9

Diving Bells

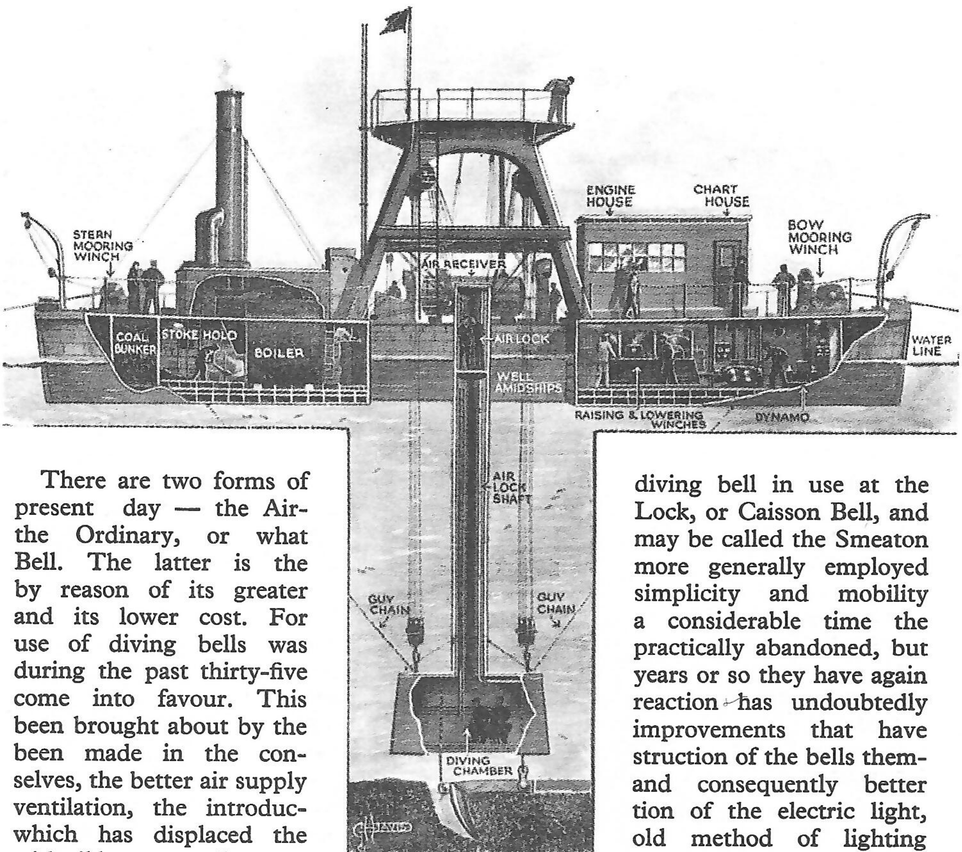


Fig. 139

There are two forms of diving bell in use at the present day — the Air-Lock, or Caisson Bell, and the Ordinary, or what may be called the Smeaton Bell. The latter is the more generally employed by reason of its greater simplicity and mobility and its lower cost. For a considerable time the use of diving bells was practically abandoned, but during the past thirty-five years or so they have again come into favour. This reaction has undoubtedly been brought about by the improvements that have been made in the construction of the bells themselves, the better air supply and consequently better ventilation, the introduction of the electric light, which has displaced the old method of lighting with oil lamps, candles, etc., the carbon from which was inhaled by the bellmen and seriously affected their health, and the adoption of the telephone, which saves so much time in the working of the bell.

The Air-Lock Bell is constructed of mild steel plates. The working chamber is usually rectangular in form, and weighted internally or externally with cast-iron kentledge to overcome its buoyancy. The interior is fitted with telephonic apparatus communicating between bell and crane room, and between bell and air compressor room. Two or three electric lamps are fixed in the roof, while there are several portable lamps for the bellmen. Running from the roof of the bell to above the water surface is a steel shaft of from 30 inches to 36 inches in diameter, with an air-lock. In some cases two shafts, each with its air-lock, are fitted—one for workmen, the other for materials. Inside the shaft is fitted an iron ladder by which the bellmen descend and ascend. The electric light cable and telephone wires are also led down the shaft. The bell is

AIR-LOCK DIVING BELL PLANT AND STEEL VESSEL

Supplied by Siebe, Gorman & Co. Ltd. to the British Admiralty for laying and repairing Moorings at Gibraltar

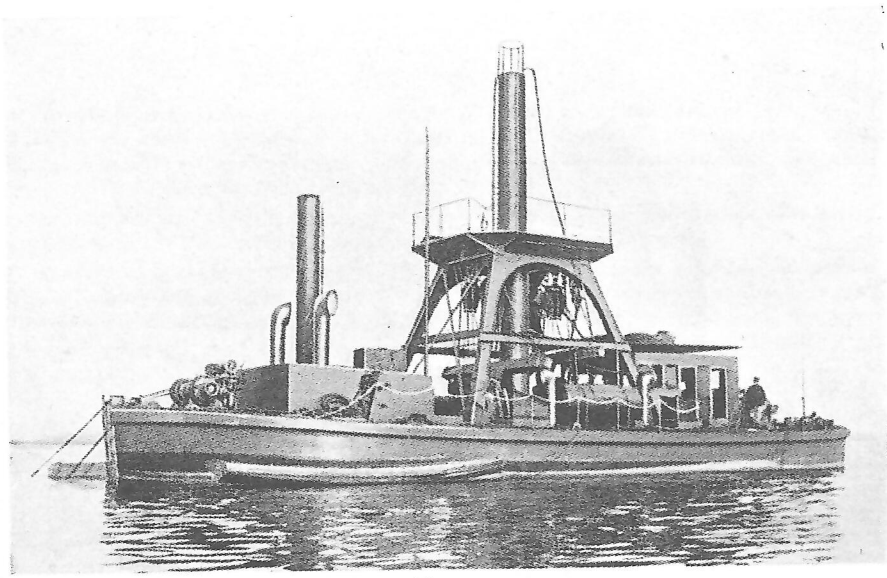


Fig. 140

The vessel is 85 feet long by 38 feet beam, with an air lock diving bell as described on page 197. The working chamber of the bell measures 14 feet by 10 feet by 7 feet high; the shaft 37 feet high by 3 feet in diameter. Total weight of the bell about 40 tons

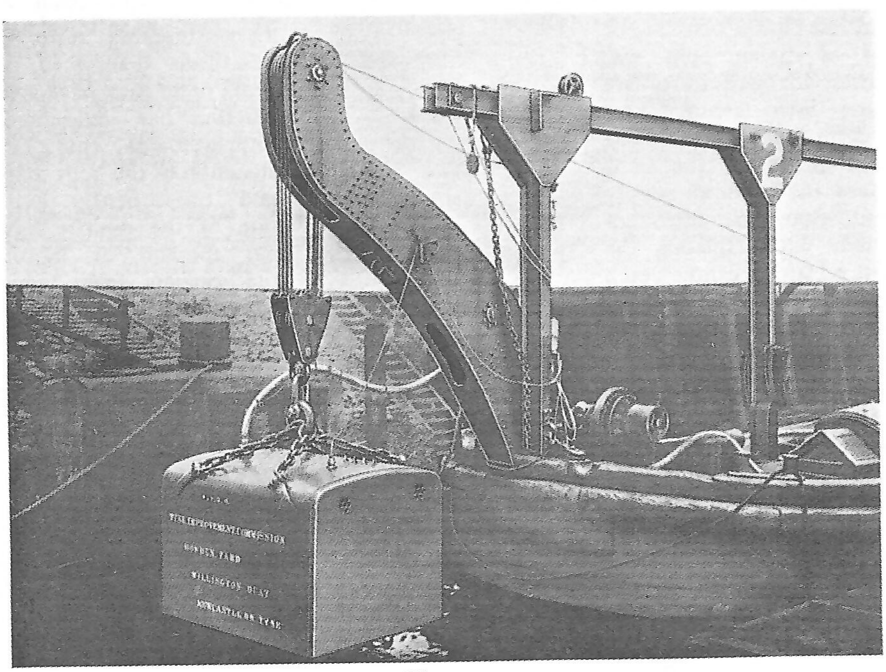


Fig. 141

Siebe, Gorman diving bell operated from barge (River Tyne Improvement Commission)

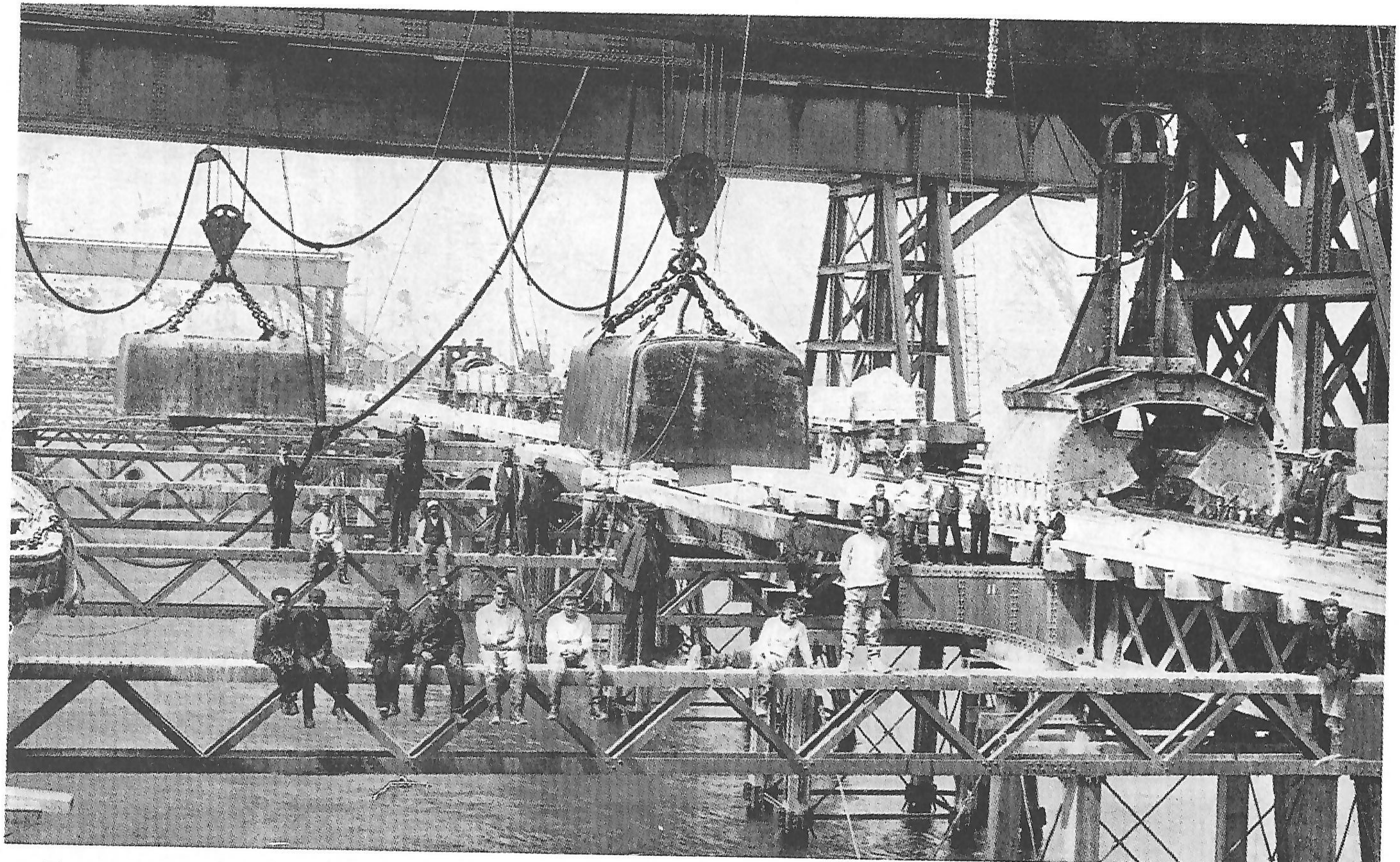


Fig. 142. Two ordinary diving bells, 17 ft. × 10 ft. × 6 ft. 6 in. high, each weighing 35 tons, supplied by Siebe, Gorman & Co. Ltd., for the National Harbour Works at Dover

worked either from a gantry or, what is sometimes found to be more convenient, from a specially constructed barge (see Fig. 139) having a well in the centre, through which it is raised and lowered by means of wire ropes over sheaves fitted to a superstructure erected over the well. The barge carries the necessary boilers, air compressors for supplying air to the bell and for working pneumatic tools, etc., hoisting engines, mooring winches, electric light engine, etc.

The Ordinary Bell is really the lower part, i.e. the working chamber, of the air-lock bell without the shaft and locks. The air-pipe is connected to a non-return inlet valve fitted in the roof, and lenses are sometimes fitted in the roof, but more often in the ends of the bell.

When asking for estimates for diving bells, the following particulars should be supplied, viz.:

(a) Dimensions of bell, or number of men it is proposed should work in it.
(b) Maximum depth of water.
(c) Capacity of lifting power available for lowering and raising bell.
(d) Particulars of work. If excavation, the nature of the sea bottom.

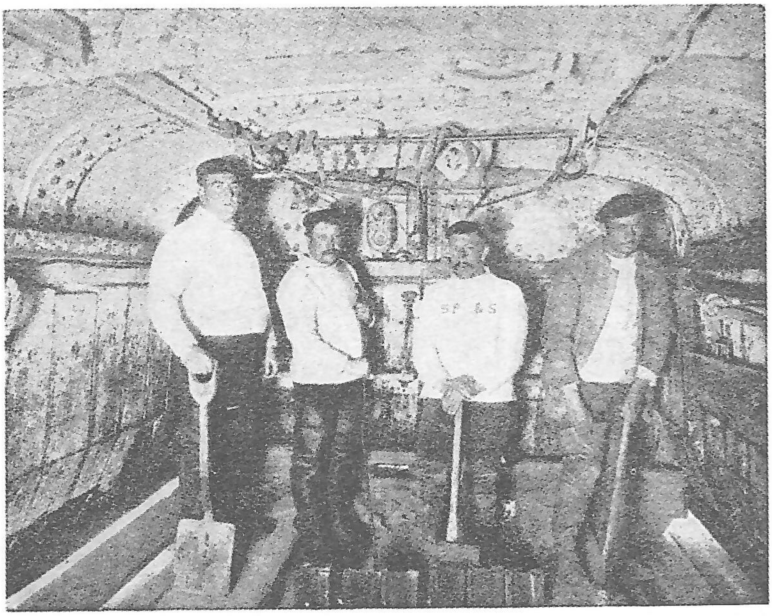


Fig. 143. Photo, taken on the sea-bed 70 feet below the surface, of the interior of one of the diving bells shown in Fig. 142

The rectangular diving bells in Figs. 142 and 143 have ballast, or kentledge, in the form of cast-iron slabs, usually about 6 inches thick, secured to the inside of the walls of the chamber. The lower edges of the slabs are chamfered off in order to allow the bell to work as close up to the underwater construction (e.g. dock walls) as possible; and if, for example, the work consists in levelling the sea-bed in readiness to receive concrete blocks, the bellmen are thus enabled to excavate the whole surface of ground covered by the bell.

While this form of bell presents a clean outside surface free from lateral projections, the available space for the bellmen is reduced by the thickness of the slabs—about 1 foot in length or breadth.

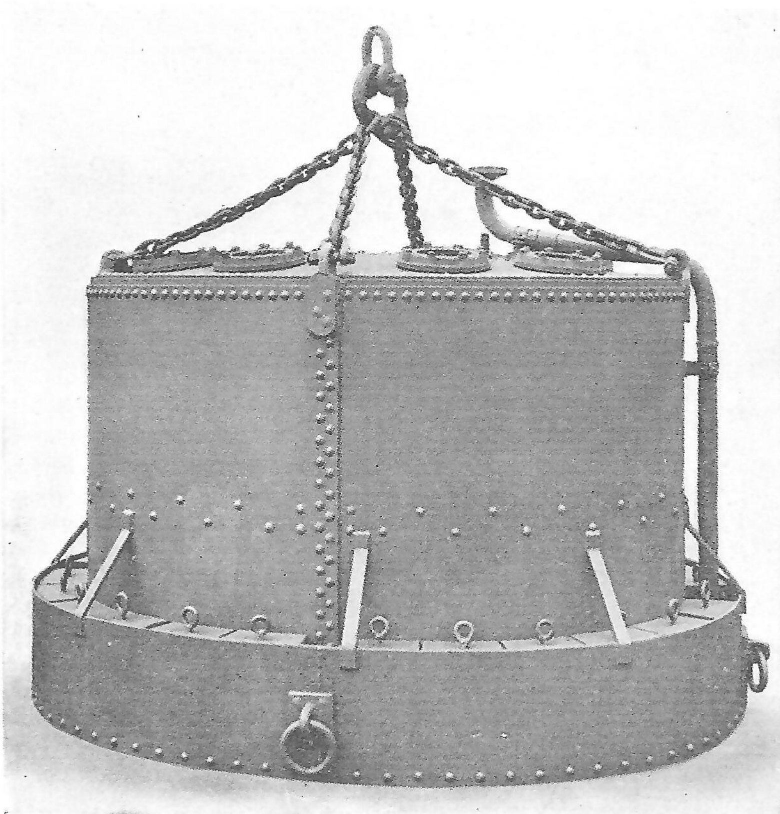


Fig. 144

The bell illustrated in Figs. 144, 145 and 146, which measures 8 feet by 6 feet by 5 feet 9 inches high, and weighs eight tons, differs from the others in that it is oval, and that the ballast (slabs of cast-iron) is carried in pockets outside the chamber. The effect of this arrangement is to increase the interior working space for the same chamber displacement, but the ballast does not permit of the bell being worked so close to the underwater construction as the type first described. The bell is electrically lighted and fitted with telephonic apparatus, depth gauge, lenses in metal frames, air inlet valve, seats, foot rails, inside chain sling, and four-legged chain sling, with lifting ring for the wire rope for lowering and raising the bell through the water.

DIVING BELL WORKED FROM PONTOON

Figs. 145 and 146 show a steel pontoon measuring 44 feet long by 16 feet wide by 5 feet deep, with a powerful hand-worked winch for lowering and raising the diving bell through a depth of 35 feet of water. Air is supplied to the bell by one of Siebe, Gorman & Co.'s oil-driven air compressors, and both bell and pontoon are lighted by an oil-driven generating set. The bell is also fitted with telephonic apparatus, etc. The whole plant, including pontoon, was supplied by Siebe, Gorman & Co. Ltd., to a foreign government.

Speed at which the ordinary Diving Bell is Lowered and Raised through Water and Air. The rates of speed at which the 35-ton Siebe, Gorman diving bells,

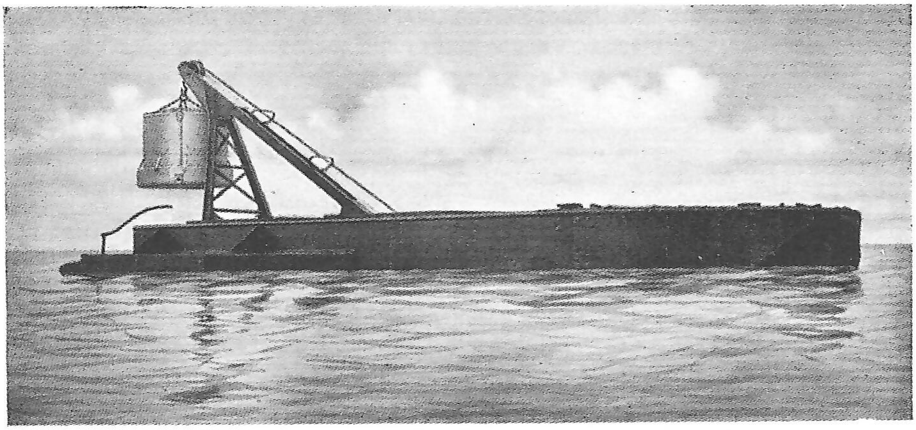


Fig. 145. Pontoon and diving bell supplied by Siebe, Gorman & Co. Ltd., to a foreign harbour

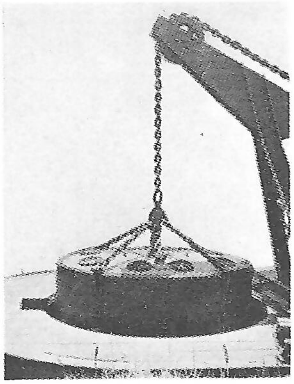


Fig. 146. Close-up of diving bell in well of pontoon shown in Fig. 145

measuring 17 feet by 10 feet by 6 feet 6 inches high, used during the construction of the National Harbour Works at Dover, were lowered and raised through water and air were as follows:

	Going down	*Coming up*
Total time for lowering to a depth of 60 feet of water	$8\frac{1}{2}$ minutes	$12\frac{1}{2}$ minutes
Speed through air ..	36 feet per minute	15 feet per minute
Speed through water ..	7 feet per minute	5 feet per minute

AIR LOCKS FOR SINKING CAISSONS, ETC.

Air Locks. In bridge building and other subaqueous operations, the caissons to be sunk are supplied with compressed air at a pressure equal to the depth at which the works are founded. Therefore, to enable workmen to pass in and out of the caissons, air locks are attached to their upper ends. When the entrance door of the air lock is open, the door giving access from air lock to caisson will, of course, be closed. The men having entered the lock and closed the outer door, a valve communicating between lock and caisson is opened until the air pressure in both is equal. The inner door giving access to the caisson may now be opened and the men descend the caisson, the inner door being closed again.

On the men's return to the surface (the entrance door of the air lock and the inner door being closed) the pressure of air in the lock must be equalized with that in the caisson, when the inner door may be opened, the men pass into the lock and the door is closed again. The air pressure in the lock will now be lowered in accordance with the decompression tables before the men emerge.

There are a number of variants on the simple design shown here, but this description serves to explain the general principle. Some designs have separate locks for men and materials.

The following is a description of one of the best forms of air lock (Fig. 147) employed in connection with cylinder sinking operations, and as used by Messrs. Sir W. Arrol & Co. Ltd., on such important works as the Forth Bridge, etc.

There are two locks—the material-lock and the man-lock—placed one above the other. The lower (man) lock has two compartments. It is semi-circular at the ends and flat in the centre, and has room for three men in each compartment. The lock is of steel plates, strengthened where necessary with beams and angles. The doors are of cast steel and have rubber joints. Bull's-eye glasses are fitted. The joints are caulked and the whole is tested to a pressure of 50 lbs. to the square inch. Cocks are provided to enable the workmen to regulate the air pressure when passing from one compartment to the other; the outer space is used as an intermediate stage in entrance and exit.

The material-lock is placed above the man-lock, the doors in this case being horizontal, and opened and shut by a rack-motion, worked from large hand wheels. A small steam engine is provided for operating the winding drum. To throw this lifting drum quickly out of gear a clutch is provided so that when the buckets are resting on the bottom door an overhead lifting arrangement may be brought into gear, and the buckets raised above the lock to tip the excavated material into the shoot.

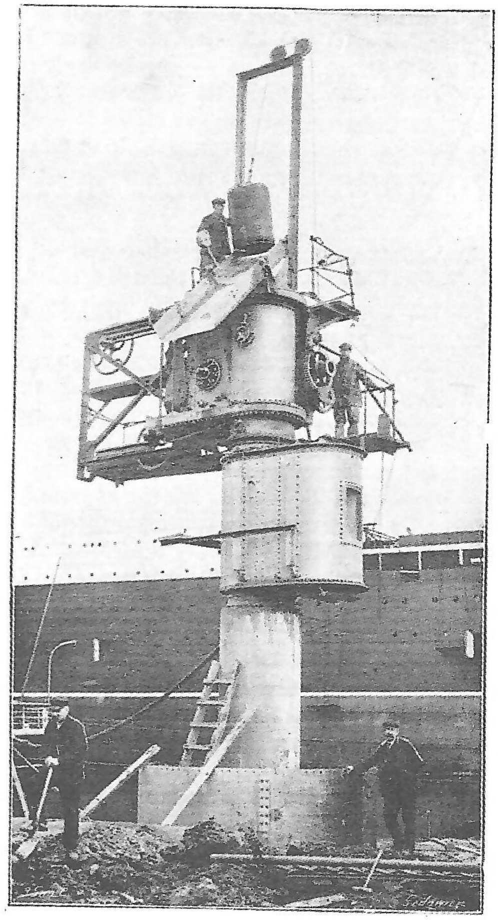


Fig. 147

QUANTITY OF MATERIAL "LOCKED THROUGH" PER DAY

As to the rate at which excavated material can be "locked through" it may be mentioned that, with a plant as described above, 160 buckets 2 feet 9 inches deep by 2 feet diameter = 8 cubic feet capacity, have been taken out in eight hours. This includes filling, hoisting 60 feet, "unlocking" and emptying, also returning bucket to the working chamber.

The Time required to Reduce the Pressure in the Man-lock is regulated according to the pressure (see remarks on "decompression" in preceding pages). To reduce the pressure in the material-lock is a matter of a few seconds only.

The Air Supply should be arranged so as to keep the CO_2 below one-half of 1 per cent (measured at atmospheric pressure). To ensure proper ventilation and allow for the gases generated by blasting, etc., 4 to 5 cubic feet per man per minute will generally be required.

When asking for estimates for air locks, particulars of construction of the caissons, and their dimensions and the maximum depth to be sunk, also the nature of the strata, should be supplied

10

Self-Contained and Armoured Diving Apparatus

The spectacular use of the self-contained regenerative type of diving dress during the Second World War led many people whose knowledge of underwater apparatus was limited to the ordinary diving dress with metal helmet supplied with air by means of pump and hose, to think that the former was a new invention. As a matter of fact, apparatus on this principle is an English invention of many years' standing (Fleuss and Siebe, Gorman & Co., see Part II, Chapter 4).

Though many improvements and variations in detail and capacity have been made by the firm during the past 70 years, the principle remains the same as in the apparatus originally produced by them, whether it be the type used in poisonous atmospheres or the type used under water. All the apparatus of these types made during the Second World War were on this breathing principle—the "Human Torpedo", the "Frogman" the "M.R.S." (Mine Recovery Suit), the "A.N.S." (Admiralty Neck Salvus), etc., the "Amphibian" (dual purpose) and the "Universal" apparatus. These types of apparatus are dealt with in Chapter 15, "Diving Equipment for Underwater Warfare in the Second World War".

Between the two world wars the Admiralty had on trial for some months in the Mediterranean a Fleuss-Davis (Siebe, Gorman & Co.) self-contained diving apparatus using a 50 per cent oxygen plus 50 per cent nitrogen mixture for depths to 70 feet. The apparatus was reported upon as entirely satisfactory.

For many wartime operations, the advantages of a diving apparatus independent of surface air supply and attendants are obvious. In peacetime diving it also has advantages under certain conditions, e.g. in flooded mines or in other intricate places where freedom from an air-pipe is an advantage. Work of comparatively short duration in shallow water, requiring mobility and manœuvrability, can be carried out economically and expeditiously in a suitable type of self-contained apparatus, e.g. examining ships' bottoms, clearing propellers, valves, etc.

The principle of the closed circuit apparatus is that the wearer continues to rebreathe the same air, the CO_2 being removed from the exhaled breath by a chemical absorbent and replenished automatically with the requisite amount of oxygen, thus rendering it pure and fit for inhalation again.

The designs first described and illustrated are those in which the standard diving dress and the rigid metal helmet are used. These can be used at depths down to 150 feet for periods varying according to depth.

It will be noticed that in some cases the gas cylinders are arranged vertically, and in others horizontally; this is a matter of expediency to suit the particular requirements of individual cases—duration of supply, nature of the operations, etc. The same remarks apply to the CO_2 absorbent chamber and, as will be seen later, to the position and shape of the flexible breathing bags in that type of apparatus in which the latter are used.

In some earlier apparatus, two breathing bags were sometimes employed—one connected between an expiratory valve and the CO_2 absorbent chamber; the other between the chamber and an inspiratory valve. This arrangement, however, was mainly employed in apparatus for use in poisonous atmospheres, seldom for underwater work.

In the original self-contained diving apparatus the oxygen feed was controlled by hand. A separate breathing bag was not used, since the diving dress itself is a flexible chamber of alterable capacity. Later, a reducing valve was employed whereby the oxygen or special mixture of oxygen and nitrogen was delivered automatically to the breathing circuit at a constant rate. A further development was the introduction of an injector, used in conjunction with a reducing valve, for the purpose of circulating the air in the diving dress through the absorbent chamber and passing it back, freed of its CO_2 content, along with fresh oxygen or mixture of oxygen-nitrogen or oxygen-helium. Finally, the reducing valve and injector were fitted inside a metal case which also contained the CO_2 absorbent chamber.

MOUTHPIECE AND NOSECLIP TYPE

This apparatus consists of the Siebe, Gorman standard type of diving dress; helmet and breastplate; steel cylinder containing a mixture of oxygen and air in the correct proportions; a metal chamber containing CO_2 absorbent; weight to be worn on the chest of the diver, containing two smaller steel cylinders with the same mixture of air and oxygen, the cylinders being fitted with a valve which is connected by a flexible tube to an air inlet valve on the helmet; a life-line.

The smaller steel cylinders are fitted with closing valves and the large cylinder also with a reducing valve and an emergency by-pass. The function of the reducing valve is to allow the requisite quantity of the mixture of oxygen and air to pass into the helmet at the varying depths at which the diver may be working. The object of the by-pass is to enable the diver to pass a supply of oxygen and air into the helmet direct from the cylinder in the event of a breakdown of the reducing valve, or other emergency.

The cover of the CO_2 absorbent chamber is fitted with two flexible tubes, which are connected to the back of the helmet. Inside the helmet is fitted an indiarubber mouthpiece, to one end of which is fitted an expiratory valve, which allows the diver's expired breath to pass into and through the CO_2 absorbent chamber into the helmet. At the other end of the mouthpiece is fitted an inspiratory valve, which is open to the helmet and through which all the air inspired by the diver passes.

All breathing (inhaling and exhaling) is performed by the mouth only, the nose being kept closed by means of the clip provided. In this way the whole of the expired air passes through the absorbent chamber, and is freed of its carbonic acid before being re-inhaled. An ori-nasal mask is sometimes used instead of the mouthpiece and noseclip.

The ordinary weighted boots are worn. The usual back weight is unnecessary, as the steel oxygen cylinder and CO_2 absorbent chamber take its place.

INJECTOR TYPE—WITHOUT MOUTHPIECE AND NOSECLIP

The apparatus illustrated in Figs. 153-156 is provided with an injector, in combination with a reducing valve, which draws the diver's expired air automatically through the CO_2 absorbent, and passes it, purified, back into the helmet, together with fresh oxygen; the noseclip and mouthpieces are, therefore, dispensed with. Otherwise the apparatus is as described above.

The arrangement in Fig. 156 has two smaller oxygen cylinders, fitted vertically, with the CO_2 absorbent chamber (which also contains the injector and reducing valve) between them, instead of one large cylinder placed horizontally as in Figs. 153 and 155.

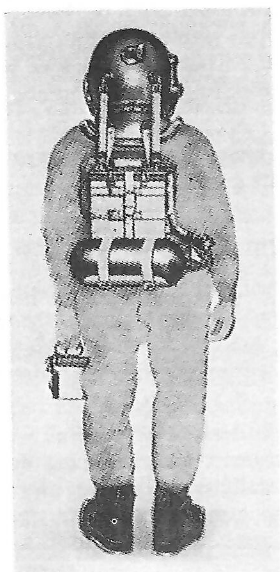
If desired, one of these cylinders may be charged with oxygen and the other with air. If they are of the same capacity, and charged to the same pressure, the resulting mixture will be half air and half oxygen.

Another injector type apparatus without mouthpiece and noseclip and using the three-bolt pattern helmet is illustrated in Figs. 157, 158 and 159.

Fig. 148

Fig. 149

An early Siebe, Gorman type of self-contained diving apparatus (mouthpiece and noseclip)



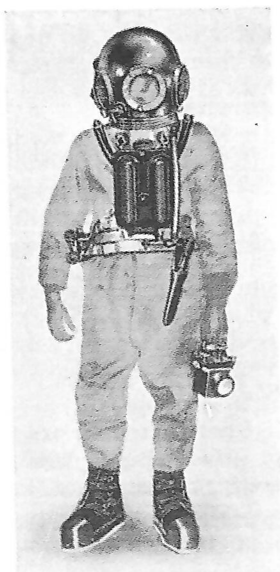


Fig. 150

Fig. 151

Fig. 152

Siebe, Gorman self-contained diving apparatus (mouthpiece and noseclip type)

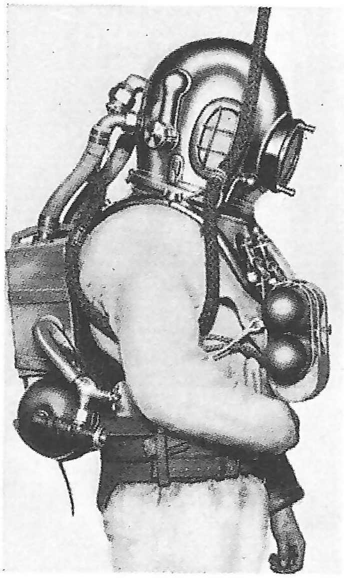


Fig. 153

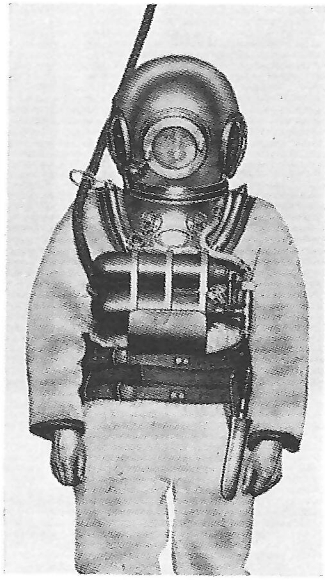


Fig. 154

Siebe, Gorman self-contained diving apparatus (injector type, without mouthpiece and noseclip)

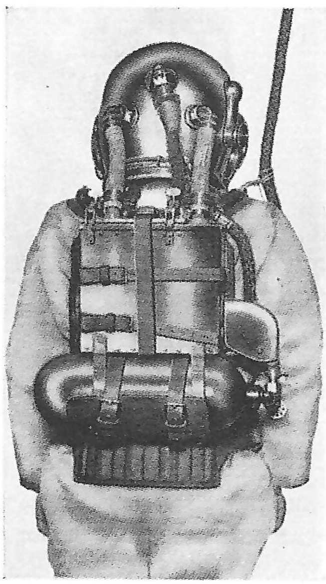


Fig. 155

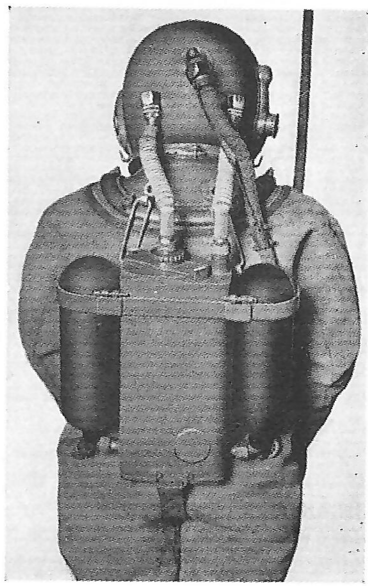


Fig. 156

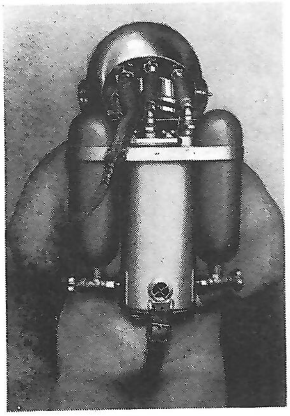


Fig. 157

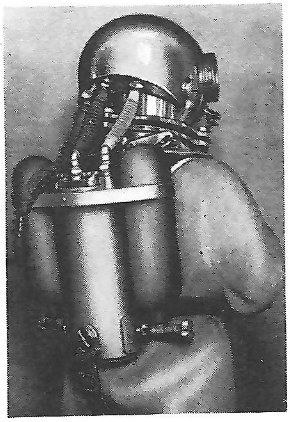


Fig. 158

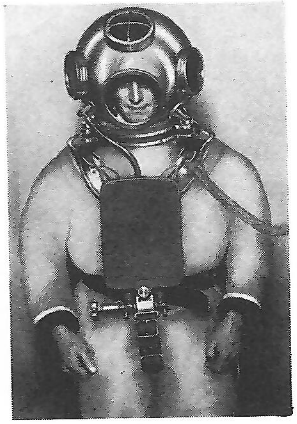


Fig. 159

THE "AMPHIBIAN" APPARATUS (MARK I)

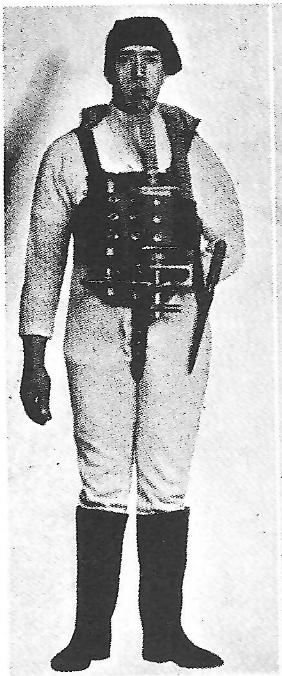


Fig. 160

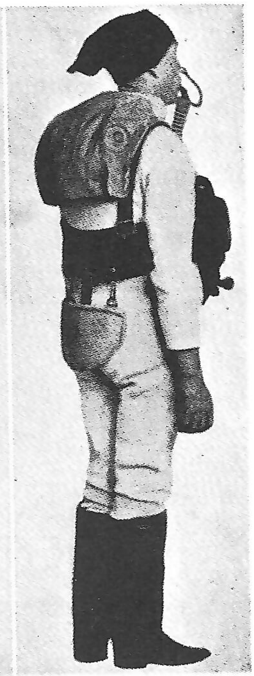


Fig. 161

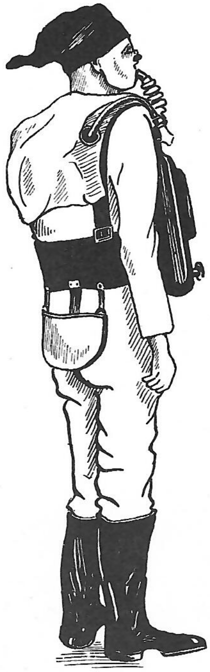


Fig. 162

This, the original "Amphibian" triple-purpose apparatus, i.e. for use in poison gas or under water, consists of a steel cylinder, charged with pure oxygen for depths not exceeding 30 feet; CO_2 absorbent chamber, mouthpiece, noseclip, goggles, a stream-lined breathing bag, with excess air escape valve; and—for use under water only—a lead balance-weight at back, jock strap, etc. For use at greater depths, a mixture of oxygen and air, or of oxygen and helium is used in certain proportions according to the depth at which the diver has to work. In some cases the gases are in separate cylinders, each with its own reducing valve set to deliver the gases in correct proportion.

In the modified "Amphibian" apparatus (Fig. 162), the excess air or exhaust valve is fitted in front of the wearer, over his shoulder, so as to be more readily accessible. While still of the automatic type, like the more remotely-placed valve (Fig. 161), the new arrangement also enables the valve to be controlled by hand.

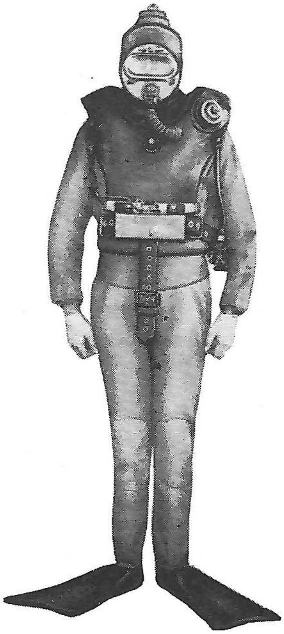


Fig. 163

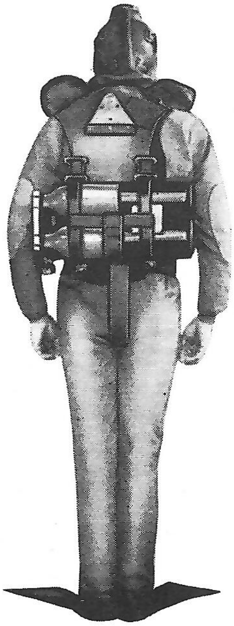


Fig. 164

Modified "Amphibian" Mark IV apparatus (see "Frogmen", Chapter 15) with twin cylinders on back, two-piece suit with hood, and "swim-fins"

THE "UNIVERSAL" BREATHING APPARATUS

Fig. 164a

The "Universal" is a variant of the "Amphibian" apparatus; it is on the same regenerative principle, and has the same triple-purpose uses. It is designed so that it may be adapted to the requirements of special operations, *e.g.* it may be used as an ordinary shallow-water apparatus with continuous oxygen supply, or for clearance diving or similar deeper work it may be altered to supply oxygen/nitrogen mixtures or, thirdly as a breathing apparatus for use in poisonous atmospheres. It consists of: (*a*) two oxygen cylinders joined together, as shown in Fig. 164a, one of them being fitted with a special neck extension on which the main supply control valve, automatic reducing valve, by-pass valve and supply tube to breathing circuit are fitted, with the object of ensuring the valve group being completely under the control of the diver, the whole arrangement as originally designed and patented by H. A. Fleuss and R. H. Davis; (*b*) water-tight breathing bag containing: (*c*) CO_2 absorption canister of the radial design, as shown in Fig. 164a, and as originally made by Siebe, Gorman & Co. Ltd., for diving apparatus known as the "Human Torpedo" type; (*d*) flexible rubber hood, and facepiece with full-vision window; (*e*) mouthpiece and nose-clip; (*f*) complete diving dress; (*g*) lead weights arranged for quick-release, partially or wholly, for buoyancy and ascent to surface; (*h*) suitable harness for carrying the apparatus.

There are many occasions when the owners of ships and yachts could be saved much time and expense if a simple and economical type of diving apparatus were carried. Minor underwater repairs and clearances could be carried out without the necessity for docking. The Siebe, Gorman & Co. self-contained compressed air apparatus here illustrated is well suited for these tasks and for many other classes of shallow water diving.

It is intended for diving to depths up to about 40 feet, but can be used at greater depths. It is not of the regenerative type using oxygen and CO_2 absorbent; it is on the open circuit principle in which the exhaled air is not re-breathed but is allowed to escape. The duration of the air supply is dependent, therefore, on the depth and the amount of energy expended by the diver, but the average may be taken as approximately 30 to 40 minutes at a depth of 40 feet. The diver then returns to the surface, where he can rest or make arrangements concerning the work in hand whilst his air cylinders are being replaced.

The Apparatus—Breathing Set (Figs. 165, 166 and 167). Twin cylinders of special steel, each of a capacity of 26 cubic feet of free air when charged to a pressure of 120 atmospheres = 1,800 lbs. per square inch. The high pressure air from the cylinders is led to a reducing valve, and thence the low pressure air to a demand valve.

Fig. 165

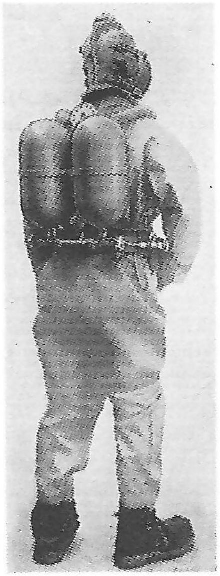


Fig. 166

Fig. 167

The action of the demand valve is controlled by the wearer's lungs, thereby ensuring that the amount of air passed is requisite for his needs and no more; economy in the use of air is thus effected. A by-pass is fitted by which the wearer can augment his demand under special circumstances. Separate shut-off valves are fitted, so that one cylinder only need be used for a task of short duration. A luminous dial pressure gauge, with shut-off valve, which enables the wearer to see the state of his air supply, is fitted to the set.

The apparatus weighs approximately 42 lbs. and is carried on the back in a comfortable position, leaving the arms and front of the body free. It has been used for entry into compartments only accessible through manholes of 28 inches in diameter.

Cylinders may be charged by ships' or shore compressors, if available, or from storage cylinders of 100 to 200 cubic feet capacity by a hand-operated Booster pump made by Siebe, Gorman & Co. Ltd.

Air filters are, of course, necessary to ensure the supply of pure, oil-free air to the diver.

This apparatus is sometimes used with a surface air supply from compressed air storage cylinders, the portable cylinders being held in reserve.

Diving Dress. Two types of dress may be used:

(a) The light two-piece shallow water diving suit, in the top half of which is incorporated a partial hood for the head and with which is used a face-mask with mouthpiece attached (Fig. 165); or

(b) The heavier one-piece shallow water diving suit which has a complete hood with mouthpiece attached (Figs. 166 and 167).

Boots and weights are used with both suits.

The choice of suit depends, to some extent, on the amount of work expected to be undertaken and the nature of the climate in which it is to be used. In hot climates the set can be used with an ordinary boiler suit, or bathing dress.

COUSTEAU-GAGNAN "AUTONOME" (LA SPIROTECHNIQUE) COMPRESSED AIR DIVING APPARATUS

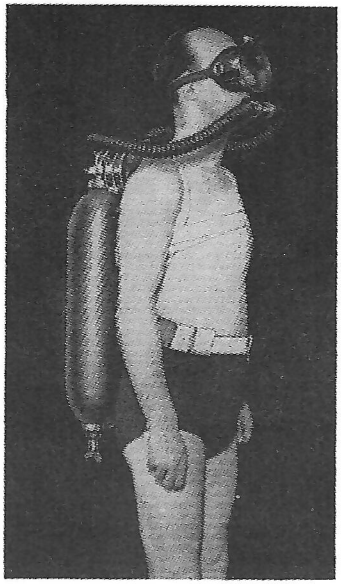


Fig. 168

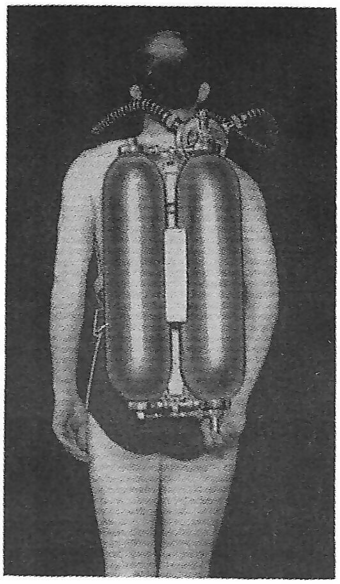


Fig. 169

This apparatus has one, two or three aluminium cylinders carried vertically on the back. Each cylinder has a capacity of approximately 35 cubic feet when charged to 200 atmospheres. Inhaling and exhaling breathing tubes connect a mouthpiece to the demand valve (two-stage) mounted at the top of the cylinder or cylinders. A dive-mask, covering eyes and nose is worn.

The apparatus has been popularized through the activities of the well-known French naval officer, Captain J. Y. Cousteau, author of that fascinating book, "The Silent World". It is manufactured in the United Kingdom by Siebe, Gorman & Co. Ltd., under licence, where it is known as the "Essgee" aqualung and is illustrated on the following page.

"ESSGEE" AQUALUNG COMPRESSED AIR DIVING APPARATUS

Sabrina fair
Listen where thou art sitting,
Under the glassie, cool, translucent wave,
In twisted braid of Lillies knitting,
The loose train of thy amber-dropping hair,
Listen for dear honour's sake
Goddess of the Silver Lake. *from Milton's "Comus"*

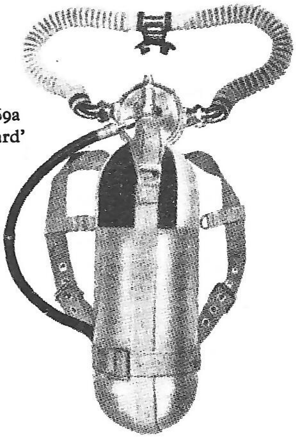


Fig. 169a 'Standard' Set

The "Essgee" Aqualung, with its self-contained air supply and automatic lung-governed breathing device, is becoming increasingly popular for under-water swimming, for observation of fish and other marine creatures in their natural habitat, marine plant life, etc.

Many of the scenes below, especially in the warmer waters of the world, are extremely fascinating, colourful and beautiful.

The under-water photographer now has at his command the Essgee "Cameraqua", a water-tight instrument with easily accessible controls, enabling him to take unique pictures of the submarine scene.

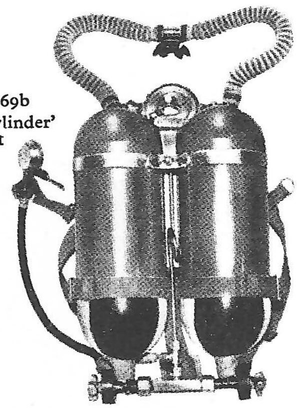


Fig. 169b 'Twin-cylinder' Set

For the sub-aqua enthusiast who desires more exciting sport, there are the submarine gun and spear for use against the larger and, in some cases, the more combative denizens of the deep.

Comparatively little training is necessary to use an aqualung, but beginners should start with experts in safe, shallow water. They are warned against using improvised, home-made apparatus.

The "Essgee" Aqualung, used with swim-fins, makes swimming exercise both easier and speedier, and with less fatigue; the many graceful, sinuous evolutions which can be performed by its users are very pleasing, both to onlookers and exponents alike.

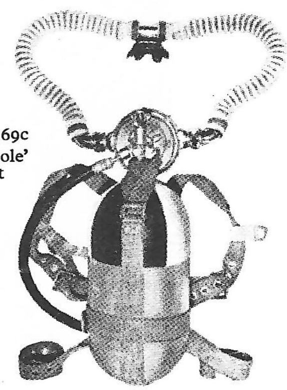


Fig. 169c 'Tadpole' Set

It also has its utilitarian uses; for example, minor repairs below the water-line of yachts and other small vessels, clearance of fouled propellers, thus saving the time and expense of docking, recovery of articles lost overboard, etc.

Cylinders should always be charged with compressed air and NOT oxygen, which is dangerous.

With air cylinders charged with air to 120 atmospheres = 1,800 lb. per square inch, the duration at surface and under water in minutes at different depths is approximately as follows:

Duration	"Tadpole" (26 cu. ft.)	"Standard" (40 cu. ft.)	"Twin-cylinder" (80 cu. ft.)
At surface:	30 min.	40–45 min.	90 min.
At depths:			
10–12 ft.	24 "	35 "	70 "
33 ft.	12 "	22 "	44 "
60 ft.	—	15 "	30 "
80 ft.	—	12 "	24 "
100 ft.	—	10 "	20 "

The main feature of any metal deep-diving armour is the design of its articulated parts, the aim of the designer being to devise jointed arms and legs which, while perfectly watertight at great depth, will also allow the diver freedom of movement when on the bottom. Many attempts have been made to attain these desiderata, but the majority have failed to achieve both at the same time. The Neufeldt and Kuhnke armour, illustrated in Fig. 171 on this page, is one of the best of its kind yet produced, but even with this the movements are very restricted and slow. This armour has actually been used for work at a depth of 400 feet=about 170 lbs. to the square inch. The joints are of a special ball and socket type, the friction being reduced as far as possible by interposing ball-bearings between the two halves; at the same time the joint is kept watertight by means of a thin and strong strip of rubber, so placed that the water pressure tends to squeeze it down on to the polished surface of the ball of the joint.

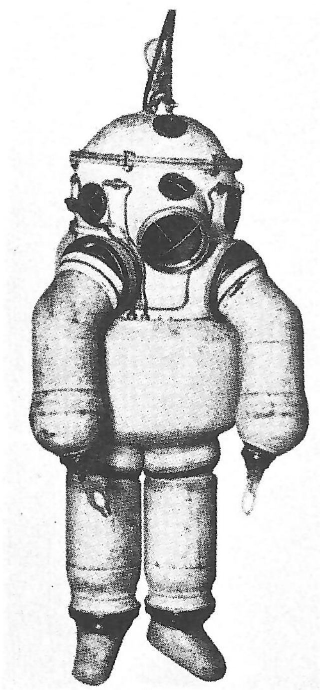


Fig. 171
Neufeldt and Kuhnke

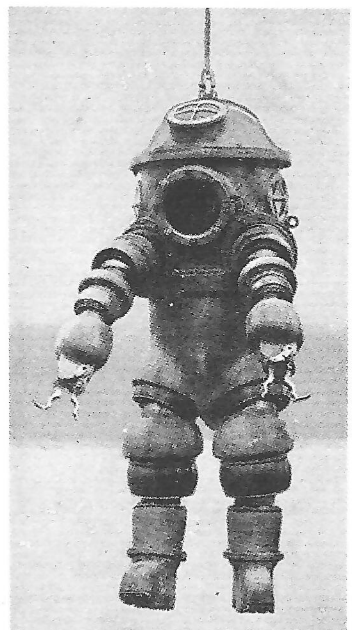


Fig. 172
Peress deep diving armour

In this dress, negative buoyancy is obtained by admitting water to a ballast tank surrounding the body, the water being expelled by means of compressed air when the diver wishes to ascend.

Another type of metal armour which has been satisfactorily tested is that designed by J. S. Peress (Fig. 172). This differs from the Neufeldt and Kuhnke mainly in the system of articulation adopted. The Peress joints are sealed with a liquid, i.e. they are so constructed that a certain quantity of liquid is trapped between the movable portion and the fixed portion, and effectively separates them. At no point, therefore, is there friction of metal against metal. The weight of the dress is about 800 lb. There is no buoyancy or trimming tank, as in the Neufeldt apparatus, but negative buoyancy is obtained by a weight, which is released when the diver wishes to ascend. Like the Neufeldt, the Peress armour has claws manipulated from inside; also telephonic apparatus and breathing apparatus of the Siebe, Gorman regenerative type.

The bulk of the articulated limbs in both types will be noted, their displacement being such as to give them positive buoyancy and thus to increase their mobility.

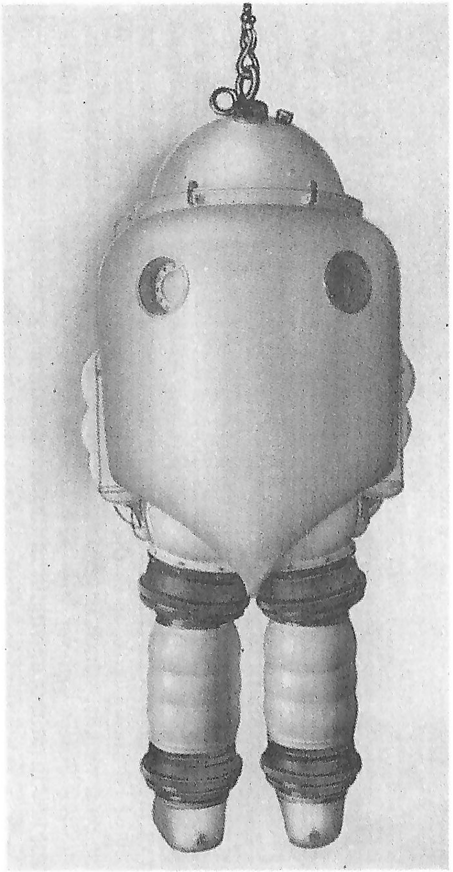


Fig. 174A

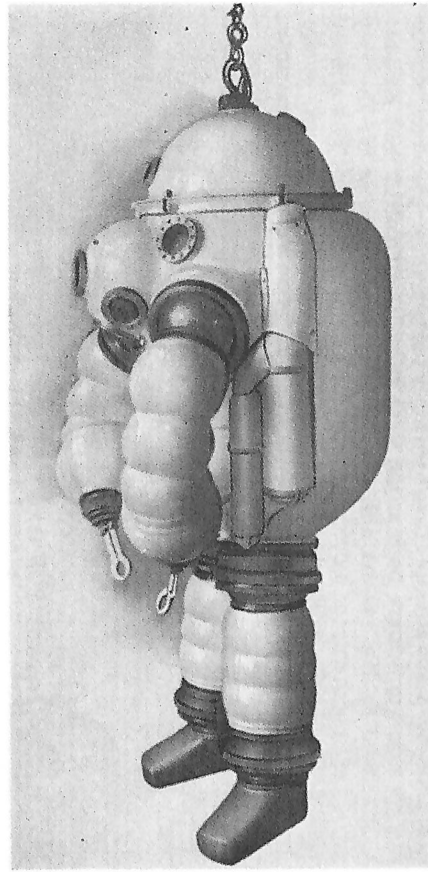


Fig. 174B

GALEAZZI DIVING ARMOUR

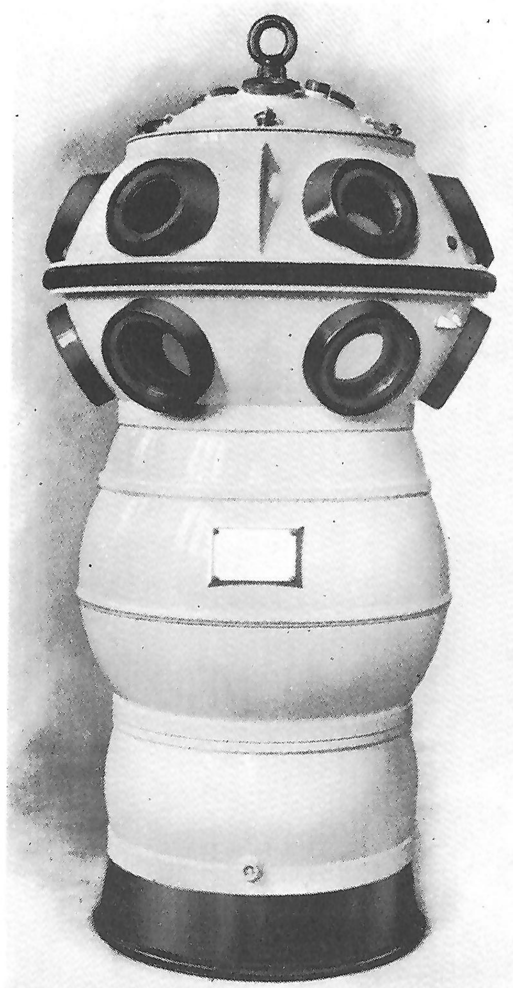


Fig. 174C

THE GALEAZZI METAL DIVING ARMOUR AND OBSERVATION CHAMBER

As already stated, the problem of producing a metal diving armour—called by divers "The Iron Man"—which will enable the occupant to move freely on the sea bed has not hitherto been satisfactorily solved.

The latest attempt to solve all the problems involved is the armour shown in Figs. 174a and 174b, which has been made from the designs of an Italian engineer, Signor Roberto Galeazzi. Hopes are entertained that this design will come nearer to the ideal in performance than its predecessors in the same class. The results of official trials are eagerly awaited.

It is claimed that the armour has been tested to a depth of 250 metres = 820 feet = 364 lbs. per square inch, and that the observation windows have withstood a pressure of 60 atmospheres = 882 lbs. per square inch = 1,980 feet sea depth.

Signor Galleazzi has also designed submersible observation chambers which have proved successful; his latest is shown in Fig. 174c.