ENGINE AND BOILER STEAM LAUNCH "FLIRT."

markable energy, making the air thick with spray, but with skillful steering and occasional "slowing," no water was shipped, and her owner was confident he could go anywhere in her.

Parties desiring further information may address "Paddiefast," No. 49 East 28th Street, New York city.

RAISING SUNKEN VESSELS.

*On a Practical Method of Raising Sunken Vessels.**

By LATIMER CLARK, C.E.

THE raising of sunken vessels has been at all times a question of great interest to the maritime world, and the loss of the *Vanguard*, has recently drawn an unusual amount of public attention to the subject. Having, in conjunction with my partner, Mr. John Standfield, given great consideration to the matter, we have ventured to bring our plans to the notice of the Institution of Naval Architects, in the hope that they may be deemed worthy of their examination, and that their merits or defects may be fully discussed.

The plans which have been proposed for effecting this object are very various, and while many of them are perfectly impracticable, others are marked by great ingenuity. It would be outside the scope of this paper to attempt any detailed mention of them, but there is one characteristic common to nearly all of them, viz., that with few exceptions they effect their object in a makeshift manner, the operations being performed piecemeal. They do not provide, as they ought, for the construction of some complete and powerful apparatus which can, with slight adjustments, be made applicable to vessels of all sizes, sunk in various positions and depth, but they are more usually of such a character that each case has to be specially considered and dealt with; it naturally follows that the apparatus designed to meet one set of conditions is not found suitable for others, and it is, we consider, chiefly from this cause that wreck-salvage as a business has never come into existence on a large and profit-

able scale; moreover, almost all the plans that have been adopted have been dependent on the aid of divers. These can only work in fine weather, and it is necessary that steamers and crews must wait in attendance on them, and remain idle while the operations are being carried out below, and the submarine attachments are being made, much time is wasted, and the cost of such operations becomes very serious and in many cases prohibitory. The depth to which divers can descend and work effectively is, moreover, very limited; and, where masts and rigging are in the way, the occupation becomes a most hazardous one, for which high pay is necessarily demanded; it is true that jointed diving dresses have been devised, with a view to take the pressure wholly or partially off the diver; but, apart from the stiffness of the joints and the difficulty of working effectively in such rigid dresses, the principle of the well-known Bourdon's pressure-gauge must inevitably come into play, and the body or limbs once bent could only be straightened again by great muscular effort, and at considerable depths, not at all.

Very generally, too, the plans proposed involve the passage of chains and ropes beneath the vessel, or the attachment of chains to hawse-holes, masts, and rigging, etc., an operation of much difficulty; and there is also great difficulty in such cases in equalizing the strain on several attachments. Lastly, when air bags are employed, the tendency of the air to expand as the vessel lifts causes it to come to the surface with inconvenient rapidity and dangerous force.

Mr. Standfield and I, having studied the subject *de novo*, have long since arrived at the conclusion that ship-raising should be carried out on a large scale by a single machine capable of raising ships of all sizes, and that it should be large enough and powerful enough to grasp the vessel bodily from the outside without the intervention of ropes or chains, and without the assistance of divers. The idea of thus dealing with a vessel is not new, and it had in fact been previously described by Mr. Joseph Thomas Parlour in 1871, who has recently shown us his plans, which he has however hitherto had no opportunity of putting into practice.

It will be seen from the model exhibited and from the diagrams that the apparatus we employ to carry out our ideas is practically a submarine dock, somewhat resembling an ordinary floating dock inverted. It is sufficiently large to be submerged over the vessel intended to be raised and entirely to cover it. The breadth inside must therefore be greater than that of the vessel, but the length may be either greater or less, according to circumstances.

The two sides of the dock are each constructed in one continuous length and form two hollow box girders; their cross section is triangular as shown at *a a* in the diagrams, the apex being downwards and forming a knife-edge intended to rest at the bottom—the two sides are connected together at the top by a number of transverse box girders *b b* placed at suitable distances apart, adjusted according to the position of the masts or other obstructions on the deck of the vessel. These girders are very firmly attached to the sides by numerous and powerful bolts, allowing them to be shifted laterally, and also allowing the sides of the dock to be placed nearer together or further apart, according to the breadth of the vessel to be lifted—these adjustments are of course effected in harbor before proceeding to the scene of operations.

At the four corners of the dock rise four cylindrical columns of large diameter (say 20 ft. more or less), the tops of which are always considerably above water, even when the dock is submerged over a sunken vessel. These columns rise from the transverse girders at the ends of the dock, which are made of suitable breadth to accommodate them; and they are braced together in pairs and connected by a bridge.

They contain the engines, pumps, and machinery, and to give them greater strength they are, up to a certain height, made double, that is to say, they consist of two concentric cylinders, the space between being divided into cellular compartments.

The whole structure is built of hollow riveted ironwork, and when empty is extremely buoyant, the sides alone being more than sufficient to float the whole. When it is desired to submerge the dock over a vessel, water is admitted first into the sides of the dock and subsequently into some of the transverse girders, and if necessary into the vertical cylinders; the dock is thus allowed to sink gradually in the water until only the four vertical columns remain above the surface—the operation is further continued until the dock is sunk over the vessel, either resting upon its deck, or the knife edges of the sides resting upon the ground—as shown in Fig. 3. Assuming for the moment that the vessel is upright and free from any accumulation of sand, it becomes necessary to grip the vessel. This is effected in the following manner: A number of grappels or curved iron clutches, fitting approximately to the sides of the vessel, are hinged at the top to the sides of the dock along its whole length. They are each 10 ft. or 12 ft. broad, constructed of hollow wrought iron plate, and are of great strength; during the submergence they lie back close against the sides of the dock. Each of these clutches can be thrown forward at pleasure, by the inflation of a large air bag secured to its back and resting behind it against the side of the dock. A single pair of these clutches, situated near the middle of the vessel, is first thrown forward and caused to grip the vessel; a second pair is then similarly brought into bearing, and the remaining pairs in succession; each pair of clutches, as the latter take their grip, is held in position by ratchets and pawls behind in such a manner that the clutches cannot be forced back again; this is to give them additional support when the strain of lifting comes upon them; it will be observed that the curve given to the clutch gives it a secure bearing beneath the bilges of the vessel; at the stem and stern air bags without clutches press up beneath the vessel and afford an additional support; in this condition of things it is evident that the dock and the vessel are firmly united, so as to form practically one structure, and the buoyancy of the bags alone will in many cases be sufficient to cause the whole structure to begin to rise; should they not do so, water is forced out of the cross girders, and if necessary out of the hollow sides, until the vessel rises; as soon as it begins to float it would come entirely to the surface were it not that the four large cylinders as they emerge from the water reduce the buoyancy and so prevent the dock from rising too suddenly.

As the bags approach the surface the external pressure of the water upon them is diminished and their internal pressure is increased; in order to relieve this they are provided with the usual pressure valves, opening outwards and adjusted by springs to such a pressure as is deemed best for gripping the vessel; this pressure can never be exceeded, as the surplus air escapes through the valves into the sides of the dock, or, if its buoyancy is not wanted, into the open water.

The engines and air pumps are of very great power, so as to perform their functions rapidly, and are four in number, situated one in each of the four corner cylinders, and pipes lead from them through the sides to every compartment of the dock; each is of course provided with a pressure indicator, as the pressures are sometimes excessive, amounting in some cases to 70 lbs. or 80 lbs. on the square inch; the pumps are duplicated and so arranged that they can either both work in conjunction or can each work separately under half pressure—that is to say, one can pump into a pressure chamber at 35 lbs. or 40 lbs. pressure, and the other work out of this chamber at full pressure; even in ordinary use a large space is devoted to air chambers, in which a store of air is accumulated under pressure ready for immediate use, so that the grippers, for example, can be closed at a moment's notice.

We will now suppose that instead of the vessel lying in clear water it has sunk into the sand or mud, or become surrounded with sand; on lowering the dock the knife-shaped edges of the sides will rest on the sand in some uneven position, too high to permit of the vessel being properly gripped; in order to afford means for removing this sand the bottom edge of the sides is divided into compartments, and each compartment has a number of holes close to the lower edge; the compartments being full of water, a large reservoir of compressed air is suddenly turned upon the water, which drives it out of the apertures with great violence, stirring up the sand and washing it away, and allowing the dock to settle down to a lower level until it either rests on the bottom or bears on the deck of the vessel, as shown in Figs. 1, 2, 3, and 4. The center pair of clutches is now caused to grip the vessel, as shown in Fig. 3, the sand being driven out before them by a rush of water as just described; a second pair is then caused to grip in the same way, and so on till the whole are secured—the clutches themselves, which are of hollow boiler plate work, have also orifices at their points through which powerful jets of water are forced in order to clear their way through the sand, or if preferred they may be used as sand pumps, water and sand being sucked in in front and discharged behind.

When the vessel does not lie on an even keel the dock has

* Paper read before the Institution of Naval Architects.

to be lowered in a slanting position, Fig. 1, by admitting water at one side and not at the other—when passed over the hull of the vessel she has clutched temporarily, and by giving buoyancy to one side only, she is first brought to an even keel and either raised to the surface or gripped a second time in her upright position. The vessel when raised is floated away to a tidal harbor and repaired or broken up. In the case of a vessel with a hole in her sides or bows, such as that in the Vanguard, an attempt would of course be made to fit an air bag directly over the aperture, and as the dock would be furnished with powerful pumps water might be pumped out of her compartments while she was being towed to port.

afloat, any adjustment of width and position may be effected.

I have thus described as briefly as possible the construction of the dock, and will only add in conclusion that owing to its peculiar form its stability is so great that if forced down purposely on to its beam ends it would right itself instantly, and with great power. If sunk over a vessel only the four cylinders would be above water, and from their small area and great strength they would withstand the heaviest storms without danger or injury. In raising a vessel no divers are required and no chains or attachments have to be made; she is supported under the bow and stern as well as under the bilges, the points where the weight of

equally marvelous that the bearings should have been allowed to get into such a condition. It would be interesting to know when the screw of the Thetis was last lifted, and who was responsible for the state of affairs shown by our engravings. We may add that another photograph in our possession shows that the worm employed for turning the engines by hand had been subjected to extremely severe wear, the engines requiring, we understand, enormous power to move at all, a fact which ought to have drawn attention to something being amiss. Altogether, so far as the information at present available enables us to form an opinion, the failure of H. M. S. Thetis is the reverse of creditable to all concerned.—*Engineering.*

CLARK & STANDFIELD'S IMPROVED METHOD OF RAISING SUNKEN VESSELS.

We may now consider the degree of pressure required on the bags to give an effective grip. A vessel drawing 20 ft. of water has, when afloat, an upward pressure of about 10 lbs. per square inch over her whole bottom surface. Disregarding her loss of weight when in water, and assuming that the air bags bear against over one-half her bottom area and support the whole weight, we should require a pressure upon them of about 20 lbs. per square inch to raise her; but this assumes that the powerful framed iron grippers support no portion of her weight, whereas they are strong enough to support the vessel without assistance; the weight is therefore borne partly by the grippers and partly by the upward pressure of the air bags. The bags are made of several layers of stout canvas and vulcanized india-rubber and are easily able to withstand a pressure of 30 lbs. or 40 lbs. per square inch, or if inclosed in netting a much higher pressure. They are protected from injury by stout matting or thick rope netting.

The sides of the dock contain a passage running along their whole length, provided with stout glass eyes at inter-

her cargo chiefly rests, and where she is best fitted to withstand the strain, the lift in fact takes place along the whole of her length from stem to stern. The operation under favorable circumstances may be effected in a single tide, and the apparatus ought in average weather to raise at least two ships every week. It is obvious that the depth at which the Vanguard is sunk offers no practical difficulty in the application of the apparatus described; on the contrary, such an apparatus could very well raise vessels sunk at twice that depth. The operation of lifting such a vessel as the Vanguard would probably repay the entire cost, and the salvage value of the property recoverable around the shores of the United Kingdom alone would doubtless be sufficient each year to recoup the value many times over.—*Engineering.*

PROPELLER AND PROPELLER SHAFT OF THE "THETIS."

H. M. S. THETIS was recently disabled whilst in the Mediterranean by the failure of her screw, and had to be

PUMP PROPULSION.

A SMALL steamer, called the Alpha, built in Baltimore, and propelled by pumps, lately arrived in New York. The boat is 43 feet long and $7\frac{1}{2}$ tons burden. Amidships is a boiler, and in the place of an engine a No. 7 Knowles pump. The steam furnishes the motive power of the pump, and the pump, it is said, moves the boat through the water at the rate of eight knots per hour. But we presume the velocity here stated is an exaggeration. The water to supply the pump is drawn from the stream in which the boat moves, unless an accident to the hull should occur, when the motive power of the vessel would be drawn from the leaking hold. Four copper pipes, $2\frac{1}{2}$ inches in diameter, are connected with the pump. The ends of these pipes terminate in heavy brass nozzles five-eighths of an inch across, two opening flush with the stern of the boat four feet below the water-line on either side of the rudder. The other two nozzles open flush with the stem, one each side, about a foot above the keel. With sixty pounds of steam in the boiler the pump makes 180 revolutions per minute, each revolution sending a stream of water forcibly through either the stem or stern nozzles. To go ahead, the water is driven through the stern nozzles, and *vice versa* and so the boat is pushed on.

CORROSION OF PROPELLERS.

A CURIOUS fact respecting the corrosion of the cast-iron propeller blades of all transatlantic steamers was recently illustrated by the exhibition of a screw blade before the Franklin Institute. The "following" side of the blade was much corroded, but the thrust side not at all. The surface at one part was very deeply pitted, but a line of about an inch and a half from the outer edge was not at all corroded. A circular hole made through the upper center for convenience in shifting, and through which, of course, the water passes, is not corroded in its interior; but the surface of the blade adjacent to this hole, under the line of the cur-

PROPELLER AND PROPELLER SHAFT BEARINGS OF H. M. S. THETIS.

vals, so that the operator, provided with a powerful light held against one of them and looking through the other, can descend and examine any obstructions or see the position of the ship in respect to the dock, and so regulate its descent. By means of these passages one is enabled to get from column to column, and in fact all around the dock without coming to the surface.

In order to adjust the distance asunder of the sides and the position of the top girders, the whole dock is floated on to a framework in harbor, of such a height that the girders rest on the frame at the same time as the sides of the dock rest on the bottom; by unfastening the ends of the girders at opposite sides alternately, and keeping the sides nearly

towed into Malta to be there docked and overhauled. One of our engravings has been prepared from a photograph of the stern of the Thetis taken soon after she was docked at Malta, while the other views have been engraved from photographs of the shaft bearings, etc., taken after their removal from the vessel.

It will be seen from our illustrations that the Thetis was fitted with a lifting screw and that the outer bearing had been allowed to wear completely through, the outer end of the shaft then falling, and the propeller being only prevented from going to the bottom by catching at the stern post. Looking at the photograph, it appears marvelous that the propeller should not have been completely lost, while it is

rent which issues from the hole, is pitted. Also the blades of all the propellers of all transatlantic vessels laid up at the yards of the Messrs. Cramp are, says the *Polytechnic Review*, similarly corroded. The thrust side is never corroded; nor are the blades of coastwise steamers so affected.

THE owners of the Great Eastern are, it is said considering the propriety of converting their vessel into a huge refrigerating chamber for the conveyance of American meat. The trade in meat, which is being developed not only with the United States, but also with Brazil, promises to open a wide field of usefulness—a trade which will generally provide the great vessel with a full load.