in one motion of the firing-lever, the firing-bar successively shuts off steam from the motor, withdraws the motor-clutch from engagement with the intermediate-clutch, withdraws the stop-pin holding the torpedo in place in the tube, and fires the impulse-cartridge by which the torpedo is ejected from the tube. It is therefore impossible to discharge the torpedo without first withdrawing the clutch.

The intermediate-clutch is double, consisting of the outer intermediate-clutch, U′, and the inner intermediate-clutch, U, mounted on the ends of the intermediate-clutch shaft, R. The inner clutch is machined in one with the clutch-shaft and the outer clutch ships on a square on the outer end of the clutch-shaft, to which it is secured by a lock-screw. The intermediate-clutch shaft passes through the stuffing-box within the casing which forms a part of the fly-wheel frame. The stuffing-box is held in place by the follower, which screws in a thread cut in the casing, and the intermediate-clutch shaft is packed with braided cotton wicking, which prevents ingress of water to the interior of the torpedo. Channels admit oil to the packing around the shaft for lubricating

the shaft-bearing. The packing is set up by the gland, S, which screws left-handed in a thread cut in the casing.

The fly-wheel clutch ships on a square on the end of the fly-wheel shaft, to which it is secured by a lock-screw. The intermediate-clutch shaft is capable of longitudinal motion within the stuffing-box, as well as of a motion of revolution. When the motor-clutch is pressed into engagement with the outer intermediate-clutch, the clutch-shaft is forced inwards and the inner intermediate-clutch engages with the fly-wheel clutch. The backs of the clutch teeth are inclined, and the instant that the motor-clutch is withdrawn the fly-wheel clutch drives away the intermediate-clutch, freeing it from engagement, thus avoiding unnecessary friction and resistance.

The clutches, the intermediate-clutch shaft and the follower are of steel. The stuffing-box and gland are of bronze.

THE AFTER-BODY.

Plate XI.

The after-body, M, ogival in shape is stiffened and strengthened by the joint-ring, K, in its forward end, the middle joint-ring, N, the immersion-regulator frame, L, and the after bulkhead, B. The shell of the after-body is made in two parts permanently connected to the middle joint-ring, N, to which the abutting ends are secured by being brazed to it. The forward joint-ring is brazed inside the shell and ships over the sleeve of the after joint-ring of the middle-body to which it is secured by eighteen steel joint-screws against a solid rubber gasket of circular cross-section let in the angle of the joint-ring of the middle-body, thus making a water-tight joint.

From the bulkhead in the forward end of the middle-body to the after bulkhead, B, of the after-body, the