Correspondence.

Mr. EDWARD BOX remarked that, having received his early training in the works and drawing-office of Messrs. Clark and Standfield, under the late Mr. John Standfield, and having acted at a later period as consulting engineer in connection with the design of floating docks, he was much interested in Dr. Salmon's Paper. It appeared that Southampton had become recognized for the time being as the most convenient home port for the fast liners trading between Europe and America, and had suddenly required a larger dry dock. The matter being urgent, a floating dock of a design such as would lend itself to quick construction was the solution of the problem. Moreover, the company would be in possession of a dry dock which could be readily moved to another port, should any unseen developments require it, and that seemed to be a distinct advantage possessed only by the floating dock. Dealing with this particular design of self-docking floating dock, Dr. Salmon stated (p. 211) that the dock was similar in structure and of equal strength to the ordinary box, or non-self-docking, dock, which appeared to be a somewhat questionable statement. Mr. Box was familiar with the particular bolted form of joint which Dr. Salmon's firm had adopted in many of the floating docks of their design, and had known such a joint to be overstrained, which led to the joint being butt-covered and permanently riveted up. Such a joint should be removed as far from the centre or point of maximum bending-moment as possible, and should not fall within the centre half of the dock—a condition which would, of course, render this particular sectional form of dock non-self-docking. Dr. Salmon's statement that a dock, having only a flange-bolted joint as the bottom connection, retained the strength of an ordinary box dock, seemed to suggest that a girder completely divided, having its lower or tension member flange-bolted, and with its web-plate partially covered, was as strong as a similar girder entirely web-covered, and having its lower or tension flange double covered. The only reason why the lower joints in the dock were not on the double-covered principle appeared to be because it was practically impossible to adopt such a method, which had to stop at lowest draught-line. If Dr. Salmon maintained that the bolted Mr Box.

Mr. Box joint in combination borrowed, as it were, sufficient strength from the web-covers, considered as a beam, and in combination the joint was strong enough to take the stress which should, under normal conditions, come upon it, due to the efficient control provided for in connection with the pumping arrangements, that would seem to be a feasible contention, but it was not quite the same thing. Whatever calculation might be made to show that a dock, in combination with its vessel, was strong enough to withstand undue longitudinal deflection, it had to be remembered that a dry dock required to be strong enough, and of capacity enough, to overcome undue deflection when a vessel was undergoing extensive repairs, perhaps with a portion of its bottom plating removed, or similar conditions, due, say, to collision, when side plates and frames were being renewed, when one side of the vessel would be opened out, and for the moment her longitudinal rigidity as a girder would be destroyed. In such a case the dock had to be capable of supplying the necessary strength and control against undue deflection. In that respect the extra lifting-capacity beyond normal requirements, embodied in the design of the Southampton dock, was a wise and necessary precaution. He would like to know whether the joint-chambers, which did not appear to be furnished with a branch pipe, were pumped out with the lifting of the dock, or whether they were allowed to flood at will, their lifting-power being consequently omitted. The method adopted of central control—a distinct advancement—was of paramount importance. It would be impracticable to try to control such a dock otherwise than centrally, but, however perfect the system of control might be, a reliable means for ascertaining that everything was in order was equally necessary. The anxiety of the designers to ensure that no undue stress should come upon the dock seemed a wise precaution, especially with that particular design of dock, and it was difficult to imagine that, with ordinary precaution, any undue straining should take place with a dock so well protected in that respect. It would be interesting to know what weight was allowed for in the loading on the cross girders. Was the maximum weight on a cross girder taken as equal to its portion of the total displacement of the pontoon or floor of the dock, any unevenness of loading allowed as being distributed by the longitudinal pontoon or floor girders? Was the maximum weight taken as entirely on the keel, or proportionately on the keel and bilge-blocks, and were the bilge-blocks required to be placed in position before the vessel was lifted out of the water? Also, was the entire breadth of the top and bottom plating between the cross girders of the pontoon or floor of the dock taken in the sectional area allowed for calculating the resistance to the bending-moment in the cross girders, as 7 tons per square inch would seem rather much to allow as a safe load over the entire width of plate? The weight of paint and compositions seemed to be omitted from the weight allowed for. It would be interesting to know the total weight of the several compositions. It seemed unfortunate that the site should have been so costly, otherwise the total cost of the dock would have shown to very great advantage. The cost of the dock itself seemed to be exceptionally reasonable. Mr. Box.

Mr. R. C. Bristow remarked that it was a matter of great importance to engineers to have definite data as to the comparative capital and maintenance costs of floating docks and shore docks. He would be glad if Dr. Salmon could give some idea of cost under the following heads: Mr. Bristow.

(*a*) Total cost of machinery.
(*b*) Estimated cost of maintenance per annum, for the dock and auxiliary shore works, and the machinery, respectively.

Sir E. H. Tennyson d'Eyncourt remarked that the Papers were valuable additions to the literature on docks, and that they showed to what perfection the floating dock had now been brought, very largely by the work of Messrs. Clark and Standfield on the designs. The success of this very large dock had been absolutely shown by the results of the dockings which had taken place since the dock was completed at Southampton; and a remarkable feature appeared to him to be that for the small cost of a little over £400,000 a dock had been constructed which could lift the heaviest ship in existence. Owing to the excellence of the design, the cost of the dock worked out at less than £7 per ton of lift. He considered that was a wonderful achievement in these days of very high costs of production, and also in comparison with the cost of former docks, made when construction was much cheaper, which came out at about £10 per ton of lift. Regarding the part his own firm had played in the construction, the most interesting feature was, he thought, the extreme accuracy with which the work had had to be done in connection with the joining of the various sections. Very special measures had had to be taken to attain that accuracy, but the results had been satisfactory, as practically no difficulties were experienced when it came to the joining-up, an operation which had to be done with the sections afloat. He was grateful to the Authors for bringing knowledge of floating docks right up to date by the presentation of the Papers, which contained information on the greatest floating dock in existence. Sir Tennyson d'Eyncourt.

Mr. Du-Plat-Taylor.

Mr. F. M. DU-PLAT-TAYLOR considered that the following figures might be of interest in connection with the question of the cost of pumping :—

(1) Southampton Floating Dock, 960 feet long by 130 feet wide by 38 feet deep over the keel-blocks at maximum immersion.

Lifting dock light for setting blocks, etc., 1,374 I.HP.-hours. Lifting dock plus S.S. "Olympic," 3,888 I.HP.-hours. Cycle for S.S. "Olympic," 5,262 I.HP.-hours.

(2) King George V Dock, London, Dry Dock, 750 feet long by 100 feet wide by 35 feet deep over the blocks. A smaller dock, but also having electrically-driven pumps.

Pumping out dock to set blocks, from impounded level, 2,460 I.HP.-hours. Pumping out dock when containing a ship of three-quarters of the content of the dock, 615 I.HP.-hours. Cycle, 3,075 I.HP.-hours.

(3) Canada Dry Dock, Liverpool, 925 feet long by 94 feet wide at entrance by 34 feet deep over the blocks. This dock would take the S.S. "Olympic." It was provided with steam-driven pumps.

Pumping out dock (at H.W.S.T.) to set blocks, etc., 2,250 I.HP.-hours. Pumping out dock with S.S. "Olympic," 675 I.HP.-hours. Cycle, 2,925 I.HP.-hours.

These figures showed, he thought, that, in cost of pumping, the advantage lay with the dry or graving dock.

Dr. Salmon stated that bitumastic enamel was used for coating the drowned parts of the exterior, and "Admiralty mixture" was employed above. The repainting of floating docks must always be a source of serious expense, and in his experience some form of enamel was necessary on such structures, as bituminous solution or paint alone was not satisfactory. The practice at Southampton of using the ships' winches for berthing seemed to be admirable, and it had always seemed to him that the right station for the dockmaster or other official in charge of the berthing of a ship was on the ship's bridge, where he could see the whole of the vessel, not on the quay, where he could only see one side of the ship, and had to depend upon the reports of subordinates as to what was going on on the other side. Shore capstans should really be unnecessary in a dry dock, except for berthing damaged vessels or vessels which had no steam at the time. One of the chief advantages of floating docks was in the berthing of damaged vessels, because the dock could be canted to the same inclination as a damaged vessel with a heavy list, which could then be brought into a vertical position when the dock was lifted. The docking of a damaged vessel in a graving-dock was a matter of great difficulty, often attended with serious risk, special blocks and shores having to be provided, in most cases at considerable expense. Mr. Du-Plat-Taylor.

He was surprised that a 2-ton crane plumbing the centre of the dock was sufficient for requirements. In the Port of London a 5-ton crane plumbing the centre of the dock had been found necessary for lifting propeller-blades and similar work, and a 25-ton crane, also plumbing the centre of the dock, for lifting turbine-casings, boilers, etc. It did not appear that the 150-ton floating crane would plumb the centre of the floating dock except at the ends, if the clear overhang of 65 feet mentioned was from the outside of the pontoon.

With regard to Mr. Wentworth-Sheilds's Paper, it would be interesting to know what had been the difference in the rate of driving between the piles assisted by a water-jet and those not so assisted. To avoid the divergence of piles with water-jets, the jets should be brought out 4 feet above the point of the pile, and pointing upwards, so as to relieve the frictional resistance above that point while allowing the pile to keep on its correct course by the direct driving effect upon the first 4 feet above the point. The question of the silting of the basin in which the floating dock was situated was interesting, and it appeared that it would be difficult to take any reliable soundings by the aid of divers. The pumping or plunger effect of the rising and falling of the dock would, he thought, be found to be negligible, for the action was too slow to make any impression on the accumulation of mud. If, however, the pumps were so designed as to deliver the water under the bottom of the dock, they might be employed to assist in eroding the mud, particularly in the early stages of pumping out, when the bottom of the dock was not far above the bottom of the river.

Mr. R. F. HINDMARSH remarked that the position for the dock was stated to have been chosen both because it was near the berth used by large steamers and because it was there possible by means of bridges to connect the dock with the existing quays of the Southern Railway Company. The first reason did not appear to be of such importance as the second reason, as presumably tugs would have to be used for moving large vessels to the dock, and a short additional distance would have made very little difference. It would be of interest if Mr. Wentworth-Sheilds would state the estimated rate of silting in the dock-berth. The 32,000-ton floating dock berthed in the Tyne in 1915, in a position in the main run of the stream, both ebb and flood, remained in its berth about 9 years, and the amount of silting was almost negligible, although the depth of the berth was 70 feet at H.W.O.S.T., and the adjoining channel of the river was 45 feet deep at H.W.O.S.T. A large mooring-tier with four buoys Mr. Hindmarsh.

Mr. Hindmarsh. was provided immediately eastward, and in the same line as the dock, for vessels waiting to go on to the dock, and it was also intended to use that tier for mooring the dock if it had to be moved out of its position in order to enable the berth to be re-dredged. The material around the berth consisted principally of sand and clay; the slopes were dredged to 6 to 1, and remained permanent. The slopes of 3 to 1 around the dock at Southampton appeared to be rather steep, and it would be interesting to know whether there had been any slipping of the slopes into the berth. Fifteen months for dredging the berth appeared to be a long time, but perhaps there had been special circumstances which had rendered it unnecessary to have the berth dredged in a shorter time. At Jarrow, at the site of the 32,000-ton floating dock on the Tyne, 1,250,000 hopper tons were dredged out of the berth in a little more than 3 months. It would be of interest to know whether consideration had been given to mooring the Southampton dock entirely by means of chains and anchors, instead of by the method chosen, as it would appear that with the dock more or less rigidly moored on the beam to dolphins, damage was more likely to occur when docking vessels than if the dock were moored by chains, which admitted of a certain amount of movement.

Capt. Munro. Captain D. J. MUNRO, R.N., remarked that the installation of the dock had evidently been accomplished with great credit to all concerned. The mooring-system seemed to be very suitable, taking everything into consideration. The system on which a floating dock was moored in any position depended upon that position. During the war he had to moor floating docks in the middle of a harbour, and, of course, the whole security of the dock depended upon the holding-ground, anchors, and cables. Such an arrangement necessitated a regular system of moorings and the service of men expert in carrying out the work. In fact, every site had to be considered on its merits, and no hard-and-fast rule could be laid down. There was no reason why a floating dock should not be moored in any harbour, irrespective of winds and tides, provided the water was not too deep and the holding-ground was reasonable.

Dr Salmon. Dr. SALMON, in reply, observed that Mr. Box, in his criticism of the statement that the sectional box type of floating dock was equally as strong as the box or non-self-docking type, apparently had not allowed for some important considerations which rendered his parallel case of a divided girder not quite applicable. It must be remembered that the top flange of the dock girder in Southampton had a width of only 30 feet, whereas the bottom flange had a width of 170 feet, whence it resulted that the area of the bottom flange was much greater than that of the top flange, even although the

Dr. Salmon.

latter was doubled, and quadruple riveted. It was, therefore, quite unnecessary to make riveted or bolted joints of very high efficiency in the bottom plating, and it was not difficult to make the bolted joint used in Southampton of equal strength to the riveted joints used in the ordinary box type, and elsewhere in the Southampton type. In other words, the area of the top deck determined the longitudinal strength of the dock, and not the efficiency of the joints in the bottom plating. The longitudinal strength of each type could, therefore, be made the same. The joint-chambers were pumped with the next adjacent compartment, and not allowed to flood at will. The maximum weight on a cross girder was that due to the weight of a short ship on the keel-blocks, which was assumed to be carried entirely on the keel-blocks without relief from the bilge-blocks. The excess load on the keel-blocks over and above the local lifting-power of the pontoon was distributed by the longitudinal girders, of which the two side walls were far and away the most important.

In estimating the weight of the dock, the gross weight of the plates was taken, and the saving in weight due to holes, etc., was assumed to be equivalent to the weight of the paint and composition.

In reply to Mr. Bristow, the scheduled cost of the machinery proper was £48,700. No figures were available for the cost of maintenance of the machinery as a separate item, but the total cost of maintenance of the whole, including hull, shore-work, and machinery was, as stated on p. 270, in the neighbourhood of 1 to 1½ per cent. of the first cost, per annum.

He desired to thank Sir Eustace Tennyson d'Eyncourt for his kind remarks on the work of his firm, Messrs. Clark and Standfield. In view of the higher costs of present-day production, the cost of the dock was certainly very low. Messrs. Sir W. G. Armstrong, Whitworth and Co., Ltd., were to be congratulated on the accuracy of their workmanship, and the very satisfactory way in which the sections had come together.

He considered that Mr. Du-Plat-Taylor's figures were not a true comparison. The two graving-docks mentioned were very much smaller than the Southampton dock. For example, the total water contained in the King George V dock was approximately 88,000 tons, and in the Canada dock 92,200 tons, whereas, as stated in the discussion (p. 271), the cubic contents of a dock similar to the Esquimalt graving-dock, which was of practically the same internal dimensions as the Southampton floating dock, was 162,800 tons, or nearly twice as great. Further, to render the comparison fair, the I.HP.-hours of the leakage pumps should be added to the graving-

Dr. Salmon. dock figures. In a floating dock there was no leakage pump. It might be added that S.S. "Olympic," with her beam of 92 feet, was a tight fit in the Canada dock, and therefore an exceptional case.

The "Admiralty mixture" was used on the decks only. The interior was coated with bituminous enamel right up to the top deck. The cost of repainting was included in the maintenance figures already given. The floating crane would lift 40 tons with a clear overhang of 90 feet, so that it could easily plumb the centre of the dock.

Mr. Went-worth-Sheilds. Mr. WENTWORTH-SHEILDS, in reply, stated that piles driven with a water-jet had gone down easier and rather farther than those driven without a jet; but he could not give exact figures. As regarded silting, it was found to be taking place as was expected, and no doubt the site would have to be dredged out at intervals of a few years. He did not think that the mud at Southampton could be dispersed by water-jets, as it was of a very clayey nature, and such jets merely bored holes in it. The 3-to-1 slopes around the site had stood well, and no slipping had occurred. The dredging had not been specially hurried, as the building of the dock had been delayed by the boilermakers' strike. The question of mooring by chains alone had been considered, but abandoned, as it would have complicated the design of the approach bridges, which were very important accessories.