

1905
HANDBOOK FOR SEAMEN GUNNERS.

MANUAL
FOR
DIVERS.



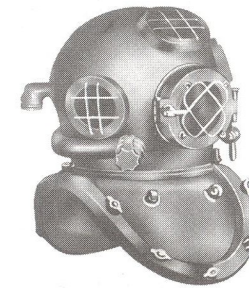
PREPARED AT THE
NAVAL TORPEDO STATION.

WASHINGTON, D.C.



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DEDICATED
TO THE MEN AND WOMEN
OF THE U.S. NAVY



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CHAPTER I.

REQUIREMENTS FOR DIVERS.

Before men are detailed for diving, they should be examined as to their fitness by a medical officer. As this is sometimes impracticable the following list of requirements and of physical defects which should cause the rejection of men having them is given for the benefit of those who may be called upon to select candidates for this employment.

Divers are-

1. To be cool-headed, calm, and of a phlegmatic temperament.
2. To be in good health, have a strong constitution, and the action of the lungs to be normal.
3. Not to be short-necked, full-blooded, or with a strong tendency to nosebleed.
4. Not to have bloodshot eyes, or a high color on the cheeks, caused by the interlacement of numerous small but distinct blood vessels.

5. Not to be very pale, nor have lips more blue than red, nor be subject to cold hands or feet.
6. Not to perspire freely.
7. Not to be affected with cough, asthma, or catarrh.
8. Not to be subject to headaches or dizziness, or affected with deafness.
9. Not to be hard drinkers, nor have suffered frequently or severely from venereal disease, or have had sunstroke or rheumatism.
10. Not to have been subject to palpitation of the heart or fainting spells.
11. Not at any time to have spat or coughed up blood.

Men who have long trunks with well developed chests and loins generally make good divers.

DESCRIPTION OF DIVING APPARATUS.

The essential parts of a diver's outfit consist of---

1. The air pump.
2. The air hose.
3. The rubber suit.
4. The breastplate.

5. The helmet.
6. The weights.
7. The life line.
8. The belt and knife.
9. The shoes.
10. The crinoline.
11. The lamp.

THE AIR PUMP.

Two kinds of air pumps are used at the Torpedo Station in the instruction of seamen; one known as the American and the other as the English pump.

The *American* pump (manufactured by A. J. Morse & Son, Boston) consists of three single-action cylinders, each capable of supplying about 40 cubic inches of air per revolution.

The pistons have holes through their axes in which leather-faced supply valves are fitted and kept in place by spiral springs.

A similar valve for the outlet of air is placed at the bottom of each cylinder, and on the down stroke of each piston is opened and connects the cylinder with the supply pipe running under all three. Motion is communicated to the piston by means of connecting rods joining them to the crank shaft.

The three cranks are set at angles of 120° with each other: at one extremity of the shaft is a fly wheel, while the other extremity is fitted to receive a crank handle. The tops of the piston rods pass through guides on the pump frame. The cylinders are surrounded by a tank which is kept full of water to keep the air cool. A pump, worked by an eccentric on the crank shaft keeps the flow of water in the tank continuous.

The air pump is set in a strong wooden case, and low down on the sides of the case are the ends of the supply pipe to which the air hose is connected. If two divers are to work at the same time, the air hose can be connected to each end of the supply pipe, but if one diver is to go down at a time, the second air nozzle is closed by a plug which is screwed into it. The pump has no depth or pressure gauge, and is always worked in its case.

The *English* pump (manufactured by Siebe & Gorman, London) consists of two double-action cylinders, each capable of supplying about 135 cubic inches of air per revolution.

The pistons are solid, and motion is communicated to them by an arrangement similar to that in the American pump.

On the top cap of each cylinder are two valves, one the inlet valve and the other the outlet valve for air: on the foundation plate on which the cylinders are placed are also two valves of similar shape and for the same purpose, viz, outlet and inlet valves. The top and bottom outlet valves are connected by a passage at the side of the cylinder leading to the nozzle, to which the air hose leading to the diver is attached by means of a nut and joint. This pump can supply air to two divers working independently at different levels, each diver being in direct connection with one of the cylinders. A depth and pressure gauge shows the depth of water corresponding to the pressure of the air the diver is receiving, and serves as a guide to the men at the pump. The pump is secured in a strong wooden case and has one fly wheel and two winch handles; these handles, and those of the American pump, can be taken off and protecting nipples screwed on during transportation. A water tank surrounds the cylinders to cool the air; it is filled by hand and emptied by a "draw off" pipe, there being no pump attached. On the front of the case is a valve handle working a valve in one of the outlet pipes.

Two brass plates are also fitted at the same place, one reading "one diver deep water" and the other "two divers." By turning the valve handle to the first both cylinders deliver air to one nozzle, and by turning it to the second the cylinders supply air independently, one to each nozzle.

THE AIR HOSE.

The *American* air hose consists of a vulcanized-rubber tube surrounded by a five-ply canvas covering.

The *English* air hose consists of a vulcanized-rubber tube with a galvanized-iron wire embedded.

The idea in both is to preserve the shape of the hose so that the diver's supply of air may not be cut off in case the hose is stepped upon or otherwise subjected to pressure that might deform it.

Both kinds are made in lengths of 50 feet, and the internal diameter is $1\frac{1}{2}$ inch. The lengths are fitted together by means of gun-metal union joints.

THE RUBBER SUIT.

The suit is made of solid sheet india rubber, covered on both sides with tanned twill; it has a double collar, the inner end to pull up around the

neck, the outer one of vulcanized india rubber to go over the breastplate and form a water-tight joint. The cuffs are also of vulcanized india rubber and fit tightly around the wrists, making, when secured by "snappers," a water-tight joint, leaving the hands free.

THE BREASTPLATE.

The breastplate is made of tinned copper. The outer edge is of brass, and has twelve screws securely fitted to it at intervals, and projecting upward. These screws pass through corresponding holes in the outer collar of the dress, the four pieces of the breastplate band being secured to them by thumbscrew or wing nuts. The neck of the breastplate is fitted with a segmental screw similar to that on the helmet. There are two studs on the front of the breastplate to which the front and back weights are attached.

THE HELMET.

The helmet, of tinned copper, has a segmental screw at the neck corresponding to that of the breastplate, which enables the helmet to be removed from the breastplate by one-eighth of a turn. The *American* helmet has four strong

plate glasses in brass frames protected by guards; the English helmet having three. In either, the front glass can be unscrewed to enable the diver to give or receive orders without removing any other portion of the dress.

An out valve is provided at the back of the helmet, a spring, which can be regulated for different depths, preventing the air from flowing out too fast, and the pressure of the water seating the valve thus preventing any entrance of the water.

An elbow is securely fitted to the helmet in which is placed an inlet valve, the air hose being screwed on to the elbow by a screw coupling. The inlet valve is so fitted that the air can enter but can not escape, so that in case of a leak in the air hose enough air is kept in the suit to allow the diver to be hauled to the surface before being suffocated.

The air, after entering the valve, is conducted by pipes in the top of the helmet to the diver's face so that he inhales fresh air and his breath does not condense on the face plate. There is a brass stud on each side of the helmet, the life line being made fast to the one on the right and the air hose to that on the left side. A foul-air valve is fitted on the left side of the helmet near the front.

THE WEIGHTS.

The front and back weights are of lead, heart-shaped, and weigh about 40 pounds each. Sometimes, a leather belt, made with pockets into which lead weights fit, is used. These weights can be removed when necessary, thus making it an adjustable belt for both large and small men.

THE LIFE LINE.

The life line is used to haul up or lower the diver; and is also a method of communication by signals with the surface. It is cable-lain to prevent kinking and is about 2 inches in circumference. It should be about 30 fathoms long and marked at every fathom for convenience.

THE BELT AND KNIFE.

A leather belt goes around the waist and serves as a support. It carries a knife for use when working on wrecks, etc. The blade enters the sheath and the lower part of the hilt screws into the upper part of the sheath to keep the knife from dropping out.

THE SHOES.

The shoes are of stout leather with either lead or iron soles, and are secured over the in-step by two straps and buckles. Each shoe weighs about 20 pounds.

THE CRINOLINE.

The crinoline is a sort of wicker ring covered with cloth, and goes around the waist inside the suit to support the body in opposing the pressure of water when diving at considerable depths. The diver himself is the best judge as to whether he needs it or not. It is not generally used in the United States.

THE LAMP.

The lamp is an incandescent 150-candlepower lamp of commercial construction. Its voltage depends upon that of the dynamo from which the current is derived.

The handle consists of a brass tube, the upper end of which carries the incandescent lamp, and with its accompanying parts provides for the secure attachment of the outer ends of the leading wires in such a manner that short-circuiting, whether by water or by metallic contacts,

is avoided. Inside the upper end of the brass tube is secured, by three screws, an ebonite sleeve which carries, secured to it by two screws, the socket for the incandescent lamp. Inside the lower end of the brass tube is soldered, water-tight, a brass stuffing box carrying a seat for a rubber packing and fitted with a water-tight entrance for the leading wire through the water cap and rubber packing into the handle, and to the binding screws of the lamp socket.

A rubber tube forms the junction of the lamp with the upper end of the brass tube. After the rubber tube has been slipped on over the brass tube the lamp is shipped in its socket, and the rubber tube is slipped up until it covers the globe of the lamp to a height of about 1 inch above the brass collar of the lamp and is held in place by a temporary seizing. The rubber tube is then turned back from the globe, a coat of thick shellac is applied to the glass surface exposed, and to the collar of the lamp, and, while the shellac is still wet, the rubber tube is replaced. When the shellac is dry the rubber tube is secured in place by flat seizings of stout flax twine, a narrow seizing being passed around the rubber tube and the neck of the lamp globe, and a broad seizing

around the rubber tube and the brass tube for the entire length of the latter.

The guard frame to protect the lamp from breakage and help to sink it, is made of stout brass wire. The frame is made in two parts, upper and lower, which, when assembled, are secured together at the equator of the frame by four machine screws. The upper half of the frame carries a ring by which the lamp may be hung up when desired.

The lower half terminates in a collar, slit in three parts, which, inclosing the handle, is held firmly in place by a stout seizing of marline passed around it.

The shield is used to protect the eyes of the diver from the glare of the lamp. It is made of copper in the shape of a dish and is fitted to the outside of the guard frame. The inside face of the shield is silvered and polished to serve as a reflector. When all-around illumination is desired the shield is taken off.

The leading wire is of the double-conductor kind, 100 feet being furnished with each lamp. The pattern is the same as that used in spar-torpedo work.

The connector is a plug designed to fit the sockets of the particular system of lamps carried by the ship to which the diver's lamps is issued. The inner ends of the lamp leading wires being secured to two binding posts in the connector, connection between the diver's lamp and the dynamo can readily be made by shipping the connector in any standing lamp socket conveniently placed.

Each diver's lamp complete is firmly secured in a lock box of special design, in the corners of which are pockets for the connectors. A copy of instructions is pasted on the inside of the lid. Each box is marked on top "Diver's Lamp" and is packed in a rough box for transportation.

Care must be exercised that the current is not turned on until the lamp is entirely submerged, and that it is turned off before the lamp is removed from the water. Neglect to observe this precaution will result in breaking the globe.

Keep the leading wire free from kinks and subject to as little strain as possible.

To prevent the leading wire of the lamp from being torn out of the socket by sudden jerks, seize it to the ring on top of the cage.

After use carefully clean and dry the apparatus.

CHAPTER II.

ACCIDENTS THAT MAY HAPPEN.

The air supply may be cut off by the pump, the safety valve may be out of order, or the air hose may break, above or under water. The supply of air in the suit will only last four or five minutes. If the diver can not come up alone, pull him up by the life line; if this is broken or foul, use the air hose. *Rapidity of action is imperative.*

By throwing himself on his back the diver may cause the air to go into the legs and upper part of the suit, and by this means may help himself in coming to the surface. If the knife is handy, he can cut off the front weight; this will throw him on his back and effect the same object.

RULES FOR RESUSCITATION.

GENERAL RULES.

As soon as the body comes or is brought to the surface, it should be lifted head first into the boat or on deck.

The front glass of the helmet should be opened, and the helmet and weights taken off; if necessary, the suit should be cut off; at the same time send for a doctor.

DROWNING.

Do not stand the diver on his head. If weather permits, lay him face downward in the open air with a pad of clothes under his stomach. Clear his mouth and palate and loosen all tight clothing, especially around the neck and chest. Turn him on one side, supporting his head, and excite the nostrils with snuff or ammonia, or tickle the palate with a feather. Chafe and rub the breast and face, and sprinkle both with cold water. If he shows no sign of breathing lay him on his stomach again, with a pad of clothes under his breast and one arm across his face, at the same time firmly pressing a hand between his shoulder blades. Carefully turn the body on its side, or a little farther, and then rapidly on its stomach again, about fifteen times a minute, at the same time supporting the head. Reverse and turn on the other side alternately. While this is being done, dry and rub hands and feet and remove wet clothing.

If no indication of breathing appears after several minutes, turn him on his back, laying a pad under his head and neck so that the chest is high. Pull his tongue forward and keep it there, tying a string around the tongue and chin if necessary. Get behind his head; grasp both arms just above the elbows and steadily but gently bring them extended above his head, holding them there about two seconds, then shove them down alongside his body again for two seconds, and keep this up about ten times a minute.

As soon as he begins to breathe lay him on his back, chafe his limbs and body to induce warmth and circulation of the blood. Place hot-water bottles around the lower part of his body and cover him up warmly. As soon as he can swallow give him from time to time a little lukewarm water with wine or brandy, or coffee or tea.

The effort must continue as long as the body is presumed to contain life and cease only when the pallor and rigor of death has set in.

SUFFOCATION.

Lay the diver on his back with his head raised, clean the mouth and palate, and thoroughly

sprinkle the head and face with cold water. Give cold douche and proceed as in case of drowning.

If a doctor or apothecary is present let him bleed the patient.

As long as there are no pronounced indications of death the efforts at resuscitation must be continued.

CHAPTER III.

SIGNALS.

Different methods of communicating with the surface are now in use, such as the telephone, acoustic tube, and the slate. These have all been tried with more or less success, but are not regarded with much favor by practical divers.

A short description of a diver's telephone is, however, given that those using this book may have a general idea of its construction. The receiver is fixed in the helmet and so arranged that when the helmet is in place on the diver's head the receiver presses against his ear. The transmitter is so arranged that its position is in front of the diver's mouth. A special connection prevents the cable from being broken off at the point at which it enters the helmet.

The telephone is worked by a battery of six dry cells, which are contained in a leather case, which, by means of a strap, can be carried about by the attendant. This strap passes over the

shoulder and the cells in the box are suspended by it.

In actual trials with this instrument, it was noticed that no distinct sound could be obtained with this number of cells; the best results being obtained by the use of two cells in series.

The attendant's telephone was shaped like a handle, one end being used for a receiver and transmitter; the handle serving to carry the telephone about and the other end consisting of a thin diaphragm of rubber, under which was placed some finely divided graphite. This was not compressed into the form of a button, but was filled loosely into the case. If the attendant could not hear distinctly, by pressing the graphite with greater or less force, he could so change the resistance of the circuit as to hear properly. The current passes through a choke coil (a coil of copper wire wound on an iron core), and connections were so arranged that the attendant could converse with one or with two divers.

One hundred and fifty feet of cable were used with the outfit and the different wires were made into a single cable.

The life line and the air hose provided with the apparatus are the means generally used in

the service for making signals and are found quite sufficient for all requirements.

The following is the code adopted at the Torpedo Station in the instruction of seamen qualifying as seamen gunners. The important point to observe is that the diver and tender have a thorough understanding of the signals to be used.

ON LIFE LINE.

PULLS.	BY DIVER.	BY TENDER.
One.	Am "all right".	Are you "all right?"
Two.	Ease me down.	I will ease you down.
Three.	Pull me up.	Come up; or, I will pull you up.

ON AIR HOSE.

PULLS.	BY DIVER.	BY TENDER.
One.	More air.	Answer by one pull on life line, (I will comply).
Two.	Less air.	Answer by two pulls on life line, (I will comply).

Two pulls of the life line and two on the air hose,

in rapid succession, indicates that the diver is foul and can not free himself. On receiving this signal no attempt should be made to haul him up, but his signal should be answered and another diver sent down to release him.

Never arrange a code of signals for carrying on work that involves any of the established signals on the life line, as it is a dangerous experiment and may lead to serious misunderstanding.

THE PERSON IN CHARGE.

The person in charge must thoroughly understand diving and the use of the apparatus. He must also understand the rules for resuscitation and the care of persons injured in diving. He will see that a full complement is present at the work, or exercise, and will have full charge in all things.

He will assure himself that the diver understands the different parts of the apparatus, and what to do. Also that all parts of the apparatus are correctly and thoroughly adjusted.

He will see that the pump is worked regularly, closely observing the pressure gauge to see if air is being delivered properly. He will also see that the tender leaves just slack enough on life line

and air hose for the diver to work by.

He will cause the diver to come up if, when anchored in a current, bow and stern, the position of the diving launch is to be changed, or any alteration occurs on the surface which may interfere with or imperil the diver.

If engaged in clearing mooring cables or lines, no hauling or veering should be done until the diver comes up.

As soon as one man comes up, if another is to go down, coil down the air hose and life line, and examine the pump and all valves and joints afresh while the second man is being dressed.

Make it a rule to keep the gear in the diving launch neatly arranged, and place all articles not in use well out of the way.

No talking or laughing is to be allowed after the diver's face plate is put on, or while he is under water.

THE DIVER.

Coolness and courage are the necessary qualifications for good divers.

A diver should not go down for at least one and one-half hours after eating a hearty meal, or for two hours after drinking spirituous liquors.

He should empty his bladder and, if the diving is to continue for any length of time, relieve his bowels before going down, as the increased pressure will not only cause great inconvenience but, probably, disagreeable consequences if this precaution be neglected.

He will not go down or come up on any anchor cable, line, or rope secured to the bottom. When working on the bottom a weight, with a line attached called a "circulating line" is used as a guide in moving about. If under the bottom of a ship, a jacob's ladder, coming underneath and up each side, is convenient.

Fouling of the life line or air hose might occur when working on a wreck, and if the diver can keep cool he may be able to follow up his line or air hose and free himself.

THE DIVER'S TENDER AND ASSISTANTS.

A diving crew consists, in addition to the diver, of the following men:

- 1 diver's tender.
- 1 assistant to diver's tender.
- 1 man to observe pressure gauge.
- 2 men to man the pump.

Two men should be added to this complement, as reliefs to the pumpmen, when carrying on

operations in deep water or where the work is arduous or continuous.

THE TENDER.

The tender is the responsible person and must be vigilant at all times. Occasionally he will give one pull on the life line, and the diver should return the signal by one pull, signifying "all right."

If the signal is not returned the diver should be hauled up; but, if he wishes to work without interruption, he gives one pull independently for "all right, let me alone."

If the tender feels any irregular jerks, such as would be occasioned by the diver falling into a hole, he should signal to know if he is "all right," and if no reply is received should haul him up immediately. If while being hauled up the diver gives one pull, it signifies "all right, don't haul me any more."

If the tender wishes the diver to come to the surface, he gives three sharp pulls on the line, to which the diver answers (three pulls) if he is ready to come up; otherwise (one pull), if he wishes to remain longer below.

He will see that the diver does not descend or ascend too quickly, controlling his motions by signal and the life line.

He will never allow a man to go down in more than 20 feet of water without a "descending line," made fast to the diving launch.

He will carefully observe the air bubbles as they come to the surface. If they rise at regular intervals of three or four seconds the diver is all right and breathing regularly. If the bubbles rise continuously, without any interval, it shows the diver is nervous. In a current the bubbles will appear a distance beyond, and may not be seen; in this case use signal (one pull) very frequently.

He will always make fast the bitter end of the life line in the diving launch.

His assistant will aid him in keeping lines clear and coil down, and may attend either the hose or life line when so directed, and will always be ready to assist in pulling the diver to the surface in case of emergency.

THE PUMPMEN.

Under no circumstances must the men at the pump allow their attention to be diverted from their work while the face plate is on and the diver down. The pump must be worked steadily and uniformly, the speed being designated by the man watching the gauge.

CHAPTER IV.

PREPARATION. GENERAL REMARKS.

As a general rule diving operations can be carried on better from a boat or stage than directly from a vessel. If it should be necessary to send a diver under a vessel near the gangway, the platform of the gangway could be utilized as a place for the pump and attendants, but the boat, or launch, is used by most experienced divers.

Always hoist a red flag in the bow of the diving launch as a warning for other boats to keep clear of you.

Never carry on diving operations in foggy weather unless it is absolutely necessary to do so. In that case sound the fog signal very frequently.

DETAILS OF PREPARATION.

1. In working in a tideway moor the launch head and stern, and have a small boat along-side ready in case of accident. An iron ladder

should be provided, with stays to bear against the sides of the launch from which the diving is carried on. If working in deep water, a jacob's ladder, weighted at the end, should be attached to the iron ladder. An ordinary "descending line" may be substituted for the jacob's ladder if the diver so wishes.

2. Lash the pump securely in the launch, placing it so that it may be about 6 feet from the head of the ladder and facing it. Examine all the working parts very carefully and oil them. None but the best olive oil should be used, as the smell of other oils is apt to make the diver sick, especially if he is a beginner.

3. Examine the inlet and escape valves in the helmet to see if they seat properly; even a grain of sand may cause a valve to leak by preventing its being properly seated. Therefore be very careful in this examination. See that the foul-air valve works properly; if the diver is working on his back in the mud, the escape valve may become closed and then the foul-air valve becomes of the greatest importance.

4. If the suit has been in store for any length of time clean off the verdigris, take the valves apart and tallow them slightly. Examine all couplings and test the air hose by placing the hand over

the end of it, working the pump at the same time. Listen for leaks about the pump at this time. A second method of testing the air hose for leaks is to hold the end in the hand and pay the bight overboard gradually; any leak, and its position, will be shown by the presence of bubbles as that particular part goes in the water.

5. Connect the pump for the cooling tank (American pump), and ship the crank on the main shaft. When satisfied that the pump is ready proceed to the next step.

6. The diver dresses as follows:

a. He first puts on a suit of heavy woolen underclothes, then the shoulder pad; sometimes a soft woolen cap is worn to prevent colds in the head from the current of air from the pump. If diving in shallow water the crinoline may be left off; otherwise it goes on at this time.

b. He then gets into the suit through the neck part, lifting it up as soon as the arms are in the sleeves, the cuffs being opened by an assistant with a pair of cuff expanders. Pull the inside collar well up. If the diver is to wear gloves, the rings must be put inside the cuffs before the dress is put on; otherwise, put on the "snappers" over the edges

of the cuffs. In cold weather warm the suit before attempting to put it on.

c. The shoes are next put on and buckled and the breastplate placed on the shoulders, the diver sitting down while it is done.

d. The outside collar is then drawn very carefully up over the breastplate screws so as not to tear through the holes in it. Now put on the four parts of the breastplate band and screw them up securely with wing nuts, the center screw of each part of the band being set up first. Then put on the chafing pants, or overalls.

e. Put on the belt and secure the life line around the waist. The diver is now helped to the diving ladder, and as soon as he is on it the life line must be secured to a cleat or bolt so that there may be no danger of his slipping off.

f. The front and back weights are then put on and secured by a line attached to them and made fast around the body.

g. Start the pump to expel any dust that may have accumulated in the air hose, as well as to drive out the hot air. The helmet and its glasses having been cleaned, screw the air hose to it. Put on the helmet, leaving off the face plate.

One-eighth of a turn will firmly secure it to the collar of the breastplate. If the helmet has the safety-pin arrangement, put in the pin, to keep it from unscrewing.

The air hose passes from the back of the helmet down under the left arm, and is secured to a lug on the left side of the helmet in front. The life line passes around the body with a loop, and is then stopped to the lug on the right side of the helmet.

7. The pump is now started and the face plate screwed on; the diver breathes regularly for a few minutes, when the pump is stopped and the face plate unscrewed. The diver is then asked if everything works satisfactory; any defects must be immediately remedied.

8. If everything works right, the order "pump" is given and the face plate screwed on. The diver is then given a pat on the helmet as a signal that all is ready and that he is to descend.

OPERATION.

The pump should be worked steadily and the tank surrounding the cylinder kept filled with water to cool the air; in warm weather ice may be used in the tank with the water. The diver's

depth will be determined by the amount of life line out. With the English pump the depth and pressure gauge will show this.

Generally the pump should be worked so as to give above 5 pounds per square inch more than the pressure required for the depth. At any hard or fatiguing work the diver will need more air than when at light work or resting.

The diver should descend slowly, about *one fathom a minute*, stopping for a few moments after his head is under water to satisfy himself that he is all right. If he feels oppressed or experiences a humming noise in the ears, he should rise a few feet and swallow his saliva several times.

He must not continue to descend unless he feels comfortable. If the oppressive singing in the ears or the headache continues, he must return slowly to the surface.

The nervousness occasioned by the first attempt at diving increases the pulsations and causes a peculiar gasping for breath; this happens in some cases to be so strong that it would be unadvisable while in that condition to allow a man to descend. An explanation of the apparatus and the example of others will soon banish this nervous fear, and by descending slowly and rising a few feet when

feeling uncomfortable the body will accustom itself to the change of pressure and the disagreeable feeling will wear off.

The diver should habitually walk backwards; if he strikes an obstacle he should turn around and feel, as there is danger of the glasses in the helmet being broken by spikes, or other objects, especially if working on a wreck.

On arriving at the bottom the diver will give one pull on the life line to signify that he is "all right." While under water the diver requires a tender to hold his life line and air hose and an assistant to keep them clear. Both the hose and the life line should be just taut and clear of the gunwale so that at any moment the diver may be felt.

On going down, the diver takes with him a ladder line if a weighted jacob's ladder is used; this he attaches to the foot of the ladder. As he leaves the ladder he pays out on the line but keeps the bitter end fast to his wrist by a loop, so that at any time he can find his way back if he wishes to return. He must return to the ladder by the way he left it, otherwise he may foul his air hose or life line.

If two divers are down, they must work together and understand each other, being careful not to cross each other's path for fear of fouling the lines or air hose.

The diver must not lose courage or become frightened; if he does, or if he feels the want of air, or if his nose bleeds, or if he feels sick, he should immediately give the signal for coming up, but should not come up too quickly, about one fathom a minute if possible.

In case the air hose gets foul, it may be noticed when, after repeated signaling (one pull on the air hose, "more air"), sufficient air does not come. After trying to clear it, as a last resort, in moderately deep water, signal (three pulls on life line), throw off breast lead, cut the air hose, holding the end tightly, and come up. This should only be attempted when there is no second suit available with which to go to the assistance of the diver.

If sunk deeply in soft ooze or mud, signal more air, close foul-air valve, and close escape valve (if it can be reached) with the finger. This will inflate the suit more and probably free the diver.

CHAPTER V.

METHOD OF INSTRUCTION.

None but experienced and reliable persons thoroughly understanding diving should be intrusted with the instruction, which should be as follows:

1. The pupil will first be instructed in the general construction of the apparatus and shown how to disassemble and assemble it.

2. Full instruction in signaling will be given, combined with practical work in transmitting and receiving signals by life line and air hose.

3. The suit and helmet will be put on and the pupil will practice breathing for a while, the pump being worked regularly. He must accustom himself to the unnatural position of being shut up in a suit and endeavor to overcome any tendency to nervousness.

4. The pupil, fully clad, will enter the water. He will remain near the surface and will endeavor to accustom himself to the different sensations and pressures. If he feels any distress he should come up.

5. Practice is next had in sinking to the bottom and in ascending. Sometimes heavy sweating and a disagreeable ringing in the ears occurs. This is caused by a greater pressure at a greater depth, and will gradually disappear with practice. If the pressure in the ears pains the pupil, he must stop and swallow his saliva. If this does not relieve him, he must, if the distress occurs during descent, ascend a little until accustomed to the pressure, and then continue the descent; or, if the trouble occurs while ascending, he must descend a short distance until relieved.

6. Practice in working under water; the bodily efforts give the lungs more work, thus making the labor more exhaustive. First do easy work and then practice moving heavy weights and digging. It must be understood that bending forward increases the difficulty in breathing, and that sitting or kneeling is the best position for heavy work.

7. The instruction of the pupil will be completed in all the details of the apparatus and its action with practical exercises in disassembling and assembling the parts. He will be required to possess a thorough knowledge of the rules and their application, and of what is to be done in the various contingencies that may arise.

CHAPTER VI.

CARE AND PRESERVATION OF APPARATUS.

The apparatus must be overhauled weekly and after every time it is used. *It is to be always kept in repair.*

After being used the suit must be washed off with clean fresh water, and, in case salt water has entered it, that part must also be washed.

It must then be hung up in a cool dry place, but not in the sun or where it is too hot. Each time it is laid away it must be folded in a different manner so that no creases will form.

A convenient stretch upon which to dry the dress, heels up, is made of two cross battens to go up the legs, and a third loose through the arms.

The cylinders of the pump must be thoroughly cleaned, polished, and oiled after being used. After detaching the air hose from the helmet, air must be pumped through it, and the threads on the couplings must, after being cleaned, be protected by pieces of linen.

The shoes must be washed off in clean fresh water, dried very slowly, and then greased.

The helmet must be cleaned, dried, and polished.

Overalls and belt must be cleaned and slowly dried.

Underclothes and overalls must be frequently aired and beaten out to preserve them from moths and mildew.

If the suit is torn or damaged it may be repaired with the prepared cloth and rubber cement in the supply box.

In repairing a diving dress first wash the part requiring repairs with clean fresh water and let it dry thoroughly. Put on a coat of the cement and rub it in evenly, allowing it to remain about two hours before the second coat is applied.

The second coat is rubbed in evenly, similarly to the first, and allowed to remain about thirty minutes before putting on the third coat.

Let the third coat dry so that it just fails to stick to the fingers. The patch, of repairing cloth, should be given an even coat of cement about ten minutes before being applied. Very little pressure is required, as the texture of the dress and the repairing cloth make them adhere easily.

CHAPTER VII.

DIVING OUTFIT.

A complete diving outfit consists of---

- 1 air pump.
- 3 pieces of air hose (150 feet) with couplings.
- 1 helmet.
- 1 breastplate.
- 2 diving dresses.
- 1 set of weights.
- 1 pair of diving shoes.
- 1 pair of wrist expanders.
- 2 pairs of ring mittens.
- 1 pair of rings and clamps.
- 12 feet of snap tubing.
- 1 shoulder pad.
- 1 pair of overalls.
- 1 life line.
- 2 wrenches for setting up nuts on breastplate.
- 1 dozen extra bolts and screws for helmet.
- 1 can of rubber cement.
- 1 yard of repair cloth.
- 1 pair of extra couplings.

(42)

1 safety check valve.

1 cutting punch.

2 pairs woolen stockings and 2 pairs woolen mitts.

2 suits of woolen underclothes.

1 basket for helmet, hose, and dresses.

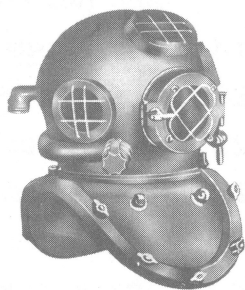
PRESSURE AT DIFFERENT DEPTHS.

The following table represents the pressure in pounds per square inch, to the nearest half pound, at a given depth of water:

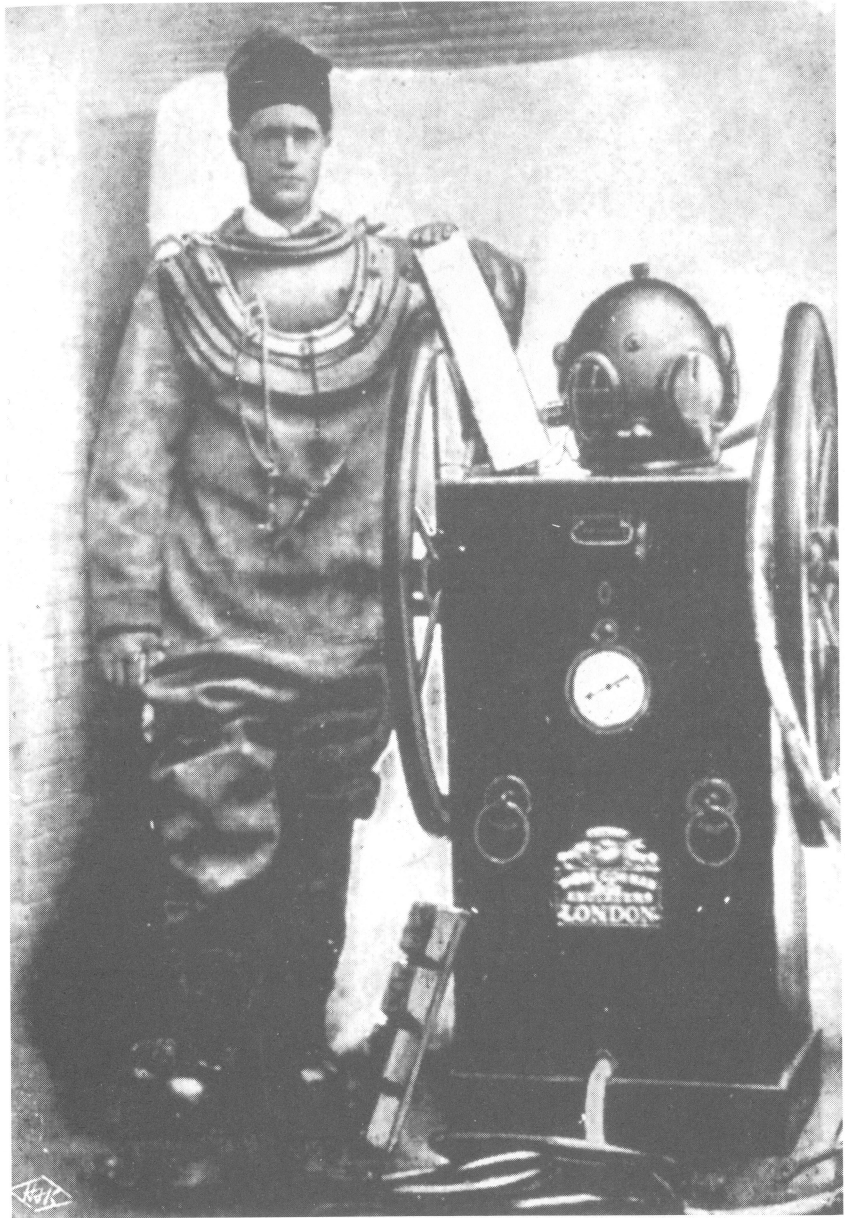
20 feet.....	9	lbs. per square inch.
30 feet.....	13 1/2	lbs. per square inch.
40 feet.....	18	lbs. per square inch.
50 feet.....	22 1/2	lbs. per square inch.
60 feet.....	27	lbs. per square inch.
70 feet.....	31 1/2	lbs. per square inch.
80 feet.....	36	lbs. per square inch.
90 feet.....	40 1/2	lbs. per square inch.
100 feet.....	45	lbs. per square inch.
110 feet.....	49 1/2	lbs. per square inch.
120 feet.....	54	lbs. per square inch.
130 feet.....	58 1/2	lbs. per square inch.
140 feet.....	63	lbs. per square inch.
150 feet.....	67 1/2	lbs. per square inch.
160 feet.....	72	lbs. per square inch.
170 feet.....	76 1/2	lbs. per square inch.

180 feet.....81 lbs. per square inch.
 190 feet.....85 1/2 lbs. per square inch.
 200 feet.....90 lbs. per square inch.

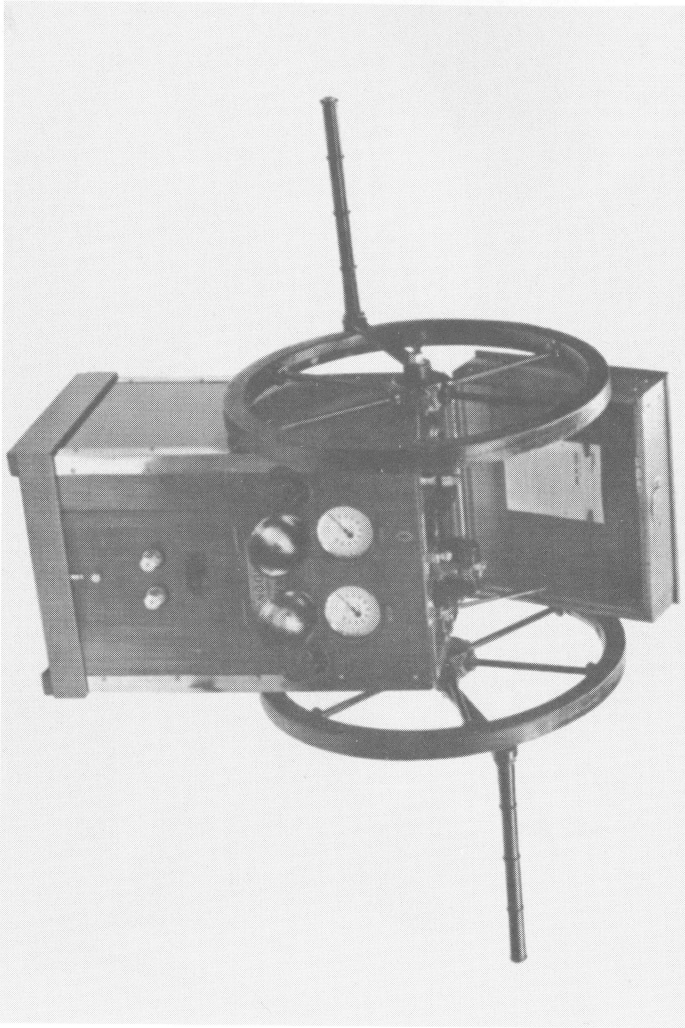
As a rule diving should not be carried on much below 20 fathoms, although experienced divers have gone as deep as 34 fathoms.



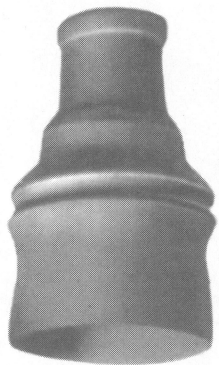
Diver Ready to Descend.



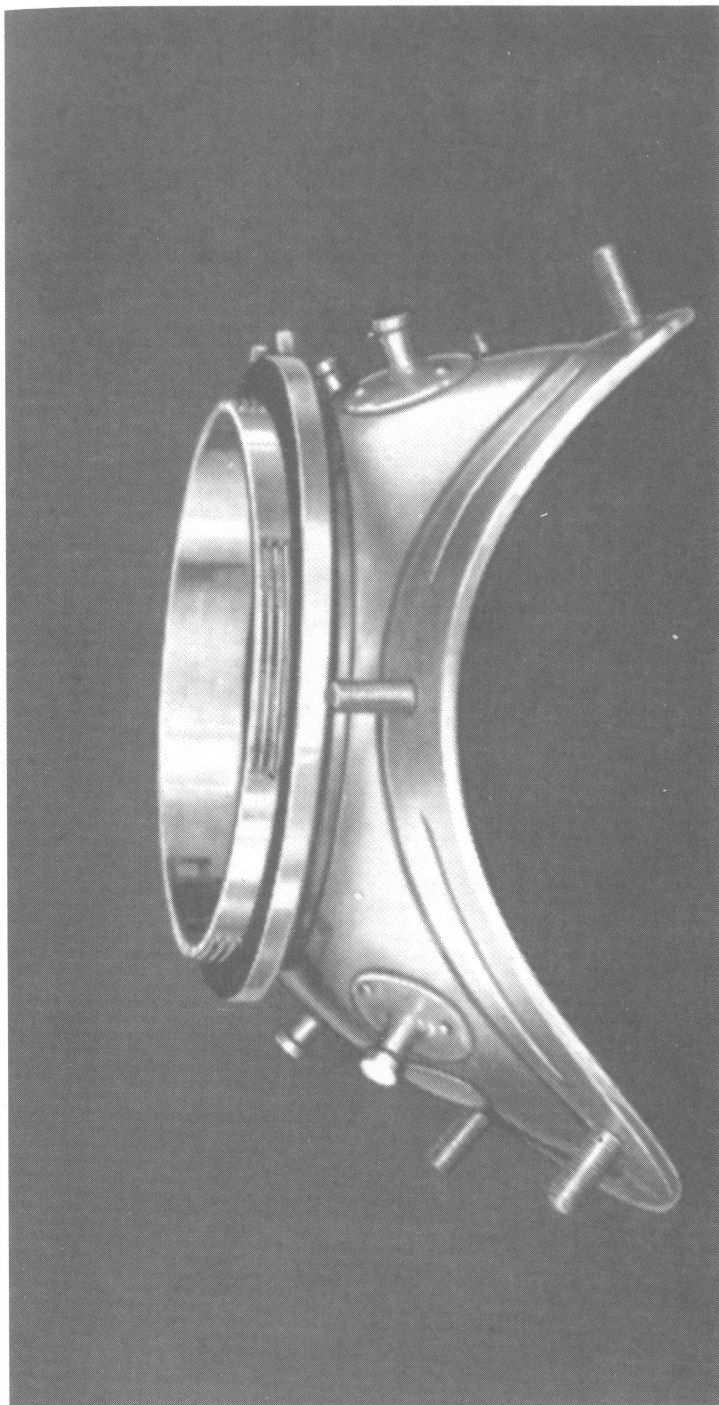
Life Line, Hose, and Suit.



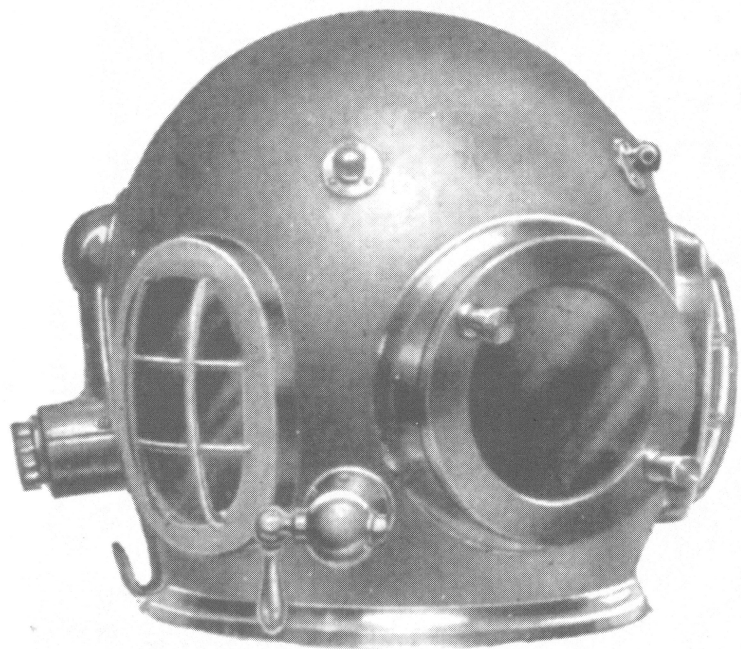
The Air Pump.



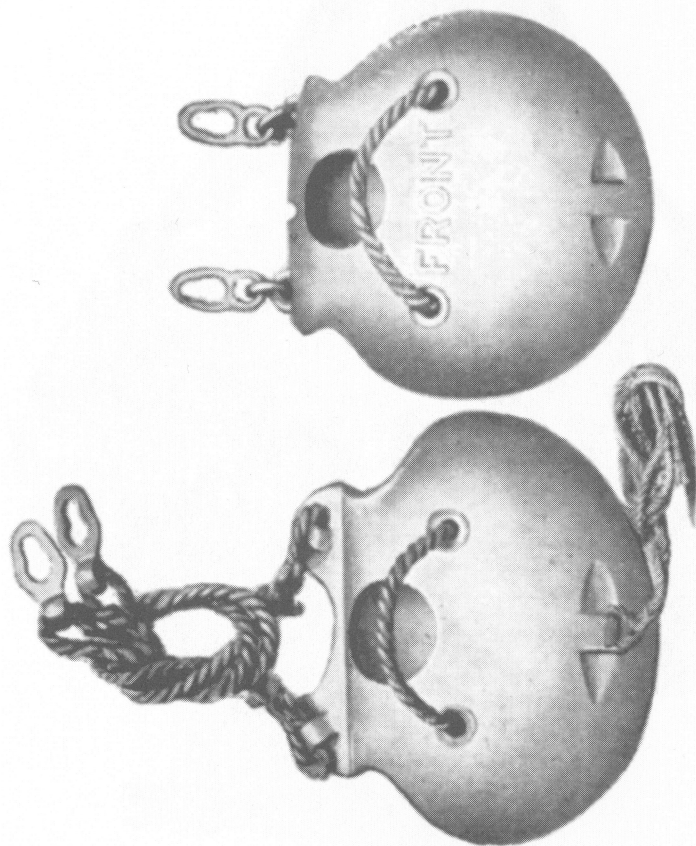
Bands, Cuffs, Expanders, etc.



The Breastplate.



The Helmet.



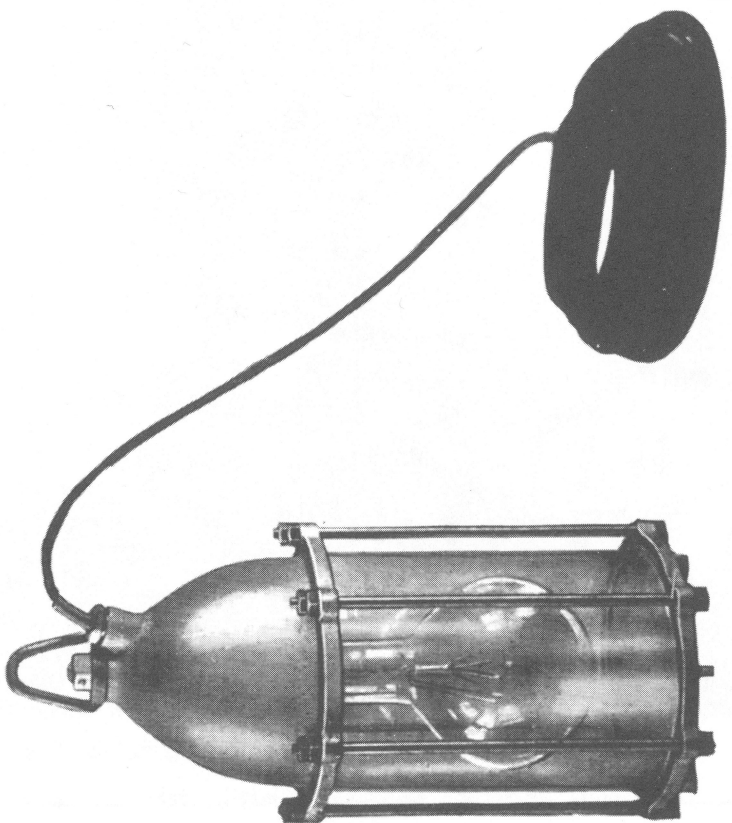
Chest Weights.



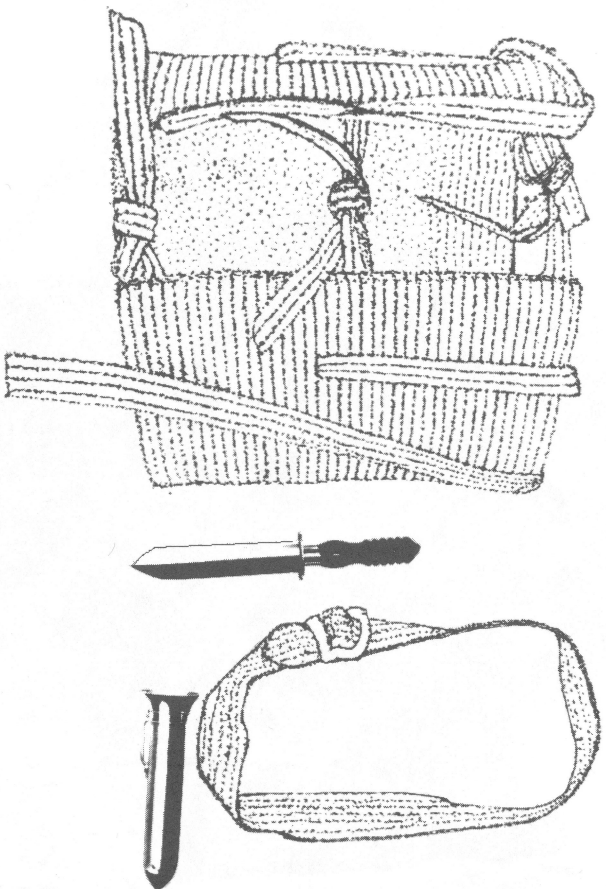
Belt and Weights.



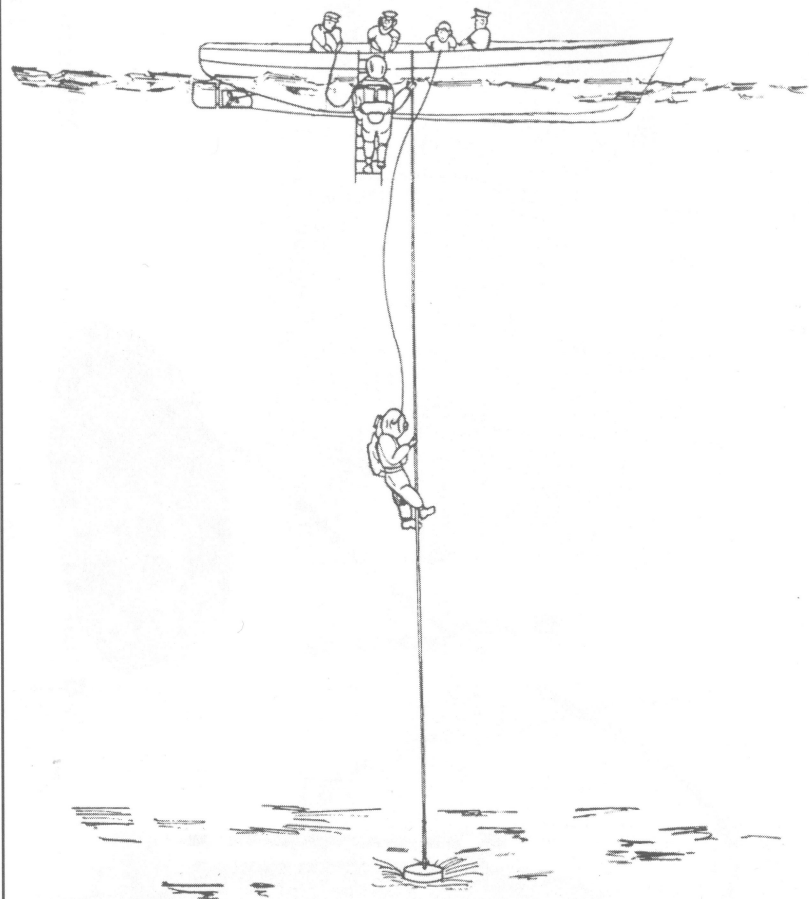
The Shoes.



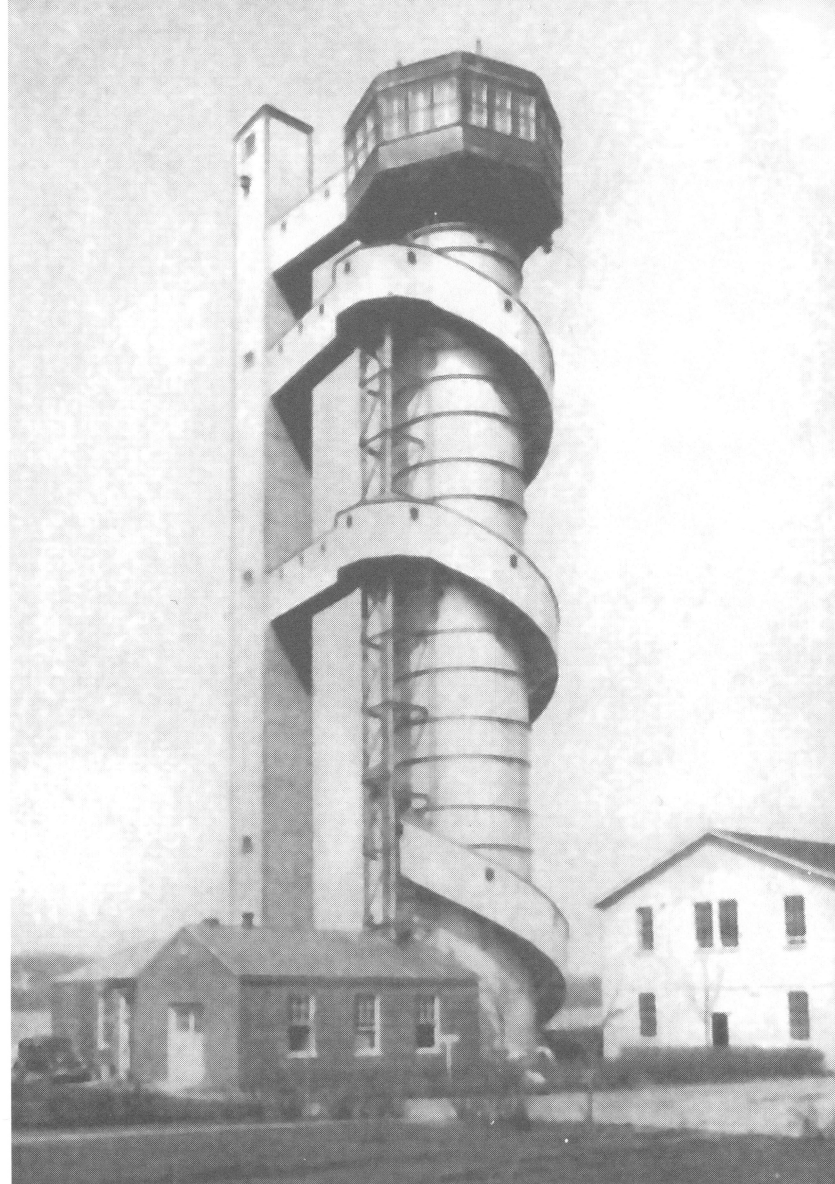
Electric Light.
11



Crinoline, Knife, and Belt.



Diving Launch.



The U.S. Navy training tank at New London, Connecticut. The 130 foot tank is used for diving experiments and submarine escape training.



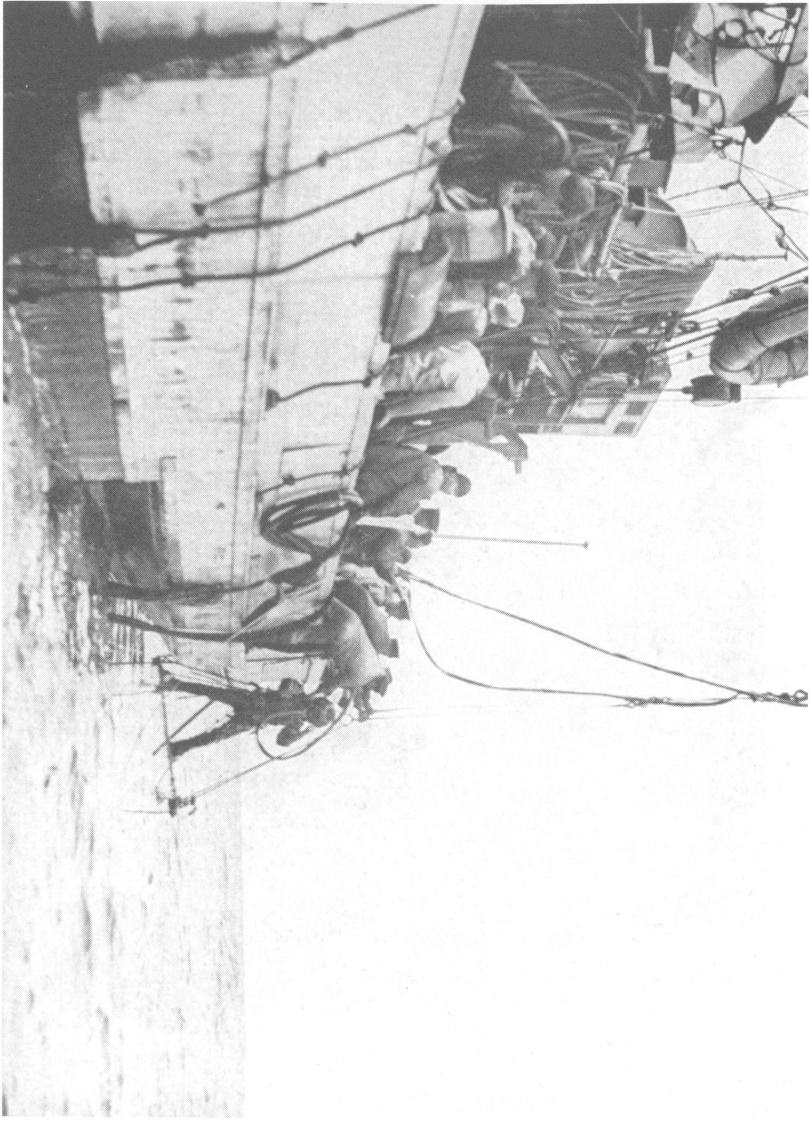
The British Royal Navy diver training tank at Portsmouth, England in which recruit divers are taught diving fundamentals.



Diver wearing double layers of woolen underwear preparing for a dive.



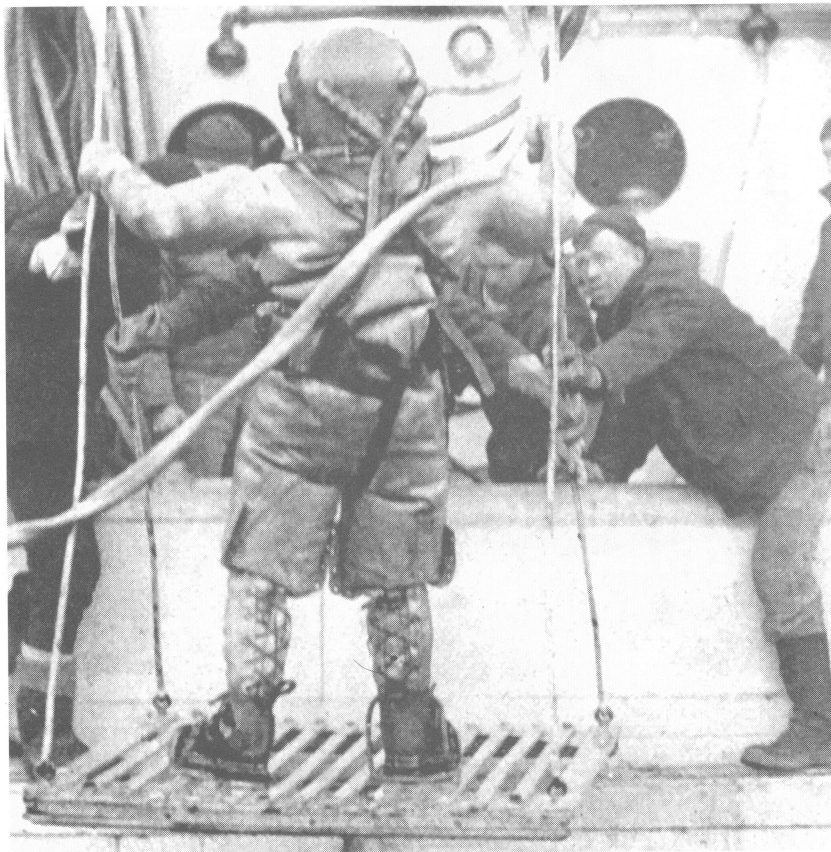
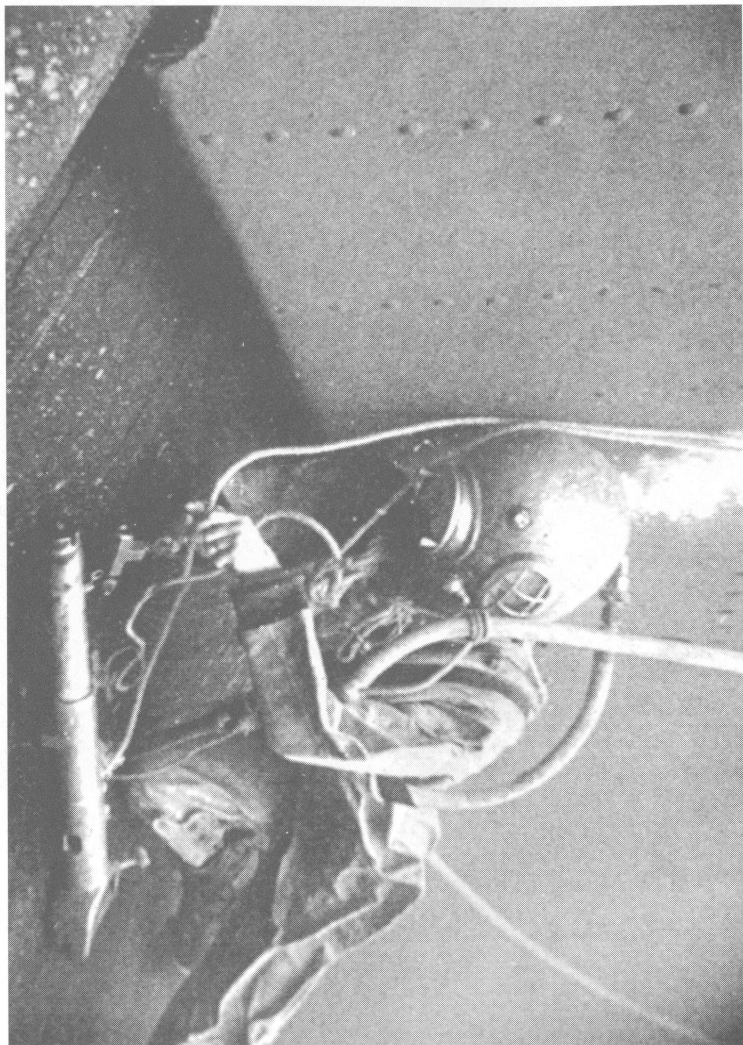
Diving officer speaks on telephone with divers on the bottom.



Diver on stage swung over the ship's side and ready to descend.

A diver hooking up an air-line to pump air into a
crippled submarine.

18

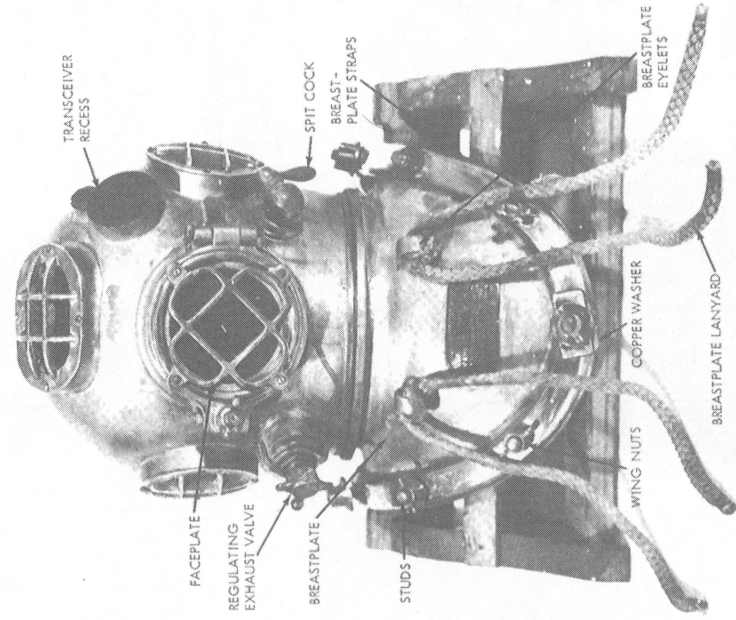
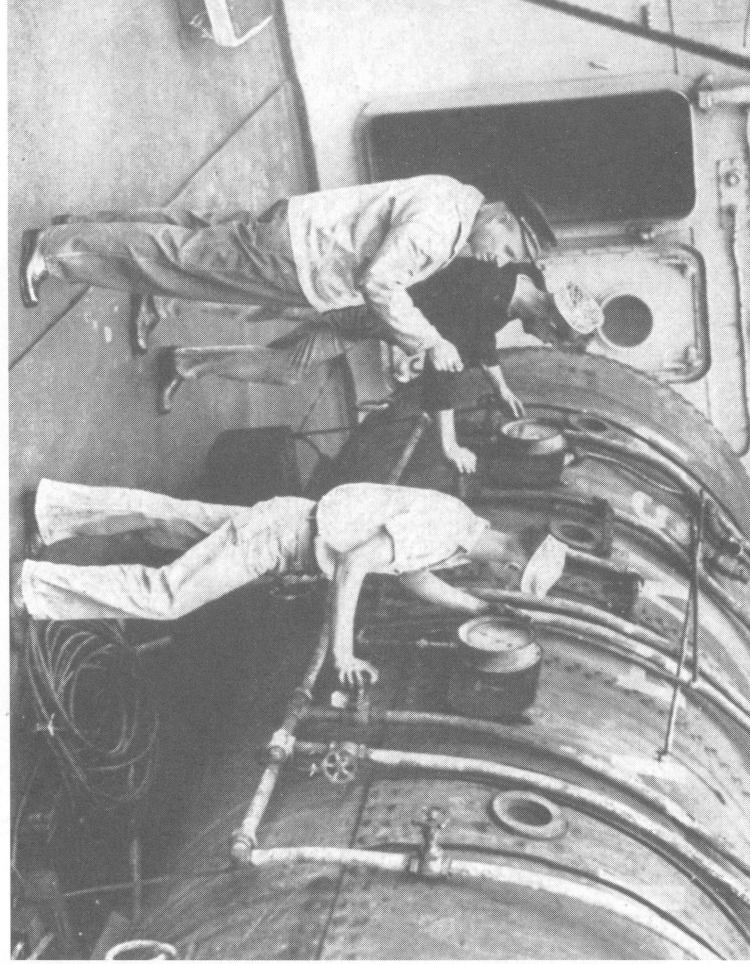


**Coming up from a dive the diver grasps the stage
bails and is swung aboard by the tenders.**

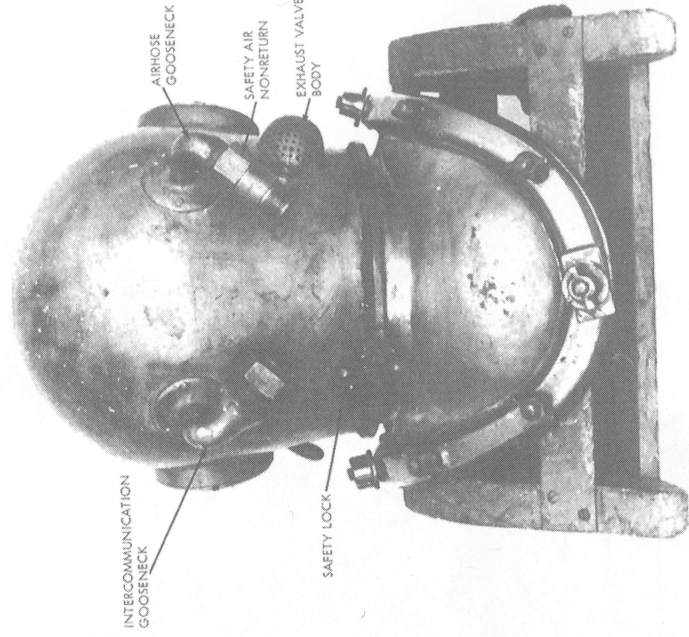
**(On standard deep sea dress, legs are laced to
prevent them from inflating and ballooning the
diver upside down to the surface.)**

19

The exterior of the "Iron Doctor", the diver's recompression tank.

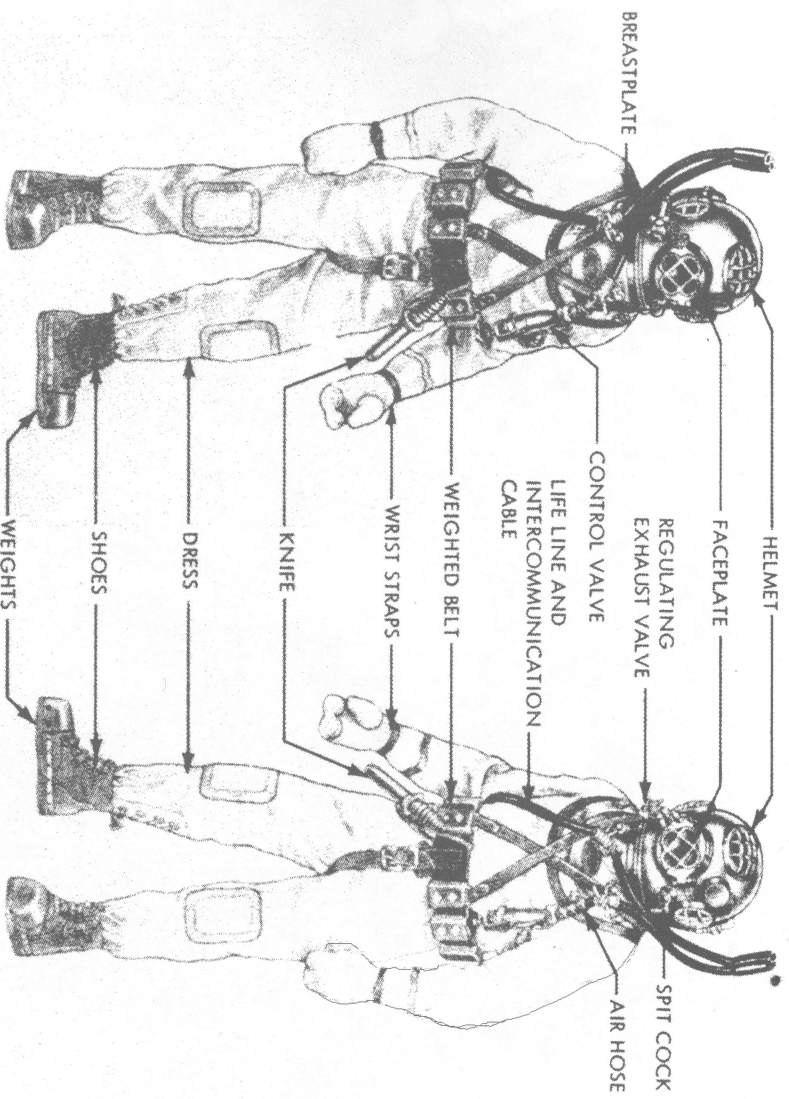
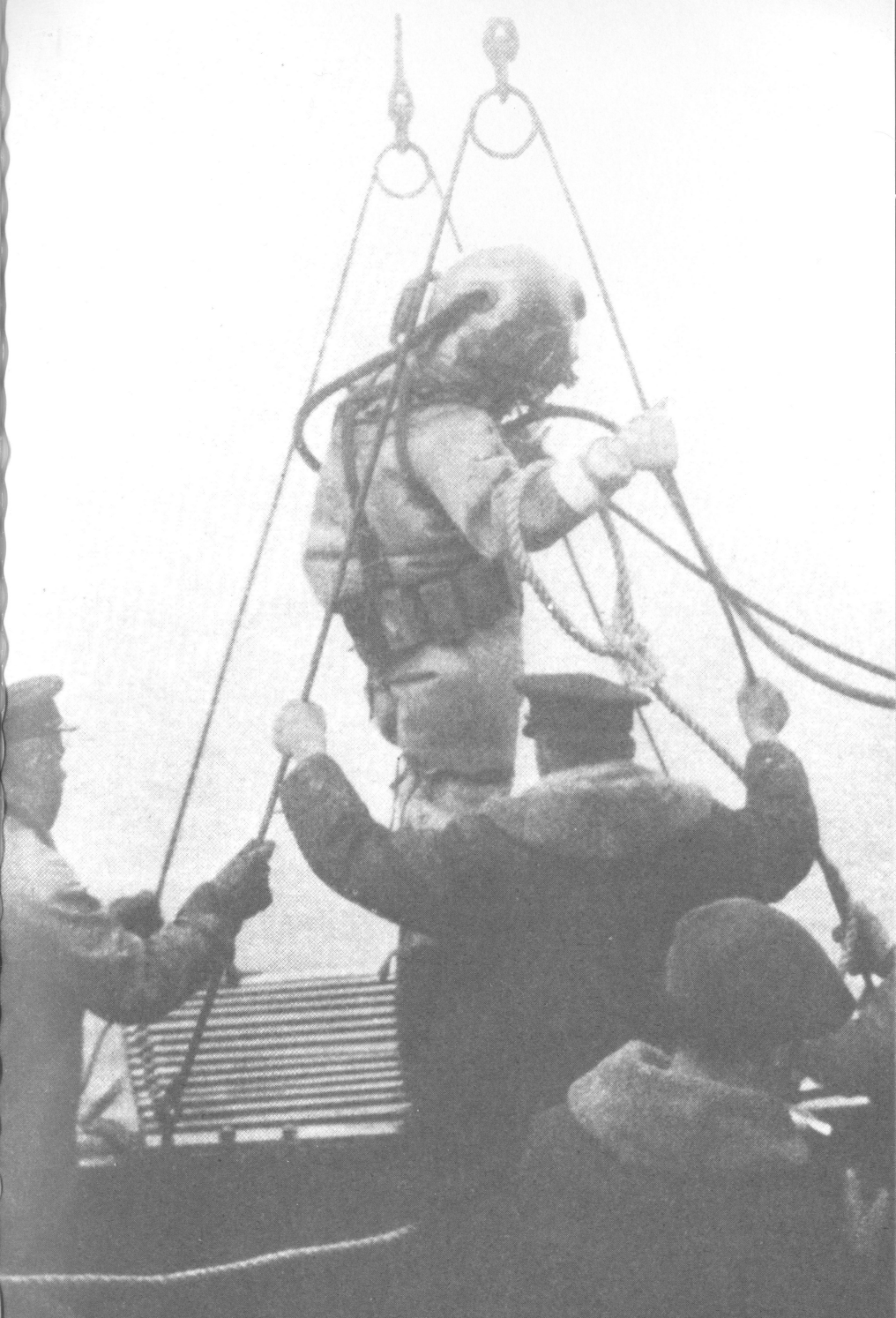


(front)

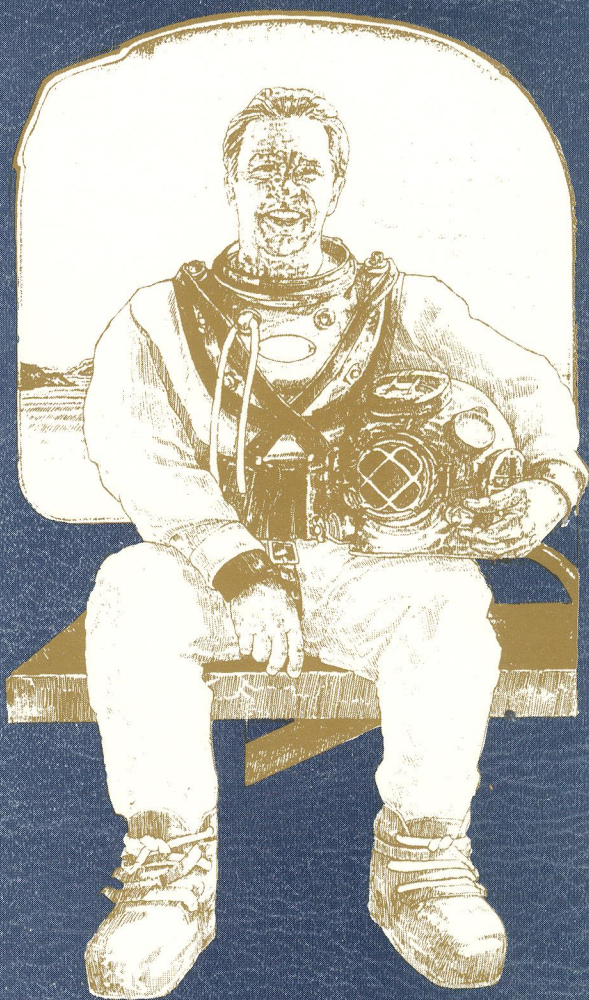


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Standard diving helmet assembly.



Deep-sea diving outfit.



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