INSTITUTION OF NAVAL ARCHITECTS.

THE annual meetings of the Institution opened at the Society of Arts on Wednesday. There was a very full attendance. After the usual routine business had been transacted, the Chairman—the Right. Hon. Sir John Dalrymple-Hay, Bart., K.C.B., D.C.L., F.R.S., Vice-President—delivered the opening address. After referring to the absence of Lord Brassey in India, and congratulating his hearers on the position of the Institution, he went on:—Let me now express the deep regret which we all feel for those of our colleagues who have died since our last meeting in this hall. In the last volume of our "Transactions" interesting notices are published of the excellent colleagues whom we lost in Vice-Amiral Paris, who died on April 8th; of Rear-Admiral Long, who died on April 24th; of Mr. E. A. Cowper, who died on May 9th; and of Mr. Henry Laird, who died on May 26th. I trust I may be permitted to add a few words to express the esteem in which they were held by all who had the honour of their acquaintance. Vice-Amiral Paris had been our Associate since 1862, and had taken great interest in our proceedings. Six papers by him are recorded in our "Transactions," and all full of varied information. This able and courteous French seaman joined that navy in 1822. He had three times circumnavigated the globe. He served in the Crimean War, and was one of the captains of the three French armour-clads which assisted in the capture of Kinburn, the first occasion on which armour-clad ships took part in a naval engagement. He early studied the use of the marine steam engine, having become a pupil of Mr. William Fawcett for that purpose. He was at the head of the French Hydrographic Office for several years, and had in 1863 the honour to be elected a member of the French Institute, and of the Bureau des Longitudes. Later he was Conservator of the Museum at the Louvre. He was a copious author on professional subjects. He and his son, Lieutenant Paris, were collaborateurs in many scientific inquiries, and I may be permitted to observe that our colleague, Mr. White, in his "Manual of Naval Architecture"—Notes on Deep Sea Waves, pp. 189, 193, 209—says:—"Of French observers, the most laborious and distinguished is Lieutenant Paris, whose able memoir on Rolling—*Revue Maritime*, vol. xxxi. — is highly commended." Alas! he was cut off in his prime, and left his distinguished father to mourn his loss. It is sad to think that the father's last days were clouded over by the death of his distinguished son, and that Lieutenant Paris's future services are lost to the great French navy, of which both were such distinguished ornaments. You will remember that on March 22nd last year our opening paper was read by Rear-Admiral Long. His intelligence and the great interest he took in our proceedings recommended him for the Council, to which you elected him at that meeting. On April 25th he died of a fall from his horse, and his early death deprived the Navy and the country of a young admiral of whom there were the highest expectations. He was followed on May 9th by Mr. E. A. Cowper, an early member of our Institution. His scientific knowledge was of great advantage in our discussions. He was an early advocate of the compound engine, and an inventor of many useful improvements of the marine steam engine. He had filled the office of President of the Institution of Mechanical Engineers in 1881-82, and was a founder of the Iron and Steel Institute. On May 26th we lost a friend and colleague whose name is known wherever British shipping shows our national colours. Mr. Henry Laird, who was a Member of Council, and had been a member of the Institution for nearly twenty years, was cut off in his prime by the prevailing epidemic. To the large experience he had enjoyed in the great Birkenhead yard, he had added the training which he had received when studying in the works of the Messageries Imperiales at Ciotat. His father, Mr. John Laird, and uncle, Mr. McGregor Laird, had been the first to avail themselves largely of iron for shipbuilding, and I well remember when I was a young officer serving on the Bight of Benin, in 1834, meeting one of the steamers which had been built at Birkenhead, and in which Mr. McGregor Laird investigated the mouths and course of the Niger. Since that time—1832—every improvement has been readily adopted by the Messrs. Laird, and none of us cross to Ireland without thanking them for our speedy transit in the splendid vessels with which they bridge the Irish Channel. To the death of one other Associate you will expect me to allude. When, by an inexplicable error, the great catastrophe befell the Victoria, and illustrated for all time the spendid discipline and stout courage of her officers and crew, our brave Associate, Sir George Tryon, died with those who perished at their posts, thus terminating a long and distinguished career. Wounded in the trenches before Sebastopol, Director of Transports in the Abyssinian War, Permanent Naval Secretary, 1882-84, Commander-in-Chief in Australia, Commanding the Naval Reserves, prominently skilful in the command of two Squadrons in our Autumn Manœuvres, he became Commander-in-Chief in the Mediterranean. The mournful story of his tragic death is known to all. An able officer, a skilful tactician, a vast store of practical knowledge has been lost to the profession and the country by his death.

I think, without exaggeration, it may be hoped that the great depression in trade, which has affected the shipbuilders as much as anyone, seems to be passing away. In Lloyd's Register Shipbuilding Returns for December 31st, 1893, which gives a fair and dispassionate review of the conditions of the ship-producing industries, I find that, omitting warships, there is a perceptible increase of the number of vessels under construction. 269 steam vessels, of 578,026 gross tons, were under construction on December 31st, 1893, against 227 steam vessels, of 506,782 tons, on December 31st, 1892. There is a slight falling off in the number of sailing ships—sixty-four on December 31st, 1893, against seventy-nine on December 31st, 1892; but the total shows 333 vessels of 641,981 tons in 1893, against 306 vessels of 570,741 tons in 1892, an increase of twenty-seven vessels and 71,240 tons. Of these 333 vessels, 294 are building under the supervision of Lloyd's surveyors. During the last quarter, 107 steam vessels of 212,182 tons were commenced, and twelve sailing of 21,729 tons; 101 steamers were launched, and seventeen sailing vessels. Of the ships under construction, 207 steam vessels of 470,061 tons, and thirty-nine sailing vessels of 48,134 tons, total 246 of 518,195 tons, are building for this country; and with an addition for our Colonies of two steam vessels of 1250 tons, two sailing of 545 tons, total fcur of 1795 tons, making 471,311 tons of steam vessels and 48,679 tons of sailing vessels for the British Empire. The total amount under construction is 269 steam vessels of 578,026 tons; sixty-four sailing vessels of 63,995 tons; or a total of 333, as stated above. This wave of industrial recovery has only as yet reached the Clyde, the Tyne, and the Wear; but we trust that other ports may soon share its benefits. Of this number 60,557 tons of steam vessels are building here for foreign countries, as well as 46,158 tons, the nationality of which is not divulged, and it is interesting to see that these same countries which come to us to build are only building for themselves 90,370 tons of steam vessels; the great shipbuilding firm, Messrs. Cramp and Son, of Philadelphia, are building two large steamships for the Inman and International Line, of the same size as the New York and the Paris, and they are building or about to build two more, exceeding in dimensions and in horse-power the Campania and Lucania. All these it is intended to build under the supervision of Lloyd's Registry. Nor is this the only instance of the friendly rivalry of the United States of America. All of us must have admired the pluck of Lord Dunraven, who has endeavoured to bring away the American Cup from the best yachts of our cousins. All the skill in design of our colleague Mr. George Lennox Watson, all the skill in building of the Messrs. Henderson, all the skill in seamanship of Lord Dunraven were in vain, and the Vigilant beat the Valkyrie—by a very small margin, it is true, but still by enough to save the Cup for America. I cannot attempt to discuss the merits of centre-board or no centre-board; but I say to this meeting we must look to our laurels, and see to it that success is not always on the other side of the Atlantic.

Last year H.M.S. Howe, having grounded at the entrance of Ferrol Harbour, was considered to be in peril of total loss. The Admiralty may be congratulated on her salvage, and that the Howe is now an efficient unit in the Mediterranean Squadron. The skill of the Swedish Salvage Company who floated her, the perseverance and ability of Admiral E. Seymour and his officers, and the ready assistance of the Spanish authorities have been becomingly acknowledged. The shipbuilding programme of 1889 for the Navy is now practically complete. Of the seventy ships then projected all but nine are completed, and those nine are of the smaller classes and will be completed shortly. The great exertions of other nations to add to their navies has awakened a corresponding desire in this country not to be outnumbered by any probable combination. The Admiralty, by producing Return No. 465, has given us an accurate measure of the relations in which our numbers stand to those of some other European Powers. Our empire is so extensive that other navies than those mentioned have to be considered, if we desire to maintain our trade routes under all conditions free for the passage of our food supplies:—

	Armour-clad battleships.							Combination of two Powers.			
	Gt. Bn.	Fr.	Rus.	Ger.	It.	U.S.	All.	F.-Rus.	Fr.-Ger.	Fr.-It.	Fr.-U.S.
First class	22	18	10	4	12	4	48	28	22	30	22
Second class	12	13	8	7	4	—	32	21	20	17	13
Third class	11	6	—	11	5	2	24	6	17	11	8
Total battleships ..	45	37	18	22	21	6	104	55	55	58	43
	In the return No. 465 nine first-class cruisers may be classed as third-class battleships. I add them accordingly:—										
	9										
Giving	54	37	18	22	21	6	104	55	59	58	43

But, in addition to the countries named in Return 465, to which I have added the United States of America as possessing first-class battleships, there must be considered other nations whose battleships of the third class are numerous, and some formidable. I need not remind you that twice in recent years our flag in the Pacific was placed in jeopardy by being hoisted in an unarmoured frigate. On the first occasion the Zealous and on the second the Triumph were sent as flagships to the Pacific,

	Armoured cruisers.									Combination of two Powers.					
	Gt. Bn.	Fr.	Rus.	Ger.	It.	U.S.	Aus.	Sp.	All.	F.-R.	F.-G.	F.-It.	F.-U.S.	F.-Aus.	F.-Sp.
1st class cr.	31	14	11	—	6	3	1	6	41	25	14	20	17	15	20
2nd class cr.	47	25	2	9	–	–	4	–	40	27	34	25	25	29	25
3rd class cr.	51	31	3	19	–	–	7	–	60	34	50	31	31	38	31
	129	70	16	28	6	3	12	6	141	86	98	76	73	82	76
	9	Deduct 9 in 3rd class bat'lship													
	120	70	16	28	6	3	12	6	141	86	98	76	73	82	76

Coast Defence.

Gt. Bn.	Fr.	Rus.	Ger.	It.	U.S.	Sp.	Arg.	Bra.	Chi.
16	6 + 8 armoured gun-vessels = 14	15	13	4	19	1	3	3	1

Den.	Nlnds.	Nor. & Sw.	Total.
4	16	12	105

but too late to enable the Commander-in-Chief on that station to carry out the orders of the Government, and to give protection to our trade in those seas. The battleships belonging to these countries are as follows:—Argentine, 1; Austria, 4; Brazil, 3; Chili, 3; China, 4; Denmark, 4; Greece, 5; Japan, 2; Netherlands, 7; Spain, 2; Turkey, 15: total, 50, making of sea-going battleships 154, against our 54, or 100 more than we have built or are building. The foregoing table shows the number of protected cruisers built and building for our own and other Governments.

It is necessary to take account of coast defence ships. If Great Britain is superior at sea, and establishes a blockade, coast defence ships must be counted upon as able to assist in breaking that blockade. Having rapidly glanced at the numbers and conditions of the navies of the world, I need not remind you of the spirit in which the nation has emphasised the necessity for an addition to the Navy, and the prospect of employment for all the various trades and professions connected with shipbuilding to be derived from that necessity. I know that this Institution, possessing so many persons skilled in naval construction, will be ready to co-operate with the able Naval Architects who serve the country at the Admiralty in devising means to make our new armour-clad ships superior, if possible, to those existing, in unsinkableness and in speed. It also affords some expectation that our magnificent private dockyards may find ample employment in the not distant future.

The gold medals of the Institution were then presented to Mr. G. Calvert and M. Otto Schlick, for their papers on the measurement of water currents, and apparatus for measuring and registering the vibrations of steamers. Mr. Calvert was unavoidably absent; M. Schlick returned thanks in appropriate words.

The first paper was then read, by Mr. W. H. White,

"ON THE QUALITIES AND PERFORMANCES OF RECENT FIRST-CLASS BATTLESHIPS."

This was a very long and interesting paper, made still longer and much more interesting by Mr. White's digressions and explanations of rolling, given by means of a large moving diagram. The paper was so long indeed, that the latter part of it was hurried over by the author in abstract, and may be regarded as taken as read. We give in full, however, that portion which refers to a most interesting question, the behaviour of the Resolution in a gale. Mr. White began by describing the conditions under which eight very large battleships had to be built, and the paper is an account of the ships and the results obtained with them. The main conclusions of the author may be summarised, that the ships were quite successful, and that as regards rolling, all ships roll when the waves fit them. This will be clearly understood from what he said concerning the Resolution.

Experience at sea, Mr. White said, with the new battleships has been very limited, except in the case of the Royal Sovereign, which was commissioned in May, 1892, as flagship of the Channel Squadron. The sister ships, Empress of India and Resolution, were commissioned for service with that squadron in September and December last. The turret ship Hood joined the Mediterranean fleet in June, 1893, and the Ramillies became the flagship on that station in October; but except on the passage out these ships have not had experience in the Atlantic. It is to the Royal Sovereign therefore that one must turn for information as to behaviour over any considerable period. Apart from long-continued experience under various conditions of wind and sea, no fair appreciation is possible of the true qualities of any ship or class.

He recapitulated the broad conclusions in regard to the rolling of ships, which have been established by theoretical investigation, and confirmed by experiment and observation during the thirty-four years that have elapsed since the late Mr. W. Froude brought his new theory before this Institution. (1) The behaviour of a ship depends chiefly upon the ratio of her period of oscillation to the apparent period of the waves which produce rolling. (2) The slope of the waves, their ratio of height to length, is an important factor in the rate of accumulation of rolling and its maximum amplitude. (3) The resistance offered by water to the rolling motions of ships is most influential in limiting rolling, and any means available for increasing that resistance and the "rate of extinction" of rolling must be beneficial. (4) For any ship the condition tending to produce the heaviest rolling is that when the waves pass her at a rate which synchronises with her natural period of oscillation in still water. Apart from the action of resistance, the successive impulses of a regular series of synchronising waves would increase the amplitude of the oscillations so rapidly that any ship must be capsized in a very short time. (5) Every ship, no matter what her size and period of oscillation, is liable to this condition of synchronism. It may occur with a beam sea of period identical with her own, or it may result from the course and speed being such as to produce synchronism with waves of dissimilar period. In fact, allowing for the infinitely varied conditions of sea necessarily encountered, no ship can altogether escape from heavy rolling. (6) Experience has confirmed the deduction from mathematical investigation that ships which are slowest in their still-water oscillations, as a rule, are steadiest at sea. (7) For slow-moving ships, of long still-water periods, the condition of synchronism is sometimes reached in a long and very low swell, with practically no wind. This swell results from waves which have travelled long distances, from the storm region in which they were formed, and in transit have been greatly degraded in height, while retaining considerable length and period. (8) When rolling is set up in ships by the passage of waves it may be anticipated that the heavier ships, with greater moments of inertia, will accumulate the largest angles of oscillation. He then went on to consider the performance of the Royal

Sovereign, and he gave the following among other figures :—

Inclinations on Each Side of the Vertical.

	Mean Deg.	Max. Deg.
Royal Sovereign	7	11·5
Empress of India	5·9	10·5
Immortalité	2·8	5
Narcissus...	3	7
Bellona	6·2	13·2

The Rodney was in company, but did not take simultaneous observations on the occasion described in the table. Taking all the observations made at various times during this day, and disregarding changes which may have occurred in the course and speeds of the ships, or changes in the state of the sea, the following summary represents the facts :—

Mean Inclination on Each Side of the Vertical.

	Degs.
Royal Sovereign	6·8
Empress of India	9·4
Immortalité	3·
Narcissus	3·3
Rodney	5·8
Bellona	6·1

In order to illustrate the general character of the motion of the large ships, the gradual increase in ampli-

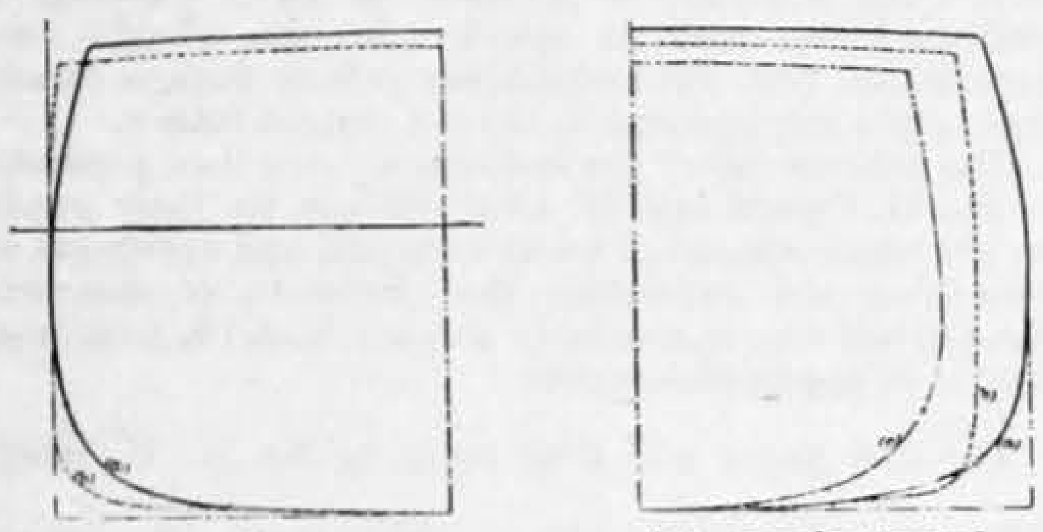


Fig. 1.—Midship Sections.

tude, attainment of a maximum inclination, and subsequent gradual decrease, Fig. 11 has been prepared from a series of actual observations. One feature in the accumulation of rolling under the trying conditions of synchronism is the apparent suddenness with which comparatively large angles of inclination may be accumulated. Here, again, theoretical investigation anticipates observation. Apart from the action of resistance, the passage of each synchronising wave should add an angle equal to about three times its maximum slope to the range of oscillation. In the long, low swell which syn-

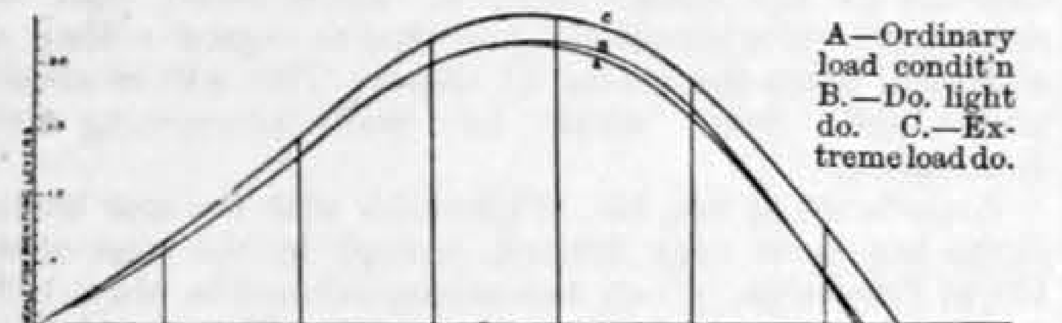


Fig. 2.—Curves of Stability for H.M.S. Royal Sovereign.

chronised with the Royal Sovereign class, the maximum slope was about 3 deg. only, corresponding to an increment in range, apart from resistance, of more than 9 deg. for each wave, apart from resistance. There would be four waves passing in a minute; and it is easy to understand therefore in how short a time considerable angles of rolling may be reached, especially in a slow moving ship, where resistance acquires no great moment until there is a good swing. When the Royal Sovereign and Empress of India were placed beam on to the swell, and a series of nearly regular waves of synchronis-

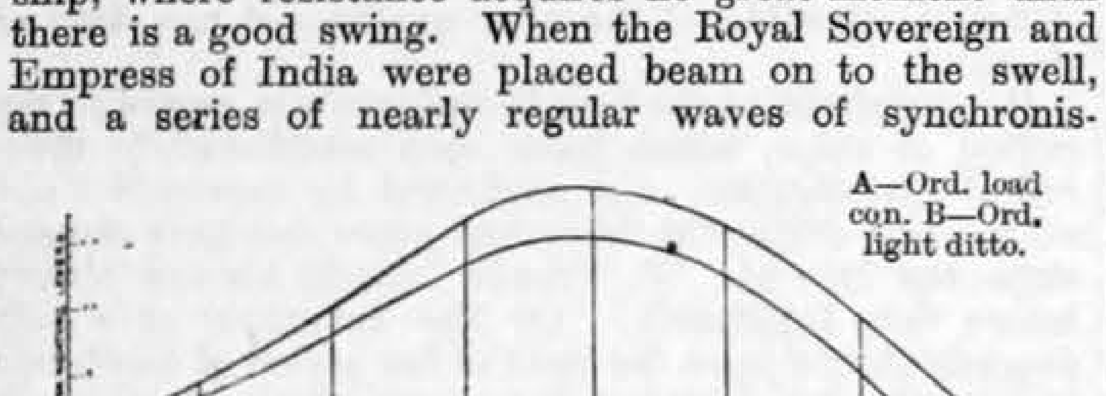


Fig. 3.—Curves of Stability for H.M.S. Monarch.

ing periods passed the ships, much larger inclinations were reached at times than are shown in the foregoing tables. The maximum inclinations recorded under these very trying conditions were about 25 deg. to 30 deg., which is undoubtedly heavy rolling, and has naturally been made the subject of adverse remarks. It may be well to explain, therefore, that this kind of behaviour has been experienced long ago, under very similar circumstances, in vessels having unsurpassed reputations for average steadiness, and about the same

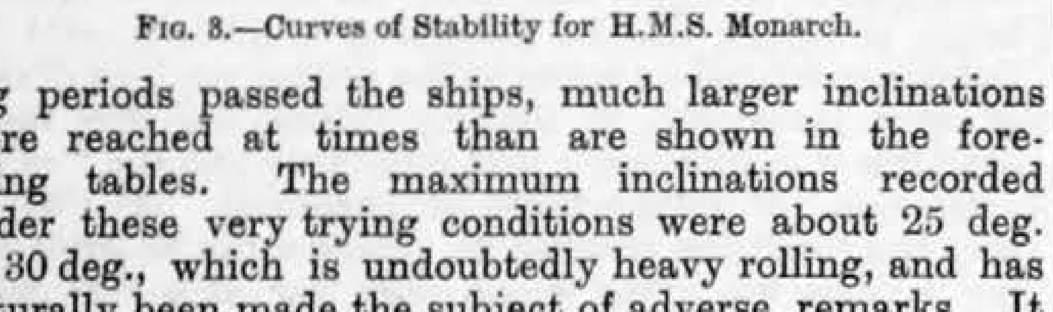


Fig. 4.—Curves of Stability for H.M.S. Devastation.

periods of oscillation as the Royal Sovereign class. In this connection he quoted a condensed passage from his "Naval Architecture," published nearly twenty years ago. The Hercules, as a rigged ship, was remarkable for average steadiness of platform. Yet on some occasions, in a swell very similar to that which set the Royal Sovereign class in motion, she rolled to angles of 25 deg. and 30 deg. on each side of the vertical. Similar experience has been obtained with the Inconstant and other vessels.

Small changes in course and speed relatively to synchronising waves also produce marked results on rolling. As an illustration I may take a recent observation made by the Royal Sovereign. With swell abeam the mean inclination to the vertical was about 9 deg., and maximum —occasionally reached—18 deg. With the swell two points before the beam the mean inclination was about 5½ deg., and the maximum 10½ deg. With swell four points before the beam the mean inclination was about 4 deg., and maximum 9½ deg. He then proceeded to deal with the Resolution.

The Resolution, a newly commissioned ship, left Plymouth at 2 p.m. on December 18th last to join the Channel Squadron at Gibraltar. On December 23rd, at 9 a.m., she arrived at Queenstown. According to the newspaper accounts, the ship had been seriously strained in structure by heavy rolling, reaching to angles of 30 deg. or 40 deg. from the vertical. Dangerous leaks had been developed, and she could only be kept afloat by continuous pumping. Considerable repairs were said to

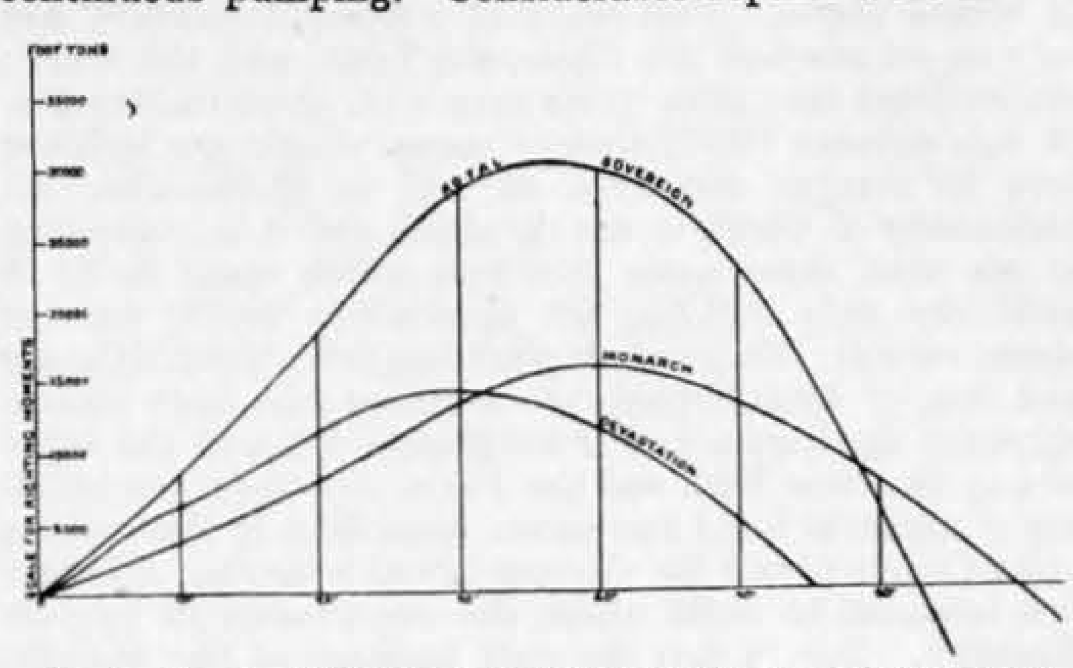


Fig. 5.—Curves of Righting Moments in Ordinary Load Conditions.

be required, and it was alleged that she was in such a state that she could hardly proceed without risk as far as Plymouth or Portsmouth before being taken in hand. Graphic accounts followed of the terrible weather which had been encountered, of the unsatisfactory behaviour of the ship, the great discomforts suffered by all on board, and the immense quantities of water which were said to have passed down into engine-rooms and stokeholds. In short, the impression was produced, and possibly still remains in many minds, that the Resolution had a narrow escape from disaster, and her behaviour was considered the more unsatisfactory seeing that the torpedo

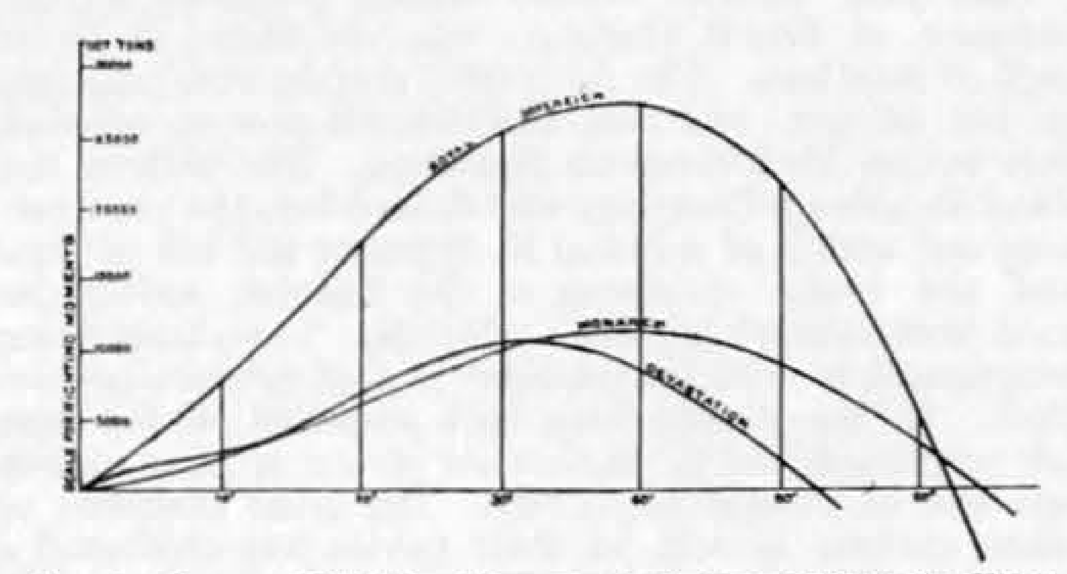


Fig. 6.—Curves of Righting Moments in Ordinary Light Condition.

gunboat Gleaner, which was in her company, had proceeded to her destination, while the big ship put back.

Now for the facts. It has been stated by the representative of the Admiralty in the House of Commons that the captain of the Resolution, in the exercise of his undoubted discretion, put back to Queenstown because he considered it the wiser course, having regard to the possible continuance of bad weather, and the quantity of coal remaining on board. The ship proceeded to Devonport, and a careful survey was made by the officers of Devonport Dockyard, who had nothing whatever to do with the construction or fitting out of the Resolution.

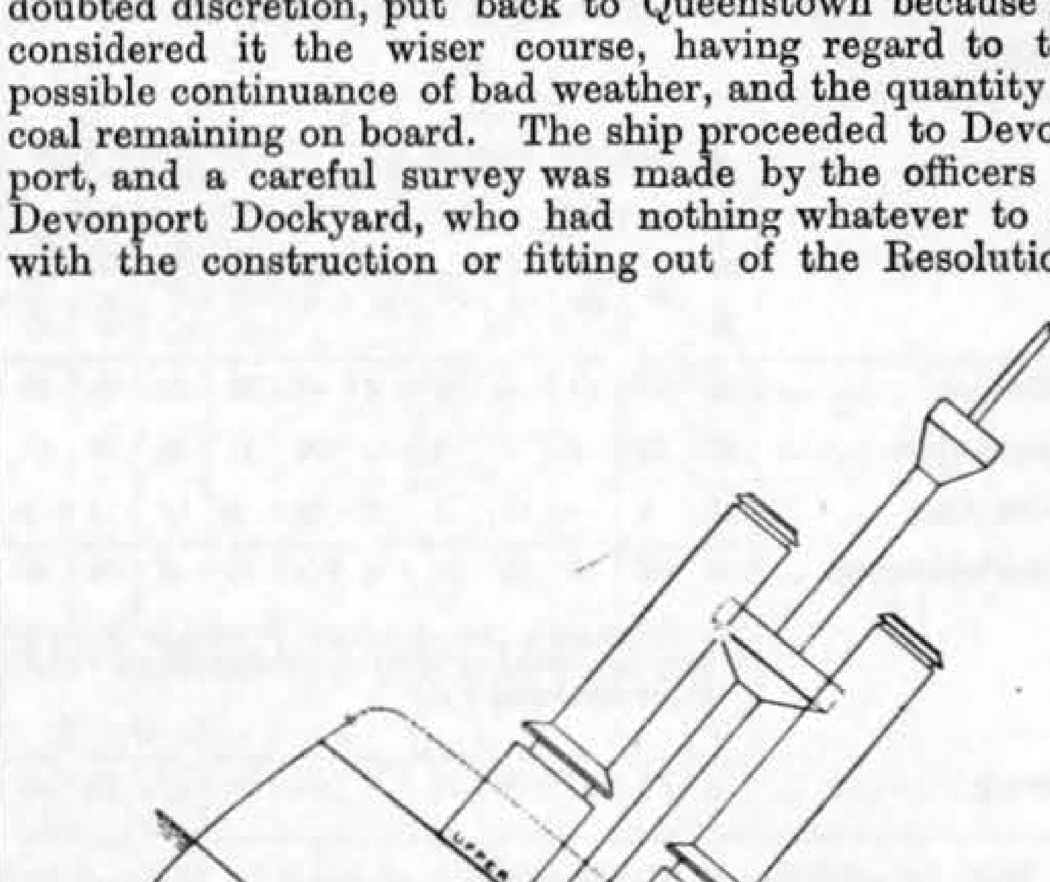


Fig. 7.—H.M.S. Resolution, if Inclined at 40 deg. in Smooth Water.

This survey established the entire absence of any working or weakness in her structure. Various fittings on or above the upper deck and outside the ship were damaged or washed away by the sea. The bridges, which are merely light superstructures at a considerable height above the shelter deck, showed some small signs of movement, but nothing of any importance. There were no serious leaks anywhere. One or two places were found where small fittings had been attached to the sides, and the rivets were not absolutely water-tight. A few local defects in deck planks had permitted trivial leaks to occur here and there. Some small leakage also occurred at gun ports, deck pipes, and other openings provided with covers that had been thoroughly tested during construction, but were apparently not so well secured as they might have been when the storm was encountered. In dealing with such fittings, experience counts for much, and a newly commissioned ship is always at a disadvantage. Other fittings which were in place need not have been there under the circumstances, arrangements having been made for stowing them in safe positions at sea, or when bad weather was anticipated. The covers to the forward barbette gun wells were washed away by the sea, not because they were not strong enough, but because they were not properly secured; and this circumstance led to the entry of water through the barbette. The best possible evidence to those conversant in such matters of the trivial and unimportant character of the defects arising from this experience of the Resolution is found in the fact that they were all made good—including repairs to damaged fittings and renewals of fittings lost—for the sum of £440.

There is no evidence that large quantities of water,

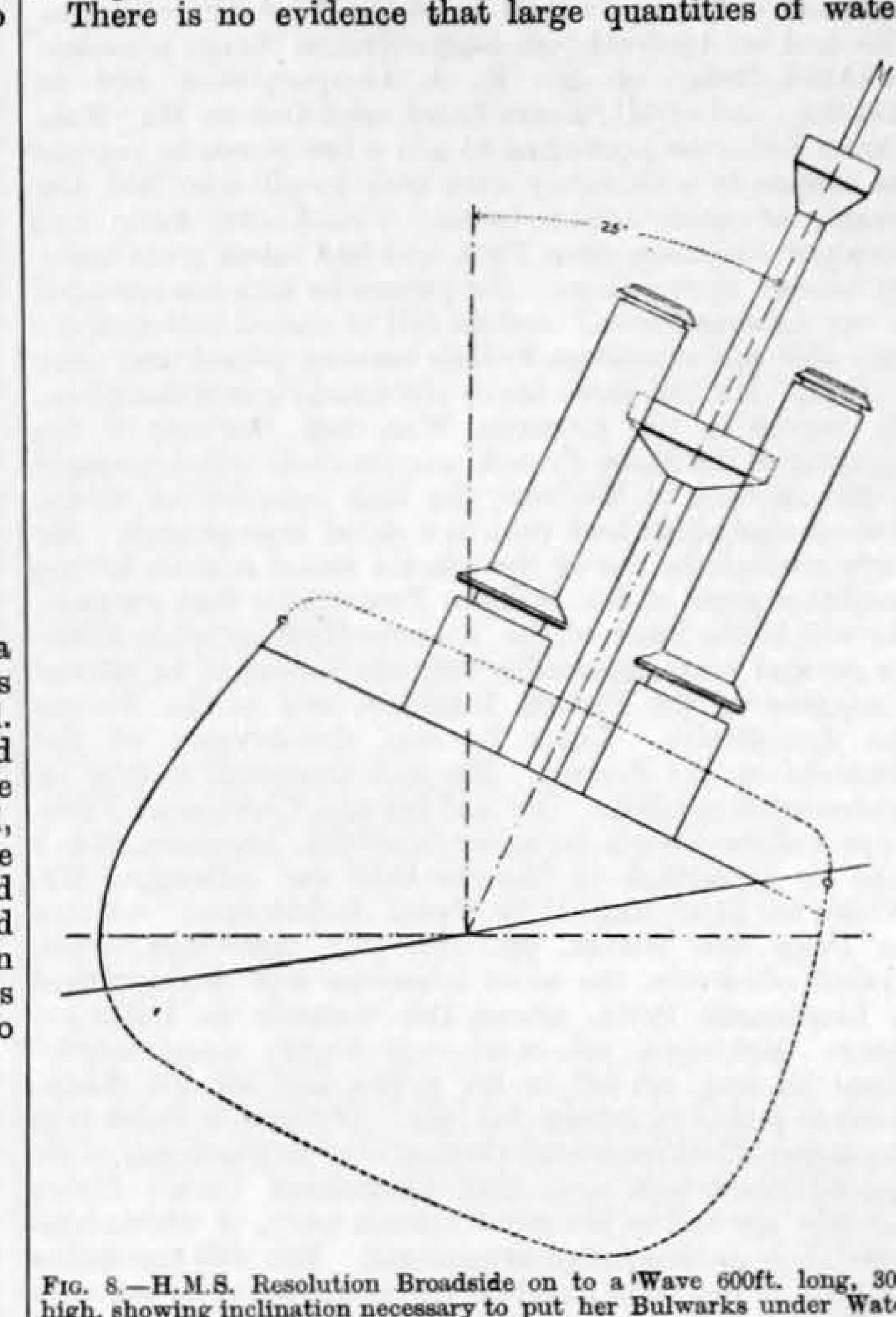


Fig. 8.—H.M.S. Resolution Broadside on to a Wave 600ft. long, 30ft. high, showing inclination necessary to put her Bulwarks under Water.

much less dangerous quantities, passed into the interior. Before the hatches were battened down amidships a sea broke on board, and some water found its way down to the main deck and into the engine-room, but this did not recur after the battening down. Discomfort there was, no doubt, during the three days the ship was battling with the storm; but that is a common experience, and not peculiar to warships. It has come to my knowledge that two large passenger steamers which were crossing the Bay about the same time had a very similar experience, but they continued their voyages, and I have not

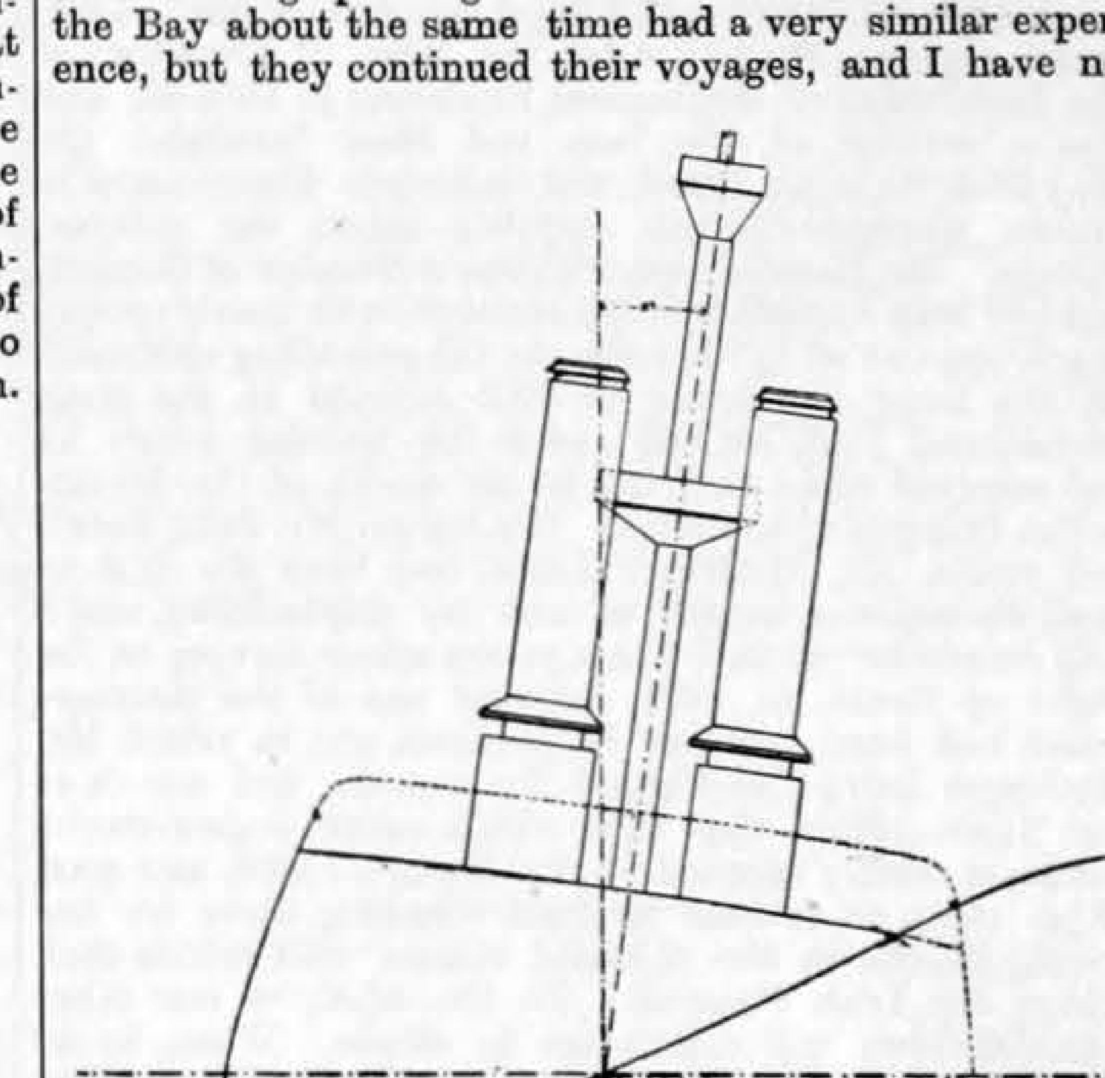


Fig. 9.—H.M.S. Resolution Broadside on to a Wave 300ft. long, 42ft. high, showing inclination necessary to put her Bulwarks under Water.

seen any comments in the Press in regard to their behaviour, The storm was undoubtedly severe, and the sea was exceptionally high and steep for a considerable time.

After passing Ushant early on the morning of the 19th, the Resolution had a swell on the beam, which caused her to roll considerably. The wind, which was south at starting, veered during that morning to west, and then to north-west. She was kept on her course for seven or eight hours, until about 7 p.m. Two exceptionally heavy rolls then occurred, and the sea broke over the upper deck amidships. The hatches were not battened down at the time, and water passed through them on to the main deck and into the engine-room, as above described. After this happened the ship was brought head to sea, gear secured, and battening down completed. She then resumed her course; but, as she again began to roll considerably, she was once more brought head to sea, and there kept steaming slowly. This happened about 9 p.m. on December 19th. The swell increased and the wind freshened during the night. By 8 a.m. on December 20th it was a whole gale, with tremendous squalls. Measurements of the waves were made that day with all the care possible under the circumstances. Accurate measurement, especially of length, was hardly possible. The wave heights were obtained by horizon observations, and are probably more nearly correct. Heights of 42ft. were observed from the hollow to crest, and lengths of 300ft. from crest to crest. The exceptional steepness of these waves will appear from the fact that extensive observations have fixed the average height of large Atlantic storm waves at one twentieth of the length, so that waves 42ft. high would be over 800ft. long. Similar observations give 15ft. as the average height for waves 300ft. long. No doubt in this instance, as in many others, where the wind has veered during a long-continued storm, there were an independent series of waves running in different directions and superposed on one another, which would account for the height and steepness of the waves. The ship was kept head to sea until four p.m. on December 21st, when the swell had begun to drop somewhat, but was still from the north-west. Measurements of waves that morning showed heights of 26ft. to 30ft.,

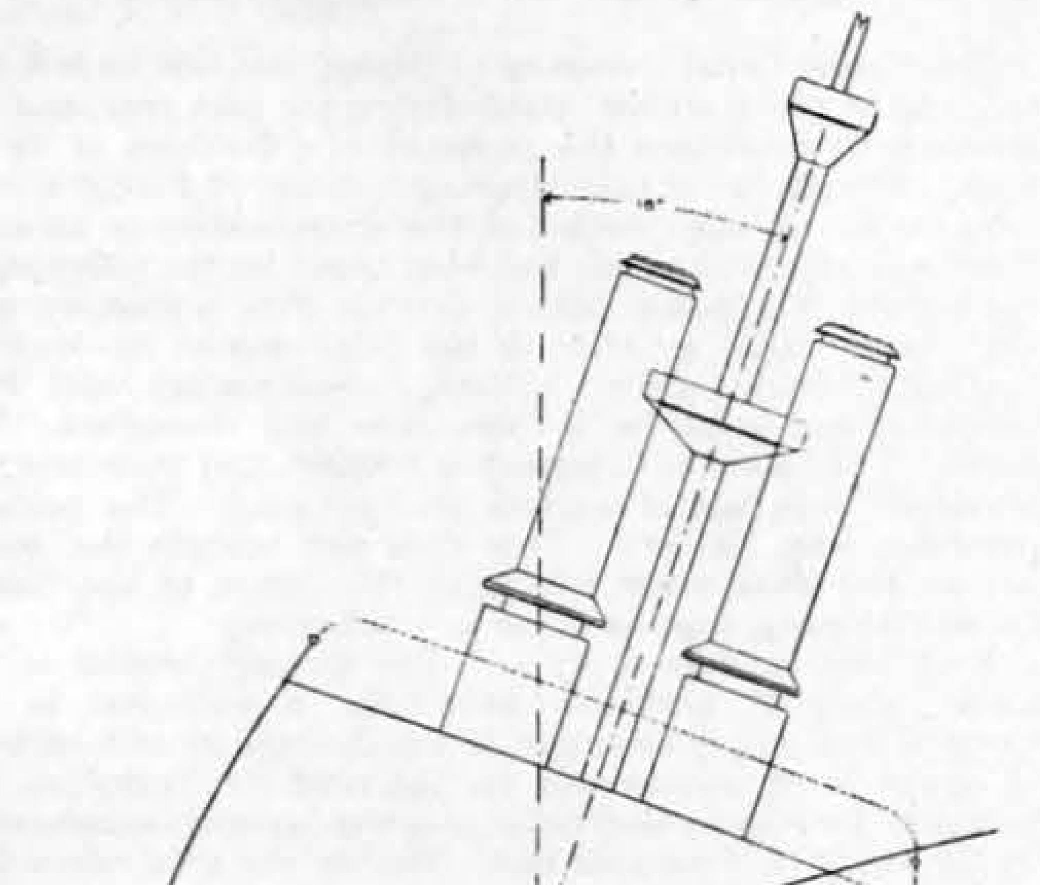


FIG. 10.—H.M.S. Resolution Broadside on a Wave 300ft. long, 20ft. high superposed on another Wave 600ft. long and 20ft high.

and lengths estimated at 280ft.—still a very steep and heavy swell. A northerly course was then shaped; and, as the swell decreased gradually during the night, on the morning of the 22nd the ship proceeded to Queenstown. On arrival she had over 450 tons of coal on board, having left Plymouth without about 790 tons.

There are two stages to be considered in this narrative. First, that during which the ship was exposed for some hours to a swell abeam, described as moderate, but said to produce occasional heavy rolling. This resembles the case above discussed for the Royal Sovereign class; and in his report the captain of the Resolution expressed the opinion that the cause of rolling was approximate synchronism between the period of the ship and that of the waves. The second stage is that where the ship was kept head to the sea. Her behaviour under these circumstances is reported to have been most satisfactory. She was very buoyant, rode well over the very heavy sea, and pitched easily. At times she rolled considerably, which is not remarkable when the state of the sea and its confused

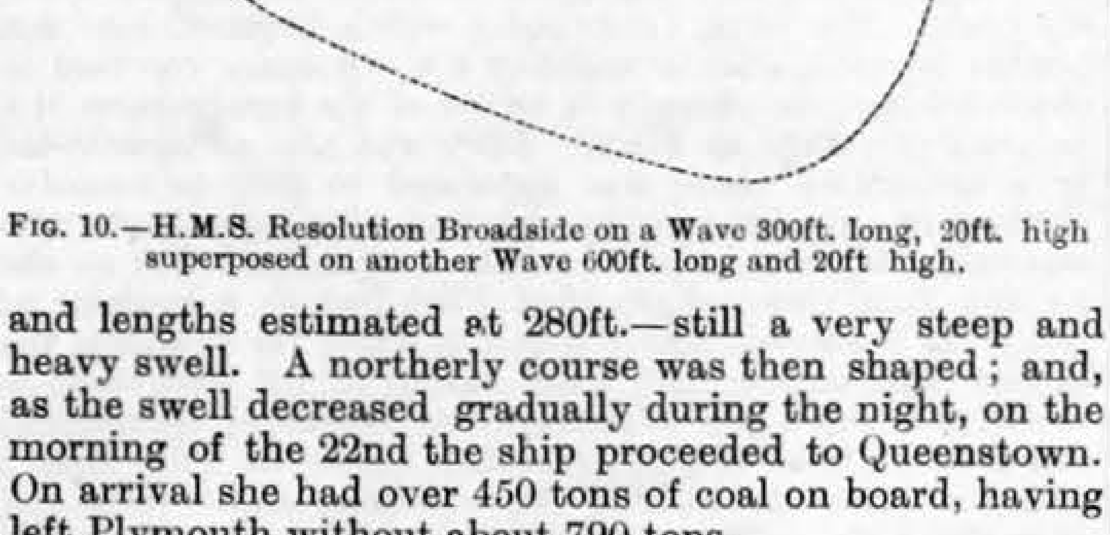


FIG. 11.—H.M.S. Royal Sovereign. Diagram of Rolling for ten minutes, swell on the beam, of period 14 to 14½ seconds.

character are taken into account. It is reported also that, under these conditions, the oscillations were quite different from those which occurred when the swell was abeam. In the latter case the rolling gradually increased, reached a maximum, and then gradually diminished—completing a "phase," in fact, like that represented in Fig. 11. Head to sea the ship is stated to have "lurched" at once, or nearly so, to her maximum inclination, and then to have gradually lessened her swing in succeeding oscillations. This is what would be anticipated from the position she occupied in relation to the short steep sea, and the pitching and 'scending motions impressed upon her. Under these circumstances there would necessarily be great variations in the distribution of the buoyancy as compared with still water, and considerable temporary reductions in transverse stability, which would account for the occasional heavy lurching. Moreover, there must have been very severe longitudinal bending moments on the structure, and it is most satisfactory to find that there was no indication whatever of working or weakness.

Another fact of great importance must be stated. There is no trustworthy evidence of the angles through which the Resolution rolled on this occasion. The only observations recorded were made with a short, quick-moving pendulum placed in the chart-house, at a height of 35ft. to 40ft. above water. I need not dwell upon the possible errors of pendulums so placed in a ship rolling among waves. Cases are on record where the indications of pendulums, similarly placed in ships of about the same period, have been twice the true angles of oscillation, observed simultaneously by trustworthy methods. In fact, no experienced naval officer trusts pendulum observations, spirit levels, or gravitational instruments of any kind for use at sea. One cannot fix precisely what was the actual error of the pendulum in the Resolution. But it is certain that its movements placed at such a height must have grossly exaggerated the rolling of the ship. When angles of inclination of 30 deg. or 40 deg. are said to have been indicated by, or estimated from, the movements of the pendulum, the actual angles must have been much less, and may have been only half what was shown on the scale. It is important to note also that, even had these great angles of inclination been reached, there would have been no reason for apprehension of danger to the ship. The curves of stability—Fig. 2—show that the maximum righting moment occurs at an inclination to the vertical of 37 deg., and that instability is not reached until the inclination exceeds 60 deg. There is a popular impression, no doubt, although an absolutely erroneous one, that if a ship is inclined past her angle of maximum stability she will capsize. To this Institution I need not explain that even in a ship with large sail power, and exposed to squalls of wind, there may be no danger in angles of inclination much exceeding that at which the righting moment reaches its maximum. But when, as in the case of the Resolution, there are no sails, and the inclining force of the wind on the broadside is relatively so small, there is a much greater margin of safety. In Fig. 7 a cross section of the Resolution is given for an inclination, in still water, of 40 deg. to the vertical. At this inclination the righting moment, for all practical purposes, may be considered as maintaining its maximum, and has a value of more than 30,000 foot-tons. This is the greatest angle of roll which, by pendulum or estimate, has been attributed to the Resolution. For the reasons just stated it is practically certain it was never approached. Had it been approached the upper deck must have been invaded by the sea to a much greater extent than actually happened.

Among waves, the rise of the sea, as well as the rolling of the ship, necessarily influences the amount of water which comes on to the deck. This fundamental truth is often overlooked, and in some discussions on the Resolution's behaviour this has been done. Simply to illustrate the well-known fact Figs. 8 and 9 have been prepared. The latter shows the Resolution beam-on to trochoidal waves of the heights and lengths said to have been observed on December 20th, but to which she was then kept bow-on. The maximum slope of the waves is 26 deg., and an inclination to the vertical of 8 deg. would then immerse the top of the bulwarks. In this position the corresponding angle of the curve of stability for measuring the righting moment would, of course, be 34 deg. Fig. 8 shows the Resolution beam-on to an Atlantic storm wave 600ft. long and 30ft. high, the maximum slope being 9 deg. Here an angle of inclination to the vertical of 25 deg. would bring the top of the bulwarks awash. In practice, of course, waves have not the regular forms shown on the diagrams, nor are successive waves of identical size and height. The "rise of the sea" on occasional waves in a series often considerably exceeds the average rise, and in a confused sea formed by superposed series these variations in height are very striking. Even with my limited opportunities for studying wave-phenomena, this has been much impressed on my mind, and experienced naval officers have frequently drawn attention to the same fact when the assumptions made in the mathematical theory of rolling have been explained to them.

Fig. 10 has been constructed on the hypothesis of two superposed series of waves, one 600ft. in length by 20ft. in height, and the other 300ft. by 20ft. in height. At certain times the ship on such a compound wave, if broadside-on, might immerse her bulwarks at an inclination of 18 deg. If end-on, the wave crests passing rapidly, might also rise considerably above the bulwarks, and come on to the upper deck. The presence of water in considerable quantities, at times, on the upper deck of the Resolution cannot, therefore, be regarded as any proof that the ship approached the angles of inclination indicated by the pendulum; much more moderate angles, under the circumstances described, would have produced this result.

It is undoubted that the ship at times rolled considerably, and that the Gleaner, although of small dimensions, made better weather of it when beam-on to the swell first encountered. The Gleaner is said to have "risen over the beam swell and sea like a cork," which is what would be anticipated from the fact that she is a quick-moving ship, her period being only one-third to one-fourth that of the Resolution. On the swell which synchronised with the movements of the latter and accumulated rolling, the Gleaner could move so quickly as practically to accompany the waves. Everyone knows that under such circumstances the smaller ship is likely to have an advantage; but it is equally true that under most conditions the larger and slower moving ship will be better behaved than the smaller, and more capable of maintaining her speed. The Resolution was, in fact, put to a severe test at the very commencement of her service, when those on board had not grown familiar with the vessel, and particularly with the fittings provided for use in rough weather. She was not fully prepared when the sea first broke on board, and the washing away of certain fittings which were not well secured, or which were left in place instead of being stowed, permitted water to pass below. This involved discomfort, but not danger; and the statements to the contrary are unfounded. So are the accounts that were published in regard to the straining and leaks produced by the rolling. As to the extent of the rolling, there is no exact information, but there was undoubted exaggeration in the published reports. The rest of the paper was devoted to the manœuvring powers, and relative size of the Royal Sovereign class; and the Centurion and Barfleur.

The discussion on Mr. White's paper was at once interesting, instructive, and amusing. The speakers were nearly all naval men, and they all spoke of what they knew—of facts occurring in their own experience. Mr. White, in some of the digressions to which we have referred above, spoke of certain phenomena as being well known to sailors, though not to the landsmen who criticised ships and their performances; and concerning these phenomena the discussion supplied much information. The first speaker was Mr. W. Laird, who said he had had some experience on board the Royal Oak, one of the new class of battleships. She behaved in a very satisfactory manner in rough weather, at times a gale, and reached Portsmouth in due time. Her behaviour was equally good during the gunnery trials. If the Royal Oak and her sister-ships rolled, the roll was easy; if safety was secured, the result was satisfactory. There could be no doubt that smaller ships were needed for certain departments of the service, but he hoped the Admiralty would go on building big ships, so as to be able to cope with any nation, united or otherwise.

He was followed by Admiral Field, who, alluding to the need which existed for practical information, suggested the expediency of sending young naval architects from Mr. White's department to sea in her Majesty's ships, so that they might augment the value of their theoretical acquirements by sound practical experience. He referred in amusing terms to the modern Member of Parliament, who has nothing to learn about ships, guns, or anything else, knows a great deal more, indeed, about such subjects than naval architects, or captains, or admirals, and he thought Mr. White's paper might perhaps open his eyes to the truth that he did not know quite so much as he thought. We must have big ships. The small ship, costing 30 per cent. less than the big one, was, no doubt, a splendid structure to catch votes of the Little England party, but it would not do for Britain to be inferior to any other nations. But he was not quite sure that Mr. White had not underrated the merits of the Centurion, as she might be able to carry a much more powerful wire gun than the 10in. she had on board. He was sorry that sufficient stress had not been laid on the true reason why we must have big ships, and that was that their coal endurance was much greater than that of small ships.

He was followed by Admiral Morant, who gave details of his experience in gales with the Achilles, Northumberland, and Minotaur. Crossing the Bay of Biscay in a south-westerly gale, and a heavy cross sea, the Northumberland rolled 40 deg. each way, and the Minotaur 36 deg., the Achilles 34 deg., and they took green seas on board at each side as they rolled, yet these were described as able and stable ships. All ships are liable to roll if the impulse of the sea chances to synchronise with the period of rolling. A very remarkable instance of this was supplied in his own experience in Vigo Bay. The Agincourt, Neptune, and Hercules, were proceeding under steam in nearly smooth water, when the Neptune began to roll on the swell, and rolled so heavily that her guns broke adrift, neither of the other ships rolling at all.

Admiral Boys said that his experience in the Warrior in 1869 precisely confirmed Mr. White's arguments, but it must be remembered that a ship might remain at sea for months or even years without encountering a sea that fitted her. She would establish a splendid character for steadiness, and then one day she would find a synchronising sea, and would roll her bulwarks under. He had known the Warrior and Achilles without apparent reason roll heavily for a quarter of an hour and then become steady again. The Bermuda Dock when being towed across the Atlantic had rolled 15 deg.

Captain FitzGerald had a somewhat lively and good-tempered passage of arms with Mr. White. He maintained that the Resolution had behaved in a way that her designers had not expected, and that in consequence they were going to do now what they ought to have done at the first, namely, fit her with bilge keels. It was, however, quite true that ships developed rolling in a very erratic way. Thus, for example, on one occasion the Empress of India began rolling in such a fashion that before ports could be shut she had flooded her cabins, to the infinite annoyance of the officers whose property was destroyed. He was glad to find that bilge keels were to be fitted even experimentally. As to a slight movement in the bridge, it was all very well for Mr. White, who stayed at home, to talk about slight movements, but the captain had to use the bridge, and he really did not relish the notion of slight movements in that structure. He did not hold with those who were always comparing one British ship with another, and depreciating both.

Mr. Thornycroft dwelt on the fact that big ships could be propelled at a given speed with less power and fuel than small ships. They had a much larger range of operations, and for Great Britain that was a matter of much importance. Dealing with rolling, he remarked that a long slow roll meant a large angle, and big ships in the Navy had very commonly a period of fifteen seconds, or four rolls in the minute, which just fitted heavy waves. He had made investigations and observations which strongly supported this view. A large ship and a slow period of necessity went together. As to bilge keels, Mr. White had no doubt made his case good. They were, under certain circumstances, of great value, but it had to be proved that they would be of use to such ships as the Resolution.

After some remarks by Mr. Martell in favour of bilge keels, and a question by Mr. Henwood concerning liquid fuel, Mr. Biles spoke. He explained that while a great fuss was made about the rolling of ships in the Navy now and then, the same thing went on daily in the mercantile marine, and no one thought anything of it. As a fact, most of the great Atlantic liners rolled 30 deg. each way in rough weather. It was taken as a matter of course than they should do so. No one anticipated the least danger because there was none. Such rolling was uncomfortable, that was all. The stowage of cargo had a great effect in bringing about such an alteration in the period of rolling as might, on the one hand, make it synchronise with the wave period, and on the other might put it out of step with the waves, and he instanced one 4000-ton Atlantic steamer which was a roller or not according to the way her cargo was stowed. Various expedients had been tried to avert rolling by mechanical devices; none had succeeded hitherto, but he hoped for better results from Mr. Thornycroft's investigations.

Mr. White, in replying, said that really, as regarded Captain FitzGerald, he had nothing to apologise for in the design of the ships he had described, nor did he intend to apologise. He had only to deal with facts, and those he had set before them. It was the simple truth that bilge keels were not forgotten. To fit them or not had been carefully discussed, and it was decided not to fit them. Then Captain FitzGerald was not correct in saying that that had happened which was not anticipated. In his own—Mr. White's—book on "Naval Architecture," written twenty years ago, he had clearly shown that under certain circumstances every ship must roll heavily. It was physically impossible to prevent the rolling save by changing the circumstances. Certain ships in the Navy had an excellent character as stable ships; this stability was due to their rolling period. In designing the new ships every effort had been made, and with great success, to secure a similar rolling period, and no more could be done to get stability. The Royal Sovereign had been afloat for two years and eight months before she rolled. It was only under special conditions of wave length that she would roll. At certain seasons of the year, and in certain seas, ships with a given period were sure to roll. This could not be helped. All that could be done was to get the best average performance. As to Mr. Henwood's questions about fuel, as it was burned, the captain could if he liked take water into the double bottom, so as to keep the ship down in the water. He did not hold with the notion. "put a penny in the slot and the ship will work." He held that officers should be left a large discretion. As to oil fuel for ships of war, that was a subject which he positively declined to discuss. As to Admiral Field's suggestion about sending young men to sea, he assured him that they did what they could, but they were too short handed at the Admiralty to spare men. For the rest, his business was to build ships which should comply with conditions dictated by the Board of Admiralty, which included the most careful and competent men imaginable. As to the Centurion, they must remember that she was a very special ship, intended to go through the Suez Canal. She was sheathed and coppered, had a large coal capacity, and great speed. Our ships are not intended to fight each other, and the endless comparisons of English ships with English was waste of time; they should be compared with those of other countries. Mr. White concluded with a warm tribute to the merits of the Admiralty Board.

A vote of thanks having been passed by acclamation, the chairman said that as time was short certain papers would be taken as read. The hall rapidly emptied, and Professor Greenhill then read his paper on stresses produced by rolling, which was of far too abstruse a character to bear abstracting.

On Thursday morning Mr. C. E. Ellis, the well-known Managing Director of Messrs. John Brown and Co.'s Atlas Works, read the first paper on

"RECENT EXPERIMENTS IN ARMOUR,"

of which the following is a summary. The writer began by noting that the adoption of a new type of plate for three important battleships marks an epoch in the development of armour, and deserves special notice in view of the expected increase in our navy. When M. Barba, of Creusot, read his paper on armour in 1891, the writer considered that compound armour still held its own fully against steel, because it resisted projectiles of medium quality, as M. Barba admitted, better than all steel, and because its very hard face was specially adapted to resist shot striking obliquely. In support of this view the writer compared the results obtained by the Vickers all-steel and Cammell compound plate, tested on September 6th, 1888, on board the Nettle. He noted that Messrs. Cammell had themselves achieved considerable success with steel plates tested on board the Nettle, and both Brown and Cammell with nickel steel plates, used for the secondary armour of the Royal Sovereign class. These plates, each 4ft. by 4ft. by 4in., unbacked, kept out three Palliser 5in. shot, 49 lb. in weight, with a velocity of 1200 f.s. For unbacked plates nickel was most beneficial in imparting toughness. The writer then noticed the excellent Vickers steel plate tested at Ochta in November, 1890, the Texel trial of Schneider armour in August, 1893, and successful trial of Schneider's nickel steel armour for the Tri Sviatitelia. St. Chamond has been singularly successful in the production of tough steel armour as well as Harveyed plates. In Ochta, in December, 1892, a remarkable plate was tested, made at St. Chamond. The Chatillon Commentry Company has made excellent deck plates, and has experimented with Harvey armour with good results.

Krupp exhibited at Chicago several excellent plates, two of which were illustrated in the paper: (1) a nickel steel plate, 12ft. by 8ft. by 15¾in., which had thrown back four steel 12in. projectiles and broken up one of chilled iron; (2) a 10½in. nickel steel plate with a hardened face, against which five Krupp steel shot had broken up. The Dillinger Huttenwerke Co. has also made good nickel steel armour, and steel plates are being successfully made in Russia, Italy, and Austria, the firm of Witkowitz having been recently successful in trials at Pola.

The above results show that great progress has been achieved since the reading of M. Barba's paper, but the particular matter to notice is the characteristic power of Harveyed armour to break up armour-piercing projectiles by imparting a specially hard face to all steel plates. Captain Tresidder devised a process of water chilling which was naturally applied to compound plates then made at Brown's, and which gave very successful results, forged steel shot breaking up on impact like chilled iron projectiles. The Harvey process, by which steel plates have faces highly carbonised on the face and water chilled, has been still more successful, and having achieved great results when used by Bethlehem in America, has been taken up by Vickers and other British firms subsequently, and has been adopted by the British Admiralty for three important battleships now building.

Speaking of the tests of different nations, American trials, the writer considered, were characterised by conditions rather more favourable to the plate than to the shot, while in France the reverse is generally the case. In English and some foreign trials, he held that the authorities had accurately gauged the resisting power of the Harvey plate, as in the Nettle tests of 6in. armour. These, he considered, indicated a superiority in resisting power as compared with wrought iron of 183 per cent., while in France a superiority was indicated of from 177 to 205 per cent., according to the formula used.

In the United States it has been assumed that, the nickel plates being found excellent, Harveyed nickel plates would be better than Harveyed all-steel. In the Indian Head trials of 1891, a low carbon all-steel Harveyed Bethlehem plate was beaten by a Harveyed high carbon nickel steel plate of the same company, but the amount of carbon affects the question. In Great Britain the cost of nickel led to a close examination, which led to an opposite conclusion to that arrived at in the United States. With a slightly increased tendency to crack, all steel has shown greater resistance to penetration. Besides the question of cost, it is found that high carbon nickel steel is unmachineable, so that it becomes impossible to drill and tap any small hole that may be required in the plate face. This difficulty has arisen in the United States.

Next comes the important question of curving and shaping hardened plates as required. This has been regarded as a serious difficulty by both Dutch and Austrian Governments; but armour makers in this country have confidence in readily overcoming any difficulty in this respect, as the Bethlehem Company has succeeded with the side armour of the Maine, and as we have succeeded with sample Harveyed plates. As to mechanical tests, a 4ft. by 4ft. by 9in. plate, which had broken up 6in. Holtzer projectiles without cracking, was tested mechanically, and it was found that in all of the ten samples taken from the unhardened portion the metal had not suffered. One remarkable characteristic of this kind of plate is the extraordinary power of resistance of small fragments, and has been conspicuously shown in a Bethlehem 14in. plate and a Brown 6in. plate.

Altogether the writer held that it had been abundantly proved that Harveyed armour would be a more efficient defence to the vital part of any ship of war than any other kind, and he estimated their power at at least 50 per cent. above the steel and compound plates of 1888. Whether the gain be taken in increased power of protection on any given portion of the ship or in extending the protected area, it is a matter of satisfaction that the British Admiralty have been the first European Naval Power to adopt the Harveyed steel armour.

In the discussion that followed Mr. Hall, of Messrs. Jessop and Sons, spoke of the early success achieved by the firm to which he belonged, in thinner nickel steel plates, and he expressed such confidence in nickel steel that he suggested the possible success that might attend the construction of a small and heavily-plated ram, with nickel steel spur. In fact, he wished to call the attention of Mr. White to the value of nickel steel applied to the ram, whose power had been so sadly impressed on us in the loss of the Victoria.

Mr. W. Beardmore regretted that his experience in Harveyed steel armour had not been so successful as he could have wished. Having made a steel plate, and having submitted it to be Harveyed, with rather doubtful effect, he had since failed to get the process repeated. He took this opportunity of deprecating the manufacture of armour being confined to one or two Sheffield firms.

Sir Nathaniel Barnaby testified to the value of the paper.

Captain FitzGerald, R.N., asked whether the difficulty referred to the drilling in the face of nickel steel plates might not be got over by employing the arc light.

Captain Orde Browne suggested that a false impression might be conveyed by the general statement that American trials were less severe than English, for all their earlier trials were considerably more severe than our own, although more recently we had tested our plates to destruction. He also questioned whether the gain of the Harvey process was not at present mainly applicable to thinner plates, the water-chilling effect being constant in the depth of its action and the carbonisation difficult to carry deep. He referred also to the disadvantage of keeping all armour for so many days in a furnace.

Mr. White, the Director of Construction, expressed his appreciation of the great value of the paper as a complete record of experiments on "tested armour." He said that the Admiralty had no wish either to keep back facts or to limit the manufacture of armour to any number of makers. Early trials had not been published in the interests of makers who might suffer from publicity being given to unimportant experimental disappointments.

He testified to the success of the first 2in. nickel steel plate brought forward by Mr. Riley and to the 4in. plate referred to by Mr. Hall. He spoke of the value of nickel in unbacked plates; but in side armour he fully supported the author of the paper in advocating the advantage of Harveyed steel plates containing no nickel. The saving in cost was very great, but he spoke rather on the actual superiority of such plates. He said that the arc light drilling suggested by Captain FitzGerald had proved effectual in dealing with steel plates with hard faces. As to Captain Orde Browne's questions, he held that any theoretical diminution of good effect of treatment in thicker plates did not matter much, seeing that they had obtained a great measure of success up to all thicknesses with which they were at present concerned, and slowness in work at the furnace was met by multiplying the number of furnaces. He held at the present moment England took the lead in the investigation of armour.

Mr. Vickers observed that Mr. White had greatly relieved him of work in reply to questions raised. He regretted the omission of any plate trial in his record, but he had included all that he thought of as within the scope of the work, and all he could hear of, not omitting one unfortunate sample of his own firm's work. As to arc light drilling, he explained that it overcame hardness from water chilling, but not that due to nickel. It had been found also that the tendency of nickel to crystallise at a low temperature was damaging in the Harvey process.

HARBOURS AND WATERWAYS.

THE Grand Canal Company of Ireland has had an increase of traffic to the extent of £4665 during the past year, and the directors have advised the payment of a dividend of 3½ per cent. The capital of this company consists of £666,000 ordinary stock. At the meeting of the shareholders an arrangement was approved which had been made for the purchase of the Barrow Navigation, which extends from a junction with the Grand Canal at Athy to the tidal way at St. Mullins, passing through Carlow, Milford, Leighlinbridge, and Bagnalstown, and going on to New Ross and Waterford. The capital of the Barrow Company is £60,000, and their last two dividends were paid at the rate of 3 per cent. The price of purchase was £30,000. This does not include the boats, horses, and other plant, which, at the option of the Grand Canal Company, may be taken at a valuation.

East coast harbour of refuge.—The County Council of the East Riding of Yorkshire have sent a memorial to the Government calling attention to the desirability of a harbour of refuge being constructed on the coast of Yorkshire, the necessity for which, they point out, was seriously emphasised by the storm of November last. During the gale referred to no fewer than thirteen casualties occurred within an eighteen-mile radius of Flamborough Head. The stream of traffic which passes along this coast is very large. In addition to the colliers which are always going to and fro, there are the vessels engaged in the Baltic and continental trades, and a very large fishing fleet belonging to different stations along the coast. The Royal Commission which inquired into this matter in 1858, after examining 400 witnesses, reported in the following year strongly in favour of the construction of a harbour of refuge at Filey. Filey was also recommended by a committee which was appointed in 1883 to consider the best means of employing convicts. Sir John Coode, who was called upon to report on this matter, held that no site on the East Coast approached Filey Bay as a harbour of refuge, as it afforded ample depth of water for vessels of the largest class in the navy; the nature of the anchorage is excellent; there are advantages in favour of economical construction from the net of rocks known as Filey Brigg; and also from the facility for obtaining stone from the adjacent cliffs. The plan he proposed was to carry the breakwater along the Filey Brigg reef of rocks to the extent of 1800ft., then curving to the south-east and terminating by an arm 1400ft. long bearing S.W. to W., the total length being 3200 yards and having the opening bearing nearly south. The entrance would be protected by the coast, which trends to the south-east. This breakwater would enclose 200 acres having a 5-fathom depth at low water, and 400 acres having 2½ fathoms. The estimated cost was £860,000. A second scheme having an opening to the north, and on a more extended, scale was estimated to cost £1,250,000.

Amongst local mariners and coastguard officers Bridlington appears to be more in favour than Filey. It is contended that for every vessel that now takes shelter in Filey fifty go to Bridlington. Bridlington has the advantage of the natural protection from northerly gales off Flamborough Head. In the bay are two shoals, called the Smithies, composed of limestone, which would provide a foundation for the required breakwater. Inside the bay, when dredged to the required depth, vessels of the largest capacity could shelter at all states of the tide, and in gales from all quarters. One design would require a breakwater 3½ miles long, enclosing 300 acres, with anchorage of from 5 to 6 fathoms, the same area of over 4 fathoms, and 1400 acres over 3½ fathoms. The other would provide 300 acres of deep water, and 1000 acres varying from 2½ to 4 fathoms, and require a breakwater 2¾ miles long.

The formation of a harbour in Tees Bay was reported upon favourably by the late Mr. Rendel in 1855, and by Sir A. Rendel in 1883. The former placed the site at Hartlepool, and the latter at the mouth of the Tees, the estimated cost being £1,400,000. The next point in favour of this site is the ease with which slag could be obtained for its construction, whereas at Bridlington there is no material within ten miles. Another advantage is that, in the event of war, vessels going in the harbour could retire to a place of safety up the river Tees. A harbour outside the Tees would also have the advantage of obtaining supplies of coal and other materials from a large commercial centre, and in addition to acting as a harbour of refuge for ships passing along the coast, would prove of very great service to the vessels navigating the Tees, and in these respects be superior to either Filey or Bridlington.

Cape Town.—The first of the new iron jetties in course of construction at the docks has been completed. This jetty is 660ft. long and 70ft. wide, and runs at right angles to the breakwater, having a depth of 30ft. of water, and consequently capable of berthing the largest of the Union Company's steamers. The cost of this jetty and attendant works has been £73,000. The iron was sent out from this country ready for fixing, and the work has been carried out in a very short space of time, under the direction of Mr. Thwaites, the resident engineer, from the plans supplied by Messrs. Coode, Son and Matthews, who are the engineers of the Cape Government.

AT the meeting of the Association of Municipal and County Engineers, on Saturday, April 7th, at Reading, the breaking up of macadam by machinery will receive special consideration.

ON THE CONSTRUCTION OF THE MODERN LOCOMOTIVE.

SECTION V.—THE MACHINE SHOP.

[*Continued from page* 172.]

THE following are a few operations that can be done by milling, which perhaps do not adequately represent what the author would wish to convey, but will tend to show, and perhaps suggest to some, the extent to which milling may be applied as far as locomotive or any other work is concerned.

After the coupling and connecting rods—Figs. 227, 229, in THE ENGINEER, vol. lxxv., page 223—have been marked out, they are placed two at once upon the machine table for milling by two cylindrical cutters, each 10in. diameter, and 11in. long, on a 5in. spindle attached to the cross slide, and supported by three brackets. Each rod is fixed at its ends by aid of a jacket, which is simply a box, attached for the occasion to the machine table. These boxes have adjusting screws through their ends and sides, so that the rods can be set to the centre lines by aid of the surface gauge in the first instance, but of course after one side has been milled it acts as a foundation for the opposite. These are parallel Fig. 278 clearly showing this. They are then dropped upon a pin fixed in the same table at each end, and secured with nut and washer and milled round the edges, cutters being used which leave all fillets and radii alike.

The stirrup link—Figs. 237-239, THE ENGINEER, vol. lxxv., page 223—also for the Joy motion, after being marked out is placed upon a vertical milling machine, and the outside faces milled up by parallel traverse of the table, then the pin holes are drilled and again dropped upon the milling table, and the profile edges gone over. These, as well as the swing links and all other work with sides not parallel but straight tapers, are set so that one side is made parallel with the cutter or the traverse of the table, milled, and then the other side done. After each side has been machined they are put on to the table of a vertical cutter having circumferential movement, which mills the circular ends or round corners. The only rough portion remaining is between the forks, and this is machined by using the jacket shown in plan and elevation—Fig. 279—and section A B—Fig. 280—which is held to the table by aid of the T slots, and the cutter passes to its work after a very rapid fixing. Finally—Fig. 281—refer also THE ENGINEER, vol. lxxvi. page 187, Fig. 253—shows, perhaps minute and $\frac{1}{16}$in. feed per stroke, after which they are removed to the drilling machine, which really consists of two radial arms 18ft. 4in. apart, the table for each being a carriage or trolley on an 18in. gauge capable of free traverse, which enables the driller to give the frames longitudinal movement as the work proceeds, the whole process being exactly similar to that adopted for the barrel plates in the boiler shop, and previously referred to. Some frames require a set inwards at the smoke-box end, for radial-wheel clearance, and this is done on the straightening table by the afore-mentioned hydraulic jacks. The cross stay, motion plate, and the foot or drag plate are first machined on an ending or double-headed rotary facing machine, which will face up anything that goes between the frames of an engine. A little margin is allowed for adjustment of each head, there being twenty tools fixed in each disc—2ft. diameter—by wedge bolts, and speeded to 25ft. per minute, and 1in. feed for steel castings, and increased to $1\frac{1}{4}$in. for iron castings. All the necessary holes for bolting or riveting to the frames, slide-bar brackets, anchor links, &c., are drilled and bored by the aid of jackets, and the steel castings are sent to the grinder to be scaled. The foot or drag plate has the bearing for the tender-buffer rubbing blocks machined by an end milling

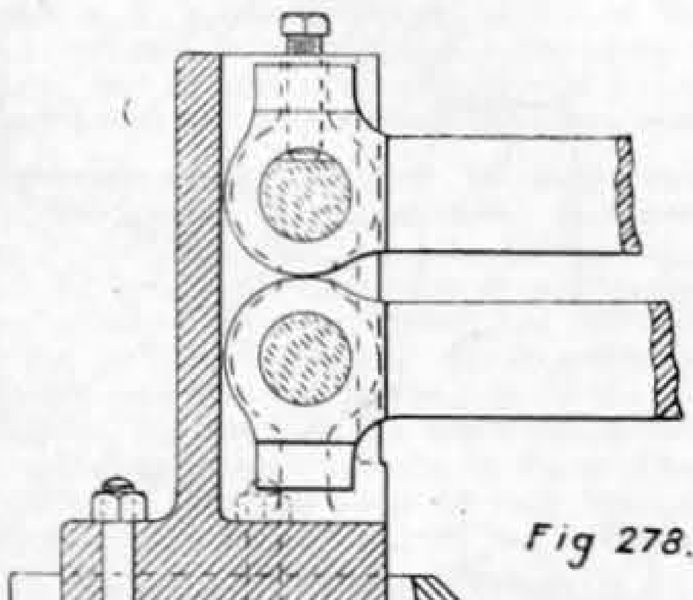


Fig 278.

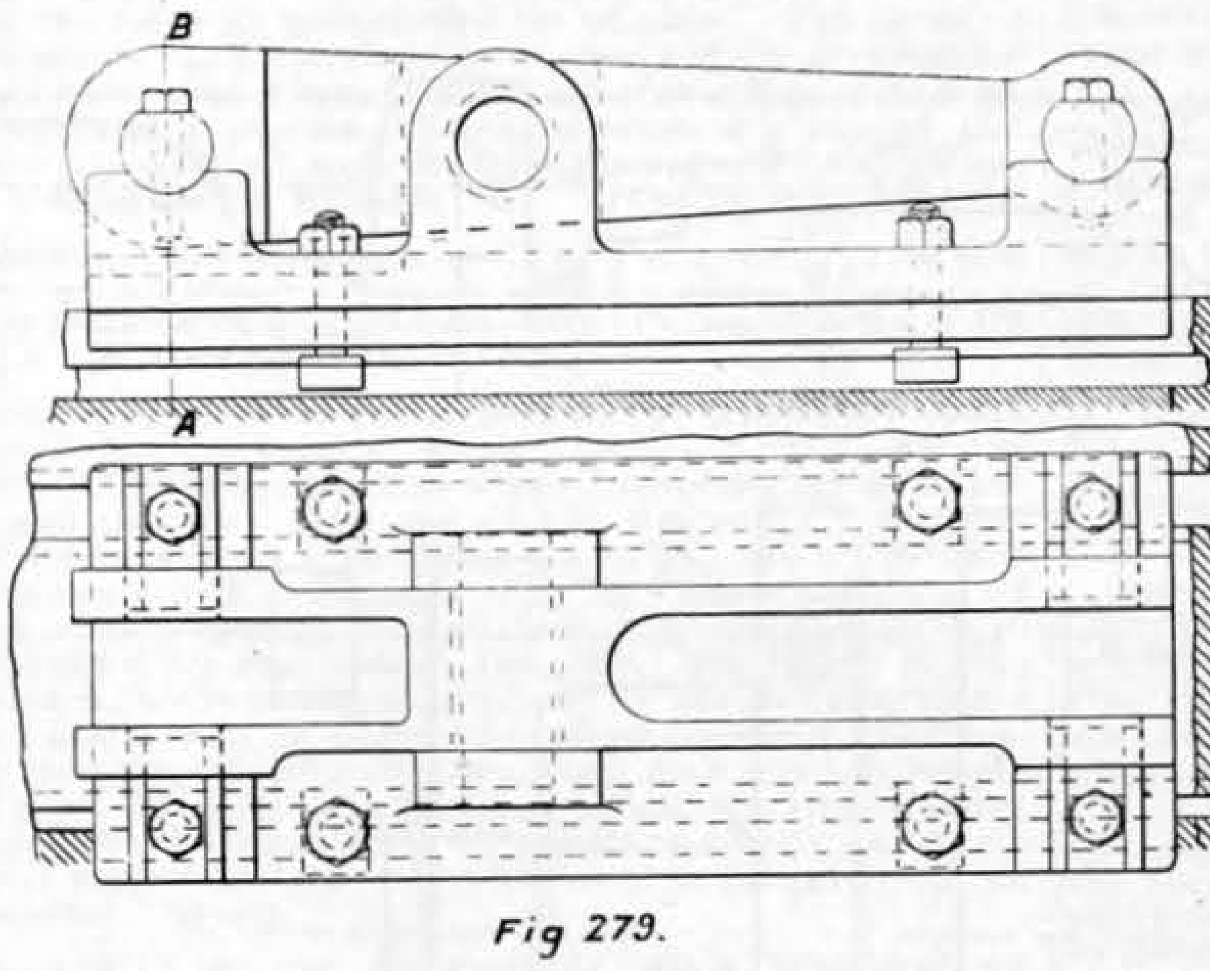


Fig 279.

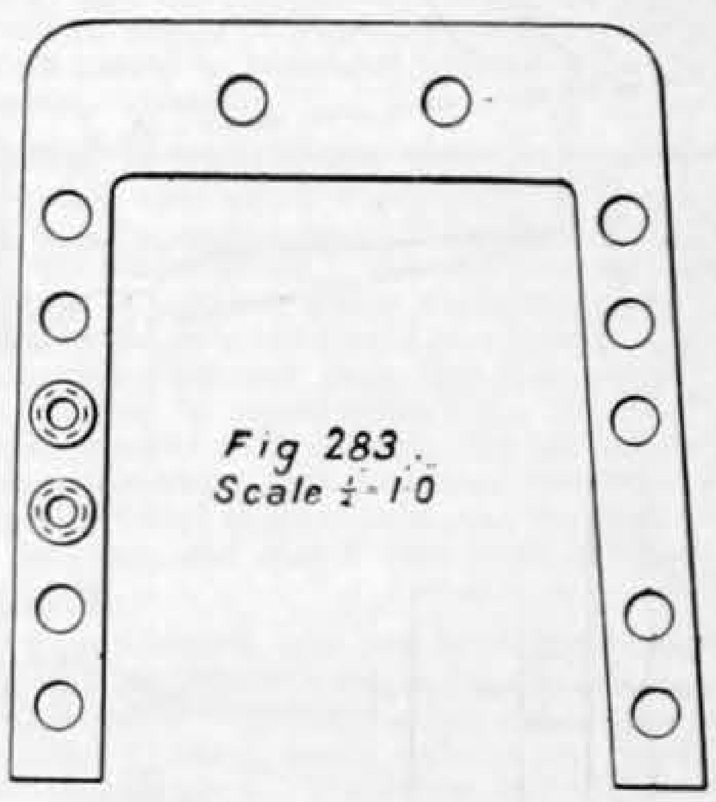
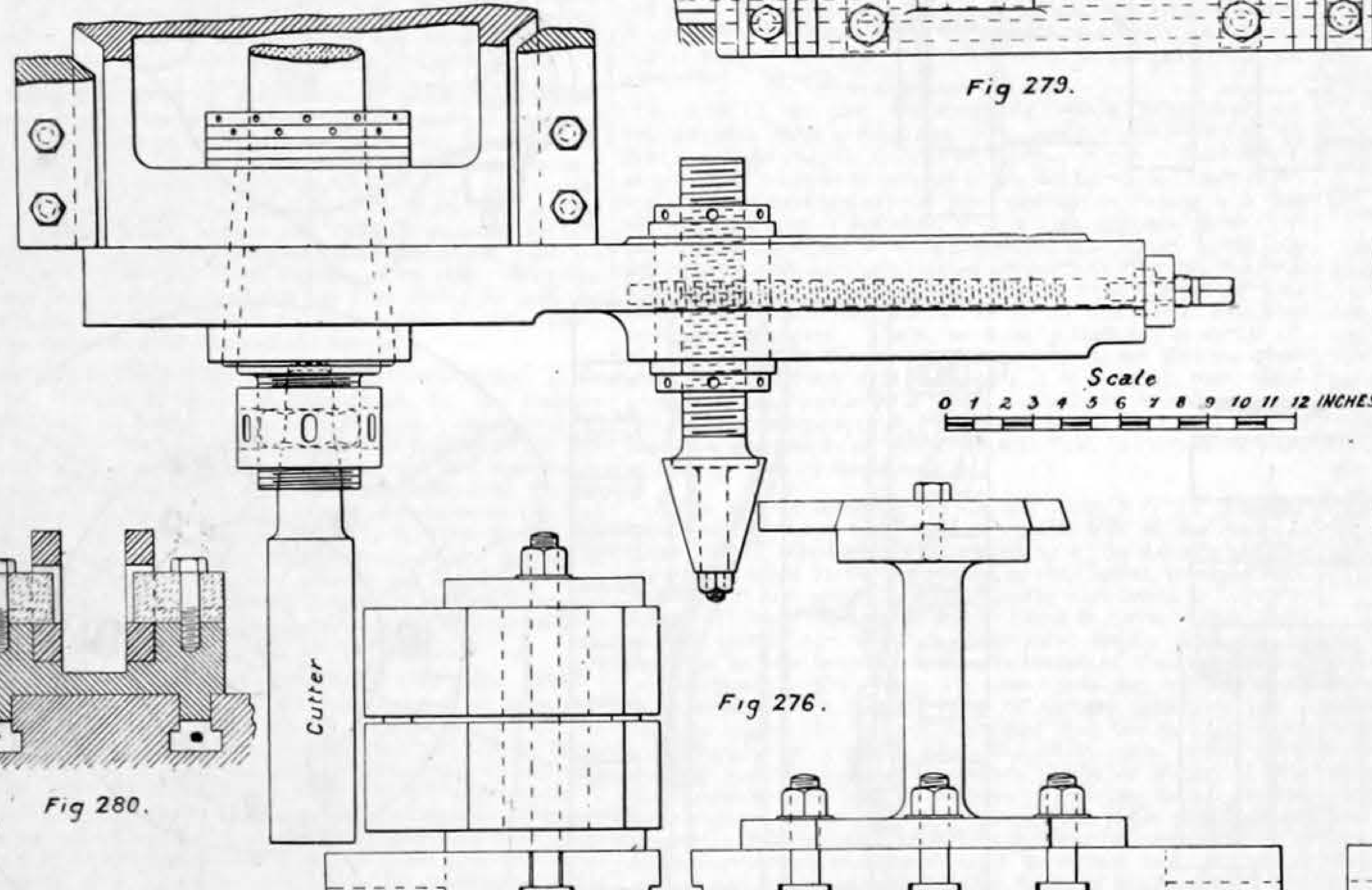


Fig 283. Scale ¼ = 1 0



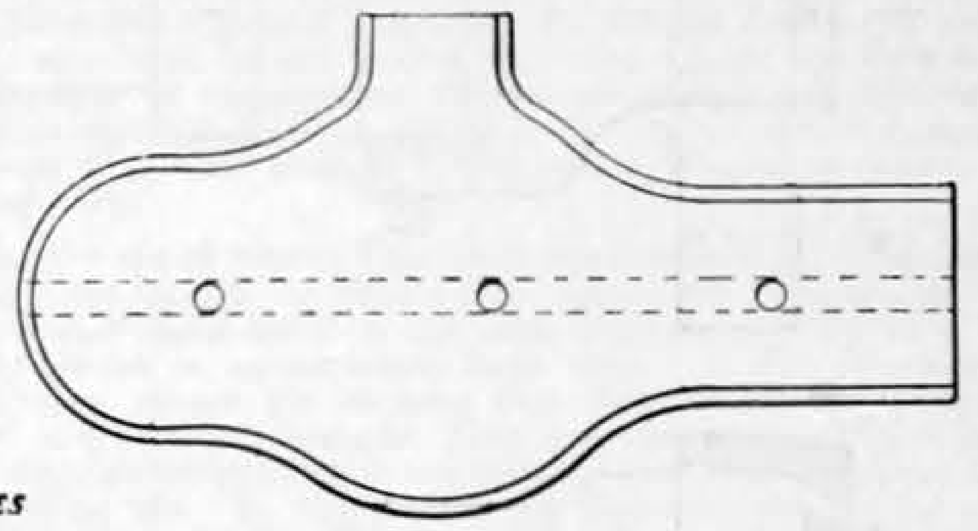


Fig 277.

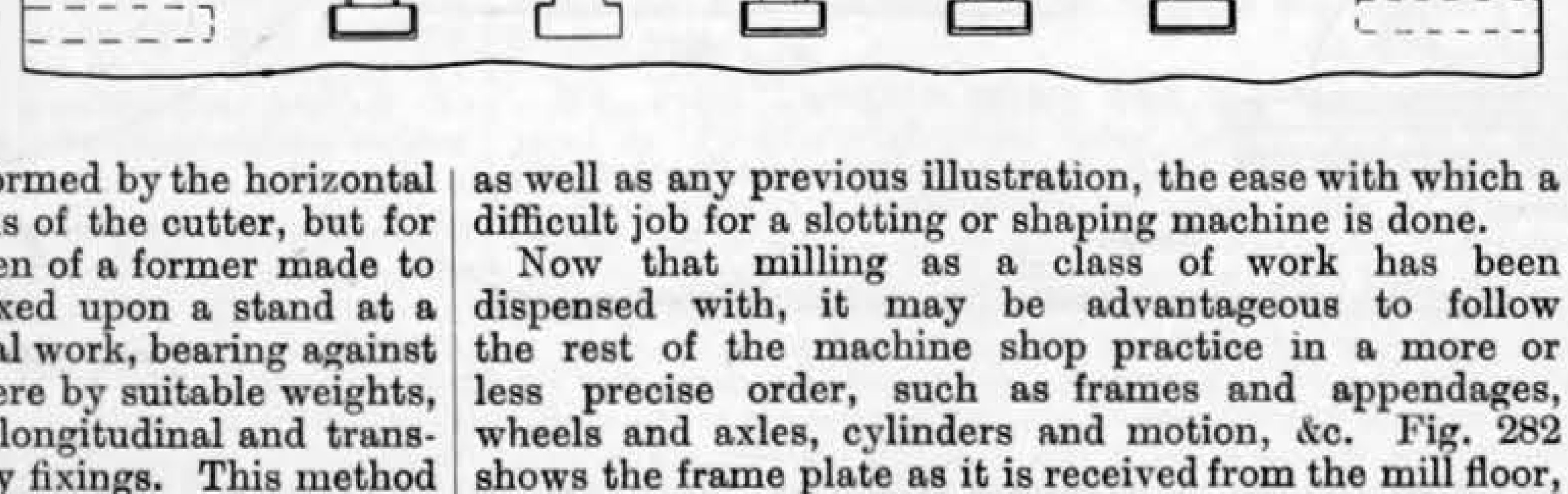
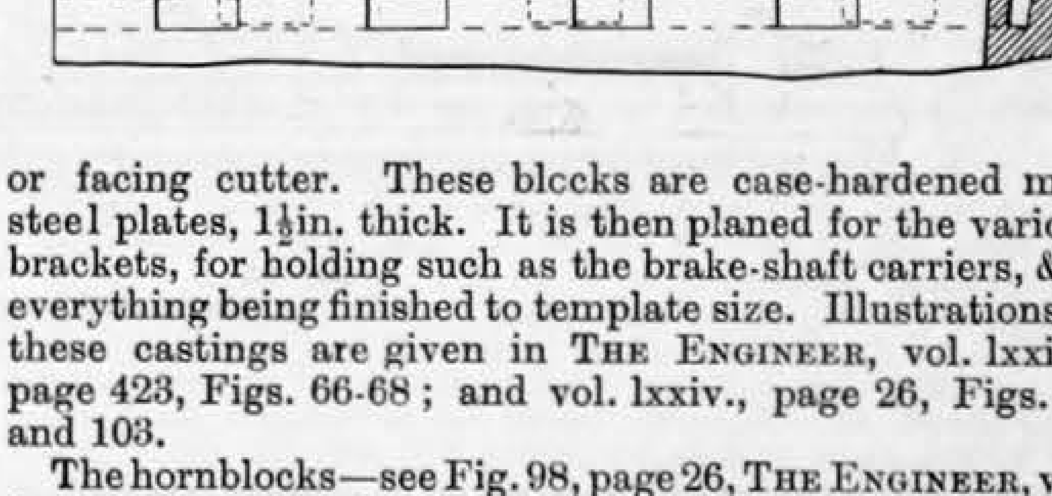


Fig 276.



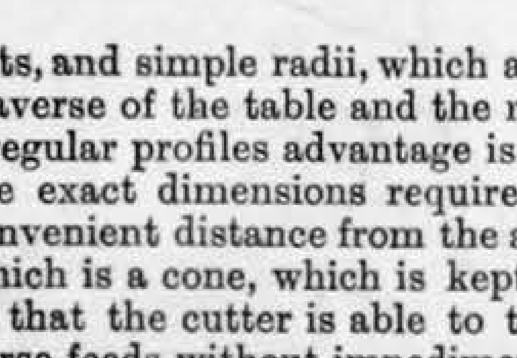


Fig 280.

cuts, and simple radii, which are formed by the horizontal traverse of the table and the radius of the cutter, but for irregular profiles advantage is taken of a former made to the exact dimensions required, fixed upon a stand at a convenient distance from the actual work, bearing against which is a cone, which is kept there by suitable weights, so that the cutter is able to take longitudinal and transverse feeds without impediment by fixings. This method is illustrated by Fig. 276, which shows the profiling arrangements for the joint end of the coupling rods. In the fixing of this, advantage is taken of the holes for the crank pins, which have been bored out, so that by fixing standard mandrils in the T slots of the table, these rods are very expeditiously set and without trouble, and, moreover, there is no encumbrance whatever to impede the progress of the feed when once started. Fig. 277 is a side elevation and plan of the former and its stand. After these operations have been accomplished, the bolt and oil syphon holes are drilled and reamered out, which finishes the machine work. Nothing now remains but to finish on the fitting bench, by coupling up the brasses and straps to the connecting rods, and forcing in the bushes of the coupling rods, then all is ready for the erecting shop.

The valve rods and anchor links—Figs. 233-35, THE ENGINEER, vol. lxxv., page 223—are first milled upon each side of the boss, and afterwards the pin holes drilled, two at once by the aid of a jacket, with case-hardened bushes and a twist drill. Afterwards they are put on a 2in. mandril in the centre of the table of a vertical milling machine and worked round the bosses. Then they are placed upon the table of a small profiling machine, and milled upon the flats by the aid of a jacket, which is secured to the table, and made specially for this job; they are of sufficient depth and width to receive the ends of two links—as well as any previous illustration, the ease with which a difficult job for a slotting or shaping machine is done.

Now that milling as a class of work has been dispensed with, it may be advantageous to follow the rest of the machine shop practice in a more or less precise order, such as frames and appendages, wheels and axles, cylinders and motion, &c. Fig. 282 shows the frame plate as it is received from the mill floor, also, as it leaves the slotting machine, the centre lines of buffer, cylinders, axles, and the drilled clearance holes for the slotting tool. All frames are first put on to the levelling table, tried over, marked and straightened by the aid of two hydraulic jacks, which are attached separately on carriages, or conjointly on one carriage, having longitudinal movement, the jack itself being capable of traversing transversely. Dealing with frames, it has been found preferable to dispense with the thin template, as it is so liable to get out of truth by constant use, such as buckling, no matter how well it is braced with angle irons, which are always more or less in the way, and the means adopted in its place is to mark out one frame, which is a two hours' job, and proceed in a somewhat similar manner to that described in the boiler shop practice—THE ENGINEER, vol. lxxiii., page 1. This serves as a jacket for drilling and marking out, until the last batch is finished. They are slotted at a three-head slotting machine, four pairs—or eight frames at once—each head having a drilling arrangement for the slotting tool clearance, the plates being first roughed out by the three parting tools, which are $\frac{7}{8}$in. or 1in. wide at the point, leaving $\frac{1}{8}$in. for finishing. All bolts and cramps are slackened previously to finishing, to allow the elimination of any spring or buckle that may be held by internal strain, and released by the removal of the roughing-out pieces. They are then finished, twelve strokes per or facing cutter. These blocks are case-hardened mild steel plates, $1\frac{1}{2}$in. thick. It is then planed for the various brackets, for holding such as the brake-shaft carriers, &c., everything being finished to template size. Illustrations of these castings are given in THE ENGINEER, vol. lxxiii., page 423, Figs. 66-68; and vol. lxxiv., page 26, Figs. 87 and 103.

The hornblocks—see Fig. 98, page 26, THE ENGINEER, vol. lxxiv.—are first planed for the frame seating to template a quantity at once, at 21ft. per minute, and then sent to a vertical milling machine for machining the axle-box seating and the space for the adjusting wedge. This is accomplished by placing the casting planed face downwards upon a jacket, which at once fixes it, and then passing a cylindrical cutter over each side, which covers the whole surface, and afterwards this is removed and a facing cutter placed upon the same spindle to cut out the groove for the adjusting wedge. It is then slotted at the bottom for the keep and also for the wedge bolt hole. The holes are then drilled through the cast iron jacket —Fig. 283—having hardened bushes, to standard 1in. holes. It then goes to the bench, and the wedge, keep, &c., are all put together and sent in sets to the erecting shop.

The axle-boxes shown in Figs. 157-161, THE ENGINEER, vol. lxxiv., pages 384 and 573, are made of phosphor bronze. Steel castings are also used, wrought iron case-hardened being a thing of the past. The bronze boxes are first put on to the planing machine twenty-two at once, in two rows of eleven each, upon parallel strips, and secured to the tables by bolting to the T-slots, for machining to gauge between the jaws for the keeps, the cutting operation being performed from the cross slide and the feed vertical. After the keeps have been planed, they are dropped in a good fit and the $1\frac{1}{4}$in. hole opened out for the mild steel case-hardened pin which carries the spring link. The boxes are again fixed on the planing machine attached to a double angle plate, which is secured to the table, and brings them within range of the tool boxes upon each upright, besides those on the cross side, thus machining one horn seating and one face of twelve boxes, six on each side, at one operation, this method being repeated for the other seating and side. Afterwards they are taken to the bench, and the lids or caps to the oil and tallow boxes fitted on. In passing to the erecting shop, they stop at a handy little shaping machine which puts the oil grooves in the horn seating, a much neater and quicker job than chipping; and here it may be mentioned that many oil grooves in various seatings, &c., such as slide blocks, are milled in at a quick rate by a small circular cutter. The boxes are bored six at once in a machine located near the erectors, and dealt with in that section. The speed of the table for planing is 25ft. per minute, and the feed 1/16in. for each stroke. This speed, compared with that for turning brass, appears very low, but it must be remembered that wear and tear, which takes place in a centres are then adjusted by the set screws and rigidly keyed up, care being taken that they do not move during this operation. Fig. 284 gives the longitudinal elevation and Fig. 285 the end elevation of these centres, with jack bolt complete. The whole arrangement is then placed in the crank sweep milling machine, which, *inter alia*, consists of a disc with about eighty ordinary tools wedged in the periphery, 4ft. 2in. in diameter, and having a circular speed of 10ft. per minute. The feed can be adjusted so that as a less number of cutters are engaged simultaneously, it can be increased, and may average 6in. per hour circumferential speed of feed, the centre of the crank pin for the radius; or in other words, the whole space, may be removed in from eight to ten hours, leaving ½in. for finishing the crank pin. This machine has been described upon more than one occasion, and is well known. The crank is then removed to the finishing lathe and completed, four tools being used, that is two back and two front slide rests. The webs are then slotted round, there being two tools in separate boxes on the same head, each the required distance apart, of ordinary dogs to the face plate, and this git is removed by a parting tool, which is made out of bar steel 3in. deep, ⅝in. wide at the top, and ½in. at the bottom, jumped up to ⅞in. wide at the cutting edge. While thus fixed they are rough turned all over, including the wheel seat, topping on the tread, and also the sides of the balance weight. They are then re-annealed, and the wheel seat is bored to the standard size, and pressed on to the axle. The pair are then turned to gauge for the tires, the speed varying from 16ft. to 18ft. per minute. Fig. 287 shows an extremely handy chuck for wheels of small diameter, say bogie, &c., which is attached to the ordinary face plate. The drivers are represented at A, the bearings for the spokes at B, and adjustment under the rim at C. This arrangement admits of the following operations being performed during the one setting:—Boring the boss or wheel seat, turning the tread, and facing upon each side of the rim.

The crank pin seatings are then bored out at a quarter-centre boring machine, parallel and both at once. This machine consists essentially of two headstocks, fixed

Fig 282. Scale 1/8-1 0

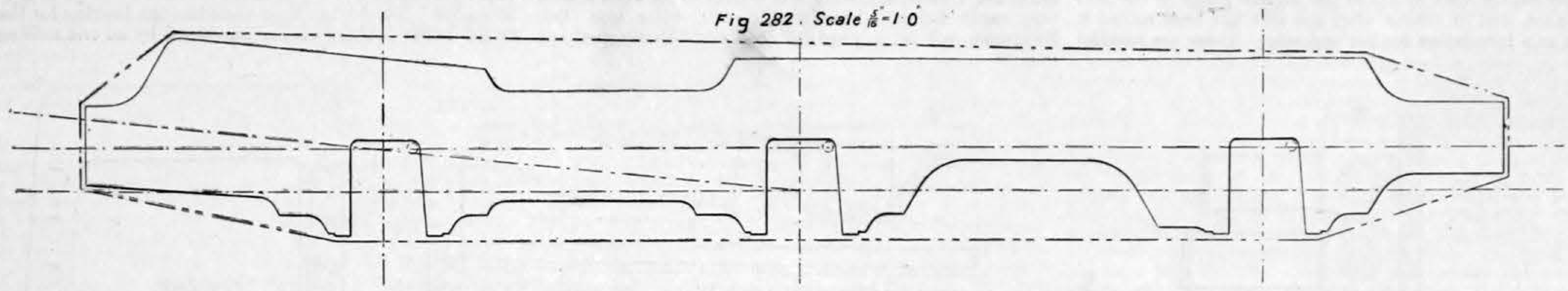


Fig 284.

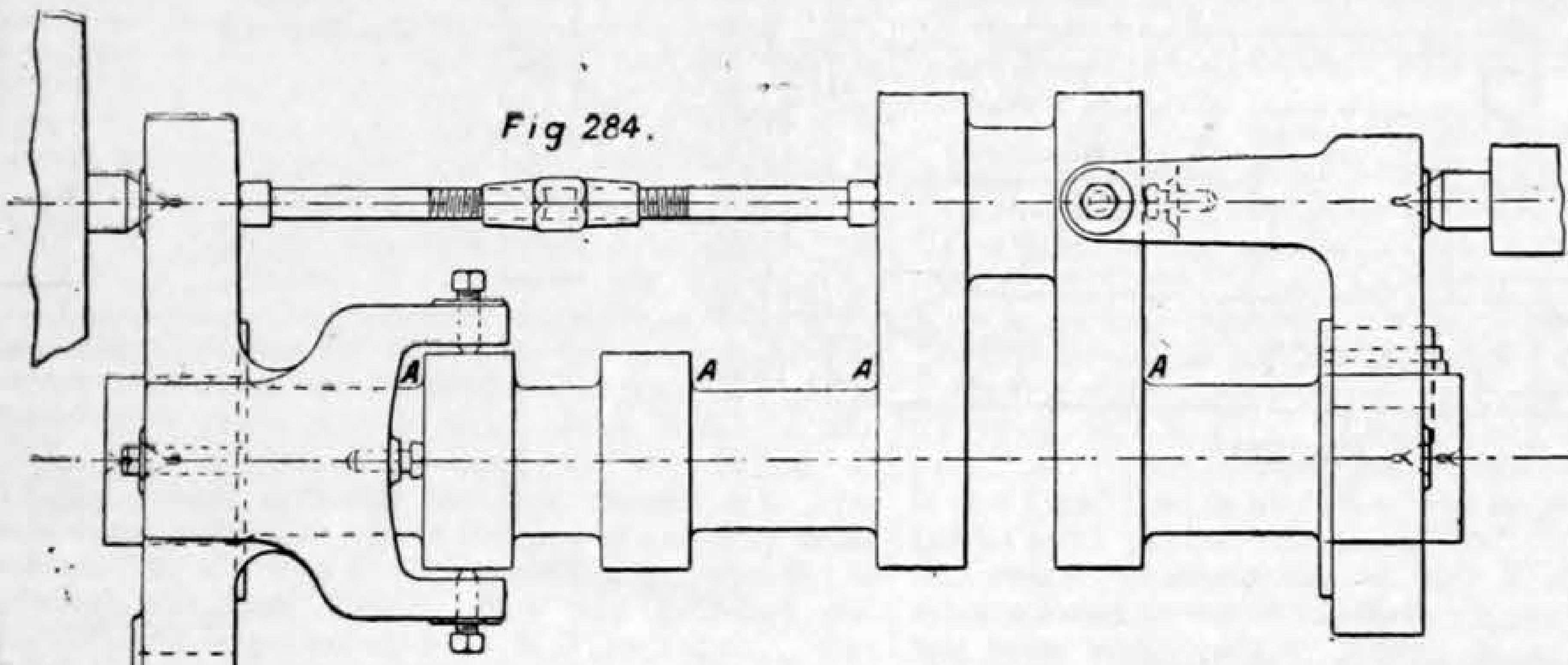
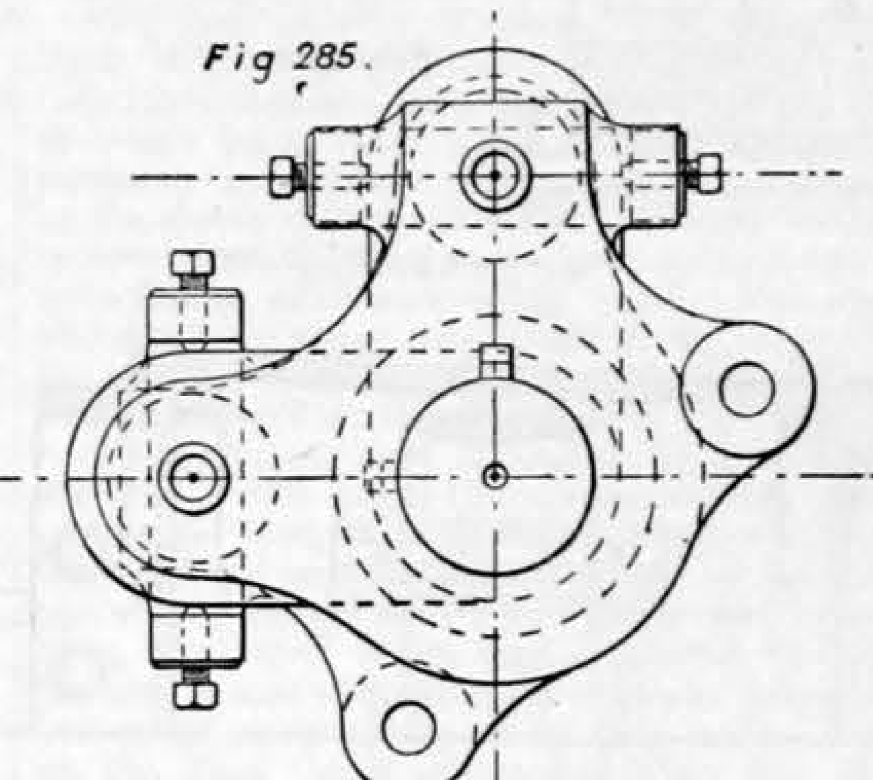


Fig 285.



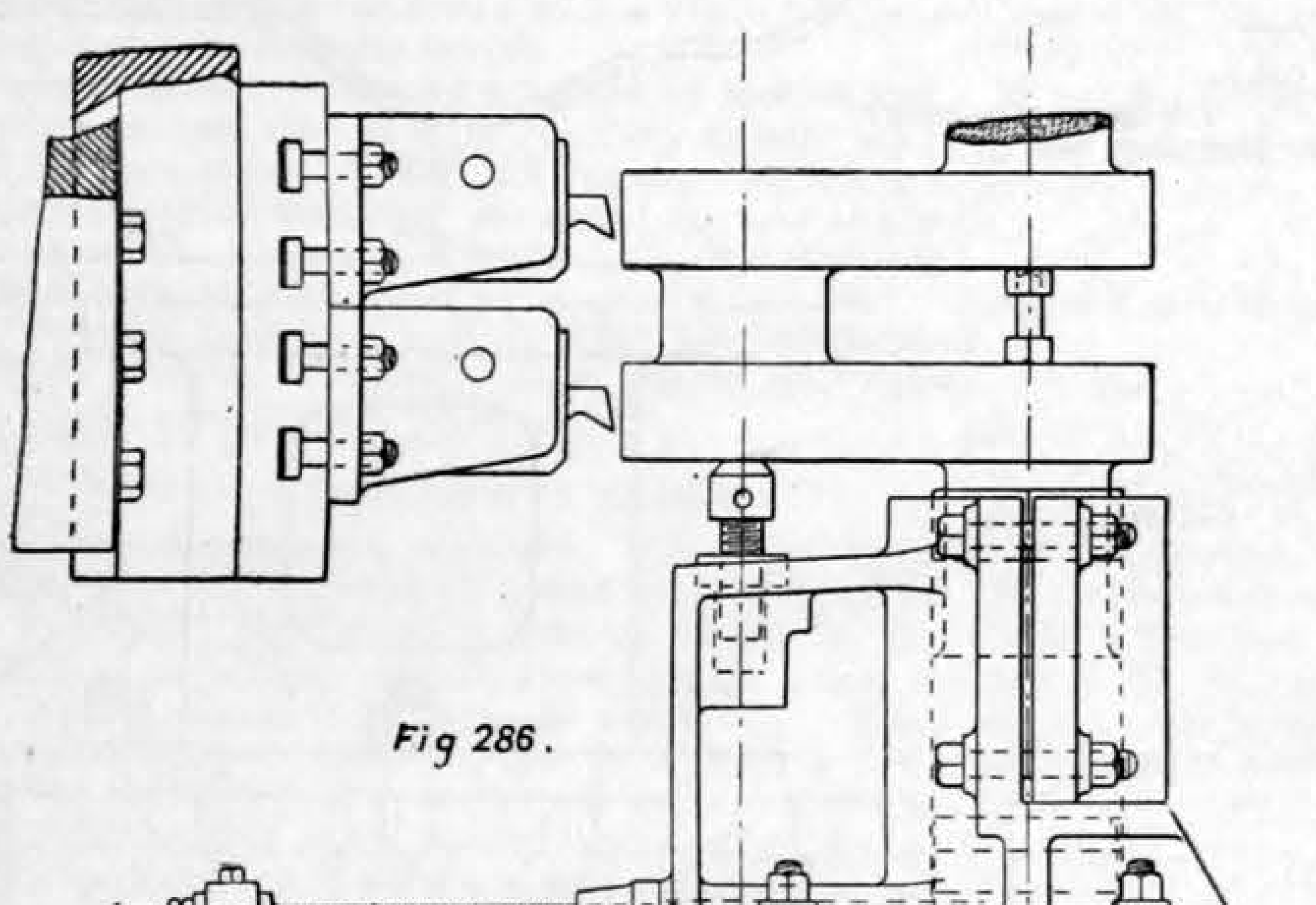


Fig 286.

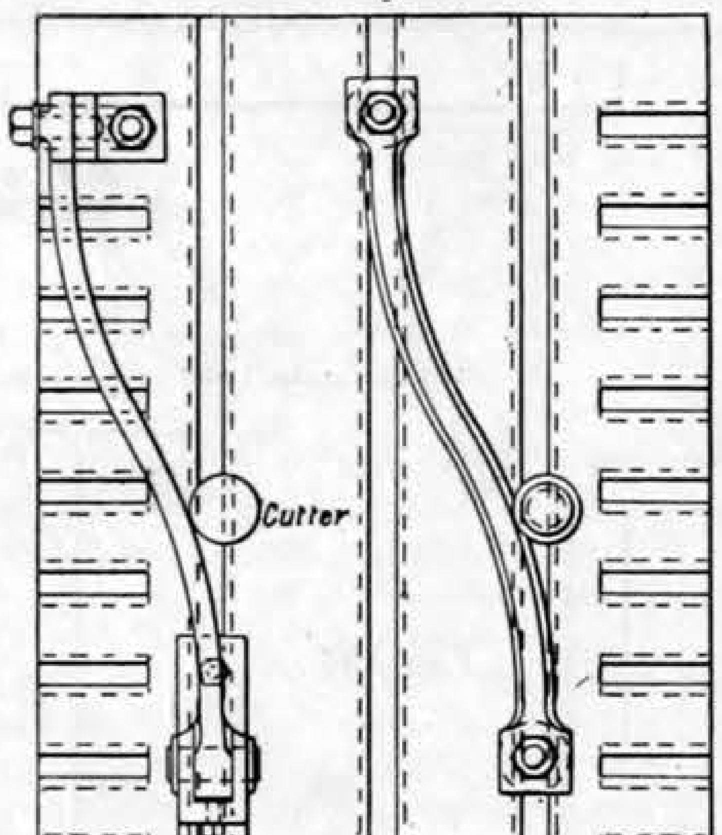


Fig 281

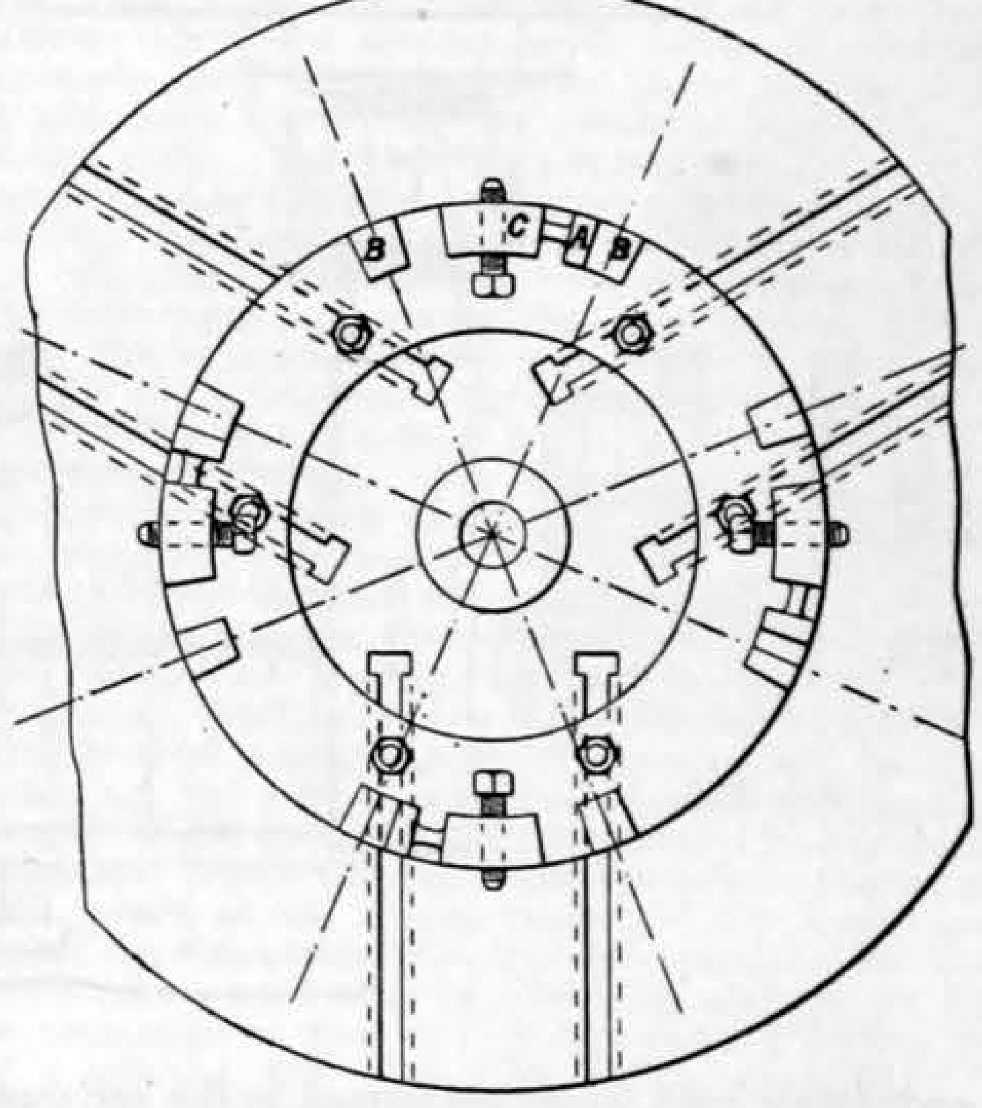


Fig 287.

Scale

high degree upon every reversal of the table, would be accelerated by any increment of speed.

The crank axles—see Figs. 219-222, THE ENGINEER, vol. lxxv., page 157—are first put in the lathe, square-centred, cut to length over all, and rough turned on the wheel seat and journal, leaving ⅛in. for finishing and also a square ridge in the fillets A, Fig. 284, to assist in the adjustment of the quadrant centre plates. They are then placed on the setting-out table to ascertain the error, if any, in the twist, which is never more than ¼in. Every crank must be tested for this, and the quadrants accurately set accordingly, for the finished crank depends entirely upon the initial adjustment and firm fixing of these quadrant centres. The error itself is discovered by setting level the horizontal sweep, and then fixing a square up against the ridges in the fillets A, and marking at the top of the vertical sweep upon each side, which shows the error to be the formation of more or less than the right angle. This is then divided between the two throws, by canting the horizontal sweep in the required direction, which alters slightly the position of the centre lines, and is finally eliminated by the slotting machine. It has never been known sufficient to return the crank to the forge for re-adjustment, if that were so trouble would ensue, for the forge twisting template is better looked after than to admit of so much error. The quadrant which arrangement necessitates only a 5in. stroke, twelve per minute. It is fixed for slotting by simply dropping into a box—Fig. 286—which is fixed and secured to the tables, and has a graduated scale which facilitates any required adjustment. The straight axle—Fig. 226 THE ENGINEER, vol. lxxv., page 157—is turned accurately to gauges, and the same speed is employed as for the pins and journals of the cranks, viz., 22ft. per minute, with a feed of ⅜in. to ½in. per minute. The key seatings are milled out at one cut, on a specially arranged horizontal machine. They then have the wheels pressed on at the wheel press, a total of one ton to two tons per square inch on a 9in. ram being employed. This range of pressure is not in any way due to inaccuracy of turning or boring, because every axle and every wheel seat, will be turned and bored upon every occasion to gauge and template, as near as any operator's touch will permit; but mostly to a difference in materials, cast iron of course requiring the least, and in steel castings some wheel seats may be harder than others, and a little extra resistance in the wheel seat makes a large difference on the pressure of the ram. Afterwards the wheels are keyed up, the crank pins for the outside rods fixed, and the whole sent to the erectors.

The wheels—Figs. 91, 94, page 25, THE ENGINEER, vol. lxxiv.—after being annealed and dressed up, come into the shop with the gits on. They are chucked by the aid upon one bed at a suitable distance apart, and in each is the gearing for driving the boring bar. The wheels and axle are placed between the centres, one crank pin seating below in a vertical centre line, the other seating will then be either leading or trailing. Between the wheels are two other standards or frames, for supporting the other end of the boring bar in a pedestal; this for the vertical seating is simply arranged for upward or downward traverse only, whereas the opposite can be transferred as required, leading or trailing, with a certain range of horizontal traverse, the boring bar being also capable of similar re-arrangement. The wheels are now ready for the tires, which have been bored and grooved to template at 10ft. to 20ft. per minute. These are put on by expanding, Bunsen jets being the heating medium employed, which is simply a perforated tube encircling the tire, and giving to the whole a very uniform heat. The ⅝in. tapping holes are then drilled through the rim for the securing bolts by a double-headed drilling machine, a smaller hole being drilled into the tire 1½in. deep for the end of the set screw, it being turned down accordingly.

(*To be continued.*)

THE TOWER BRIDGE.—At a meeting of the Court of Common Council, on the 8th inst., it was announced that the Prince and Princess of Wales had consented to open the Tower Bridge on a day in June next to be hereafter fixed.

RAILWAY MATTERS.

THE Great Northern Railway Company has built recently at Doncaster two new express engines of the famous 8ft. "single" class, the first constructed for seven years, viz., since 1887. They have the latest improvements—sand blast, carriage-heating apparatus, &c., but in all main points are identical with Mr. P. Stirling's original design of 1868.

THE convention regarding the cession of the working of the Bellova-Sarembey section of the Oriental railway to Bulgaria has been signed at the Ministry of Public Works by the Ottoman and Bulgarian representatives of the Eastern railways. The arrangement also comprises the Bellova-Vacarel Railway, which was seized by Bulgaria in 1888, and provides for the payment of an annual indemnity. The convention, which holds good for ten years, will now be submitted to the Porte for approval.

ABOUT 10 per cent. of the electrically welded rails in Boston have, according to an American contemporary, broken in service. The experiment proved that a continuous rail, protected by the pavement, shows no ill effect from expansion; but whether the rails broke from contraction or from inherent weakness due to the welding, is yet to be determined. Hereafter the entire end surfaces, including the head, will be united, and care will be exercised not to injure the fibre of the metal or to restrain the expansion due to the heat.

THE Secretary of State for Foreign Affairs has received from her Majesty's Consul at Cairo a despatch reporting that the Egyptian Railway Department will, until the 15th of May next, receive tenders for the construction of two bridges over the Nile and of three lines of railway, namely, Menouf to Achemoun, Barraris—section of Belcas to Bielah, section of Bielah to Kafr-Cheikh—and Guirgueh to Nag-Hamadi. The plans, specifications, &c., in French, may be seen at the Commercial Department of the Foreign-office, London, S.W., between the hours of eleven and six.

AN unusually large number of new railways were opened in Russia towards the end of 1893. One of these, 140 miles long, is an addition to the South-western system; another, 88 miles long, east of Warsaw; a third, 25 miles of narrow gauge line, and a fourth, the branch of the Vladikaukaz line 166 miles long, eastward along the northern foothills of the Caucasus to the Caspian Sea at Petrovsk—the first rail connection of the Russian system with the Caspian, the line from the Black Sea to Baku being separated from the other Russian railways by the mighty range of the Caucasus, while the Volga has been the only transportation route to and from the Caspian.

WORK on the stations over the West Highland Railway is being rapidly proceeded with, and at several places the offices—of brick and timber for the most part—are nearing completion. Within the past day or two the general passenger superintendent, general goods manager, and other officials of the North British Company, who will have the working of the new line, were inspecting the Helensburgh section with a view to arranging working details. The railway is expected to be opened in July, according to present calculations. A feature of the new route will be the running of corridor trains from Craigendoran to Fort William.

THE recent returns of accidents to railway servants shows that for each of thirteen years for which returns are given, the servants killed in the employ of each company were as follows:—Caledonian, 1 in 409; North British, 1 in 477; Lancashire and Yorkshire, 1 in 552; South-Eastern, 1 in 608; London and South-Western, 1 in 620; Great Eastern, 1 in 646; Midland, 1 in 750; Great Northern, 1 in 754; London and North-Western, 1 in 767; Highland, 1 in 774; London, Brighton, and South Coast, 1 in 787; Great Western, 1 in 882; North-Eastern, 1 in 1129. Why the Caledonian Railway Company should kill 1 in 409 of its servants per annum and the North-Eastern only 1 in 1129 is a matter which causes one to question the whole of the figures.

ACCORDING to the report on the Intercontinental Railway by Mr. William F. Shunk, of Harrisburgh, Pa., the distance from New York to Buenos Ayres is 4300 miles, which could be reduced to 4000. The cost of the roadbed and bridges on the line to be built would be £6000 a mile, and for a road and equipment, ready for operation, £10,000. The northern division of the line surveyed lies along the Pacific slope from Tehuantepec to the Bay of San Miguel, crosses the Isthmus, thence to the river Atrato, and ascends the Sucio, an affluent of that river, to the vicinity of Antioquia. The southern division ascends the valley of Canca River for 300 miles, and thenceforward occupies an upland ranging from 7000ft. to 12,000ft. above the sea, between the great Cordilleras of the Andes, blocked by occasional cross ridges.

AMONG the committees appointed by the Master Mechanics' Association to report this year, none is so important as that on "Boiler and Fire-box Steel." This committee has had one meeting, and it is to be hoped that work will not be intermitted. There never was a time, the *Railroad Gazette* remarks, "when steel makers were as ready as now to fill any reasonable specification at a low price. Fire-box and shell steel according to Government specifications has been recently sold at a price lower than inferior boiler steels were sold at last year, and now is the time to make up a standard specification for locomotive boiler steels that will answer all the practical requirements for a long time to come. This is what is expected of the committee, and there are several railroads which are awaiting the report of the Committee, hoping that it will contain a recommendation looking to standard specifications."

AN exhibition was given of the two-line railway known as the Boynton Bicycle Railroad between Hagerman Station and the Great South Bay, at Bellport, L.I., on the 16th, which was witnessed by 27 members of the Massachusetts Legislature, including the members of the Senate Transit Committee, the Senate Committee on Street Railways, and the House Committee on Transit. In addition to the above there were about 100 prominent railroad men from different parts of the United States. The road is two miles long, but in that short distance a speed of over fifty miles an hour was obtained. This is another of those inexplicable curiosities like the so-called single-rail railway, which always have at least three rails. This bicycle railroad has two rails, but by way of varying the monotony of the ordinary railway with two rails on the horizontal plane, and by way of increasing the cost of construction, the two rails in the Boynton bicycle road are placed vertically one over the other. They are held in position by large frames through which the carriages pass and which are supported on columns.

ON the 20th of January the boiler of a locomotive burst at the Ringwood station, Melbourne, with terrific explosive effects, although no person sustained any injury. The boiler was torn open like so much paper, and one piece of the boiler plate weighing 7 cwt. was found 200 yards away from the line. A lamp-room, a small wooden structure—opposite to which the engine was standing—was completely demolished. Windows were broken in houses more than a mile distant by the concussion. Both the driver and the fireman were on the engine at the time, and the *Adelaide Observer* says this accounts for their escape, the force of the explosion being expended laterally. Had they been standing on either side of the engine they must have been killed. The pointsman had walked past the engine just before the accident; and the guard, who was making his way towards it, was called back by the stationmaster for some purpose and delayed for a moment. To this circumstance he probably owes his life. The engine was built at the Phœnix Foundry, Ballarat, and had been in use eleven years. Mr. Richardson, Minister of Railways, has decided to appoint a Board of three experts, outside the department, of acknowledged skill in mechanics, to inquire into the cause of the explosion.

NOTES AND MEMORANDA.

AN interesting article on "Homogeneous Division of Space," describing the means of dividing any volume of space into equal and similar parts without residue, and also for dividing any area into equal forms of varied patterns, the design of which may be determined, was printed in last week's *Nature*.

IN a paper on "The Allotropic Transformation of Iron under the Influence of Heat," M. Georges Charpy draws conclusions indicating that the transformation is more rapid at the higher temperatures, but appreciable time is required, and hence duration of heating as well as temperature should be regarded in metallurgical operations.

THERE are about 200,000 miles of telephone wire owned by the Western Union Telegraph and the American Bell Telephone Companies, says the Chicago *Tribune*, and the former company is said to own a four-fifths interest in these wires. The telephone has a monopoly in about 2000 cities and towns in the United States, serving 175,000 subscribers and furnishing the means for 550,000,000 talks in 1893. The profits of the company are claimed to be £800,000 per year. At an estimated cost of £40 per mile for stringing a single telephone wire the plant of wire and poles alone is claimed to represent about £8,000,000. The Bell patent on the telephone receiver having expired, anyone in America can now put up his own short line telephone; but he must still pay as before for the advantages of being connected with a system which can afford an extended service.

A PAPER on the symmetrical aplanatic objective was recently read before the Paris Academy of Sciences by M. Ch. V. Zenger. The author has constructed systems of lenses imitating as far as possible the conditions obtaining in the human eye. He gives the necessary mathematical investigation. Two lenses, a plano-convex lens of phosphate crown glass, and a plano-concave of borate crown glass of less refracting and greater dispersive power, are combined to produce a system for which it is claimed that (1) the achromatism is exact for the entire length of the spectrum; (2) astigmatism is corrected very thoroughly; (3) spherical aberration, with a convenient aperture $\left(\frac{1}{F} = \frac{1}{20} \text{ to } \frac{1}{30}\right)$, is reduced to the minimum value of a second of arc; (4) the curvature of the field is absolutely corrected.

THE committee on standard sizes for catalogues, specifications, &c., appointed at the last meeting of the Master Car Builders' Association, has made a report recommending the following standard sizes. Postal card circulars, 3½in. by 6¼in.; pamphlets and trade catalogues, 3½in. by 6in., 6in. by 9in., and 9in. by 12in.; specifications and letter paper, 8½in. by 10½in. The matter of standard sizes for pamphlets and trade catalogues was discussed editorially in our issue of June 29th, 1893. The 6in. by 9in. size appears to be the coming standard and its universal adoption is a much desired end. A library of catalogues classified by subjects is a great convenience. We have often dealt with this subject, and agree with the *Railroad Gazette*, which says:—"Any variation in size which hinders grouping the pamphlets on one subject in one case or compartment is a serious hindrance in arranging them for convenient reference."

A REPORT on the discovery of crude petroleum on the Ashwick Estate, Somerset, was recently prepared by Mr. Boverton Redwood, F.I.C., and Mr. Topley, F.G.S. They stated, as the result of their investigation, that sufficient oil exists in the locality to warrant the expenditure necessary for boring, and that the detonations of a few charges of a high explosive in the well might have the effect of liberating deposits of the oil in the contiguous rock and causing a further considerable flow into the well. This recommendation was acted upon on Saturday last at Ashwick Court with satisfactory results, an ounce and a-half dynamite cartridge being used. The water came up thickly coated with oil. Mr. Redwood and Mr. Topley state in their report that the specimens of the oil obtained from the well at Ashwick were transparent, of straw colour, exhibited practically no fluorescence, and had an odour resembling that of refined rather than crude oil. It had a specific gravity of ·816 at 60 deg. Fah., and a flashing point of 175 deg. Fah. by the closed test.

AT a recent meeting of the Edinburgh Royal Society Dr. John Murray gave an address on the floor of the ocean at great depths. He discussed the character of the deposits and the organisms found at the sea-bottom by the Challenger expedition. Exclusive of the *protozoa*, certain species were found in Antarctic waters which corresponded to species found in Arctic waters, while no such species were found in intervening tracts. This may be supposed to have been due to the production of the same species, from different origins, under the same conditions; but it is more in accordance with modern ideas to suppose that they had a common origin. Dr. Murray suggested that the common origin was referable to a period when the whole ocean had a fairly uniform high temperature of perhaps 70 deg. or 80 deg. Under this condition there might have been a universal fauna. As the polar regions became colder, similar portions of the fauna became adapted to the like conditions of the northern and southern tracts; while the portion which was forced to retreat from the colder regions was now represented by the fauna of the coral reefs and tropical waters.

MR. JOHN AITKEN recently read the third part of a paper to the Edinburgh Royal Society on the number of dust particles in the atmosphere of certain places in Great Britain and on the Continent. Observations had been taken at Hyères, Cannes, and Mentone. There the air was never found to be very pure, the lowest number of dust particles recorded being 600 per cubic centimetre. At the Italian lakes the conditions were found to be somewhat similar. When the wind blew up the slopes from the valleys, the number of dust particles was greater than when it blew across the mountain tops. On the Righi it was also found that the air from the mountain was purer than the air from the plains. The haze increased with the number of particles. A connection was also observed between the amount of dust and the appearance of the sunset. When there was much dust, the light was warm and soft; when there was little, the lighting on the landscape was cold, clear, and sharp. A careful series of observations had also been taken at Kingairloch, which, along with others, had been used in the determination of constants in equations connecting the haze with number of dust particles.

ONE of the factors in the self-purification of water in rivers is regarded by some authorities to consist in the destruction and oxidation by bacteria of some at least of the organic material present. Professor Pettenkofer is of opinion that the green living algæ found in the river Isar also play no unimportant part as purifying agents. Professor Schenck, who has been making a special study—from this point of view—of the Rhine in the neighbourhood of Cologne, mentions that, to his surprise, he found comparatively few algæ where most impurities were present, the former being apparently crowded out by the large masses of bacteria. On the other hand, Professor Percy Frankland has recently stated that, contrary to what might have been anticipated, he found a comparatively small number of bacteria present in the water of a lock, which was so turbid that it was practically opaque when viewed in a glass, by reason of the immense number of algæ present. Professor Shenck's investigations show that the alleged action of green algæ as important water purifiers cannot be accepted without reservation, but that in the case of each river or stream the nature and growth of these plants must be studied. He concludes that the sewage of Cologne may be discharged into the Rhine because the vicinity of the entry is very suitable for the aggregation of masses of bacteria, and other purification factors exist.

MISCELLANEA.

WE understand that Mr. J. Harrison Carter is erecting new works at Dunstable, on the London and North-Western and Great Northern lines, where he will manufacture flour mill, and his general grinding, crushing, and disintegrating machinery.

AMONG ordnance experts in the United States the experiments to be made with nickel steel for guns is being watched with intense interest, for it is claimed by the nickel people to be the most important departure in gun manufacture of modern times. Judging from all the tests so far made, it is believed that the new nickel gun will exceed in performance all that the most sanguine advocates of the system have claimed. Time will show. No sensible man prophecies until he is quite certain.

THE bicycle seems to have thoroughly established itself as a trustworthy vehicle for long distances. We learn that on Saturday last Mr. R. L. Jefferson commenced a journey from London to Constantinople. He started from Constantinople at Olympia, and will travel through France, Switzerland, Italy, Hungary, Servia, Bulgaria, and Roumelia. He rides a "Swift" safety bicycle, geared to 56in., and expects to reach his destination about the end of May. The object of Mr. Jefferson's ride is the production of a book on the countries he will pass through.

AN International Exhibition of the Book and Paper Industries will be held this year in Paris, from July to December. This exhibition promises to be very interesting, as it embraces the various branches of book-making and the manufacturing of paper, as well as the machinery, implements, materials, &c., used in the different processes. Mr. Gaston Rebours, the Paris representative of *Scribner's Magazine*, has been appointed commissary to the British section, and will be happy to answer demands for information or admission, which should be addressed without delay to his offices, at 33, Soho-square, London.

SECRETARY HERBERT is considering the question as to who owns the scrap nickel steel which accumulates in the manufacture of armour-plates and appurtenances for the U.S. Navy from material belonging to the Government. The Government claims that in the manufacture of armour either the scrap should be employed or credit for its money value should be allowed. On the other hand, the armour manufacturers claim that they cannot use the scrap steel without going to considerable extra expense, and that they should not be required to do so without a fair compensation. The Carnegies, according to an American contemporary, now have on hand about 2000 tons of scrap steel, and the Bethlehem Company has about 2200 tons, and nickel steel costs the Government about 500 dols. a ton.

THE French have discovered, and are actively working, a coal mine in Tonquin, which promises to produce excellent coal in large quantities. The mine is situated about eight miles from Port Hongay, in the Bay D'Along, and a railway has been laid down for the whole of that distance. The offices and huts of the miners are all situated at Hongay, and the workpeople are conveyed to the mine every day by train. The mine itself is called Hatou. The length of the seam is given as 16 miles, and it is, according to the *Times*, nearly 200ft. thick. The supply is, therefore, practically inexhaustible. At present about 500 tons a day are extracted by the simple process of quarrying, the mass of coal having only a very thin layer of soil on the top. The miners are exclusively Annamites, of whom about 200 are employed, but the higher officials are all Frenchmen, although the capital of the company, strange as it may seem, is chiefly held by English merchants at Hong Kong.

A SHIP canal across Florida is again talked of. Southern States newspapers say that a final survey will be made shortly. The canal is intended to be 150 miles long, about 300ft. wide, and deep enough to accommodate large ships. It will, according to estimates, reduce the distance from New Orleans to Liverpool 1000 miles. The *Charleston News and Courier* says:—"Who is pushing this undertaking is not stated, but it is an interesting and important one. It will shorten the distance from all the chief Atlantic ports to New Orleans as much as from Liverpool to New Orleans. It will make the distance by water from Charleston to New Orleans and Mobile less than from Charleston to New York and Philadelphia. It will revolutionise the commerce of the gulf, and add greatly to the business of all the gulf ports. It will make Alabama coal, moreover, nearly as cheap in Charleston as in Mobile, and Western coal and corn and wheat, &c., nearly as cheap in Charleston as in New Orleans."

THE thirteenth annual meeting of the London Sanitary Protection Association was held on Monday, March 5th, at the offices, 21, Great George-street, Westminster, Surgeon-General Munro, C.B., in the chair. The report showed that during the past year 488 houses had been inspected for the first time, great attention being given to thoroughly testing house drains as to their freedom from leakage into the surrounding soil. Experience showed that these drains, though free from obstruction and well ventilated, were frequently in a most dangerous condition from bad jointing, and allowed the escape of sewage into the soil beneath the house. The great need of such an association was shown by the fact that nearly 69 per cent. of the houses inspected for the first time were in a more or less bad condition. The engineers have been experimenting with a smoke machine which, it is hoped, will render the smoke tests for such parts of the drainage system as are not amendable to the water test more thorough and reliable.

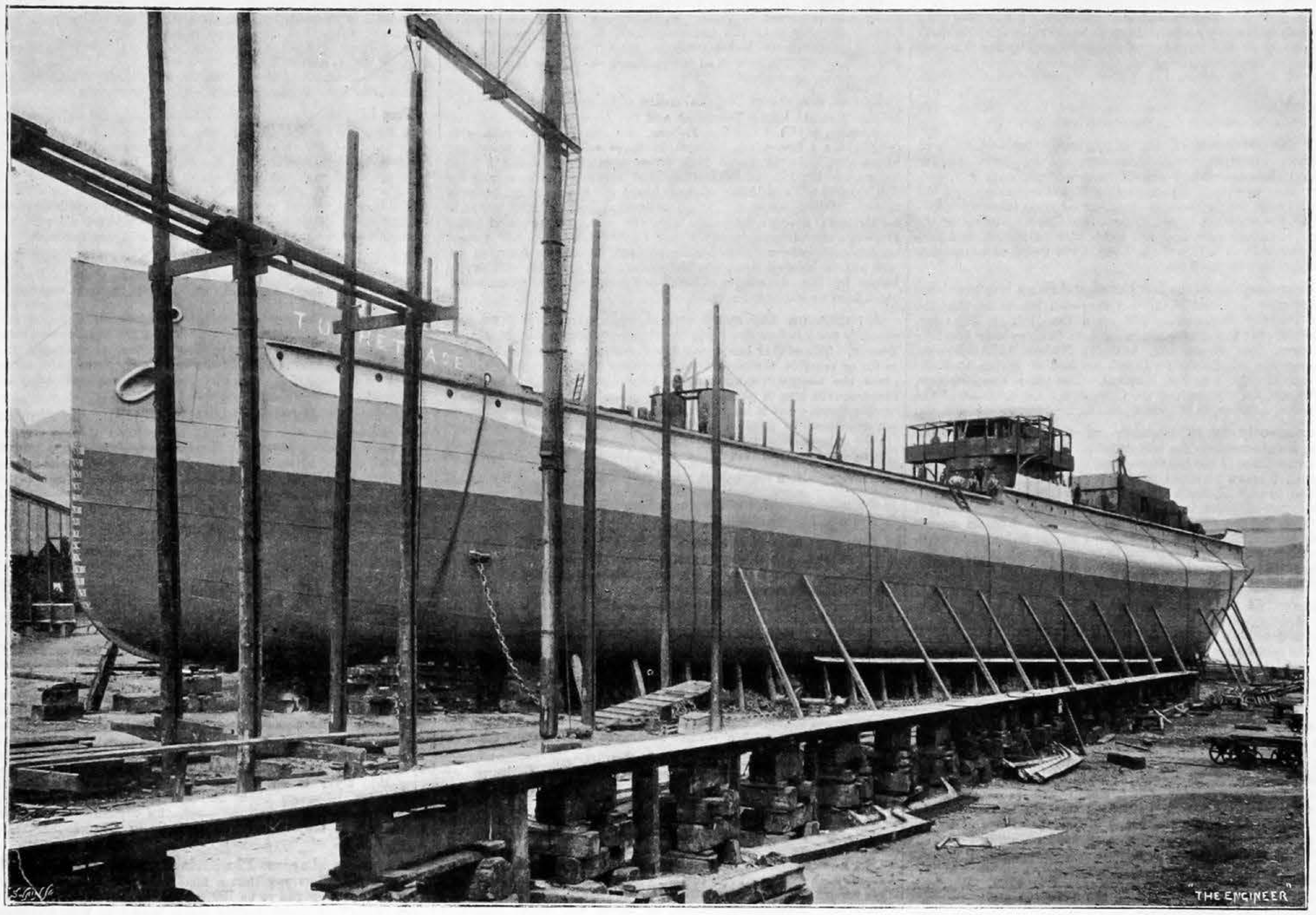
VERY large extensions of the wharves of Karachi Port are being make by the trustees, and about 2000 tons of material have recently been sent out for the purpose by the Leeds Steel Works. Some of the material is of remarkable scantling. For instance, in the 2000 tons there were about 600 tons of 5in. and 6in. round steel bars for piles of the extreme length of 51ft. We believe this is the first occasion when piles of so great a length have been supplied in one piece. Of angles and channels there were about 300 tons. Of compound girders, composed of 14in. joists, with top and bottom plates, and stiffeners at distances a few feet apart, there were over 300 tons, and of ordinary rolled steel joists there were over 400 tons. In addition to this there were about 300 tons of other work, about half of which consisted of cast iron pile screws, &c., and the remainder of the various bolts, straps, and wrought iron for attachments. The work was carried out under the inspection of Mr. Edward Jackson, M.I.C.E., London, assisted by Mr. H. R. Jackson, of Doncaster.

THE North German Lloyd Company, which was at one time accustomed to entrust the building of all its crack liners to Clyde builders, has within recent years patronised home firms for several of the vessels of this class, and at the present time it is having built by Herr Schichau, of Elbing, Prussia—whose name as the builder of fast torpedo boats and of torpedo "catchers" is as well known as Yarrow or Thornycroft—two twin-screw vessels of 6500 tons for the Southampton and Eastern service. This is the first time the North German Lloyd has gone to Schichau, and it is on his part the first time he has been called upon to build such large vessels. Notwithstanding this, the works at Elbing were founded so long ago as 1837—considerably ahead of the firm establishment of the iron age in shipbuilding in this country—and from them have emanated no fewer than 545 steamers for sea and river service, many of the latter of high speed; 190 being torpedo boats and torpedo cruisers with speeds from 20 knots to 26 knots per hour; one, the torpedo boat Adler, having attained the exceptional speed of 27·4 knots, which is slightly ahead of the estimated speed of the fleet of torpedo catchers this country is at present engaged producing. Still more notable is the work in marine engineering executed by the firm. This is represented by 665 engines, of which 355 are of the triple-expansion type, the total indicated horse-power being 326,000.

THE CARGO STEAMER TURRET AGE

MESSRS. W. DOXFORD AND SONS, SUNDERLAND, BUILDERS

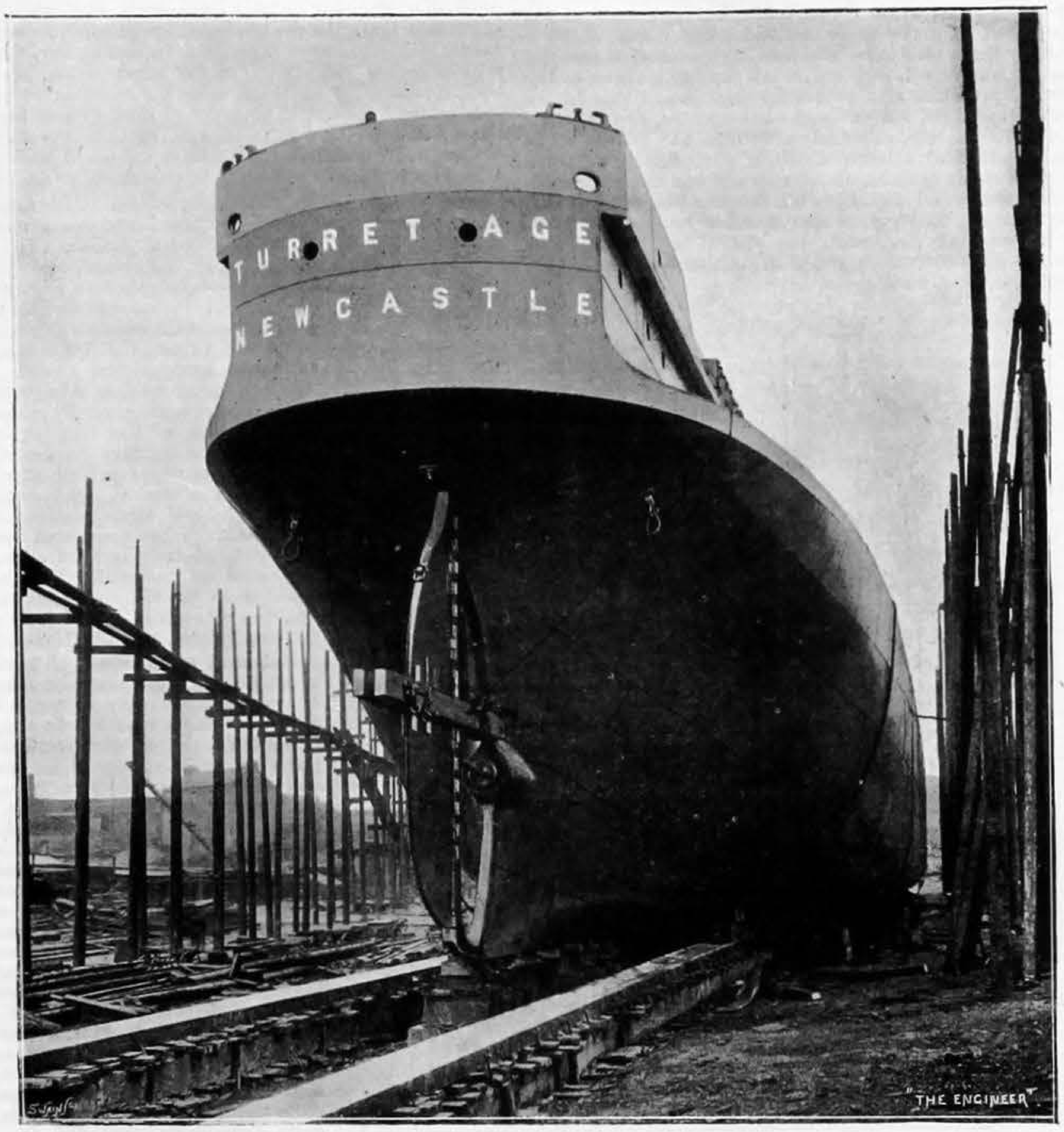
(*For description see page* 221)



THE TURRET AGE NEARLY READY FOR LAUNCHING

INTERIOR VIEW OF FORE BODY FRAME AND INNER BOTTOM

THE CARGO STEAMSHIP TURRET AGE



THE TURRET AGE.

THE prescience implied in the selection of the name "Turret Age" for the novel type of cargo steamer built last year by Messrs. Wm. Doxford and Sons, of Pallion Yard, Sunderland, is rapidly being justified. This firm, who, as is now well known, are the patentees of this "turret" type of cargo steamer, have already produced two such vessels—the Turret and the Turret Age—which are now in actual service and giving every satisfaction. At the present time they have three more under construction in their yard, each of a deadweight capacity of 3800 tons on a draught of 19½ft., while they have also, on order, four additional vessels, of a deadweight capacity of 5200 on about 20½ft., and one vessel with a deadweight capacity of 2900 tons on 17ft. This makes in all eight of these steamers now in progress, and two afloat; a goodly enough fleet when it is considered that it is only about eighteen months since the firm completed the first vessel of the type. The vessels at present under way, like the two already completed, are for North-East Coast owners, but the vessels more recently contracted for are to the order of London owners, a circumstance in itself which points to a spread of the favour with which the turret type is regarded.

On page 220 and above we give external views of the Turret Age while on the stocks, about ready for launching, and on page 220 an interior view of the fore-body framework and inner bottom as seen from near midships. The latter illustration especially brings out the contour of the vessel's upper works, which is one of the most striking of the characteristics of this new type of deadweight carrying steamer. Up to the load water-line there is no material difference between the Turret Age and any ordinary cargo-carrying steamer built on the web-frame system with wide spacing of hold beams—a type so deservedly in favour with shipowners, adapted as it is to many varieties of cargo, including machinery of great bulk. Above the load water-line, both in appearance and actual construction, there is considerable divergence from ordinary practice. It will be at once observed that along the vessel's deck line and upper works there is no sheer, a deviation from ordinary practice which, although at first sight it may appear odd, soon reconciles itself to conventional ideas.

Extending fore and aft are an upper central and two lower side weather decks, affording proper provision for working the vessel and for the crew obtaining exercise and having facilities for passing from one part of the vessel to another. In these respects the turret type of vessel is more analogous to the original spar-decker with rounded gunwale, having a deck house all fore and aft, than to the whaleback type of American lake cargo steamers, to which it was at first inconsiderately compared. The side weather-decks are principally for use when in harbour, all the mooring bits, &c., being there situate, but stanchions and rails are provided for the safety of the crew traversing the decks at sea. The upper central weather deck occupies one-third of the vessel's moulded breadth, and is of such a width as to admit of a port and starboard passage clear of the hatch coamings, and extends completely fore and aft, forming with its strong supporting sides—curved concavely up from the level of the side decks—the turret platform giving title to this type of vessel. On this central deck are the cargo hatches, of abnormal length and width, and the attendant steam winches, windlass, &c.

The freeboard to the lower weather or side decks is 5ft., whilst the height from load line to the turret deck at its lowest point is 10ft. 2in. The provision of a platform of such height above water contrasts favourably with the conditions obtaining in many ordinary cargo steamers, especially in the case of well-decked vessels, many of which proceed to sea with their main decks only some 15in. or 16in. above the water.

The dimensions of the Turret Age are:—Length between perpendiculars, 311 ft.; breadth, 38·2ft.; moulded depth, 24·1ft. On a load draught of 19ft. the deadweight capacity is 3700 tons, including coal. The capacity of the holds for grain cargoes is 180,560 cubic feet, or a proportion of 130 cubic feet per ton to the net register tonnage. This proportion represents, in the Turret Age, an advance of six cubic feet per ton upon the corresponding proportion in the Turret, the first vessel of the type, and a still greater advance is likely to be effected in the case of the vessels now building.

The design of this new type of vessel by Messrs. Doxford mainly finds its *raison d'être* in this large proportion of deadweight and measurement capacity relatively to register tonnage, but while this consideration naturally appeals to the commercial instinct of owners, it is certainly not militated against by any disadvantages attaching to other features.

In the matter of structural strength it will be readily apparent from a study of the illustrations we give that the turret design is superior to most of the popular general types of cargo-carrying vessels of the present time. The want of continuity in well-deck steamers, for example, is an evident source of weakness in regard to provisions for hogging and sagging strains, a statement which is borne out alone by the insistance of the classification societies upon local strengthening in the parts most affected. In the turret design, what Messrs. Doxford designate the side—or "weather"—decks, are continuous from stem to stern, formed of plating of the same thickness as the shell; analogous, in fact, to the sheer strake and the deck stringer in ordinary vessels, but which in this case are curved, by cold flanging, in "O. G." fashion, carried up to form the sides of the turret and down to form the rounded and unbroken line of sheer. The top-edge of the turret sides, and the deck it supports, extend at one level from the bow to a point considerably abaft midships, where it is raised and so continues to the after end. The raising of the turret deck line, which has its *raison d'être* in questions of trimming the vessel by the stern, involves a very different problem to the broken fore-and-aft line of the upper flange of the "theoretical girder," which is entailed by the quarter deck in the ordinary cargo steamer of that type. As the side or weather decks are continuous from bow to stern, as already explained, this raising of the turret deck only necessitates provision for strengthening being made good over one-third of the vessel's breadth. The case to be met is therefore simpler, and the danger of local weakness minimised. The assemblage of plating formed by the curved stringer and main sheer strake are continuous as regards strength—no openings being cut in the horizontal parts forming the side decks—the web of the girder being thus carried in unbroken continuity at the turret deck level.

From elaborate calculations made by Messrs. Doxford prior to building the first of this type of vessel—calculations which experience in actual service amply confirm—the strains likely to be induced in vessels of the type, under almost all conditions while afloat, were compared with the stresses known to be sustained by the vital members of the hull structure of all the most general types of cargo steamers. These investigations went clearly to show that the strains set up under any condition of working in the turret vessels do not exceed per unit of sectional area those which are allowed by the registration societies for the various sizes of ordinary vessels. In other words, the turret type is not only as strong but even stronger than any other class of vessel in vogue; and this notwithstanding that the hull structure as a whole is lighter. This result is due to several more or less associated causes, of which we may instance:—The general hull form—a spar-decked vessel of the same general design as the Turret Age would have from 15 to 20 per cent. less depth of girder—the superior disposition of material, and the full utilisation of the superior sections and forms of material now available for constructive purposes. For example, as regards the latter point, the main framing in the vessel is of single section bulb-angle. This has been selected in preference to the riveted combination of angle-frame and reverse-frame. Again, in the case of the plating which requires lateral stiffening, such as bulkheads, stringers, deck-houses, &c., and in many cases where corner connecting angles are required, the practice of flanging the edge of plates has been resorted to in preference to adding riveted angle bars. The great amount of flanged work, indeed, it may be remarked in passing, introduced into the structure of the vessel impressed our representative, on the occasion of his visit to Messrs. Doxford's, as most noteworthy testimony to the growing practice of not only bending very heavy steel plates cold, where easy curves are involved, but of substituting sharp-flanged plates for riveted connecting angles.

Generally speaking, it will have been made evident that the turret type of vessel is a strict reversion to the box or cylindrical girder principle of construction, the value of which was so well exemplified very early in the history of metallic construction. In the multitude and complexity of conditions to be fulfilled in modern shipbuilding and shipping service, this has not always been regarded as it should have been. In the turret ships the full section of framing is carried continuously up to, and even over the weather decks; in other words, to a height corresponding to the top flange of the theoretical girder. At the same time the fitting of lower or intermediate decks is dispensed with, involving, however, increased attention to web-framing and hold side-stringers. The fitting of intermediate decks as integral parts of the hull structure, and the stopping of the full sections of transverse framing—that is, frame and reverse frame combined—at one or other of these intermediate decks alternately—although still "according to rule"—is a remnant and relic of a bygone condition of things, and belongs properly only to classes of vessels built to carry a portion of deadweight cargo and the remainder of measurement goods. The single section bulb-framing adopted in the Turret Age leaves a more open interior for stowage of cargo, and for cleaning and painting of shell. It is deeper in the web than the ordinary angle-frame, but the neutral axis is the same distance from the outer edge, or vessel's skin, in each case. It is found in practice that the bulb-angle has greater rigidity to withstand pressure from within than the ordinary frame, while the resistance to pressure from without is the same in both cases.

While maintaining the same characteristics of design, vessels of the turret description can be built with a deadweight capacity of 5500, or even more, without necessitating the introduction of any second deck, so far as structural strength is concerned. The advantages of this, of course, more especially apply to vessels intended, as those already built are, to deal with large deadweight cargoes carried in bulk—coal, grain, &c.; but at the same time, when trade exigencies necessitate the subdivision of cargoes, an intermediate deck or decks can easily be worked into the structure. The four large 5200-ton vessels now on order, it may be stated, are all to be fitted with 'tween decks, but this, as the builders explain, is not in any way essential so far as structural strength is concerned, the only object being to render the vessels more suited to the general cargo trade for which they are being built. The turret design in this way specially lends itself to the alternative of bulk deadweight carrying or of miscellaneous measurement cargoes; no very radical structural modifications being entailed in adapting it to either kind of service.

While the Turret Age has been constructed more with a view to carrying wheat in bulk, with a turret providing 5 per cent. grain-feeding accommodation, it may be pointed out that this turret feature—as affording scope for the expansion of liquid cargo and oil feeding—makes the design equally advantageous for the oil-in-bulk trade. As the engines and boilers are placed at the extreme after end, both the outward and homeward bunker coal can be stowed close to the machinery space and separated from the petroleum cargo by a double bulkhead of iron filled with water, complying with the latest requirements of the Suez Canal authorities for vessels in this trade.

Both the position of the propelling machinery right aft and the increased height of the turret from about midships, to afford additional trunk space aft, have an important bearing on the trim qualities of this design. The general tendency of the partial awning-deck type of steamers, which, as is well known, are the favourite cargo carriers of the times, is to trim by the bow when loaded with a homogeneous cargo. In order to meet this they are usually loaded so as to leave an empty space in the forward 'tween decks. In the case of the Turret Age, however, the vessel can be filled up, from the collision bulkhead forward to the machinery bulkhead aft, and she will still be several inches by the stern. This trimming by the stern, and the advantages attendant on it, are secured by the additional trunk space afforded by the raising of the turret as above referred to.

The position of the propelling machinery at the extreme aft end has an important bearing also on the structural strength as affected by the special disposition of weights of heavy cargoes. In ordinary cargo steamers, with the machinery amidships, a considerable portion of the vessel's length is in the position of having excessive buoyancy relatively to the other parts forward and aft when the vessel is loaded with cargo. Displacement is thus far greater than what is due to the weight carried, and this is especially the case when the coal bunkers are nearly empty. The lightmidship portion and the heavy ends, therefore, together operate with the unstable sea outside to set up hogging strains. These are, of course, the strains most to be guarded against in cargo steamers, as their counterparts in the way of sagging strains are less likely to be reckoned with. Especially is this the case where, as in the Turret Age, a double bottom is fitted throughout, this feature representing a lower member for the theoretical girder, which in the matter of strength is far in excess of the corresponding upper member provided by the deck. From these general considerations it will at once be seen that where the cargo weights are mainly located amidships, as in the case of the Turret Age—and of other vessels, of course, in which the propelling machinery is aft—weight and buoyancy are better balanced and more evenly distributed.

The cellular bottom of the Turret Age is of the ordinary type, having a floor at every frame worked intercostally between continuous longitudinals. There is in addition to the main central longitudinal, resting on a flat keel-plate a sister longitudinal on each side, situated half-way between the central one and the inner bottom wing-plate at the turn of the bilge. The two side longitudinals are of a distance apart corresponding to the width of the turret deck, and the hold stanchions or pillars are situate in the same vertical line with both the longitudinal and the gunwale or side plating of the turret. The system of pillaring adopted is novel and noteworthy. The arrangement of side weather decks and central turret deck is such as affords a very much greater degree of strength than the ordinary flat deck, and this dispenses with the necessity for so many pillars. They are placed at intervals of from 18ft. to 20ft. apart, as compared with the 4ft. intervals in ordinary flat-deck steamers. The gain in lightness of structure thereby secured is considerable, whilst there are also very obvious advantages as regards stowage for bulky cargoes. The hold stanchions themselves are of a new section. Instead of the ordinary round pillar stanchions there are two channel sections riveted back to back. This permits of the connecting brackets at junctions being fitted between, thus affording a very secure fastening with large surface for rivet attachments. The inefficient manner in which round pillar stanchions are usually connected to the main structure is often an acknowledged source of weakness in ordinary ships. Cross-tie beams occur at the same intervals with the stanchions, and are connected thereto, and to deep plate-frames at the sides. Two hold side stringers in the depth are fitted, intercostally, between the deep plate-frames; but in the vessels now under construction a new method of fitting side stringers and longitudinals is adopted, whereby the break in continuity at the web-frames is abolished, and construction is at the same time facilitated.

The absence of decks, and the arrangements of the foregoing features—in some measure the equivalent of decks—have an important bearing, like the location of the propelling machinery aft, on the stowage and carrying qualities of the turret vessels. It is, as has already been indicated, in the case of grain cargoes in bulk that this design of vessel shows the greatest advantage. It will be readily apparent from the character of the contour of the turret sides and the open nature of the hold, that in pouring grain into the ship, through the free and ample hatch accommodation provided, there will be a very direct and general flow to all parts of the hold. There is thus every guarantee that the vessel can be filled quite full at starting, and that the feeding facilities of the turret can be unfailingly brought into play as the vacancies occur due to shrinkage of the cargo. In the case of ordinary vessels fitted with decks, stringers, and other obstructions, due to the style of construction, the number of spaces left unfilled originally is excessive, and the resulting shrinkage in cargo is a circumstance to be seriously reckoned with. The amount of shrinkage acknowledged by Act of Parliament is 2 per cent. In the turret vessels, for reasons already explained, the shrinkage is considerably less than this; but even allowing this percentage, the distance through which the grain can shift is considerably reduced, owing to the vacant space occurring solely within the confines of the turret casing, comparatively near the centre line of vessel. The distance of shift is little more than one-third that which would occur in ordinary vessels. This, it need hardly be pointed out, means a very large difference in the heeling moment. The effect of water on the deck of the turret vessels, where the deck rounds up to form the turret, is to form a righting moment counterbalancing the heeling effect of the grain moment. Owing to the curved nature of the surface, however, no water really lodges on deck save in the case of the vessel taking a permanent list. In this respect, as will readily be understood, the turret vessels present marked advantages to steamers with ordinary flat decks, perhaps with close bulwarks.

As regards questions of buoyancy and general stability, both theory and the result of actual experience are distinctly favourable to the turret type. The motion of the vessels amongst waves has been found to be exceptionally easy and regular. From theoretical investigations into the stability of the type, as compared with ordinary vessels, the righting moment at all angles of heel, under proper conditions of loading, redounds to the superior safety of the turret type. The vessels already built and those under construction receive the highest class in both the Bureau Veritas and the British Corporation Registry of Shipping, and are built under their special survey.

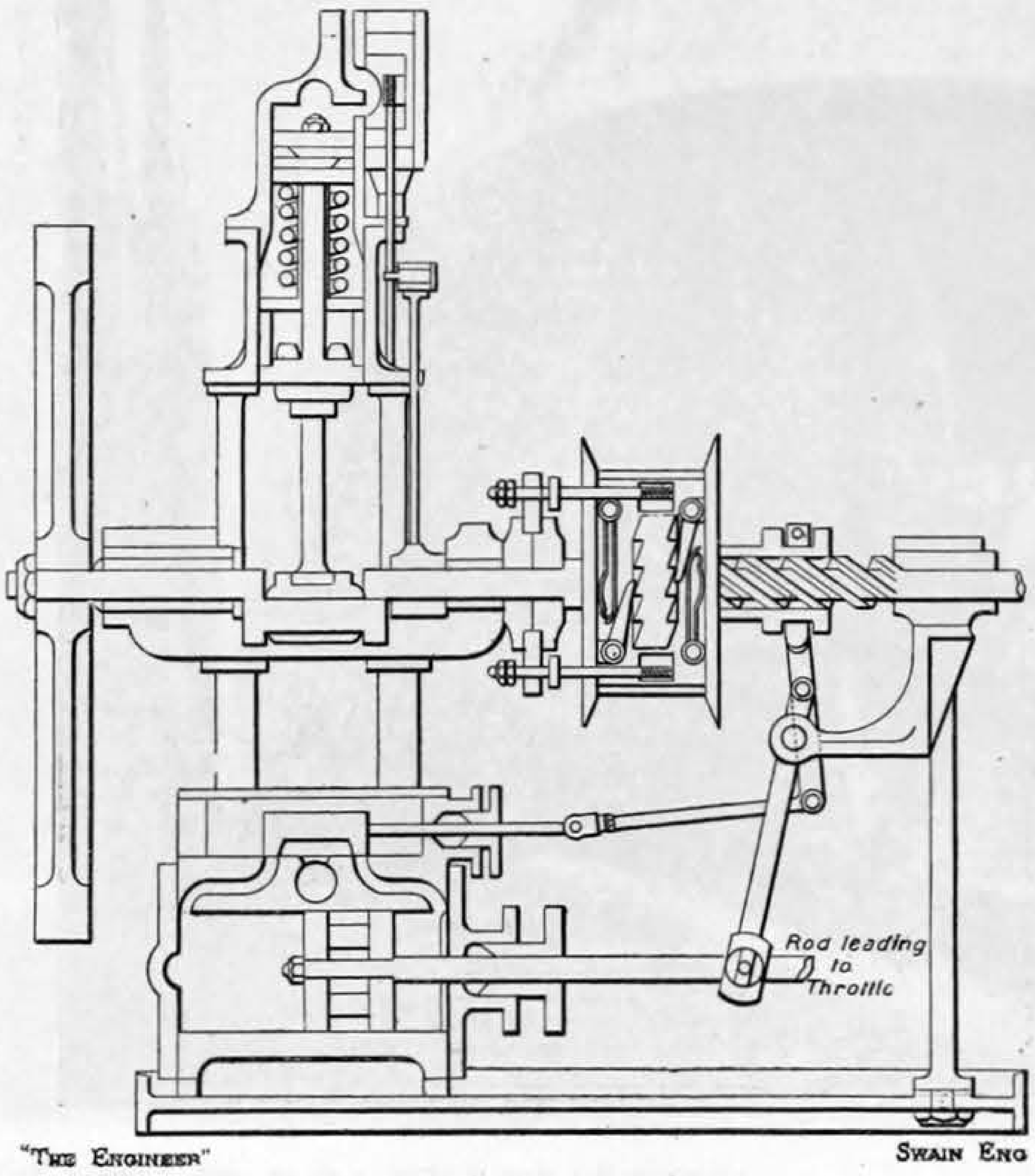
The engines and boilers of the Turret Age are also the production of Messrs. Doxford and Son. The engines are of the triple-expansion type, the boilers providing steam at 160 lb. pressure. Further particulars of the propelling machinery we must, however, reserve for a future issue, when illustrations of the machinery will be given.

THE INTERNATIONAL CONGRESS OF HYGIENE AND DEMOGRAPHY.—The preliminary arrangements of the eighth International Congress of Hygiene and Demography, to be held at Budapest from the 1st to the 9th of September this year, are already far advanced. The programme of its scientific part has been favourably received abroad, and many communications have been received at the general secretary's office from eminent scientific men abroad, who have already promised papers to the various sections. A communication from Dr. C. Müller, the general secretary at Budapest, says there are 362 hygienists and seventy-eight demographs already inscribed, who will read 440 papers. These are only the foreign scientists who have up to this moment—*i.e.*, six months before the opening of the Congress—sent in their adhesions.

MESSRS. WILLANS AND ROBINSON, LIMITED.—A company under this title has been formed to take over and extend the business of Messrs. Willans and Robinson, engine builders, of Thames Ditton, Surrey, which has been carried on with increasing success for the past thirteen years. The business was converted into a private company in 1888. Owing to the great increase in the demand for the company's engines, it is found necessary largely to extend the works and plant. The company has accordingly been reconstituted upon a wider basis, and it has been decided to offer preference and ordinary share capital for public subscription. The directors propose to provide increased facilities for the manufacture of engines of a large class, and at the same time they propose to commence—upon a small scale at first—the manufacture of gas engines and of water-tube boilers. Both classes of work can be undertaken with only a small outlay upon special plant; and both will work in advantageously with the present business.

KEATS' MARINE GOVERNOR.

THIS governor, invented by Mr. R. F. C. Keats, of Garnier-street, Fratton, Portsmouth, consists of a small vertical inverted engine with a fly-wheel, which works at a constant speed of 600 revolutions per minute, and drives a screw of very coarse pitch, which is coupled to the crank shaft, at the same speed. On the screw is fitted a nut wheel, which is driven by the engine to be governed by means of a sprocket wheel, countershaft and chain, at the same speed as the screw. By means of this multiplying gear, whatever the required speed of the main engines may be, the constant speed of 600 for the nut wheel can be obtained. To this nut wheel is attached a lever, which is connected to the slide valve of a steam cylinder, fitted with a piston and piston-rod, which is connected directly with the throttle valve of the main engines. The lever is also attached to the piston-rod, and so adjusted that when the piston has travelled the distance required by the travel of the nut wheel on the screw, the slide valve is closed again.



KEATS' MARINE GOVERNOR

When this governor is connected with the main engines, and the latter are travelling at their required speed, the screw and nut wheel are revolving at the same speed; but directly the main engines commence to go faster or slower, the nut wheel begins to travel on the screw, and opens the valve of the cylinder at one end or the other, as the case may be, when the piston-rod travels backwards or forwards, and so shuts or opens the throttle valve. If the main engine is working at 75 revolutions per minute, the nut wheel is revolving eight times as fast. When the main engine gains one sixty-fourth of a revolution, the nut wheel gains one-eighth of a revolution; when it gains one thirty-second of a revolution, the nut wheel gains one-quarter of a revolution, and works the throttle valve accordingly. When the main engines gain one-sixteenth of a revolution, the nut wheel gains one-half of a revolution, which then shuts off all steam from the main engines. When the nut wheel has gained or lost one-half a revolution, it becomes disconnected from the screw, so that the speed of the small engine is not interfered with. It will thus be seen that this governor is very quick in its action, and thoroughly adapted to the requirements of a marine engine. The governor has been fitted with highly satisfactory results in the Sunderland ships Advent and Wear.

THE ROYAL INSTITUTION.

THE MAKING OF A MODERN FLEET.

AT the weekly evening meeting on Friday, March 9th, 1894, Mr. William H. White, C.B. &c., read a paper "On the making of a Modern Fleet," of which the following is an abstract:—

The special programme of war shipbuilding embodied in the Naval Defence Act of 1889 is now approaching its completion. Of the seventy ships therein provided for, all except eight or nine will be completed and ready for service at the end of this month, when the five years' period contemplated in the Act will terminate. The few remaining ships will then be far advanced, and in the Navy Estimates for 1894-5 less than £300,000 will have to be provided for their completion. What has been done constitutes an unprecedented feat, whether it be considered on the basis of expenditure, or in the addition made in a comparatively short time to the naval strength of the empire. No other country in the world could rival this performance, which furnishes an object lesson, on a large scale, of what has to be done whenever the making of a modern fleet is undertaken.

Regarding the transaction from this point of view, the principal steps may be summarised as follows:—(1) The selection of types, and the number of ships of each type to be built. (2) The preparation of designs for each type, fulfilling the conditions laid down for offensive and defensive powers, speed, and coal endurance. (3) The making of estimates of cost; these estimates including the unit costs for each type, the aggregate cost of the whole scheme, and the incidence of expenditure on each year of the period of construction. (4) The allocation of orders, so that the actual construction of ships, machinery, and armaments may be completed within the stipulated period.

For ships of the Royal Navy, the Board of Admiralty is the responsible authority in the selection of types, and determination of the numbers to be built of each type. Since actual experience in modern naval warfare is almost entirely wanting, differences of opinion necessarily arise respecting the relative values of different types, the best methods of protection, the most suitable armaments, and other features of construction. In the ancient fleets of unarmoured sailing vessels, long-continued experience in actual war, associated with practical stagnation in the construction, armament, and propulsion of warships, made the selection of types an easy matter. Now the progress of invention is rapid, and change follows fast upon change, so that the decision of fighting and sea-keeping qualities is a difficult undertaking. Whatever is done is certain to be challenged or criticised.

The Admiralty has many advantages in its action as a "Committee on Designs." On the Board are a number of experienced and distinguished naval officers. The largest war-fleet in the world is under its orders, and from the service afloat come many reports, suggestions, and records of experiment. What is being done at home and abroad in the construction and armament of ships; the improvement of ordnance, ammunition, armour, torpedoes and other matters of importance, is well known and carefully considered. Use is made of the best engineering talent of the country in devising improved types of propelling machinery, auxiliary mechanical appliances, gun-mountings and other portions of the equipment. When considered desirable, distinguished naval and professional men are called into council. But the final decision as to the characteristics and qualities of each of her Majesty's ships necessarily rests with the Admiralty.

Universal experience in all navies and at all periods shows that there must be a considerable variety of types in any fleet. No single type can be trusted to perform all the services required at a given moment. Progress in invention and consequent change in type necessarily introduces further variety. Iron and steel-hulled ships have great durability. On the "Effective List" of the Royal Navy still remain specimens of the earliest sea-going ironclads, now over thirty years old; and examples of successive types which during that long period have made their appearance as first-class ships, only to pass gradually into lower classes, and finally into the Reserve. Obsolete as many of these vessels are in engines, guns, and armour, they are practically as strong as they ever were. Should a war take place, and serious engagements happen between the more modern ships on each side, it is quite conceivable that the so-called "obsolete" ships of the Reserve may play an important part in the final stages of the conflict.

Apart from the variety of type produced by lapse of time, there is the variety arising from the necessities of service. By common consent a modern fleet, like the ancient fleet, must have a squadron of battleships as its backbone. With these must be associated cruisers of various kinds—the "eyes of the fleet"—and vessels of the torpedo flotilla. Opinions differ as to the most suitable proportion of cruisers to battleships. Some advocate three cruisers to each pair of battleships; others would have two cruisers of different types to each battleship; and others consider that, to complete a group, there should be a battleship, two cruisers, and a torpedo vessel.

The Naval Defence Programme provided for seventy vessels—ten battleships, forty-two cruisers, and eighteen torpedo gunboats. Most of the designs were novel in character. Eight of the battleships are 380ft. long and 14,150 tons in displacement. They are the largest completed ships in the Royal Navy, and the most powerfully armed. Each vessel carries four 67-ton guns, ten 6in. quick-firing guns, and twenty-eight small quick-firers for use against torpedo boats, as well as in action with other ships. The maximum smooth water speeds are $17\frac{1}{2}$ to 18 knots. In protection, armament, speed, and coal supply they surpass all their predecessors. The ships are of high freeboard, carry their guns at a great height above water, and are specially adapted for service in the Atlantic. Two of the battleships are of less dimensions—360ft. in length and of 10,500 tons displacement. In speed and coal supply they compare well with the larger vessels. They are inferior in armament and protection. The heaviest guns are twenty-nine tons each in weight, and the largest quick-firers are 4·7in. These vessels were designed especially for service on distant stations, and can pass through the Suez Canal. There are four distinct types of cruisers. Nine are of the first class, 360ft. long, and from 7350 to 7700 tons in displacement. They have maximum speeds in smooth water of 20 to 21 knots, and large coal supplies, powerful armaments, and good protection to guns, gun crews, and vitals. The heaviest guns weigh twenty-two tons each, and the main armament consists of ten 6in. quick-firers, with seventeen smaller guns. Twenty-nine vessels are second class cruisers, eight being of one type and twenty-one of another type. They are 300ft. to 320ft. in length, and 3400 to 4400 tons in displacement. Their maximum smooth water speeds are about 20 knots, and they have good coal supplies. The armaments include 6in. and 4·7in. quick-firers, besides smaller guns, and they have fair protection. Four cruisers of the third class are 265ft. long, and of 2600 tons displacement. They are about a knot slower than the smaller second-class cruisers, and not quite so well armed, but they are equal in protection. Torpedo gunboats are of comparatively recent introduction, and are the smallest sea-going vessels built to accompany fleets. In length they vary from 230ft. to 250ft., in displacement from 750 to 1100 tons. They have a light gun armament, and a powerful torpedo armament, the maximum smooth water speeds range from 19 to 20 knots. Experience has proved them to be excellent sea-boats in the heaviest weather.

It will be noted that all these vessels are of high speed, and capable of acting together as a fleet. Further, that the Naval Defence Programme provided not merely for the largest proportionate number of cruisers to battleships above mentioned, but gave a considerable margin over and above those requirements available for service in the protection of commerce or in other ways. If a fully constituted fleet were formed from the Naval Defence ships, including all the battleships and the equivalent number of cruisers, it would surpass in speed and fighting power any equal number of completed ships of similar classes that could possibly be brought against it from existing navies. Having been created rapidly and simultaneously, it is more homogeneous in character and better equipped for manœuvring at high speed. Its armament, also, is of the most modern description, being distinguished by the preponderance of quick-firing guns. These guns can be fired about thrice as fast as guns of equal calibre but earlier patterns, and the supplies of ammunition have been proportionately increased.

In the fleet 1342 guns are mounted. Of these 776 are 6-pounders or under, and over 500 are 6in. and 4·7in. quick-firers, while 56 are from 9·2in. in the cruisers up to 13·5in. in the large battleships. Torpedo armaments, including submerged and above-water discharges, are carried in all the ships, but are subordinated to the gun armaments, except in the torpedo gunboats. There are 322 torpedo ejecting tubes in the seventy ships. All the larger ships have their bows strengthened for ramming. That method of attack, however, involves special risks, particularly since torpedo armaments have been so considerably developed. Electric search-lights and internal lighting, net defences and all other means for protecting the ships against torpedo-boat attacks have been adopted in the larger cruisers and battleships. The smaller cruisers and torpedo vessels have no net defences. Mechanical appliances of all kinds have been freely employed to reduce or assist manual labour. In habitability and sanitary arrangements the ships surpass previous construction.

The aggregate total weight of the ships, fully equipped, exceeds 335,000 tons; the total power of the propelling engines, working under conditions of maximum development, is about 600,000-horse power. This proportion of power to weight—averaging nearly two-horse power to each ton—is a clear proof of the relatively high speed of the Naval Defence fleet. Until ten or twelve years ago the maximum speeds of battleships in smooth water ranged from 14 knots to 15 knots, and of swift cruisers from 15 knots to 17 knots. Comparing these figures with those given above for the Naval Defence ships, it will be seen that a great stride has been made. Improvements in marine engines have greatly aided progress, but there has necessarily been a considerable increase in engine power. As speeds increase, so does the rate of growth in expenditure of power increase most rapidly. A first-class battleship, for example, can be driven 10 knots an hour by 2000-horse power. At 14 knots 5500-horse power is necessary; at 18 knots, 13,500-horse power. To gain four knots from 10 knots means an increase of 3500-horse power; an equal gain in speed from 14 knots involves an increase of 8000-horse power.

Modern ships depend solely upon steam propulsion, and are practically destitute of sail power. Their range of action and power of keeping the sea depends, therefore, entirely upon their coal supplies and rate of coal consumption. By the use of higher steam pressures and greater expansion, the rate of coal consumption has been greatly reduced in the last thirty years. A first-class battleship of 1860 required to burn about 5 lb. to 5½ lb. of coal per indicated horse-power per hour, whereas a ship of similar class in the Naval Defence fleet burns 2 lb. to 2¼ lb. only.

On the other hand, in recent ships great demands are made on coal for various auxiliary purposes formerly non-existent. Large quantities of sea-water have to be distilled for use in the boilers. Internal electric lighting makes considerable inroads on the coal. The multiplication of auxiliary machinery for all purposes does the same, whereas in earlier ships most of the operations now done by such machinery were performed by manual power.

Taking a broad view of the situation, it may be said that modern ships have much larger coal endurance, and can steam over longer distances. When cruising at sea or making passages under ordinary conditions warships proceed at moderate speeds. Comparisons of coal-endurances are, therefore, commonly made at the speed of 10 knots. A battleship of the first class built in 1861 carried 750 tons of coal, and could keep the sea steaming continuously at 10 knots for six days. She had auxiliary sail-power also, and could economise coal under favourable circumstances of wind and weather. A first-class battleship of the Naval Defence fleet leaves port with nearly twice as much coal on board, and can steam continuously at 10 knots for twenty to twenty-one days before her coal is exhausted. She has no sail power; her machinery and propellers are duplicated for the sake of greater safety against disablement and better utilisation of the engine-power at high speeds.

The armaments of modern ships have been made proportionately heavier, not so much in the way of increasing the weight of the most powerful guns, as by developing the secondary armaments of quick-firing guns and increasing the supplies of ammunition. It will be remarked that the heaviest guns mounted in the Naval Defence fleet are sixty-seven tons in weight, whereas preceding ships of less size carry 110 ton guns. Indeed, had there been a satisfactory 12in. gun of about fifty tons available in 1889, it would probably have been adopted by preference. Since that date such a gun has been produced, and has been made the principal armament of the Majestic class.

A distinctive feature in recent battleships is the great power and efficient protection of the secondary armament of quick-firing guns. It is within the truth to say that with this portion of the armament alone, a ship of the Royal Sovereign class could make a good fight, having regard to the rapidity of fire and the energy of the projectiles. A 6in. quick-firing gun delivering five or six aimed projectiles per minute, with energies sufficient to perforate a foot of iron armour at close range is clearly a formidable weapon.

Armour protection in the Naval Defence ships has been most carefully considered. No other feature in warship construction has given rise to greater controversies than the proper method of disposing the armour. On the whole the system adopted in 1889 has given general satisfaction. It involves large proportionate weights and costs. On a ship like the Royal Sovereign, the thick vertical armour weighs about 3000 tons, and costs over a quarter of a million sterling. Great improvements in armour have been made in recent years, increasing its defensive power for a given thickness and weight. But in view of remarkable developments in explosives and ordnance, there is no disposition to diminish weights of armour on battleships. In fact, increased protection to secondary armaments involves greater weights in proportion to displacements.

Since modern warships have higher speeds, greater coal supplies, more powerful armaments, and better protection, it is inevitable that they should be of greater size and cost than their predecessors. In the mercantile marine, also, the demands for higher speeds or greater carrying power have involved considerable enlargement of dimensions and additional first cost. The largest passenger and cargo steamers, as a matter of fact, exceed in dimensions and displacements the largest battleships and cruisers. Their costs are less than those of the warships, because they are much less elaborately fitted and carry no armaments. On the transatlantic service there are employed passenger steamers from 525ft. to 600ft. in length, and from 15,000 to 20,000 tons displacement. The largest battleships yet laid down for the Royal Navy—the Majestic class—are 390ft. long and of 14,900 tons displacement. The largest cruisers—the Powerful class—are 500ft. long and of 14,200 tons displacement. Analysing the designs of warships, and comparing them with merchant ships—as far as comparisons are reasonable between vessels built for entirely different services—one is forced to the conclusion that the sizes and cost of recent warships are relatively moderate.

If size and cost are to be reduced, as some persons strongly urge, then it will be absolutely necessary to reduce some or all of the qualities associated in the designs of the large ships; to accept lighter guns, less weight of protection, lower speeds, or lessened coal supplies. In other words, to produce fighting machines of smaller individual power, comparing badly with the ships of most recent design built or building abroad. There would be no difficulty, of course, in producing a larger number of less powerful ships for a given expenditure. But it would be a new departure in British naval policy to deliberately accept individual inferiority in our ships to foreign ships for the purpose of securing greater numbers. If the necessary expenditure is faced, superiority in numbers as well as in the powers of individual ships can be secured; and the weight of public and professional opinion undoubtedly inclines to that side.

If the constitution of the Naval Defence fleet is considered, it will be noted that only the ten battleships are really of large dimensions out of the total number, seventy. This is an illustration of general practice, although the advocates of moderate dimensions frequently proceed on the hypothesis that only large ships are built. As a matter of interest the ships built or building from my designs, since I took office in 1885, have been classified. Out of a total of 131 ships, only 15 are above 10,000 tons in displacement, 12 from 7000 to 9000 tons, 46 from 2500 to 5600 tons, 11 from 1000 to 2500 tons, and 47 are 1000 tons or under.

Warship dimensions and cost are not to be regulated by arbitrarily chosen limits. The proper procedure is obviously to decide what qualities shall be possessed by each type, and to produce ships possessing those qualities. No better guide under existing circumstances, and apart from actual experience in naval warfare, can be found than in making provision for meeting the possible attacks of foreign fleets, and securing superiority in numbers and in fighting efficiency in each class. Since British ships are built for operating on an enemy's coast, it is the practice to give them larger coal supplies, more stores, equipment, and ammunition. Hence they are, class for class, of larger displacement than foreign ships. They are not, however, of greater cost than foreign ships of less displacement. A Royal Sovereign can be produced in a Government dockyard for a net cost, excluding armament, of about £760,000. The corresponding cost for a French, Russian, or American battleship of the first-class is from £900,000 to £1,000,000. Consequently in the matter of money value risked on each ship we have a distinct advantage, thanks to our more economical construction.

Taking armament and stores into account, one of the larger battleships in the Naval Defence fleet represents in round figures a million sterling when equipped for sea. It is a great responsibility to command such a costly and complicated fighting machine. Naval officers have, however, risen to the occasion, as it is their habit to do. As regards manageability and manœuvring power, the big ships have proved most satisfactory, being as thoroughly under command as much smaller ships. It is a very striking thing to see one or two men steering a ship of 14,000 tons moving at high speed, with the aid of a steam or hydraulic engine. The huge mass answers every motion of the helm, and can be made to reverse its course at full speed in 3 to 3½ minutes, and in a path whose diameter is about five times the ship's length.

A modern fleet requires large expenditure for its construction and equipment. The seventy ships of the Naval Defence programme will cost about 22¾ millions, including armaments. Excluding armaments, ammunition, and reserves, the cost has been about 18 millions, or an average cost per ship of more than a quarter of a million sterling. This average cost exceeds the cost of the largest unarmoured screw three-deckers, carrying 121 guns, which were the most powerful ships in the Royal Navy thirty-five years ago. It is more than double the cost of the largest sailing three-deckers built about eighty years ago. What has been said above furnishes the explanation of this remarkable increase in outlay on modern ships. The range of net cost in the dockyard-built ships is from about £780,000 for a first-class down to £50,000 for a torpedo gunboat.

Allowing for alterations in designs, changes in the rates of wages to dockyard workmen, and variations in systems of accounts that have been made since the scheme was first framed, there has been a remarkably close agreement between the original estimate and the actual outlay. That estimate was 21½ millions, the probable expenditure 22¾ millions, and specific causes of increased cost represent about one million. There are few engineering works of great magnitude where the agreement between estimate and expenditure has been so close.

The work of construction has been divided between the Royal dockyards and private firms. Ten millions represent the value of the contract ships and their armaments; 12¾ millions the corresponding outlay on and for the dockyard ships. As a matter of fact, the real expenditure on the dockyards has been on labour, representing about 3¾ millions. Materials, machinery, guns, gun-mountings, and other items of equipment have been made outside the dockyards. These figures indicate how large an employment of the manufacturing and industrial resources of the country has been involved in carrying out a programme which adds greatly to our naval strength.

It is the more remarkable that the programme should have been practically carried through as proposed, when it is remembered that the five years over which it has extended have been years of unprecedented activity in merchant ship construction. No better proof could be given of the surpassing resources of this country for shipbuilding and engineering. The great requirements in guns and gun mountings have also been met with ease. One incidental result of the Naval Defence Act which deserves mention is the enlargement of our resources for the manufacture of ordnance, many eminent firms having undertaken and satisfactorily executed important contracts, and the guns having been ready in time for the ships. A necessary condition of rapid construction is, of course, thorough prevision and pre-arrangement in all departments, so that there shall be no hindrance of work while waiting for portions of armament or equipment. Rapid construction also means ample financial provision, adjusted to the greatest rate of progress obtainable. Unless such provision is made the work must linger on, and progress will be regulated by the means available.

In this brief summary of what is involved in making a modern fleet, it has been impossible to dwell upon the many difficulties that have to be met in connection with warship designs. Warships are primarily fighting-machines. Fighting efficiency dominates their designs, and more particularly the arrangements laid down as necessary for armaments and protection. Every cubic foot of internal space has to be appropriated to and fitted for some special purpose. Accepting these fixed conditions, the endeavour of naval architects is to fulfil them in ships which shall be strong, stable, and seaworthy, possessing the speeds and coal supplies specified for various types. If complete success is not attained in all cases it should be remembered that the problems which have to be solved are of increasing difficulty and complexity. And, on the whole, it may be claimed that the designers of modern warships, with the aid of their collaborateurs—marine and mechanical engineers, electricians, artillerists and metallurgists—have achieved remarkable results. Speeds have been greatly increased, offensive and defensive powers developed, and sea-keeping qualities maintained.

Those who have to design and build warships, as well as those who have to fight them, may be pardoned if they sometimes wish that earlier and simpler conditions had continued. But the progress of invention and the constant struggle for maritime supremacy demand continuous effort, in order that her Majesty's ships shall in no sense be inferior to those produced in other countries.

At the close of his lecture Mr. White had thrown upon the screen a number of very interesting photographs. One, that of H.M.S. Centurion, attracted a great deal of attention. We reproduce it from a photograph by Messrs. Symonds, of Portsmouth. She is a second-class battleship, one of two specially intended for service in foreign waters, and designed to go through the Suez Canal.

PUMPING ENGINES, BOMBAY SEWAGE WORKS.

In The Engineer, vol. lxxvi., we described and illustrated some very large Worthington sewage pumping engines which have recently been constructed and erected by Messrs. James Simpson and Co., London, for the Bombay Municipality, at the Love Grove sewage pumping station. The engines and pumps are capable of dealing with from 60,000,000 to 78,000,000 gallons of sewage per day, and we have now received information concerning some carefully made tests carried out by the Bombay Commissioners in accordance with the terms of the contract. For the purposes of the trial care had to be taken to ascertain accurately the slip on the pumps, and in an extract from a letter from Mr. James, the drainage engineer at Bombay, it is stated:—"In the trials that have been taken, the sewage discharged has been measured not only by the pumps but by observation in the outfall sewers, and the discharges as taken by floats and by inclination due to surface of sewage come out rather more than the discharge taken from the pumps, less 5 per cent., and show the slip of the pumps with good valves to be about 3 per cent.

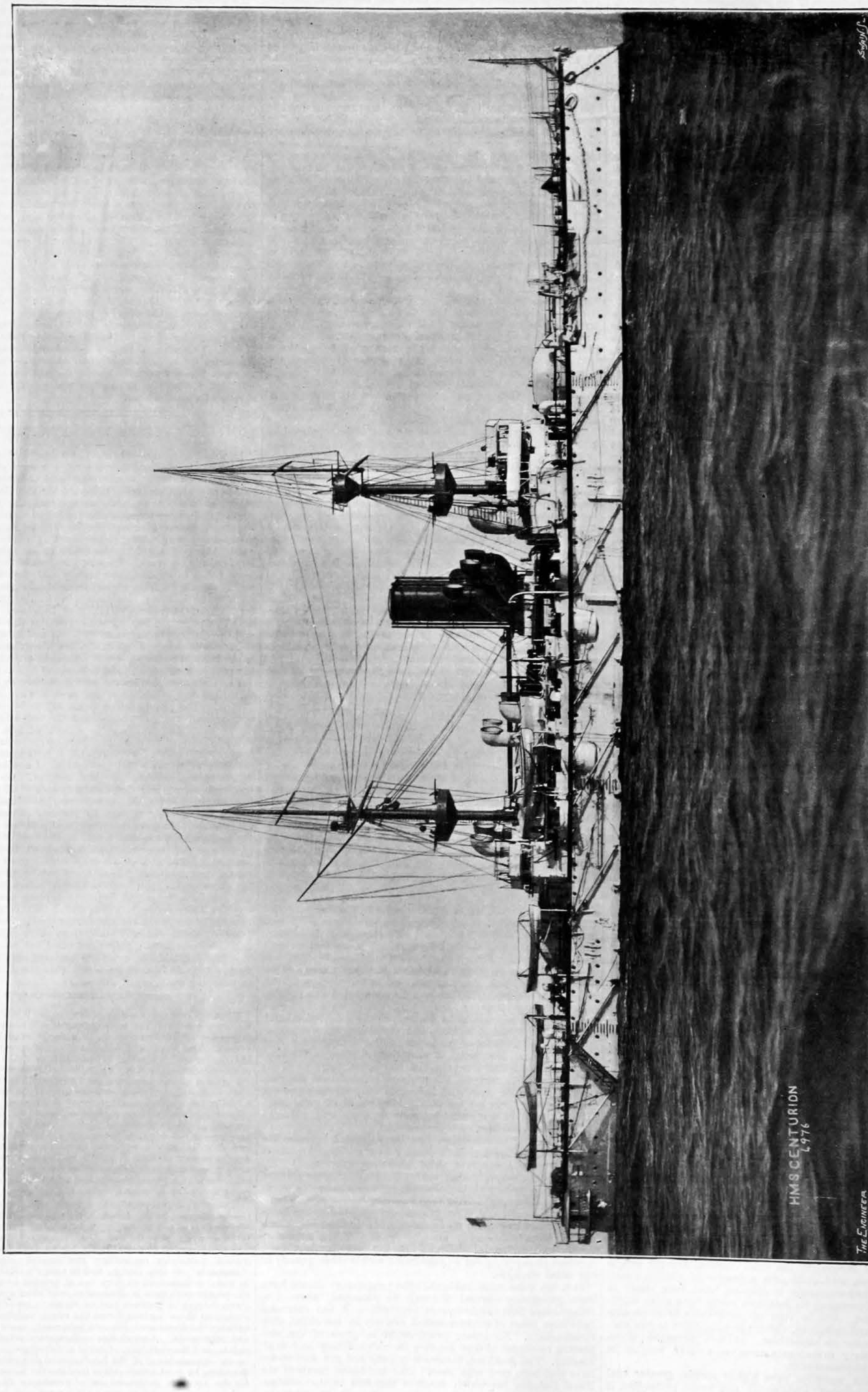
The tests extended over a period of four days, and during this time the total lift of the sewage was only 22·85ft. to 27·69ft. The pumps lifted from 10½ to 13 per cent. more sewage than was guaranteed, and the quantity of coal used shows that the consumption was only 2·8 lb. to 2·9 lb. per pump horse-power per hour. This result on so low a head is considered exceedingly good, and it is assumed to be due to the high efficiency which the system of construction of the Worthington engines adopted secures. We have seen a report giving general details and figures of all the trials, and in concluding it Mr. H. A. Acworth, the Municipal Commissioner for Bombay, writing to Messrs. James Simpson and Co., states:—"I have therefore great pleasure in now informing you that the engines have, to the best of my knowledge, performed their contract work throughout; that is to say, they have each lifted at least 15 million gallons of sewage in the twenty-four hours, and have never consumed more than 4 lb. Welsh steam coal per developed horse-power per hour." These engines have been put down to replace some large beam engines which could only deal with 8,000,000 gallons per day. It must be noted that in comparing the figures given by these pumping trials with any taken from other engines, it must be remembered that the duty mentioned has been obtained on a very low lift, with, of course, a correspondingly low possible duty. It must further be noted that the duty attained was in pumping sewage, not water.

Trent Navigation.—A meeting, called by the Mayor of Nottingham, was held last week, to consider the improvement of the navigation of the Trent so as to make it available for sea-going vessels. The Mayor of Nottingham was supported by the Mayor of Grimsby and influential representatives of the trading interests in the district. The following resolution was carried:—"That in the opinion of this meeting a good navigation between the ports of Hull, Grimsby, and Goole and the town of Nottingham and other towns in the Midland districts, is of the highest importance, not only as providing a cheap method of transit for the use and development of inland trade and agriculture, but also as a means of keeping the railway rates between the localities named reasonable; and that, if such a waterway could be made so as to admit a regular service of boats from 100 to 200 tons burden, great pecuniary gain would accrue to manufacturers, colliery proprietors, and consumers." A resolution was also adopted in favour of an expert being appointed to make a survey and estimate.

Naval Architecture.—As a sequel to an extensive investigation undertaken by Mr. Edwin J. Wilkins, naval architect, of Wivenhoe, he is engaged in writing a work—now nearing completion—treating upon the mathematical theory of naval architecture, which is intended to demonstrate from actual practice the mathematical principles controlling the correct combination of the "elements" in ship design, and to assign a relative value to each. In naval architecture no rules are at present formulated decreeing the proper variations in dimensions, and chief areas, relatively to a given volume to produce various forms or types of vessels; and in designing those various forms the naval architect is left to follow entirely the dictates of his own judgment, based upon observation and experience. A conclusive mathematical solution of these moot points, and the reduction of naval architecture to a positive system by the appraisement of the fundamental elements in design, would therefore be most acceptable as forming the necessary pre-requisite for the accurate determination of resistance due to varied form; and we await the publication of this work with interest.

HER MAJESTY'S SECOND-CLASS BATTLESHIP CENTURION

(*For description see page 223*)



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*** *Next week* THE ENGINEER *will be published on* THURSDAY, *instead of* FRIDAY. *New Advertisements should reach the Office not later than Six o'clock on Wednesday evening; alterations to Standing Advertisements before Three o'clock on Tuesday afternoon.*

CONTENTS.

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R. R. N.—*You will find a small breast wheel, say 14ft. in diameter, the cheapest thing you can use. The fall is much too small for a Pelton wheel. A turbine will do, and if there are facilities for erection it will not cost much.*

FISCHER-PETERS SYSTEM OF WATER FILTRATION.

(*To the Editor of The Engineer.*)

SIR,—I shall be much obliged if any reader can give information respecting the above.
M.I.C.E.
London, March 14th.

CONVERTING WASTE WOOD OF SAW MILLS INTO CHARCOAL.

(*To the Editor of The Engineer.*)

SIR,—Can any reader give information respecting plant by means of which waste wood of a saw mill in the West Indies may be converted into charcoal, or by the manufacture of any of the various products of the distillation of wood?
W. D.
London, March 8th.

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MEETINGS NEXT WEEK.

INSTITUTION OF CIVIL ENGINEERS.—Tuesday, March 20th, at 25, Great George-street, Westminster, S.W., at 8 p.m. Paper: "The Preven- and Detection of Waste of Water," by Mr. Ernest Collins, M. Inst. C.E.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.—Saturday, March 17th, at the Athenæum, Church-street, Hartlepool, at 6 p.m. Paper: "On Oil Engines," by Mr. William Stafford. Discussion on Mr. Frank Caws' and Mr. William Bell's papers.

CLEVELAND INSTITUTION OF ENGINEERS.—Monday, March 19th, at the Literary and Philosophical Society, Corporation-road, Middlesbrough, at 7.30 p.m. Papers: "Evaporative Condensers," by Mr. Tom Westgarth, Middlesbrough; "Bilbao Harbour Works," by Mr. William Kidd, Assoc. M. Inst. C.E., Loftus-in-Cleveland. Discussion on Mr. R. J. Worth's paper read at last meeting.

ROYAL METEOROLOGICAL SOCIETY.—Wednesday, March 21st, at 25, Great George-street, Westminster, at 8 p.m. Papers: "Relation between the Mean Quarterly Temperature and the Death-rate," by W. H. Dines, B.A., F.R. Met. Soc; "Effect on the Readings of the Dry Bulb of the Close Proximity of the Reservoir of the Wet Bulb Thermometer," by F. Gaster, F.R. Met. Soc.: "Duration and Lateral Extent of Gusts of Wind, and the Measurement of their Intensity," by W. H. Dines, B.A., F.R. Met. Soc.; "On the Calculation of Photographic Cloud Measurements," by Dr. K. G. Olsson; "Sudden Changes of the Barometer in the Hebrides on February 23rd, 1894," by R. H. Scott, M.A., F.R.S.

SOCIETY OF ARTS.—Monday, March 19th, at the Imperial Institute, S.W., at 8.30 p.m. Indian section. Paper: "Indian Railway Extension: Its Relation to the Trade of India and of the United Kingdom," by Joseph Walton. Sir James Kitson, Bart., M.P., will preside.

THE ENGINEER.

MARCH 16, 1894.

PETROLEUM IN SOMERSETSHIRE.

IT is now some time since paragraphs began to appear in the daily press concerning the find of petroleum at Ashwick in Somersetshire, and many and sage have been the comments on the importance of the discovery. It may be well before entering upon a consideration of the commercial significance of the results which have been at present obtained, to trace briefly the history of the whole matter, in order that all the grounds for an interim opinion may be stated and appraised. The presence of petroleum in the house well at Ashwick, which has suddenly found itself famous, is no new thing. Successive occupants have complained of the objectionable flavour of the water from time to time, but this peculiarity obtained only local notoriety. The first considerable outburst which received attention was during the long drought of last year, and immediately subsequent to a slight earthquake shock, when the quantity of oil pumped up with the water was sufficient to render the use of the mixture impracticable for domestic purposes. Evidence of the occurrence of this outburst has been collected in as trustworthy a form as is possible in a non-judicial inquiry, witnesses of the event and its consequences having been examined and cross-questioned with much the same care and skill as would be employed in a court of law, with the result that there is good ground for believing in the substantial accuracy of the story. The spirit of impartial inquiry in which the investigation was conducted was rendered specially necessary by two facts, viz., that the well is situated in strata not usually considered to be petroleum bearing, and that the oil itself is not of the quality commonly characteristic of crude petroleum. The whole matter first passed into expert hands when a small sample of the oil was submitted to Mr. Boverton Redwood some months ago. From this point, therefore, the evidence of casual witnesses is replaced by the observation of the trained chemist, and the record of ascertained facts is substituted for the weighing of probabilities.

With regard to the geological situation of the oil, to which reference has already been made, it may be said that the carboniferous limestone in which the oil is found has not hitherto been identified with the occurrence of petroleum. Proximity to coal measures, such as exist in the neighbourhood of Ashwick, is characteristic of some petroleum fields, but the balance of geological evidence is certainly against the existence of petroleum in the Ashwick strata. The chemical characteristics of the oil are also different from those of most crude petroleum, the samples examined more nearly resembling a distillate of the crude oil than crude oil of normal quality. In this connection it must be noted that the possession by a natural petroleum of the qualities of a distilled product may mean simply that subterranean distillation has taken place, and that an alteration of the oil corresponding with that effected in an ordinary petroleum still has occurred from natural causes. One of the chief indications that the Ashwick petroleum has undergone distillation in some way or another is that it contains a notable percentage of hydrocarbons of the olefine series, whereas most crude petroleum is chiefly composed of paraffins. The existence of petroleum of this anomalous quality is not, however, unprecedented. Several cases have been met with by Mr. Redwood, but they are not so common as to cease to be abnormal. Bearing these facts in mind, it is obvious that the first impression received from the examination of the locality of the well and the character of the oil was that the petroleum had filtered from a leakage in some store of the commercial oil in the vicinity of the well, and that its source was to be looked for in America, Russia, or Scotland, rather than in Somersetshire. The isolation of the house, the credibility of the witnesses to the occurrence of the oil throughout a long period, and the persistent though fluctuating nature of the yield, all tended to contradict the hypothesis of extra-Anglian origin, and made the prosecution of a further search advisable. Quite lately, therefore, it was decided to try the effect of a moderate explosion in the well, in the hope of increasing the flow of oil. A small charge of gelignite was employed, and a perceptibly larger quantity of petroleum thus won. The salient points in the history of the discovery of the petroleum, and the reasons for supposing that it is actually a native product having been recounted, it remains to consider the quality of the oil, and the degree of importance to be attached to the find.

The petroleum found at Ashwick is a yellow oil of specific gravity 0·815, having a flashing point—close test—of 175 deg. Fah. It is sufficiently free from both the heavier and lighter constituents—*e.g.*, petroleum spirit and tarry bituminous matter—present in most kinds of crude petroleum, to allow it to be used without previous distillation, as an illuminant. Indeed, it is stated that during a considerable outburst of the oil which happened before the matter came into Mr. Redwood's hands, several barrels were collected, freed from the accompanying water and filtered through a pad of cotton wadding, becoming by this treatment quite fit for use in ordinary household lamps. The high specific gravity and flashing point of the oil detract somewhat from its value as an illuminant, the figures quoted above being a good deal higher than those of common kerosene, and approximating to these of heavy lighthouse oil or of the heavier grade of luminant obtained from Russian petroleum. These heavy burning oils, although serving a useful purpose when perfect security is especially necessary, are not as saleable as kerosene of somewhat lighter grade—*e.g.*, 100 deg. Fah. flashing point—on account of the need for burners and wicks differing from those in general use, in order to consume them to the best advantage. In spite of this drawback, it is probable that in distilling the oil some 75 per cent. of good burning oil could be obtained without having recourse to "cracking." Of the good quality of the Ashwick oil there can be no doubt, and the value of its discovery consequently depends upon its abundance. It would be rash in the extreme to prophesy definitely either favourably or unfavourably concerning the future of Somerset regarded as a petroleum district. All that can be done at present is to indicate towards what conclusion the evidence now at our disposal tends. In arriving at this conclusion, due weight must be given to the fact that petroleum imported into this country is a wonderfully cheap commodity. How cheap it is let the dying Scottish shale oil industry tell. With advantages in the shape of valuable bye-products, and with a market for the whole output of the trade at their doors, firms once flourishing have become moribund or defunct in spite of strenuous efforts to cheapen the cost of production by improved methods and plant. The days when petroleum was sold by the ounce for medicinal use are gone, and a well to pay must have a yield of which the content of a tank steamer is a convenient unit of measurement. Of course nothing approaching this quantity has ever been yielded by the Ashwick well, but deep boring for petroleum is the rule, and a copious supply may be tapped when once the drill has been set to work. Should even a moderate amount be obtained, further exploration may be expected, for the fame of the Somerset discovery has brought news of the existence of similar wells from which both water and oil can be pumped in Wales and Yorkshire. However that may be, the necessary expenditure for sinking a bore-hole at Ashwick is certainly warranted, and money thus sunk may be regarded as risked in a perfectly legitimate speculation in which the chance of return is slight, but in the event of a favourable result the amount of return is temptingly great. With all the facts before us we are of opinion that the quotation of English petroleum in "prices current" is a somewhat remote contingency, but that no stone should be left unturned to bring that possibility about. The enterprise has, at least, the advantage of being under able supervision.

BOILERS FOR TORPEDO CATCHERS.

IN the course of the series of articles which has recently appeared in our pages on water-tube boilers, we defined an express boiler as one which, while very small and light, would produce a great quantity of steam. In other words, an express boiler is a generator which weighs very little and occupies a small space as compared with normal or well-known boilers. The express boiler—using the words in their full significance—is a recent or latter-day creation, rendered possible only by the use of distilled water. We have dealt with the subject as though an express boiler must of necessity be a water-tube boiler; but it is not certain that this is an invariable rule. Many years ago an exceedingly ingenious boiler was made and patented, we think by Hancock, for use in a steam road carriage. It consisted of flat sheets of metal on which were stamped hemispheres or circular protuberances. These, when the chambers were built up in a frame, abutted against each other, and prevented the chambers from opening when pressure was exerted inside them; the hot gases passed up between the chambers. This boiler was very light and very efficient, and it is quite possible that the idea might be developed in the present day with advantage. Be this as it may, we have no reason to doubt that while a very light boiler may be made not necessarily wholly composed of tubes, the lightest possible boiler must be made of tubes and of nothing else.

It is commonly taken in the present day that, if one indicated horse-power can be got out of two square feet of boiler heating surface, the result is very satisfactory. This means an evaporation of about 10 lb. of water per square foot of surface per hour. If it were possible to double this and get an evaporation of 20 lb. per square foot per hour, the advantage would be so great that it is worth while to do much scheming, and inventing, and experimenting to reach the required end. But it must not be forgotten that in no boiler can all the surface be heating surface; and we might have a boiler which was very efficient in one sense and very heavy in another, because the heating surface bore a comparatively small relation to the whole quantity of metal in the boiler. Thus, for example, a large so-called "locomotive boiler"—a true locomotive boiler has never yet been tried at sea—weighing under steam 13½ tons, will make steam for a triple-expansion engine indicating 800-horse power. This gives nearly 38 lb. per horse-power. Two square feet of heating surface in tubes would only weigh 20 lb., allowing one-half their surface to be inefficient. It is easy to see that the best result cannot be got out of a locomotive boiler. There is far too much flat surface to be stayed. About the maximum performance for this type has been got, we think, by a Thornycroft boiler, which evaporated 10,840 lb. of water per hour. The total heating surface was 620 square feet; 78 lb. of coal were burnt per square foot of grate. But the air pressure in the stokehold reached 6in. of water. The evaporation per square foot of heating surface was very nearly 17·5 lb. The total weight of the boiler without fire-bars could not have been much short of five tons. Taking the power as 500 horses, we have 22·4 lb. of boiler per horse-power. This does not include fire-bars or other adjuncts, and the work is too severe to be long continued in that special type of boiler. Reverting, then, to tube surface, we have to consider how it shall be used. The first essential is that both sides—in other words the whole surface—of each tube shall be fully heated, and not one side only. The next is that care shall be taken that an ample supply of water shall invariably be provided to take up the heat. If we have a long tube of small diameter, say an inch, and a very fierce heat, so much steam may be made in the bottom of the tube that all the water above will be blown clean out of it. Then water will rush in from below or above to fill the space, and this in turn will be ejected. We could name more than one water-tube boiler which behaved in this way when hard pressed. The makers called the action "circulation," but it was not circulation in the legitimate sense of the term; a boiler worked in this way will soon be burned out and cannot fail to prime heavily. This "gulping" action is exceedingly injurious, and to be strenuously avoided. Bearing in mind the stipulation that the whole surface of each tube shall be heated, it will be seen at once that it is expedient that the tubes should be short. It is also evident that they must either be vertical or very steeply inclined. Any approach to the horizontal will result in disaster unless the tubes be very short and at least 2in. in diameter. It may be taken as a rule that the fiercer the heat the more closely should the tube approach the vertical.

Experiment goes to show that so long as a tube is made of metal not too thick, and abundantly supplied with water, it is quite impossible to burn it. We have already in a former impression cited Mr. Maxim's experiments in this direction. Years before Mr. Maxim thought about flying machines, Mr. Pope carried out experiments with tubes made of common tin-plate soft soldered. These were buried in a blacksmith's fire, and everything possible was done to destroy them, but fire capable of putting a welding heat on a 3in. bar could not melt the soft solder on the tube. We may take it for granted, then, that we cannot produce too hot a furnace. In this direction, no doubt, torpedo boat builders have proceeded a long way, and when 70 lb. or 80 lb. of coal are burned per square foot of grate per hour the temperature is very high. But something still higher can probably be got with petroleum. The maximum temperature to be had with proper arrangements and oil fuel will probably suffice to melt fire-bricks of good quality much like sealing wax. If, now, there is practically no limit to the rate at which water will take up heat, it seems to be not at all improbable that an evaporation of 20 lb. or 25 lb. of water per square foot can be had. The notion that the water will be driven away from the tube surface and assume the spheroidal condition has no foundation in fact. But very great care must be taken to prevent the clinging of steam to the surfaces. An evaporation so rapid means, as far as the tubes go, only 5 lb. of boiler, and allowing 5 lb. more for the rest of the boiler, and other 5 lb. forwater, we have 15 lb. per horse-power, or for 800-horse power 12,000 lb., or, say, 5·5 tons instead of 13·5 tons; and, allowing a ton for fire-bars and funnel, we still have a boiler which gives us 100 to 120-horse power for considerably less than a ton. That such a boiler can be produced we have no doubt. That it has yet been made we doubt, although results of trials made in the United States seem to show that engineers have got within measurable distance of it at the other side of the water, and on a comparatively small scale. The boiler of the Yankee Doodle is said to have 300 square feet of surface, and to weigh only one ton under steam. Fig. 14, on page 87, illustrates it. It will be seen that we have made a tolerably liberal allowance of steam per horse per hour, and certain very excellent performances accomplished in this country are more to the credit of the engine than the boiler, a fact not to be forgotten.

If our readers will examine the designs of any express boiler, or will set about scheming one themselves, they will quickly find that there is a great deal of surface—in other words, a great deal of steel plate—that is of no use for generating steam. Not only does this weigh, but it takes up room which can ill be spared. Let us suppose that we use vertical tubes 3ft. long; under them come the feeders, say, 1ft. in diameter, and above them the receiver, say, 2ft. in diameter. As the feeders must be below the grate level, there is less than 3ft. left between the grate and the bottom of the receiver, and even then the whole boiler is at least 6ft. high. The steam receiver and separator over the fire is the great offender. If it could be suppressed or put in another position, considerable advantage would be gained as regards height. It is held, of course, that it is essential in order to get dry steam. If it satisfied this condition, and if nothing else would satisfy it, then we must perforce have it. But it may be shown that the horizontal cylinder of considerable diameter, lying along the top of the boiler, is not necessarily the only expedient by which dry steam may be got, and that, in point of fact, unaided it will not give dry steam at all. There are various ways in which steam may be dried without the use of an unwieldy and heavy cylinder holding a great deal of water. It is true that each steaming tube must deliver a very large quantity of water mixed with steam. The steam can scarcely fail to fill the whole diameter of a 1in. tube, and in any case its upward rush will entrain much water. If the tubes deliver against a flat plate, the concussion will knock much of the water out of the steam, and various devices are available for getting rid of the remainder.

It must not be forgotten that all we have just written applies to a very special and peculiar type of generator, in which a great deal is sacrificed for the sake of getting the largest possible quantity of steam out of the smallest and lightest possible boiler, and it is not to be expected that such a boiler can compare in economical efficiency with others. If we took an ordinary railway locomotive boiler and cut most of the barrel and tubes off we should have a very efficient generator left, but it would not be very economical. Let us suppose, for example, that we burned 80 lb. of coal per square foot per hour in the grate; that the boiler tubes were 12ft. long; and that a certain weight of water was evaporated per hour. If, now, we cut away all the barrel, save enough to leave tubes 2ft. long, then the evaporation would still be nearly 75 per cent. as great as before. There would be a loss in economy of fuel, but there would be an immense saving effected in weight and in space. Furthermore, the reduction in the length of the tubes would permit us to reduce their diameter, and the economy and efficiency of the boiler would both be helped by that alteration. There is, indeed, no reason to suppose that an express boiler must be dreadfully uneconomical; but, on the other hand, any attempt to make it thoroughly economical will end in failure, unless indeed it is intended to use the boiler only for very short periods, in which case the spaces for the discharge of the products of combustion may be made contracted, but only by incurring the risks of sooting them up and ruining the draught.

There are, we have no hesitation in saying, possibilities in view which, made use of properly, will give us boilers of hitherto unrealised lightness and smallness. The principles to be observed are very simply stated. The first is that the heating surface, and indeed the whole boiler, shall be as far as possible tubular. The second is that every inch of surface not used for generating or drying steam shall be regarded as waste. The third is that great care should be taken to secure a regular discharge of steam from the heating surface. If the steam has any chance of hanging or clinging to the metal disaster will follow. When we come to work with enormous temperatures there is no time for the correction of an error. If, for instance, a tube should boil itself dry, in less than five seconds it would be white hot and would burst. Fourthly, special arrangements must be made for getting the water out of the steam. To comply with all the requisite conditions is very far from being a simple matter. So much has been done, however, that more can no doubt be done, and we do not despair of seeing a boiler which, complete, shall only weigh about 15 lb. per horse-power, and nevertheless shall be sufficiently durable to satisfy all legitimate demands that can be made on a torpedo catcher.

LONDON WATER SCHEMES.

THE London County Council, intent on obtaining possession of the metropolitan water supply, and yet acting with what appears to be a certain crookedness of purpose, has passed a resolution by which it professes an intention to enter into negotiations for the purchase of the undertakings of the London water companies, according to sundry conditions of its own making. At the same time the Council is seeking to introduce a Bill into Parliament, by which it is to be enabled to take preparatory steps for bringing a supply of water to the metropolis from distant sources, situated anywhere in Great Britain. For the present the Bill is hung up over a question of the Standing Orders, but it may be taken as an expression of the policy of the County Council, though at variance with the proposal for purchasing the existing undertakings, "or one or more of them," concerning which the sources of supply are in the watersheds of the Thames and the Lea. The proposal for purchase is also encompassed with such stipulations, that it is difficult to understand how the County Council can expect to negotiate at all on the basis which it has laid down. One proviso alone is sufficient to constitute an insuperable barrier, fatal to any idea of a voluntary and amicable arrangement between the Council and the companies. It is thus specified that in the proposed negotiations "no monopoly rights" on the part of the companies are to be recognised. The companies are to be treated as though they had no Acts of Parliament by which they were established, and by which certain powers were conferred upon them. They are thus called upon to surrender their birthright for a mess of pottage, and it is perfectly certain that they will do nothing of the kind. There are other conditions attached to the proposed negotiations, all of such a nature as to render it impossible that the companies will enter into any parley on the subject. Hence, if progress is to be made, it must be by means of compulsory powers, such as the County Council signifies it will seek in the course of next year if its gracious advances are repelled in 1894. But the pretext of purchase, though based on impracticable conditions, is to serve an immediate purpose, however much it may fall short of its ostensible object. It is to place the Council in a better position for opposing the Bills brought forward by the East London, the Southwark and Vauxhall, and the West Middlesex Water Companies. These Bills, as we have previously explained, especially in the case of the two former companies, are adapted for giving effect to the recommendations of the Royal Commission which has recently reported on the subject. The County Council wishes to upset the whole of these Bills, but the necessity for enlarging the water supply of the metropolis is so pressing in its character, as shown by the Council itself, that something must be done; and if the companies are to be stopped, the Council must be prepared to go on. But the latter has no scheme prepared, and accordingly the professed intention to purchase has to be brought forward, in order to combat the plans devised by the water companies. The Committee which has reported to the Council on this subject has distinctly said that whether the London Water Bill, now promoted by that body, is proceeded with or not, "the necessity of action by the Council is not the less real." Taking this view of the case, the Committee has recommended the scheme of negotiations.

In a letter from Mr. Brayley Hodgetts, to which we gave insertion last week, it is urged that the project brought forward by the Southwark and Vauxhall Company is not in accordance with the recommendations of the Royal Commissioners, seeing that it differs from the plan to which they gave the preference as compared with two others. Of the three plans thus submitted for drawing an enlarged supply from the Thames or its tributaries, there is no doubt the Commissioners selected the best. But the choice was limited, and it seems like carrying the conclusion too far to assert that nothing worthy of acceptance could be designed outside the three projects on which the Commissioners passed their opinion. The approval expressed with regard to a system of reservoirs at Staines was not absolute in its character, but relative, as expressed by the words in the report:—"Broadly speaking, and without committing ourselves to details, we may say that the conception of this Staines scheme of storage commends itself to us as the best which has been suggested." The Southwark and Vauxhall scheme does not pretend to do the great things proposed by the plan which Messrs. Hunter and Fraser have so ably prepared, but, proceeding on similar lines, though on a reduced scale, it provides for an important addition to the supply taken from the Thames, while securing an adequate flow over Teddington weir. There appears no prospect that the rejection of this scheme would lead to the adoption of the plan which has been proposed by Messrs. Hunter and Fraser, however much the failure of the Southwark and Vauxhall Bill might promote the designs of the County Council. The fact that the Staines project, estimated to cost ten millions, is not before Parliament, is an essential feature in the case, and some weight must be attached to the circumstance that if the County Council is opposed to the lesser scheme much more would it resist the larger. That which is practicable has to be borne in mind, and not only that which may be desirable.

It must be acknowledged that the companies are acting consistently. The water supply of the metropolis must be extended, and the companies come forward with plans for giving such extension. The Council seeks to prevent the execution of these plans, though at the peril of leaving London short of water. This will never do, and Mr. Binnie, the chief engineer to the Council, has forcibly pointed out the situation in a report which he has addressed to that body, in the course of which he announces the undoubted fact that, whatever may come to pass later on, London must continue to take its supply from the Thames and the Lea for the next ten or fifteen years. As there is immediate need for enlarging the supply, somebody must set to work, either the Council or the companies. Mr. Binnie of course prefers the former, and recommends that the Council should now buy up, not all the companies, but some of them, and proceed to carry on the supply from the existing sources until something of a more ambitious character can be accomplished. The point aimed at is to furnish "a proper and sufficient supply of water" to the entire community which the Council represents. It is true that the resolution of the Council proposes as an alternative the purchase of "one or more" of the existing undertakings, but this is prefaced by a proposal without limit, and there can be no doubt it is intended to make the entire water supply of the metropolis the property of the County Council, any lesser arrangement being merely a temporary expedient. We can only say that if the people of London are to be benefited by such a change, by all means let the Council sooner or later step in, provided no spoliation is perpetrated on the pretence of promoting public interests. Unfortunately, the present aspect of affairs is more that of a fight than anything else, and a considerable amount of money is being spent in the conflict which might be turned to a better purpose. Economically, the prospect is rather vexatious. In some way or other, and at a date to be fixed by-and-bye, the undertakings which at present supply London with water are to be bought up, apparently for the mere sake of being superseded by something else. A double charge will thus rest upon the metropolis, one for the supply that is to go, and another for that which is to come. Sir John Lubbock has admonished the Council that it already has quite enough to do without undertaking the work of the water companies, and at the same time he has warned the ratepayers that if the water supply passes into the hands of the Council, the scale of charge will be increased. This must necessarily be the case, even if the present works are bought up on terms ruinous to the shareholders, seeing that whatever is paid for the old works must be added to the cost of the new. That there must be a buying up in order to make way for a fresh enterprise is clearly apprehended by Mr. Binnie, who tells the Council in his report that he is aware of no instance in which Parliament has permitted a municipality to acquire rights of water supply, without arrangements being first of all made for a fair bargain with the existing company.

The position of the County Council in reference to the water companies of the metropolis is complicated by the manner in which some of its official staff criticise the report of the Royal Commission. A similar line is taken by the Water Committee, and, on the whole, it is evident that the authorities at Spring Gardens are not satisfied with the conclusions at which the Commissioners have arrived. Objections are also taken to the plans of the water companies, as set forth in the three Bills coming before Parliament. Of course there is an advantage in straightforward and independent criticism, but it is a little difficult to see how the Council, having avowed its dissatisfaction with the existing waterworks, can come forward with proposals to purchase them. Although the Commissioners have declared that the water supply, in the condition in which it reaches the consumer, is excellent, the Council pays special attention to the impurities which are described as polluting the open stream. The deep wells of the Kent company, and the wells possessed by other companies, are accepted as yielding pure water; but it is argued that the quantity to be obtained in this way is insufficient. Much is made of the alleged lowering of the water level where the wells are in operation. Allowing that there is reason for proceeding cautiously in drawing from underground sources, and that greater care ought to be exercised in preserving the purity of the stream, there is the fact that the Royal Commissioners believe in the practicability of drawing from the rivers and subterranean waters in the Thames and Lea watersheds a sufficient supply to meet the wants of 12,000,000 of people, a number exceeding by about three-quarters of a million the population which may be expected to depend on such a supply in London and its environs in 1931. There is also the expectation that a large amount of water may be obtained from the chalk area lying eastward of the Kent Company's district. But if all this stands good, why should the County Council disparage the present supply? If, on the other hand, the supply is seriously deficient in quality or quantity, or likely to become so, why should the Council seek to purchase it?

Another question now comes up for consideration, and adds a further element to the conflict. There is the Thames Conservancy Bill, a scheme of enormous dimensions, and calculated to stir up a host of opponents. Several of the clauses relate to the metropolitan water supply, and the County Council objects to that part of the Bill which confirms certain agreements by which some of the Thames companies are allowed to draw what is considered an enlarged quantity of water from the stream. But it is obvious that if the recommendations of the Royal Commissioners are to be carried out, or, in other words, if the future wants of London are to be duly supplied, the quantity which the Bill allows to be taken from the stream must be considerably amplified. A greatly increased contribution to the Conservancy Board from the water companies is proposed by the Bill, and to this it is objected that the burden will fall on the consumer. Yet if the companies are already charging the consumer to the top of their scale, as we find generally asserted, we may rather assume that the shareholder will be the loser. Lord Farrer, speaking in the Council, has expressed apprehension with regard to the stringent powers to be exercised under the Conservancy Bill for preventing the pollution of the Thames. His lordship pictures to himself a whole army of inspectors watching every rivulet and stream in the watershed, the cost being thrown on the water companies, or, as he suggests, on the consumers; and after all this has come to pass, the County Council may be called upon to buy up the undertakings of the companies at the increased value given to them by such purification. If this argument is to have a practical bearing, it would appear to mean that the Thames is to remain dirty, in order that the Council may buy up the water supply cheap. We can hardly suppose Lord Farrer intends such a procedure, yet it seems to agree rather closely with the general policy of the County Council. Taken altogether, the problem of the London water supply seems to be growing more intricate as time goes on. If "fair and reasonable" terms could be arranged for the purchase of the undertakings of the water companies by the County Council, one part of the quarrel would come to an end. The next would probably be a quarrel between the Council and the ratepayers. The consumers, as such, might be satisfied, but if so, there would most likely be a deficit to fall on the rates.

COAL-CUTTING MACHINES IN NOVA SCOTIA.

THE report of the department of mines for Nova Scotia has some features that are of interest to engineers. That Province is one which is enlarging its yield as a coal producer. Instead of an output of about 568,000 tons, as it had in 1870, its production has risen to about 2,000,000—the exact figures for the past year not being available owing to the closing of the fiscal year with September. Cape Breton County is one of the leading parts of the producing district, its coal sales last year being over 792,760 tons. In it the coal-cutting machine of one form or other seems increasingly used. At the Gowrie mines ten coal-cutting machines of the Ingersoll type have been added to the plant last year, with an air compressor of 20in. by 24in. cylinder. In the Caledonia mine five more machines, and now out of the eight in use, seven are Ingersoll-Sergeant, and the other, Harrison. In Little Glace Bay mine there are ten Ingersoll machines; a Stanley Header is in use at old Bridgeport, as well as Ingersoll machines. Some of these collieries are of considerable extent, judging by the reported number of miners employed; the Dominion Coal Company having 1793. The report gives, as do the reports of our own Inspectors of Mines, a list of the accidents, but it adds also a statement of the timber and explosives used in some of the collieries—in one, for instance, 300 lb. of powder and 106 lb. of dynamite were used in the first nine months of last year, whilst another inspector gives a return of the kinds of explosives used: "29,326 lb. of powder; 11,700 lb. of flameless powder; 2818 lb. of roburite; 50 lb. of dynamite; 85,100ft. fuse, and 128 boxes of squibs;" so that there are details given that enable the reader to estimate the relative proportions of the explosives that are used. Of course, as a comparatively new contributor in quantity to the coal-production of the world, Nova Scotia has had the experience of others to guide it in the form alike of its legislation and of its reports. It is now selling very little of its coal to the United States—not a tithe of what it used to sell—but it finds an increasing market for its produce for its own needs, and especially for Quebec, so that with the growth of the Dominion of Canada it is probable that there will be an enlargement of the output of the Nova Scotia mines, and probably an increased employment of machinery therein, for the results seem to be satisfactory both in the extent of the yield, and in the facility and comparative safety of the working. There may perhaps be differences of opinion as regards the desirability of the introduction of machines in the older collieries and very different pits here; but there is no doubt that alike in Nova Scotia and in the larger coalfields of Illinois there is an increasing and useful employment of several types of coal-cutting machines, and that employment does seem to suggest at least the possibility of greater attention being paid here to the introduction. The subject has had intermittent attention and experiment, but not on a scale such as in proportion it seems to have had in different parts of the coalfields of America.

SUBSIDENCE ON CALEDONIAN RAILWAYS NEAR GLASGOW.

A DANGEROUS subsidence of the Caledonian main line near Hallside Junction, a few miles east of Glasgow, occurred on Tuesday morning last week; the early passenger express from the south having a narrow escape from serious disaster. The line at the spot indicated is carried on an embankment some 35ft. high, along the south side of which the river Calder runs for a short distance before passing, by means of a large culvert, under the line on its way to the Clyde. The subsidence took place at a point midway between this culvert and the place where the stream first approaches the line. It may be mentioned that the embankment was here pierced by a 12in. cast iron main used by the Steel Company of Scotland to convey water from its pumping station on the Clyde to the Hallside Steel Works. Under ordinary weather conditions the Calder is a mere brook, but the long-continued enormous rainfall had swollen it to an unprecedented extent, causing large volumes of rapidly moving water to surge almost continuously against the embankment for several weeks before the accident. Under these circumstances the railway officials had for some time been keeping this portion of the line under close observation, and though no serious mishap was anticipated, a gang of surfacemen were kept in constant readiness for any emergency. On the morning of the 6th, the postal train passed at 6.15 without anything unusual being noticed, and a quarter of an hour later a light engine also passed in safety. Almost immediately afterwards, however, a large portion of the embankment suddenly collapsed, leaving the rails of both the up and down lines suspended over a chasm some 60ft. long, and of considerable depth. The fall was so sudden and unexpected that several of the watchers had narrow escapes from being overwhelmed and carried into the Calder with the *débris*. At the time of the accident the early express train from the south was almost due; but fortunately some of the workmen were able to reach Uddingston Station, a mile to the east, in time to have the train stopped, and so to prevent a catastrophe to the express, which carried a large number of passengers. Owing to the facilities possessed by the Caledonian in the way of alternative routes between Glasgow and Motherwell and Hamilton, the accident caused little delay to the general passenger or goods traffic, and the breach in the line was filled before the end of the week, abundant supplies of material for the purpose being easily obtained from the neighbouring iron and steel works. The exact cause of the occurrence has not been, and probably will not be, ascertained. The district is undermined with coal workings, and this, coupled with the phenomenal rainfall, and consequently swollen state of the Calder, may be sufficient to account for the mishap. Some of the railway officials are inclined to attribute it to the bursting of the Steel Company of Scotland's water main, but though the pipe was found to be fractured after the collapse, it seems probable that this was the result rather than the cause of the failure of the embankment. In any case the officials of both companies may now be relied upon to fix the pipe in such a way that its failure is not likely to result in the closing of a line accommodating over 300 trains per day, and the suspension of productive operations in a large steel-making establishment.

THE REVIVAL IN TRADE.

THE evidences of an improvement in trade are increasing, and prospects for the iron and steel masters of Scotland and the northern counties of England, and for the marine engineering and some other of the engineering centres are better at the present time than they have been for many months. The position is one which has long been waited for, and now that unmistakeable proof of revival is forthcoming, it is natural that the better appearances should be matter of great satisfaction. Everything goes to show that it is to the increased demand for iron and steel shipbuilding that the country is mainly indebted for the trade convalescence. The booking of new orders for vessels continues alike in Scotland and on the Tyne, the Tees, and the Wear. It is calculated that over 100,000 tons of new work has been contracted for on the Clyde alone since the beginning of the year. Shipbuilders on the West Coast have a good programme of work before them, and are anticipating the receipt of additional orders very early. As the contracts that have been given out in all the centres are nearly all for steamships, the activity is being carried into the marine engineering works. Some of those who build the largest types of marine engines, and who have had of late Government work that is rapidly being exhausted, it is true, need more business. But most of the firms, alike on the Clyde and North-east Coast, have now booked their output for some months ahead. One large South Durham engineering establishment has, we are informed, orders that will occupy them for fully a year. The effect of this revival is seen also in a quickened call for castings and for boilers. In Cleveland the marine engineers are so busy that certain of them are finding it necessary to run their establishments nights as well as days. Five per cent. rise in prices is quoted by various firms upon the rates of last quarter. The Scotch and Northern steel masters are all very busy upon steel plates, angles, and other sections, and full work is assured over the next six months certain, and probably longer. A great revival in demand is to be seen in the Glasgow locomotive engine building trade; stationary engine builders in Lancashire have some good orders in hand for Eastern markets; and with Russia and the North of Europe a valuable trade is being done in machinery from the Midlands.

LITERATURE.

The Principles of Waterworks Engineering. By J. H. TUDSBERY TURNER, B.Sc., M. Inst. C.E. and A. W. BRIGHTMORE, M.Sc. A.M.I.C.E. London: E. and F. N. Spon. 1893.

THE engineering of the water supply of towns is already represented by a goodly array of books and a larger number of papers in the transactions of engineering societies, but from time to time new departures are made in the practice of waterworks engineering which form a sufficient basis for the text at least of a new book, and often of one which grows to be of larger dimensions than the authors originally intended. The book before us may be said to be one of high class on a limited number of the subjects which might be included in its title. It deals very largely with principles, as the title suggests, but it departs very considerably from them in order to describe specifically certain mechanical details connected with the water supply and distribution. The first chapter deals with the sources of water supply, and herein are treated several of the questions concerning percolation, subterranean water levels, effect of pumping on these; and similar questions which recently formed the subject of much inquiry by the Royal Commission on the Metropolitan Supply. The second chapter is on the measurement of water, and deals fully with this subject, and with the general formulæ relating to flow and the gauging of rivers, with special reference to modern instruments and apparatus. The third chapter relates more to the collection of water, and particularly to the interception of surface waters, lakes and rivers, catchwater drains, filters and wells; but the chapter also includes references to several kinds of pumps, the theory of which is interesting, though in practice they are obsolete, and several pages which are occupied with remarks concerning steam engines and testing engines would have been better occupied with an extension of the chapter on the storage of water, which deals particularly with the selection of sites for and the construction of dams and reservoirs, both impounding and service reservoirs. Here again the treatment is of the principles which guide the waterworks engineer, on those questions which in the early stages require so much investigation before decisions are satisfactory; and special reference may be made to the investigations concerning and summary of the knowledge of to-day relating to the sections of reservoir dams. The purification of water and the conveyance of water, occupy the fifth and sixth chapters, and both are well considered, and comprise in 120 pages a great deal of judiciously selected information on these subjects. The latter chapter quite desirably gives, either admittedly, or as can be inferred, a good deal of the sort of information which became very necessary in connection with the designs and arrangements for the construction of the great Vyrnwy Aqueduct, its balancing reservoirs, its railway, and river crossings. In the chapter which follows on the distribution of water, the principles are first dealt with and then some of the small practical details, while the concluding chapter is on the maintenance of waterworks, and herein amongst many things will be found a sufficient treatment of the waste water meter system originally devised twenty years ago by Mr. Deacon, although the subject is for some incomprehensible reason, that upon which a paper was read by the Institution of Civil Engineers last Tuesday. The book is well got up, and will no doubt soon be found on the shelves of every waterworks engineer. It may be mentioned that since the publication of this book, the name of the first author has changed to J. H. Tudsbery Tudsbery.

BOOKS RECEIVED.

The Journal of the Iron and Steel Institute, vol. xliv. Edited by Bennett H. Brough, Secretary. London: E. and F. N. Spon. 1894.

A School Course on Heat. Revised and enlarged. By W. Larden, M.A. Fifth edition. London: Sampson, Low, Marston, and Company.

A Pocket-book of Electrical Engineering Formulæ. By W. Geipel and M. Hamilton Kilgour. London: *The Electrician* Printing and Publishing Company.

Laxton's Builders' Price-book for 1894. Containing above 72,000 prices. Originally compiled by William Laxton. Seventy-seventh edition. London: Printed and published by Kelly and Company. Sold by Simpkin, Marshall, Hamilton, Kent, and Company.

Every Man's Own Lawyer. A handy Book of the Principles of Law and Equity, comprising the Rights and Wrongs of Individuals. By a Barrister. Thirty-first edition, carefully revised, and including the legislation of 1893. London: Crosby Lockwood and Son. 1894.

Architecture Navale, Théorie du Navire. Tome IV.—*Dynamique du Navire: Mouvement rectiligne horizontal oblique, mouvement curviligne horizontal. Propulsion. Vibrations des Coques des Navires a Hélice.* Par J. Pollard et A. Dudebout. Paris: Gauthier, Villars et Fils. 1894.

Electricity in the Service of Man. A Popular and Practical Treatise on the Application of Electricity in Modern Life. By R. Wormell, D.Sc., M.A. Revised and enlarged by R. Mullineux Walmsley, D.Sc. Lon. F.R.S.E., &c. With more than 950 illustrations. London: Cassell and Company. 1893.

The Engineers' Year-book of Formulæ, Rules, Tables, Data, and Memoranda in Civil, Mechanical, Electrical, Marine, and Mine Engineering. By H. R. Kempe, A.M. Inst. C.E., M.I.E.E. With 700 illustrations, specially engraved for the work. First year of publication. London: Published for the proprietors by Crosby Lockwood and Son. 1894.

The Universal Electrical Directory—J. A. Berly's. Containing a complete record of all the industries directly or indirectly connected with electricity and magnetism, and the names and addresses of manufacturers in Great Britain, India, the Colonies, America, the Continent, &c. London: Published by the sole proprietors, H. Alabaster, Gatehouse, and Company. 1894.

Lockwood's Builders', Architects', Contractors', and Engineers' Price-book for 1894. A comprehensive hand-book of the latest prices of every kind of material and labour in trades connected with building, including also a great variety of the most recent information in all matters concerning these trades, with many useful memoranda and tables. Re-written, greatly enlarged, and edited by Francis T. W. Miller. London: Crosby Lockwood and Son. 1894.

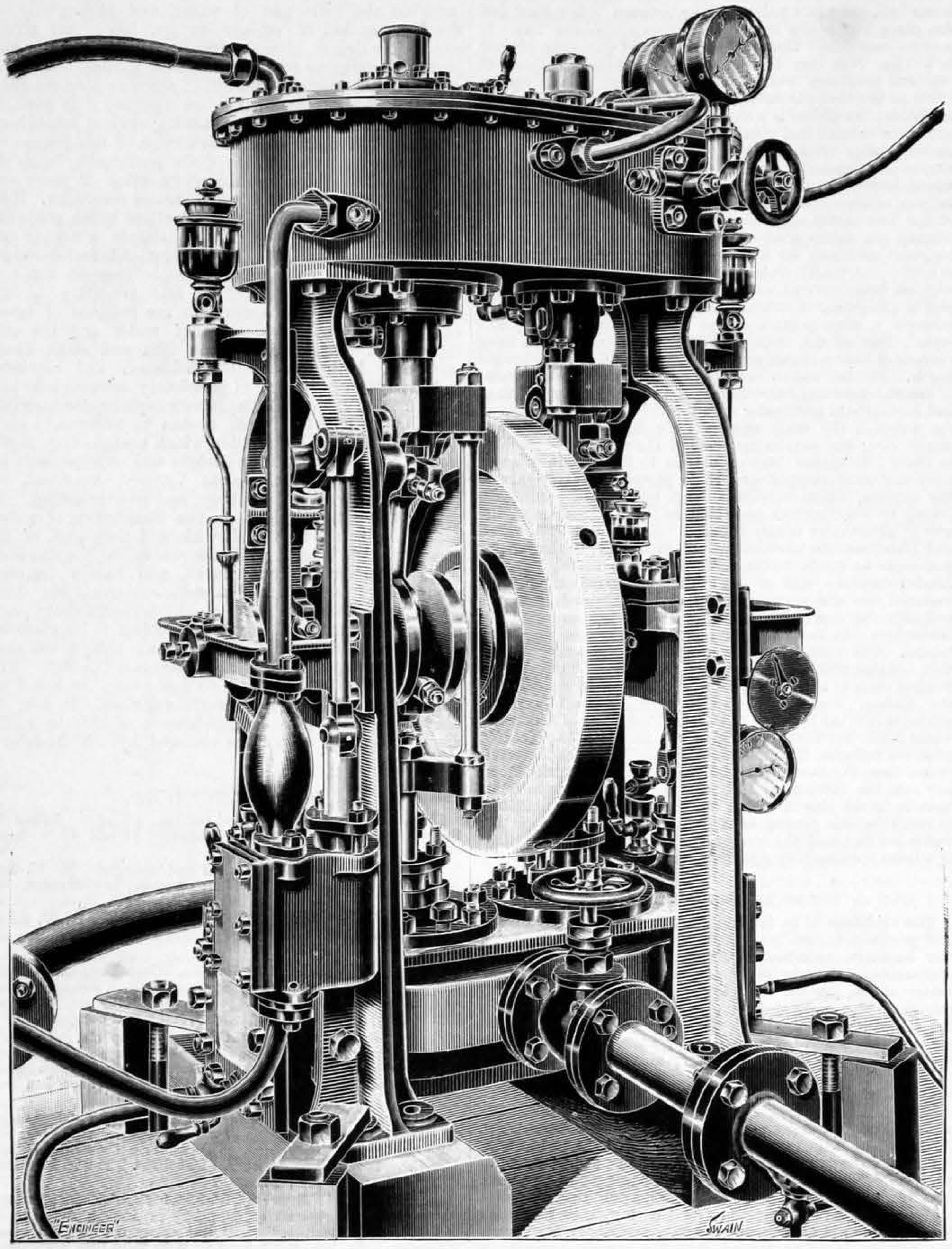
PARLIAMENTARY NOTES.

Oil fuel at sea.—Mr. Bowles asked the Secretary of the Admiralty whether his attention had been called to a statement on the 22nd February last that the British steamship Baku Standard had arrived at Philadelphia after having made the passage across the Atlantic under steam generated by oil fuel alone, and whether the Government were carrying out any experiments with the view to ascertain the adaptability of oil fuel for use in her Majesty's ships. Sir U. Kay-Shuttleworth replied that nothing was known at the Admiralty of the statement in question, and that no experiments with oil fuel were now going on in her Majesty's ships.

Supplies for Indian State Railways.—A question was put to the Secretary of State for India by Sir A. Hickman on the above subject. He asked, in particular, whether Les Usines et Fonderies De Baume et Marpent of Belgium had supplied 10,000 axle-boxes to the Indian State Railway, and whether he would use his influence to induce the railways in future to procure their supplies of such articles in this country. Mr. Fowler replied, that so far as he could ascertain no order for axle-boxes for Indian State railways had been given to the Belgian Company. According to the existing practice of the Department, a general preference is always given to firms in this country.

Irish light railways.—The latest information in the possession of the Government shows that 1285 men are now employed on the Galway and Clifden Railway, and it is hoped that the entire length of it will be ready for opening about September 1st next.

HIGH-PRESSURE AIR COMPRESSOR

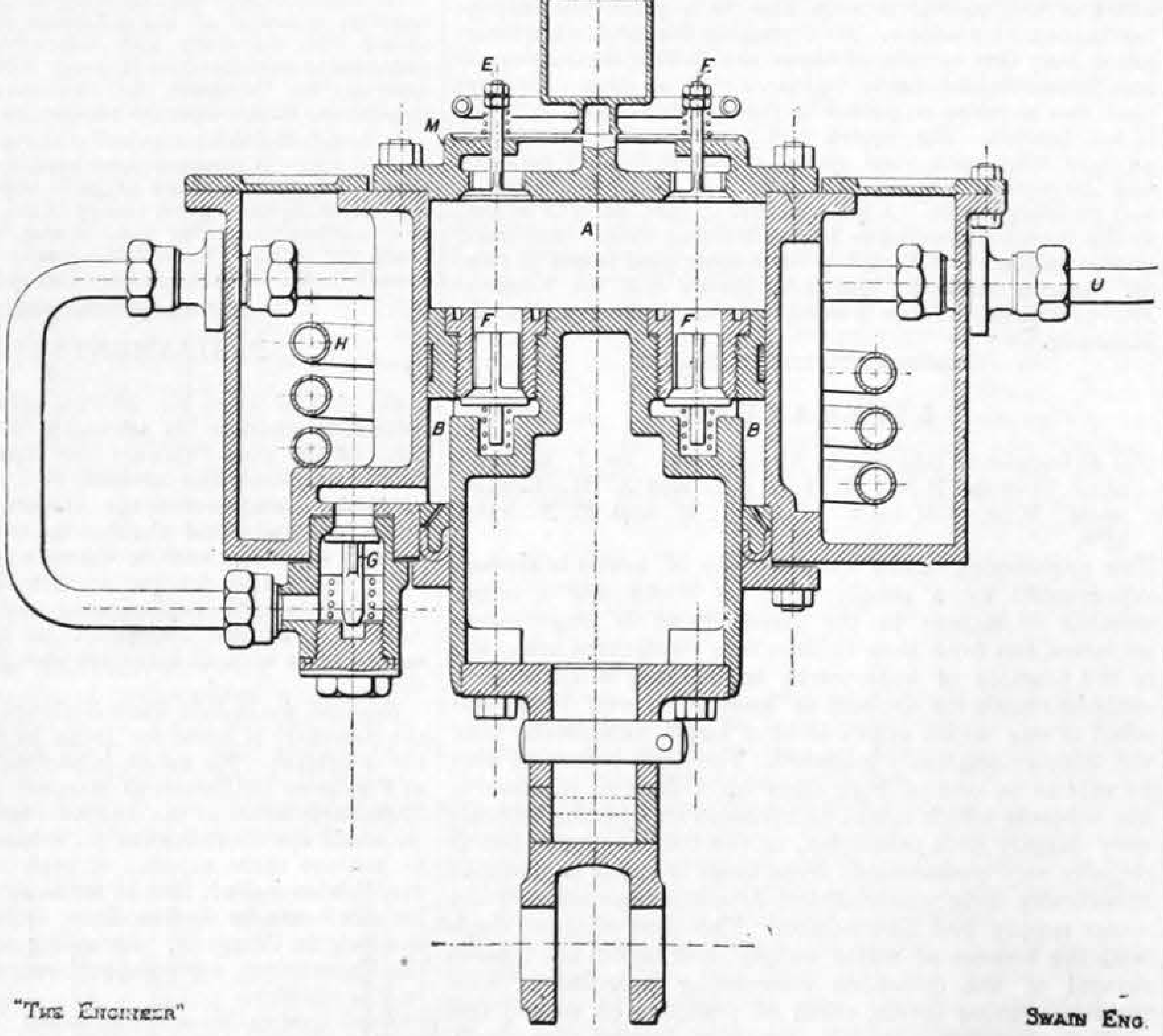


HIGH-PRESSURE AIR COMPRESSORS.

THE air compressor which we illustrate above and on page 229, is one of a type introduced and constructed by Messrs. Elwell Fils, of Paris.

The machine consists in effect of two double-acting compressing pumps, in which the air is compressed in four stages. The capacities are so calculated that the pressures shall be equalised on each side of the pistons. The pistons are provided, it will be seen, with trunks, and the first stage raises the pressure to about 57 lb. In the second stage this is brought up to 142 lb., in the third to 430 lb., and in the fourth stage to 1430 lb. per square inch. The two compressing cylinders are cast together, with a casing or jacket to contain water, in which are placed two coils of piping. The first serves as an intermediate receiver for the first cylinder, and the second coil, connected with the small cylinder, serves to cool the air before it is delivered into the storage reservoir. The air to be compressed is drawn into the large cylinder through eight valves E E in the cover, and kept closed by helical springs. A spray of water is introduced at the same time, while a small quantity of oil is drawn in from the lubricator on the top of this cover.

When the piston ascends it compresses the air in the portion of the cylinder marked A. When a certain pressure has been reached the valves F F in the piston are forced down, and the air then enters the annular space B B between the sides of the cylinder and the trunk. On the return stroke the air is forced into the coil H through the valve G. The action of the two pistons is identical. The process just described is repeated in the small cylinder. It is to be noticed that the water introduced into the first cylinder passes through all the stages and is always above the valves. It is claimed by the makers that this is a feature of much importance in machines running at a high speed, because then there is no danger of knocking a cylinder end out, or breaking a piston if too much water should chance to be admitted.



"THE ENGINEER" SWAIN ENG.

It is in reality a quadruple compression engine, the final pressure attained amounting to 1400 lb. per square inch. The machines are made in several sizes. One to deliver 17·65 cubic feet of air per hour at the stated pressure, has the following dimensions:—

Diameter of large air piston	7⅞in.
Diameter of trunk	6⅝.
Diameter of small piston	2⅜in.
Diameter of trunk	1 5/16in.
Diameter of steam pistons	6¼in.
Stroke of all pistons	4¾in.
Revolutions per minute	300 to 350.
Steam pressure	43 lb. to 71 lb. per inch.

The following advantages are claimed for this system:—(1) The use of a low pressure to begin with reduces the loss due to clearance; (2) the division of the work into four stages permits the air to be effectively cooled between the two cylinders; (3) the last stages of compression being effected by a very small piston it is easy to make the piston tight, and the space over which leakage could take place is reduced to a minimum; (4) the whole machine can be taken to pieces and put together again in a very short time; (5) the delivery of the machine is independent of the pressure in the storage reservoir.

The quantity of water admitted amounts to about 15 cubic inches for every 200 cubic inches of compressed air delivered.

Our illustrations are so complete that we do not think any further description is needed to make the action of the machine intelligible.

It only remains to add that it has been specially designed for charging torpedoes, and has, we understand, been adopted by the French Naval authorities for that purpose.

LOCOMOTIVE FIRE ENGINE.

MESSRS. MERRYWEATHER AND SONS have brought out a useful modification of the fire engine. On January 26th we described a floating fire engine for Egypt, in which the vessel was propelled by two streams of water direct from the pumps. On the 10th inst. a fire engine, arranged to be carried on a locomotive, was satisfactorily tried at Southampton.

The machine is the invention of Mr. John Clark, the engineer to the Southampton Docks, and consists of a treble-cylinder steam fire engine, with double-acting gun-metal pumps, and mounted on a strong wrought iron frame. Brackets provided with grooves are permanently fixed to the front buffer-plate of a locomotive, and the back of the frame slides in these grooves, so that it can be dropped into place in a few seconds. Connections are then made with the steam and exhaust pipes of the locomotive by means of flexible tubes, and the suction, which is also flexible, is coupled on and taken to the nearest water.

The trial took place on a line of railway in the docks. The fire engine, which weighs 10 cwt., was suspended from a crane by two rods passing through holes in the top of the frame. It was put into place, the steam and exhaust pipes connected, and four lengths of suction pipe joined together in forty-five seconds. Four 2¾in. fire hose, with 1¼in. nozzles, were operated simultaneously, and directed streams of water over the roofs of some adjoining warehouses. We are informed that the engine is capable of delivering 750 gallons per minute to a height of 160ft. The pumps, when at full speed, make 250 revolutions a-minute, with a boiler pressure of 100 lb. to 120 lb.

Messrs. Merryweather were represented at the trial by Mr. Jakeman; the South-Western Railway Company by Mr. Govett; and the Southampton Harbour Board by Mr. Dixon.

In docks, railway stations, or large factories, where there are usually several shunting engines under steam, it will be possible by fitting them all with slides and with connections to the steam pipe and exhaust, to have a powerful steam fire engine in working order and ready to proceed at a minute's notice to any place where the rails are laid.

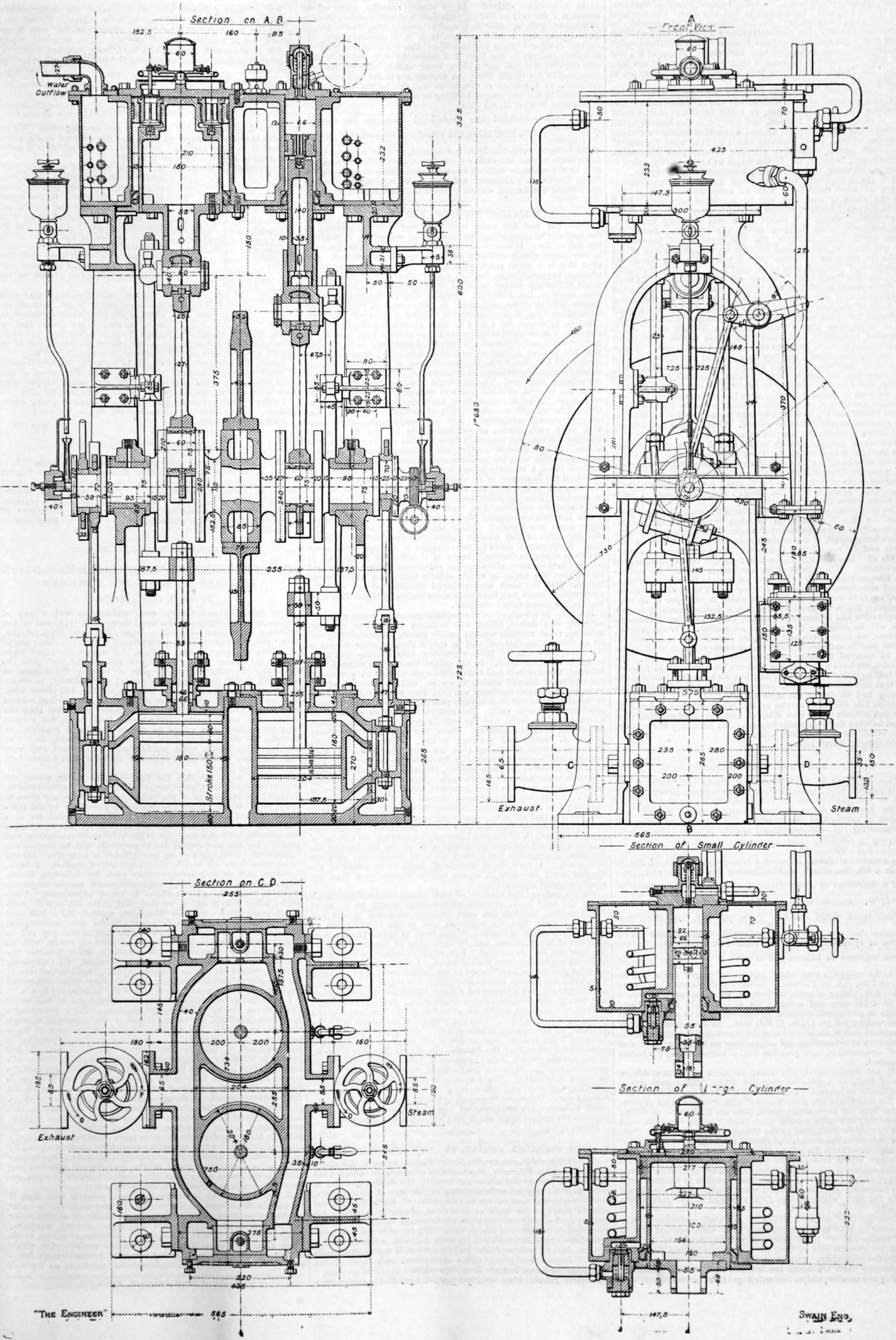
This invention should be even more useful in the United States than in England, but on account of the central buffer and "cow-catcher" it would require to be modified in shape before it could be used on American locomotives.

THE GENERATION AND DISTRIBUTION OF ELECTRICITY.—At the monthly meeting of the Leeds Association of Engineers, the President—Mr. Alfred Towler, M.I.M.E—in the chair, a paper was read by Mr. Chas. J. Hall, on "The Generation and Distribution of Electricity." He said that although electrical science dated back to 600 years B.C., it was only within recent times that it had reached the stage of rapid development. He alluded to the researches of Galvani, Volta, Ampère, Faraday, and others, and showed that in the discovery that an electric current could be generated by passing a wire across the lines of force in a magnetic field, the principle of the modern dynamo had been arrived at. The continuous current machine was useful for light, power, and storage, but with the alternating current machine storage was impossible. This type was useful for light, power, and heat. Mr. Hall described the method of distribution on the two-wire low-pressure system. A pressure of 100 volts could not be exceeded for incandescent lamps. In cases where the quantity required was large, the mains would necessarily be of great size, and when once laid down would be difficult to get at for alteration or repair. This was the more objectional when the current had to be conveyed to a considerable distance. By the employment of three wires the pressure in the mains could be doubled, and their size reduced fourfold, whilst at the same time the maximum pressure of 100 volts passed through the lamps. For distribution over large areas the two-wire high-pressure system was the best. For this it was essential to use the alternating current, the intensity of which could be diminished as required by passing it through the coil of a transformer. With a voltage of 2000 in the mains, intead of 100, their size could be reduced 400 times. The saving in material was therefore enormous, and the leads being conveyed in pipes could easily be drawn out for examination. Mr. Hall explained the construction of dynamos and transformers, and described the methods of insulation, by which high-pressure currents were rendered harmless. The paper was illustrated by numerous diagrams, models, and articles of manufacture, including a meter made by the Westinghouse Company, of America, which Mr. Hall said would not vary more than 2 per cent. in working. A discussion followed, in which Messrs. Towler, Hartnell, Atkinson, Wood, and Bowers, took part. A vote of thanks was accorded to Mr. Hall. The members of the Association have since visited the works of th Yorkshire House-to-House Electricity Company, Aire-street. Mr. R. W. Eddison kindly conducted them round the plant.

HIGH-PRESSURE AIR COMPRESSOR

MM. ELWELL FILS, PLAINE ST. DENIS, ENGINEERS

(*For description see page* 228)



"THE ENGINEER" SWAIN ENG.

LETTERS TO THE EDITOR.

(*We do not hold ourselves responsible for the opinions of our correspondents.*)

MODERN HEAT.

SIR,—I am much obliged to Dr. Lodge for giving me "a clue to an exit from a very thin fog." I am not aware myself of the existence of the fog, and I have failed to find any clue. I understand perfectly what I want to say; Dr. Lodge does not; consequently he contradicts himself. Let me recapitulate a little. In my first letter I said that a gas could not expand under certain conditions—which I described—unless its temperature was raised. Probably if I had said, that "without an increase of entropy motion could not take place," Dr. Lodge would have been content; but I prefer not to use the word "entropy."

Dr. Lodge, entirely failing to grasp my meaning, hastened to tell me that a gas *could* expand without any rise in temperature. The correction was wholly irrelevant, as I had never said that it could not. I explained what I meant, and now Dr. Lodge hastens to tell me that a gas cannot expand against a constant resistance without becoming hotter. Now, I frankly admit that the word "constant" Dr. Lodge quotes, apparently conveys an erroneous impression. Furthermore, however, Dr. Lodge seems to have entirely failed to grasp my meaning, and with your permission I beg to explain.

If a gas is supposed to expand and do work, it is possible to supply so much heat to it that its temperature will not fall, and the whole of that heat will be converted into work. By a slip of the pen I wrote "expand against constant pressure." That is, of course, wrong. I should have said "falling pressure." The resistance must decrease as the gas expands. Before the piston could begin to move, the temperature and pressure of the gas must be raised; and do what we will, at the end of the stroke the gas must be hotter than it was just before the stroke commenced. This heat is so much dead loss. It is so in the Carnot cycle, and the "cold body" is used solely to take away this heat. By just so much as the heat left in the gas at the end of the stroke exceeds the heat in it at the beginning, by so much will the engine fall short of absolute efficiency. The heat received by the gas and converted into work never appears as temperature at all in the gas.

Let us suppose that a piston carries a definite load. Air is expanded beneath it, and causes the piston to rise. The piston cannot begin to move until the air has been made hotter. If now the load on the piston is steadily reduced, and the supply of heat is steadily maintained, the air will go on expanding, doing work, and retaining the temperature at which it started, the pressure falling, and a certain quantity of heat will be converted into work. Let the heat be called T. But before the piston started there was a certain elevation of temperature, brought about by heat imparted which I shall call t. The total heat imparted was $T + t$. Then in any practical engine t must be wasted. That is what I said in my first letter, to which Dr. Lodge took exception.

Now let us imagine that we have a loaded piston as before, but that the load is kept constant. Once more we have T, and also t, and we have besides t_1, which is the extra heat required to prevent the pressure from falling as the gas expands. The total heat imparted to the air will be $T + t + t_1$, and $t + t_1$ will represent dead loss. This, again, is what Dr. Lodge's diagrams mean. I quite fail to see where the fog exists.

The only point remaining worth discussing seems to have been raised by Mr. Wiseheart, as to what "temperature" means. Apparently it is the equivalent of work. It is the measure, other things being equal, of the intrinsic energy of a gas. When we heat a gas and do not allow it to do work, the heat remains as heat, that is all. Maxwell was disposed to regard it not as a quality, but as a quantity. On page 44 of his treatise on "Heat" he says:—"A temperature, so far as we have yet gone in the science of heat, is not considered as capable of being added to another temperature, so as to form a temperature which is the sum of its components. When we are able to attach a distinct meaning to such an operation and determine its result, our conception of temperature will be raised to the rank of a quantity. For the present, however, we must be content to regard temperature as a quality of bodies, and be satisfied to know that the temperatures of all bodies can be referred to their proper places on the same scale. For instance, we have a right to say that the temperatures of freezing and boiling differ by 180 deg. Fah.; but we have as yet no right to say that this difference is the same as between the temperatures 300 deg. and 480 deg. of the same scale."

I hope this will be of service to Mr. Wiseheart, but I doubt it. It is not difficult to see that Maxwell had not quite satisfied himself as to what the word really implies. We have only to read page 45 to satisfy ourselves on this point. M. A.

Woodstock, March 12th.

BALANCING LOCOMOTIVES.

SIR,—Referring to your interesting article last week on the above subject, may I point out that the centrifugal force in such a case as you quote would be only about 65 W, instead of 80 W. Taking your own data: Vector of balance weight = 36in., and number of revolutions per minute = 252—as you say nothing of allowance for slip—the augmented velocity in usual units = 26·39 and $\text{C. F.} = \left(\frac{26{\cdot}39^2}{32{\cdot}2} \times 3\right) W = 64{\cdot}88\ W$.

As a matter of detail, however, a lune-shaped weight of 224 lb. net in a 6ft. 8in. wheel would—allowing 5in. for tire and rim—have a rad-vector of about 31½in., then $\text{C. F.} = \frac{31{\cdot}5}{36} \times 64{\cdot}88\ W = 56{\cdot}77\ W$. Also, the weight at 36in. rad. required to balance P lb. at 12in. crank would not be $\frac{1}{3}$ P, as you say, but much less. Assuming that you refer to an inside-cylinder engine, and taking centres of cylinders as 28in. and centres of weight as 60in., the weight required to balance 672 at crank $= {\cdot}78 \times \frac{672}{3} = 174{\cdot}72$ lb. This is the weight in each wheel, and at its proper angle, and its C. F. at 32in. rad. = 4·5 tons. Deducting its weight when on top centre, and adding it when on bottom, we get a vertical upward pull of 4·422 tons and a thrust on rail of 4·578 tons. There remains an additional constant load on rail equal in amount to the counterweight put in, 174 lb. in this case. In fore gear, however, the upward pull is diminished and the downward thrust increased, by pressure of connecting-rod—depending on boiler pressure and cut-off—whereas, in back gear the pull is increased and the thrust diminished.

I do not think that 672 lb. would be more than the revolving parts of such an engine as you are taking, the cranks would undoubtedly be hooped. I do not think it is a logical deduction that the Americans are more troubled with irregular wear of tires, because they say more about them, than the English do of theirs. Perhaps they are more candid than their English brethren. All credit to such an institution as the Chicago Western Railway Club, where superintendents meet and discuss the failings, so to speak, of their engines—that is the way to ameliorate them. We have cognate gatherings, where, however, the object of each appears to be the aggrandisement of his own productions, and not to invite criticism, or be grateful if he gets it. If anything remains to be discovered on the balancing question—which I much doubt—it will not remain long in the dark, with men like J. N. Barr and W. H. Lewis on the war-path.

Premising thus much, I will now say that undoubtedly the Americans do have more trouble with their tires, and not due to the "hammer-blow" particularly, as you imply, but to the slip, caused by vertical pull of that part of counterweight put in to balance the piston, &c. This should be so, for two reasons—their reciprocating parts are much heavier, and their wheels, generally speaking, are smaller; and as the centrifugal force varies as the square of the number of revolutions, with a given speed and equal percentages of reciprocating parts balanced, the pull and thrust are greater in their case. Also, I believe some of their roads are of a very sandy nature.

From what I can gather, and speaking generally, English officials are very conservative in this matter; they are content to do what has always been done, forgetting that rules that obtained when reciprocating parts were a third of their present weight ought now to be honourably shelved. As to steady running, some of the steadiest I was ever on had only one-fourth of reciprocating balance altogether. This is, however, a smaller amount than I advocate. I gave my opinion a week or two back in a contemporary. As regards reading a paper on the subject, this is emphatically not an armchair matter, as has been the treatment of it before to-day. One requires facilities for making observations, both on the footplate and in the shops, when the engines are in for repairs; these facilities, as a matter of course, do not fall to the lot of those interested in the question and willing to cultivate it.

Brighton Works, March 12th. H. ROLFE.

[We have calculated the centrifugal force by the formula $C = \frac{w\ v^2}{32{\cdot}2\ r}$. We have taken the velocity of the centre of gravity of the balance weight at 88ft. per second, or sixty miles an hour, and a little under 3ft. radius from the centre. The figures can only be approximate until we know the disposition of the weights. Bury, Curtis, and Kennedy balanced their engines by extending the hubs of the driving wheels opposite the cranks.—ED. E.]

FIREPROOF BUILDINGS AND SOUND.

SIR,—The past few years have seen very material advance in the methods of so constructing buildings as materially to diminish the risk of fire. It cannot be said, I believe, that this has been in any sense wholly averted. It has simply been reduced. But even this is a great point gained, and further experience may advance our knowledge, both in construction and of material, so as to ultimately insure practical entire immunity. The present gain, however, has not been obtained without the incurrence of certain disadvantages, and these in some cases of such striking importance that it is questionable whether it may not be forced upon us to return for a time to more primitive methods of construction if these disadvantages are not to operate most injuriously to very important interests. It seems unfortunately to be the case that the present system of constructing so-called fireproof floors lends itself to a liability to the transmission of sound to an extent unknown with cruder forms of construction. This system is now of exceedingly wide use. The numerous immense buildings erected for letting in flats, that one now sees springing up in every quarter of London, invariably have their floors designed upon this principle. In all our monster hotels of modern building it also always receives adoption. Now my own recent experiences with both such classes of residences has led me to question whether the assumed immunity from fire has not as yet only been secured by a sacrifice of comfort, and of such a degree of this as is only compatible with the preservation of health. As regards the modern hotel, I recently passed a week in one of these that had exercised the ingenuity of its designer in every possible way, and, it is only fair to say, with the achievement of an enormous amount of success. Every comfort, every convenience, every luxury, and every sanitary provision had been secured for the inmates, by whom they were evidently highly appreciated. But, alas! when night came this pleasing picture received a sad reversal. The sleeping-rooms of this modern palace little deserved that appellation. Every sound made by the occupant of the apartment overhead was almost as distinctly heard as if occurring alongside. It was my fate to have above me an elderly gentleman who snored throughout the night as surely elderly gentleman never snored before. Had his head been pillowed alongside of my own, his stertorations could not have been more distinctly heard than they were in the sound-trap I occupied.

It would be a work of entire supererogation to point out how seriously this defect, which was common throughout the vast building, must militate against public resort. The disability will be at once acknowledged, and in only a slightly lesser degree is the annoyance felt by those occupying flats sharing the same principle of construction. In the case of the hotel to which I have referred, the architect had been called upon to suggest a remedy. He confessed himself unable to do so, and the verdict of the numerous visitors at the hotel was that they would rather submit to the chances of fire than have to pass night after night under the condition of broken rest. The system of fireproof construction adopted at this hotel was the well-known one of iron girders, supporting concrete arching. Upon this bearing the ordinary system of joists and planking is laid. There are therefore numerous points of contact; in the first place with the hard concrete itself—almost bell-like in its qualities—and through this with the metal of the iron girders, the ends of which rest upon the brick main walls of the structure. Now the finer the material used in these last the more complete must be the diffusion of sound. Every inch of wall area throws off vibrations; and, in the desire to secure incombustibility of material, it is rarely if ever the case that any sound-deadening substance is placed between the iron girders and their bearing upon the brickwork. Endeavours should, I think, be in the first place made to reduce the number of points of contact between the timber-work of the flooring and the concrete, in which the iron girders are to all intents and purposes embedded. A very slight additional depth to be added to the flooring could be made to secure this in various ways that will readily suggest themselves.

Having reduced the number of such sound transmitters, manifestly the next point towards improvement should be to avoid direct contact between two such resonant materials as iron and brick. I know that the objection held to the interposition of deadening material is lest this should tend to impair the fireproof qualities of the structure, and be the means of communication of fire from one floor to another. But surely it cannot be impossible to devise means free from such chances. I would suggest that the asbestos packing so largely used in mechanical work might furnish a material adequately sound-deadening; nor would it be difficult, perhaps, to suggest alternatives equally efficacious in that respect, and equally free from liability to combustion. Sawdust chemically treated, for instance, might fill a cavity in the masonry for the girder ends to rest upon. I do not pretend to dogmatise as to the character of the remedy to be applied; I only know that one must be found if the remedy against fire is not to prove in residential cases almost worse than the disease. To the modern caravanseries at our seaside resorts flock thousands of jaded inland residents in search of health. How can the latter be secured if nightly repose be made impossible? The instance to which I have referred as affording my own experience is, I well know, by no means a solitary one. If we are to secure ordinary comfort in these fireproof buildings it is manifest that some material change must be made in the system upon which they are at present designed.

March 12th. F.

TESTING PORTLAND CEMENT BY HIGH-PRESSURE STEAM.

SIR,—With reference to Mr. Henry Faija's letter on the above subject, of 20th February, the necessity or reason for which I fail to see, will you kindly allow me to give the following data, in order to avoid any misunderstanding on the part of your readers. Dr. Erdmenger's method for the detection of faults in Portland cement dates as far back as 1879; or, correctly speaking, his observations on this subject were published at that date. In the *Thon Industrie Zeitung* of March 11th, 1882, he gave a full description of the apparatus, which in its main features is yet unaltered. I regret that no results of Mr. Faija's method of trying the soundness of cement are given, and a comparison with those of the high-pressure steam test are thus impossible.

I cannot refrain from adding a protest against the designation of Dr. Erdmenger's experiment as "made in Germany," which, though innocent in itself, by being put between inverted commas conceals a sneer, as unbecoming as it is unjust where scientific researches are concerned. CHR. ENGELHART.

(For F. L. SMIDTH AND CO.)

18, Parliament-street, London, S.W.,
March 12th.

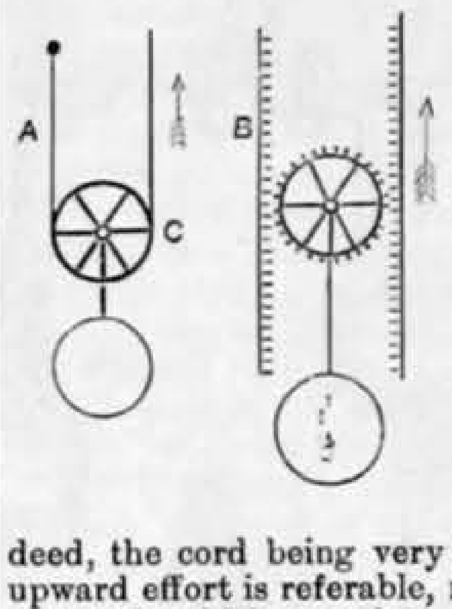
SIR,—I have followed with much interest the correspondence upon the above subject in your valuable journal. Permit me to point out, as a result of my extensive experience, that even in cases where one is satisfied that all the well-known standard requirements to arrive at correct results have been complied with, yet it is possible to have a most untrustworthy and comparatively worthless cement. W. T. PARRACK.

171, Queen Victoria-street London,
March 6th.

THE ACTION OF PULLEYS.

SIR,—A discussion has arisen in our drawing-office. We are unable to settle the point at issue, and have agreed to ask you to submit it to your readers. It is this:—Is the action of a pulley the same as that of a lever, or is it not?

In treatises on mechanics it is either regarded as a lever, or its action is left unexplained. Now, I am of the party who hold that its action is not that of a lever. In the sketch A we have a pulley and a cord, and two racks and a toothed-wheel in B. The cord is fixed at one end, and the force is applied at the other, in the direction of the arrow. The same with the racks. It is quite plain that in B the action is that of a lever, and the power gains two to one on the weight.



At first sight the case A may seem the same, but it is not, because the effort of the rope is not applied at C, as in the case of the racks; and, indeed, the cord being very flexible, it seems to me that the whole upward effort is referable, not to the rim of the wheel, but to its centre, in which case there is of course no lever action at all.

Again, if we suppose the pulley to be parted at the lowest point, it could be pulled asunder but for the rope. No action of this kind takes place in the tooth pulley. In order that the rope pulley may act as a lever, the rope ought to be fixed to the rim at C.

I think I need not make this letter any longer by giving explanations. I hope some of your readers will discuss the point.

Stafford, March 7th. SHEAVE.

SHIPBUILDING AT HIGH ALTITUDES.

SIR,—In reference to your issue of March 2nd, page 179, it would be of interest to know from Messrs. Hunter and English what is their experience as to the cost of production of steam power at 13,000ft. above sea level. I should esteem it a personal favour if they or any reader could inform me of any practical treatise or paper containing experiences of the behaviour of steam in engines at high altitudes. ENQUIRER.

Bradford, March 6th.

SOME EXPERIMENTS WITH TRIPLE-EXPANSION ENGINES AT REDUCED POWERS.*

By Mr. D. CROLL, Member.

THE following experiments were undertaken with a pair of triple-expansion engines of the usual three-crank type, and of the following dimensions:—Cylinders, 13½in., 21in., and 35½in.; stroke, 21in.; steam pressure, 160 lb.; diameter of boiler, 11ft. 4in.; length of boiler, 9ft. 1½in.; heating surface, 1129 square feet; and grate surface, 41 square feet. The object was, in the first place, to determine the most economical plan of working the engines at from 250 to 300 indicated horse-power; and secondly, to obtain data for getting the maximum results upon the full power trial. The cut-off in the high-pressure cylinder had for practical reasons been made about 0·75, which was a greater admission than the boiler could continuously supply steam for. So it was evident that we should have either to reduce the boiler pressure, to throttle the steam, or to draw up the link. I have, as far as possible, given results which can be accepted as correct, and have kept back any figures which appeared doubtful; hence some data have not been given.

I wish to point out that the figures in the column giving the steam pressures in high-pressure casing are not quite reliable, owing to the oscillations of the gauge pointer. They are given to show, to a certain extent, the degree of throttling by the stop-valve. I have also to state that the trials were carried out in a comparatively narrow basin, and the state of the tide exercised a considerable influence upon the relation between revolutions and power. For the purposes of the experiments this, of course, was immaterial. I am quite aware how difficult it is to draw general conclusions from the results of a single set of engines. I think, however, that we may safely venture upon the following deductions:—(1) Not only is the triple-compound engine singularly inelastic, but also highly sensitive to wrong adjustment. Comparing trials Nos. 6 and 8, we find that in the one case 301 indicated horse-power could be developed, against 263·5 indicated horse-power in the other, with practically the same consumption of steam. It therefore appears certain that it will pay well to supply steamers which have to work at reduced powers with an arrangement for measuring the feed water in order to enable the engineer to find the most economical adjustment. (2) Comparing all these results with those obtained by Mr. Inglis in the case of the Iveagh, it appears unlikely that working triple compound engines as double compound will lead to any satisfactory result.

I have also given a table showing the percentages of feed-water unaccounted for by the indicator diagrams. These percentages have been calculated for various stages of the expansion through the three cylinders. The only explanation of the cause of these enormous losses appears to be condensation and re-evaporation in the cylinders. I take it that a fairly acceptable view of this process is as follows:—Supposing a piston to begin its stroke with a temperature lower than the steam entering, it is evident that the steam will first heat both piston and cover faces, and in doing so deposit a film of water upon them. After the steam is cut-off and the pressure lowered, the deposited water will partly become steam again; but when the exhaust is opened and the pressure still further lowered the remainder will evaporate much more rapidly, and in doing so cool the piston, cover, and cylinder walls, so that with the following stroke the cycle is again repeated. It is worthy of remark that in a triple compound engine the steam produced by re-evaporation in the high and intermediate-pressure cylinders may possibly be usefully employed in the low-pressure cylinder, any water on the covers and pistons of the latter, however, is upon re-evaporation rejected as steam to the condenser.

It appears to me to be a most important point to note that, if we assume 30 per cent. of the total feed-water deposited as water on the low-pressure piston and covers, the thickness of this water film will but amount to $\frac{1}{250}$th part of an inch. Having, therefore, to consider films of such infinitesimal thickness, it seems worth while to inquire whether the nature of the surfaces with which the steam comes into contact may not have a considerable influence upon the amount of the condensation. As far as we know at

* Institution of Naval Architects, March 16th, 1894.

present, the cylinder walls are best made of cast iron or steel highly polished, which allow the piston to move without, comparatively speaking, any friction. In a low-pressure cylinder of a modern marine engine, where the diameter is about one and a-half times the stroke, we find that the exposed surface of pistons and covers is 50 per cent. greater than that of the working surfaces of the barrel, and it is to the former that I wish to direct your attention.

Admitting that the greater the re-evaporation, the greater will be the cooling of the surfaces, and, as a consequence, the greater the initial condensation, we must look more closely into the question whether the use of rough cast iron and steel or polished surfaces may have anything to do with the widely diverging results obtained from different engines of the same type, which apparently are well designed, and offer no peculiarities to account for something like 30 per cent. difference in economy.

If we wish to shape a body which will readily absorb heat, we give it as large an area as possible to be exposed to the hot gases. A familiar instance is a "Serve" tube. Also, if we wish to shape a body which will readily part with its heat to the substance which is to be heated, we do the same; for instance, the ribs and collars which are cast upon pipes for heating purposes. Passing to the rough surfaces of cast iron and steel, we may easily conceive that an almost imperceptible difference in the conformation of the surface may make an immense difference in the area exposed to the steam. Consider an element of piston area enclosed in an equilateral triangle; suppose equilateral triangles to be raised upon each of the sides, and joined at the top to form a tetrahedron; it is evident that the area now exposed will be three times that of the original triangle. If we divide the original triangle into four equal triangles, by drawing a line parallel to the base at the half of the height, and joining the points where this line intersects the two upright sides with the middle of the base, we can raise four triangular pyramids upon each of these parts, which will each expose an area of three times their bases, and, collectively, of three times the area of the original element. This operation can be indefinitely continued with the same result, viz., that the exposed area is three times the area of the geometrical plane. A little consideration will show that the principle involved in this rudimentary case can be largely extended if we choose to build up other forms, and make surfaces analogous to, say, coke, or even the rough, rasping surface of some steel castings. With these considerations before me, it struck me forcibly that in my own practice the most economical results were obtained with cast iron pistons and covers, and the worst with those made of cast steel. Upon inquiry among my engineering friends, I found that those engines which were troubled with water in the cylinders had cast steel pistons, and in cases where covers and pistons were of cast steel it had occurred that no diagrams could be obtained through the wetness of the steam.

Personally, I was troubled with a low-pressure cylinder which would hardly give cards, and I thought I should cure it by smoothing the steel piston with some kind of varnish. Having succeeded in getting a composition which was said to stand the temperature, I thought it advisable to try some experiments on a small scale, and made a hollow cube of brass sheets about $\frac{1}{16}$in. thick. One side was polished, and the other covered with the varnish. The cube was then filled with water at different temperatures, varying from 105 deg. to 140 deg. Fah.; a jet of steam was turned against the faces of the cube, and when a film of water was deposited, the steam jet was turned off, and the time noted that was required to re-evaporate the film. The mean times were respectively, 368 seconds for the polished surface, and 128 seconds for the varnished one. The great difference in the re-evaporative power of these two surfaces was to me incomprehensible till the chemist who had supplied me with the varnish pointed out that, under the influence of the heat applied, the varnish would crack into an almost infinite number of minute fissures, and thus present an enormous surface for re-evaporation, although the varnish remained apparently smooth. However this may be, the broad fact remained that two surfaces, apparently equally smooth, showed an enormous difference in re-evaporative power. It need hardly be said that the result did not encourage me to try the varnish on the piston in question. A more conclusive experiment appears to be the following:—A cylindrical cast iron cup was bored out till the thickness of the metal was about $\frac{1}{4}$in.; part of the outer surface was left as it came from the mould, and another part opposite was polished. The cup was filled with water at temperatures from 170 deg. to 180 deg. Fah., and it was found that the mean times required to re-evaporate the water from the steam jet condensed upon the surfaces were, respectively, 43 sec. for the rough and 83 sec. for the smooth face.

I would now summarise the argument as follows:—The greater the re-evaporative power of the material in contact with the steam, the greater will be the cooling of the surfaces, and the greater the initial condensation; the re-evaporative power of a body is increased by an increase of surface; a fairly smooth surface may, nevertheless, have a very much greater area exposed than the geometrical plane, which it is taken to represent; the total condensation in a steam-engine is a question of very thin films of water, and the structure of the surfaces exposed to the steam, merits our closest attention. As far as can be seen from the above experiments, a polished surface is far superior to that of ordinary cast iron as it comes from the mould, and a rough steel casting is probably about the worst material that could be chosen; it appears, therefore, advisable to carefully turn and polish as far as possible all parts of the steam cylinder which come into contact with steam performing work. I should have been glad indeed if I had been able to lay before you conclusive proof that turning and polishing pistons, covers, &c., had given the good results which I am confident may be expected from it. The difficulties connected with such experiments on marine engines are great, and I have not had cases before me in which I could carry them out to my satisfaction. I beg, however, to submit a few facts bearing on the question, and which I venture to think confirm my views. (1) I made a disconnecting paddle engine, in which each wheel could be driven by a perfectly independent compound engine. In the starboard engine I had all internal parts turned and polished, and in the port one the pistons were left rough; unfortunately no time could be given for experiments, and I had to content myself with observing at sea that, whereas we were occasionally troubled with water in the port engine, the starboard one was apparently perfectly dry. (2) In my experience excessive condensation has always occurred in combination with rough steel pistons and covers; in one case this was so marked that the top of piston would not give a card at all, which I attribute to the cover being of rough cast steel, and combining with the top of piston to absorb the heat of the steam. (3) Torpedo-boat engines, which have turned and polished pistons, and in some cases polished covers, are quite remarkable for the economy of steam at nearly all powers, and, at all events, are very free from water in the cylinders. (4) A pair of high-speed engines designed by my friend Mr. Martin, of Flushing, gave practically the same results in economy at full power and at one-tenth of full power. The pistons and covers were turned and polished. (5) The highest results known to me are obtained by the carefully designed land engines of Messrs. Sulzer, of Winterthur; the pistons and covers are carefully turned and polished, and a consumption of 11·73 lb. of steam per indicated horse-power has been obtained with their triple-expansion vertical type of engine. These considerations lead me to the conclusion that if we wish to make really high class machinery, which will give the highest results in economy, we must turn and polish the surfaces of pistons and covers, or else seek a method of coating these surfaces with a metallic layer which will diminish their tendency to absorb and reject heat.

No.	Boiler pressure in lbs.	Pressure in H.P. steam chest.	Cut-off H.P. cylinder.	Mean pressure. H.P. cylinder.	Mean pressure. I.P. cylinder.	Mean pressure. L.P. cylinder.	Mean pressure referred to L.P.	Indicated H.P. H.P. cylinder.	Indicated H.P. I.P. cylinder.	Indicated H.P. L.P. cylinder.	Indicated H.P. Total.	No. revolutions.	Vacuum	Temperature feed-water.	Lbs. feed per I.H.P. per hour.	Percentage of feed-water unaccounted for by indicator diagrams (mean of top and bottom cards). H.P. At cut-off.	H.P. At opening exhaust.	I.P. At cut-off.	I.P. At opening exhaust.	L.P. At cut-off.	L.P. At opening exhaust.	Means.
1	140	35	0·75	lbs. 24	lbs. 7·1	lbs. 3·6	9·66	26·7	19·1	27·5	73·3	73·5	Ins. 26	Deg. C. 30	20·02	—	—	—	—	—	—	—
2	160	101	0·75	52	15·8	7·3	20·52	67·5	49·5	65	182	85·3	20	60	20·02	0·225	0·20	0·20	0·21	0·30	0·229	0·227
3	160	100	0·75	52·6	16·4	7·72	21·25	71·0	53·5	71	195·5	88·6	24½	50	18·458	0·193	0·173	0·167	0·169	0·302	0·249	0·208
4	106	94	0·75	54·82	20·64	7·365	22·6	79·5	72·5	73	215	95·6	26	—	19·624	—	—	—	—	—	—	—
5	106	96	0·75	54·6	21·28	7·65	23·1	83	77	78	238	98·6	25	—	18·964	0·222	0·184	0·184	0·218	0·358	0·33	0·249
6	112	102	0·75	56·62	22·88	8·75	25·15	86	85	92·5	263·5	101	24½	48	18·216	—	—	—	—	—	—	—
7	155	117	0·75	64·2	22·3	8·65	25·9	106	89	98	293	109·2	25	—	17·512	0·15	0·108	0·14	0·163	0·33	0·30	0·198
8	146	127	0·655	61·8	22·2	9·2	26·05	104	91	106	301	111·6	25	—	15·838	—	—	—	—	—	—	—
9	155	116	0·75	63·4	22·3	8 82	25·92	109	93	103	305	113·6	25	43	16·83	—	—	—	—	—	—	—
10	152	136	0·655	63·75	22·4	9 3	26·5	111	94·5	111	316·5	115·6	25	—	15·796	0·118	0·102	0·247	0·135	0·332	0·288	0·203
11	160	130	0·75	65·0	22·1	8·92	26·67	121	100	115	336	122·8	25	—	16·0	—	—	—	—	—	—	—
12	160	148	0·(25	55	22·3	9·15	25·15	100	97	113	310	119	25·8	—	15·752	0·123	0·108	0·234	0·124	0·278	0·242	0·184
13	144	137	0·(9	66	24·8	11·7	30·25	132	120	160	412	131·5	24½	52	15·0	—	—	—	—	—	—	—
14	152	144	0·69	67·7	25·5	12·2	31·3	138	127	169	431	133·5	24	52	15·026	0·171	0·126	0·149	0·129	0·365	0·297	0·206

LUBRICATION.

AT the February monthly meeting of the Birmingham Association of Mechanical Engineers a paper was read by Mr. H. Rallings on "Lubrication;" the president, Mr. E. Hazel, in the chair. The lecturer first called attention to friction, that familiar resisting force which always acts to prevent or retard the relative motion of one particle or body in forced contact with another. There are three kinds: sliding, rolling friction acting between solids, and fluid friction acting between particles of liquids. Friction, whatever kind considered and whatever its cause, always results in the conversion of an amount of energy measured by the work of friction into heat. This production of heat occurs in every case in proportion of one British thermal unit for each 772 foot-pounds of work absorbed by friction. The amount of heat produced may therefore be calculated by dividing the total work of friction for any given case by this "mechanical equivalent of heat." Thus one-horse power expended in friction results in the conversion of work or energy into British thermal units per minute. For example, $\frac{33{,}000 \text{ foot-pounds}}{772} = 43$ B.T.U.

The friction of solids was dwelt upon, and attention was called to the necessity of smoothness of bearing surfaces, the proper space to leave between shaft and bearing, just to allow of proper flow of lubricant, the length of journals in proportion to their diameters, and several hints how to convey the lubricant to reduce the friction. He next dwelt upon the lubrication best suited for the surfaces above referred to, taking as his model machine "Man," noting that all joints of the body were supplied with an oily fluid, "Synovia." The glands being supplied with blood-vessels, and the blood passing through them, they select properties and convert it into this oil for lubrication; the greater the exertion 'or hard work on these joints the greater the flow of oil. The viscosity of the lubricant played an important part. If the load forcing in contact the surfaces were not kept apart by a lubricant of right viscosity, a partial rubbing of surfaces is the consequence, causing a heated bearing, which is oftentimes believed to be due to neglect or other causes. If the body of the lubricant is in excess of the force working on the surfaces, the friction is practically *nil*. The lubricants are of three classes — solids, semi-solids, and liquids. He saw no necessity to call their attention to solid lubricants, or to the semi-solid lubricant, although in many cases doing good work when well attended, but particularly called the attention to the liquid lubricant. He said the liquid should have at least five important points:—(1) Enough body or viscosity to keep substances between which it is interposed from coming in contact, under maximum pressure; (2) the greatest fluidity consistent with preceding requirements. *i.e.*, the least fluid friction; (3) the maximum capacity for receiving, transmitting, and carrying away heat; (4) the entire absence of acid, or other properties liable to injure the material with which they may be brought in contact; (5) a high temperature of evaporation and of decomposition. Oils should not be liable to decomposition by heat or wear; the quality of the oil is usually of more importance than the quantity. Sperm oil is one of the best-known lubricants, but its high price precludes its use. Other oils are cheaper, but have less lubricating power; others are good reducers of friction, but do not wear well. Castor oil is one of these; others gum so seriously that they cannot be used. Some cannot be used at a low temperature because they congeal; and others cannot be used to lubricate steam cylinders because they decompose. He advised every user of lubricants to resort to some method of identification of the material by giving some method of testing it and ascertaining whether under the conditions in his practice it will serve his purpose. The best lubricants are the following for usual conditions met with in practice, under very great pressure with slow speed:—Graphite, soapstone, tallow, and other greases. Under heavy pressure and high speed:—Sperm oil, castor oil, and heavy mineral oils. Under light pressures and high speed:—Sperm, refined petroleum, olive, rape, and cotton seed. Ordinary machines, lard oil, heavy mineral and other vegetable oils. Steam cylinders, heavy mineral oil. Having called attention to the lubricant best suited for bearings usually to be met with in engineering, attention was next called to the necessity of special lubricants for cylinders, especially under the high pressure of steam now in use, and the heat that severely tries the oils used in gas engine cylinders. The lubricant specially set forward as best suited for such was that treated by the system of superheated steam to 1400 deg. Fah. The oils treated by this heat are mineral oils, sometimes called hydrocarbon oils, the process driving off the volatile oils; it is then repeatedly filtered through charcoal, &c., until all solids are removed without the original structure of the oil being in any way damaged. This class of oil, although dearer than the black oils in use, is much cheaper in the end, when it has been proved again and again that by the sight-feed cylinder lubricators that are now so perfect, that as few as two spots per minute will be ample to lubricate an engine of 200-horse power. Having treated all points in cylinder lubrication, he turned his attention to some of the ways the lubricant was applied to ordinary bearings. The wick feed was shown as having good points, but in the hands of careless attendants the wick could be fitted too tight, and prevent the supplying of oil from the reservoir. The needle lubricator has great advantage over the other, because it was automatic, and was one that could be seen by any one, whether full or empty, preventing guesswork; but these also in the hands of careless men could remain inactive if the body of the oil was greater than the space allowed for its steady flow. A change of oil causes these to require a little adjustment.

The next best is the sight-feed spotting lubricator, where the oil, whether thick or thin, can be spotted at any desired speed; the oil can be caught and set aside for other purposes. The best form is the bearing known as "Mohler's" self-lubricating; this is also known by the name of "patent bearing." It has a well of oil, and the collar in the revolving shaft lifts the oil by capillary attraction, and when at the top a spreader in the cap spreads it over the whole length of the bearing, and will do this for one month with one charge of oil, so is always in action and requires no attention day by day as others do. Some bearings, especially large main bearings of engines and main shafts, where oil is pumped in a continous stream with small revolving pumps, this is exceedingly good, but only applicable to heavy work. He next devoted some time to semi-fluids for solid oils, also how they were chiefly used, the special forms of lubricators to use this grease, but was particular to point out that, although in some instances these greases were doing good service, yet there was not the automatic and reliable feed as there was with liquid oils. He most strongly urged the members that had under their charge large plants requiring lubricating, to read Professor Thurston's work "Friction and Lost Work;" to this valuable work he is indebted for much help on lubrication. He quotes that Professor Woodbury reports an instance out of several where a gain of power of 33 per cent. was effected by a change of grease for a light oil, the loss in cost of lubricant being comparatively unimportant.

Attention was called to reserving all used oils and filtering them, and using over and over again. Also to a simple test to prove the good and bad oils. In conclusion, he trusted that what had been placed before them would assist them to decide on the lubricant whether for heavy or light work, and that it be the best consistent with price, and to give the preference to oils that will not char or gum, and to be sure to see oil tested from bulk is same as sample supplied, and that for cylinders to have the best mineral oil money can procure, especially as it is for so vital a part, to decide upon good lubrications such that can be seen in action, then something will be done to assist in saving coal and labour, and satisfy yourself that you have given special attention to one important matter, "Lubrication."

The discussion was postponed to the next meeting. A cordial vote of thanks was duly proposed to the lecturer, to which he suitably responded.

THE GEOLOGISTS' ASSOCIATION.—The programme of the Easter excursion of this Association has been issued, and provides for a visit to Bournemouth, Barton, Swanage, Brockenhurst, Poole Harbour, Boscombe, &c., commencing on Thursday, the 22nd inst. Mr. J. Starkie Gardner will be director. The programme can be obtained from Mr. T. Leighton, Lindisparne, St. Julian's Farm-road, West Norwood, S.E.

THE COST OF SILVER PRODUCTION.—In an article in the *New York Times* of the 11th inst., giving the history of American silver mining, with the growth of the production and the temporary checks from declining prices, the author concludes that as transportation facilities and the mining methods are cheapened there will be a constant decline in the cost of silver production; that if the output is checked at 60c. per ounce because few mines pay, this is probably only temporary; and that the steady reduction in the cost of mining indicates that there is no minimum price below which silver cannot be profitably produced which can be called fixed or absolute. This minimum, in fact, constantly changes, every reduction in the cost of transport and every cent taken off the cost of food and supplies at the mines contributing towards reducing the cost of putting silver on the market. Electricity, as yet only partly developed, may further cheapen the cost of mining, enabling America to produce silver profitably, not at 60c. per ounce, but at 50c. or 45c. The writer according to the *Times* Philadelphia correspondent, says:—"The repeated congresses gathered to help silver will always fail, because they try to get a certain result from uncertain facts. The only way to control the price of silver is," he adds, "to curtail the production. There is no other way."

TRACTION ON HIGHWAYS.

FOR some time there has been a need of data giving the tractive power required to move wagons with broad and narrow tires on American streets and roads. We are all familiar with the English and French experiments made early in the century, but they are not so applicable to the light, springy American vehicle as is desirable. Consequently Studebaker Brothers Manufacturing Company, of South Bend, Ind., conducted a series of tests in June of the current year, which are highly instructive and valuable. The gentlemen in charge were Vice-President J. M. Studebaker, Master Mechanic C. M. Collins, General Superintendant H. D. Johnson, and C. M. Haeske, Superintendent of the Wagon Department. The tests were conducted by attaching a Fairbank's dynamometer to the doubletree and making the team pull the load through this instrument. The scale of the instrument was carefully calibrated before the tests. The leading results are given in the accompanying table:—

Results of Traction Experiments.

Wagon, type.	Thimble skeir, 3¼in.							California wide track, iron axle		Narrow track, iron axle
Wheels, diameter	3ft. 8in. and 4ft. 6in.		3ft. 6in and 3ft. 10in.					3ft 8in. and 4ft. 6in.		3ft 8in. and 4ft 6in.
Tire, width	4in.	1½in.	4 n.	4in.	1½in.	1½in.	3in.	3in.	1¾in.	1¾in.
	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
Total weight	4345	4235	4260	3700	4650	3500	4590	5280	5280	5130
Weight, inch of tire	272	706	266	231	675	583	383	440	754	733
Pull to start on. Block pavement ..	350	300	600	—	500	—	—	600	500	400
Pull to start on. Good sand roads ..	700	725	700	—	700	—	700	800	700	900
Pull to start on. Good gravel roads ..	600	650	750	—	—	—	—	700	550	500
Pull to start on. Muddy roads	800	900	1000	—	900	—	—	1050	1250	1000
Pull to move on. Block pavement ..	100	75	150	90	125	90	125	100	75	100
Pull to move on. Good sand roads ..	275	300	350	300	350	350	350	300	300	325
Pull to move on. Good gravel roads ..	175	175	250	—	200	—	—	200	175	150
Pull to move on. Muddy roads	550	500	650	450	550	—	—	600	700	700

The information to be gained from this table is so varied that we will only attempt to point out some of the most important features. One of these is the remarkably small influence the width of tire has on the draught necessary. Taking the third and fifth cases, where the weights per inch of tire were 266 lb. and 675 lb. respectively, the percentages of total load required to start the wagon on block pavements, sand, and mud were 14, 16½, and 23½ in the former case, and 12½, 17¼, and 22¼ in the latter, while the percentages of load required to keep the wagon moving when started on these surfaces were 3½, 8¼, 15¼, and 3, 8½, 13½. There is not a variation of 2 per cent. in these results even on muddy roads. With the wide tire, iron axle California wagon, if muddy roads are excluded, the narrow tire was found to be the better, and even where there was mud the difference in draught was less than 5 per cent. The figures also show the value of large wheels in diminishing draught in starting, although there is little difference in the traction required to move the vehicles after they were started.

It will also be seen that the average proportion of load required as a pull to start a wagon on a block pavement was 10 per cent., 16 per cent. on good hard sand roads, 18 per cent. on good level gravel roads, and 21 per cent. on muddy roads, while to keep the vehicle moving on the same classes of roads 2½, 7¼, 4, and 13 per cent. of the load was required.

Some other results were obtained in this series of tests which it is unnecessary to tabulate. It was found that under the conditions of weight and tire given in the first case a pull of 1050 lb. was required to start the load in mud from 12in. to 14in. deep, and 550 lb. to keep it moving. Under the conditions of the third tests from 900 lb. to 1600 lb. were required to move the load on muddy dirt roads filled with ruts. On sandy roads, where the wagon given in the fourth case cut into the road to an average depth of 3in., the pull required was 650 lb., and on level sandy roads, where the tires cut into the sand to an average of 4in., 1100 lb. were required to start the wagon. In order to ascertain the effect of narrow and wide tires in driving across fields, the wagon and loading of the seventh test was chosen. With the tire cutting into the sod for an average of 1½in., 1250 lb. were required to start the wagon with a 1½in. tire, and 1100 lb. with a 3in. tire, and to move it at a dead pull 650 lb. and 550 lb. respectively. On good hard roads the wagon with a 1½in. tire was started with a pull of 850 lb. and drawn with 350 lb., while to start the wagon with a 3in. tire required 700 lb., and 350 lb. to keep it moving.

To start the California wagon with a 3in. tire on roads with deep ruts a pull of 1500 lb. was needed, and to keep it running about 450 lb. To start it on good sod, where the tire cut in about ½in., 900 lb. were needed, and 600 lb. to keep it running, while with a 1¾in. tire 1000 lb. and 500 lb. were required on the same field. The tire did not cut into the sod any more with the narrow than the wide tire.

The gentlemen conducting the tests conclude from them that on hard roads and pavement there is no strong argument to bring up in favour of wide tires, for on such surfaces a narrow tire is to be preferred as giving less resistance and friction. Neither in soft mud or slush do they find any advantage in wide tires as regards draught, although on the ground that a narrow tire will cut through and a wide one will not, the latter is preferred, and, generally, the conclusion is reached that wide tires are better for farm use and narrow tires for streets and pavements.—*Engineering Record.*

SOCIETY OF ENGINEERS.

AT a meeting of the Society of Engineers, held at the Town Hall, Westminster, on Monday evening, March 5th, Mr. G. A. Goodwin, president, in the chair, a paper was read by Mr. Henry O'Connor on "Pile Driving."

The author having remarked upon the difference in the formulæ suggested by different engineers for calculating the weight required to sink a pile further in the ground, exhibited a diagram giving the result of these calculations for two piles, which showed that by one formula only seventy-two tons would sink the pile further, whereas by another formula it would take 300 tons. This great difference was accounted for by the various strata of the ground through which the pile was driven, and which, the author said, was not sufficiently allowed for, and showed a system which he had adopted of finding out the resistance of each layer of the ground, and the force required to withdraw a pile.

The author describes the steam pile driver used to drive the piles which afterwards had to be withdrawn, and then touched upon the breaking load of a pine pillar, and the side pressure, which would be exerted at the moment of impact, and the method of obtaining the resistance of the ground, which would be offered to the pile when it had been driven home. He mentioned some experiments he had made on the force of the blow, from a monkey falling different heights, and pointed out that the friction against the guides of the pile driver reduced the blow which the ordinary calculation for a falling weight would indicate. The author described the difficulty which had been recently experienced at Beckton, in getting a large number of cast iron piles to stand a specified test, and showed various shoes for fitting on the bottom of the piles, to prevent them sinking through the thin stratum of ballast which was found there. He then pointed out the shape which the pile was afterwards made, and which had the desired effect; he then passed on to the effect which the interposition of a hard wooden dolly had upon the blow given by a falling ram, and showed the results of certain experiments to ascertain the loss of effective blow upon the pile. He then gave the result of a test load placed upon a cast iron pile, which he had driven to a test of ⅝in., set for four 5ft. blows of a one-ton ram, and showed a sketch of a continuous action steam pile driver, used to drive a large number of cast iron piles.

The author then mentioned the enormous blow given in America, when driving a large number of piles, and the effective blow which the pile would receive at the moment of impact, the large blow causing many of the pile tops to crush. The author having stated what he would consider as a safe load on a wooden pile driven in such strata, as he had already mentioned, as that in which a very large number of piles had been driven under his superintendence, showed a diagram which he had recently got out, and which was the result of an enormous number of calculations, by which the safe load on unsupported cast iron columns might be easily and rapidly found.

The author, in conclusion, gave some comparative figures as to the cost of driving a wooden pile, a cast iron pile, and making the smallest workable excavation and concreting the same, showing that the cast iron pile cost about three and a-half times as much as the wooden one, while the excavation cost about eight times as much.

AMERICAN ENGINEERING NEWS.

(*From our own Correspondent.*)

Bicycle railway.—An electric railway on the Boynton "bicycle" system is being built on Long Island, and will be about fifteen to twenty miles long. The cars are narrow, with cross seats wide enough for two passengers, and rest upon two wheels running on a single rail. The journals are attached to vertical posts passing up through the car and carrying at its upper end small horizontal guide wheels running on either side of an overhead wooden rail. An experimental line built a few years ago had two-storey cars and steam locomotives, but the new line will have electric motive power, the conductor being a light 12 lb. steel flange rail inverted and placed inside the overhead guide rail, and thus protected above and on each side, while the trolley wheel attached to the guide wheel brackets runs along the head of the rail. The motor car, seating twenty-four people, weighs six tons, and the trail car, seating fifty people, weighs four tons. The cars are 51ft. long, 4ft. wide, and 7ft. high. They pass with ease round a curve of 640ft. radius. The car body is supported on springs attached to the vertical columns, so that it rides easily without its motion affecting the wheels. The motor is of the Gramme type, with a Gramme ring bolted to the driving-wheel, the wheel and ring rotating while the field, bolted to the framework, remains stationary. The wheel is 5ft. diameter, ring 3ft. 7in. diameter, developing about 75-horse power. The plant consists of a steam engine, boilers, switch-board, and four-pole Westinghouse dynamo of 100-horse power. The return current is carried back along the track rail.

Artificial fuel.—One means for utilising the waste anthracite coal on the culm banks at mines is to crush it to powder and to mix it with a cementing material to form blocks or lumps of fuel. The "eggette" coal is made in this way, and being passed between rolls having half egg-shaped pockets, the material is delivered in the form of lumps about the size of hens' eggs. There are three or four plants in operation, and the fuel is said to be very satisfactory. The question is an interesting one to all mine owners and workers, and has been the subject of several investigations. Even lignite can be treated in this way, and makes a commercially useful fuel.

THE JUNIOR ENGINEERING SOCIETY.—On the 24th ult. the Tottenham and Forest Gate Railway Works were visited by the members, a party of about 100 being present. To facilitate the inspection, a train of wagons, kindly supplied by the contractors, Messrs. Lucas and Aird, conveyed the party from one end of the line to the other, stoppages being made *en route* to examine the numerous features of interest. The railway, which is about six miles long, forms a connection between London and the Midlands. Starting at South Tottenham by a junction with the Tottenham and Hampstead Railway, it passes through Walthamstow, Leyton, Wanstead, West Ham, and East Ham to Forest Gate, making a junction there with the Tilbury line. Included in its length are seventy-two steel bridges, in the construction of which 4000 tons of Siemens-Martin steel have been used. Of these bridges fifteen are over and fifty-seven are under, and of various types and spans, no two being alike. The line for about half its length is carried on embankment and in cutting, and three miles of it consists of a viaduct of brickwork arches of 30ft. span. The amount of the contract is £264,422, exclusive of station buildings. The engineer is Mr. Arthur C. Pain, whose representative, with Mr. Jackson and Mr. J. G. T. Browning, representing the contractors, showed the members over. Mr. Browning has had charge of the diversions of sewers, roads, &c., and has, we understand, now been appointed resident engineer for the Eastwood and Greasley drainage scheme, in the county of Nottingham. Before the party dispersed, their thanks for the arrangements made were expressed by Mr. P. J. Waldram, the chairman of the Society. At a numerously attended meeting held at the Westminster Palace Hotel on the 9th inst., Mr. Percy J. Waldram in the chair, a paper on "The Design, Construction, and Working of Boilers for Locomotive Engines," was read by Mr. G. F. Burtt, of Brighton. In deciding the type of locomotive to adopt for the particular work it had to perform, it was shown that conditions of loading and gradients were guiding considerations; from them the requisite power was determined. Water and fuel consumption, heating surface, grate area, &c., were dealt with, the necessity for a reserve of power being strongly urged. As to material, the author was of opinion that iron, owing to its greater durability, was much preferable to steel. Details of construction were described, comparisons being drawn between various methods, and theoretical points in connection were referred to. The Belpaire type of fire-box was included in the descriptions, and by the aid of a model its superior characteristics were explained. Riveted joints, tubing, staying, and boiler fittings, formed the next sections of the paper, the varying strains induced by expansion and contraction being considered. Alluding to questions affecting economical and successful working, inferior economy was shown to be largely due to the necessity of being prepared to work effectively in any of the many varying conditions of weather. Testing, maintenance, and prevention of explosions were referred to in conclusion. The paper was illustrated by an extensive series of diagrams, and an interesting collection of specimens. In the discussion which followed, Mr. B. H. Joy, Mr. F. S. Page, Mr. W. J. Tennant, Mr. E. Gobert, Mr. R. W. Newman, Mr. L. W. Gates, Mr. H. Fraser, and other members took part.

THE IRON, COAL, AND GENERAL TRADES OF BIRMINGHAM, WOLVERHAMPTON, AND OTHER DISTRICTS.

(*From our own Correspondent.*)

BUSINESS is rather more active, as is customary prior to the Easter holidays, and this state of things was reflected on 'Change to-day —Thursday—in Birmingham and yesterday in Wolverhampton. In manufactured iron the increased transactions are chiefly on home account. In the pig iron market inquiries are to hand for delivery over the ensuing three months. Hot-blast all-mine pigs were quoted 55s. to 57s. 6d. and 60s. according to makers; part-mines, 44s. 6d. to 45s.; and common, 38s. to 39s. Cold blast iron moved fairly well at 97s. 6d., there being an augmented demand from heavy ironfounders for chilled rolls and other ironworks and general engineering castings. Welsh forge pigs were on offer at 55s. to 56s., which quotation was mostly prohibitive, and there were some consumers who stated that they had obtained supplies at 53s. Vendors of Northampton and Derbyshire makers asked 44s. to 44s. 6d., less 2½ per cent.; and of Lincolns, 44s. 6d. to 45s. net at stations, or a shade more.

In manufactured iron, hoop makers reported an increase of American competition for the custom of Canada. Prices on this market are quoted £6 10s., and gas tube strip is £5 15s., marked bars continue £7 10s. The L.W.R.O. brand is £8 2s. 6d.; best, £9 10s.; double best, £11; treble best, £13; and treble best crys., £13 10s. Angles of the same make are £8 2s 6d. for ordinary qualities, £10 best, £11 10s. double best, and £13 10s. treble best. Black sheets, doubles, are in some cases to be obtained as low as £6 15s. to £6 17s. 6d. Galvanised sheets of 24 gauge are £10 to £10 7s. 6d.

It is this week announced that the ironworks at Moxley, formerly belonging to Messrs. Rose, have been leased to Messrs. Joseph Tinn, of Bristol, for the manufacture of sheet iron, and will be restarted shortly.

The amount of work in hand at the various engineering establishments is larger than when the year opened, but there is still plenty of room for further improvement before the trade can be said to be at all brisk.

Tangyes Limited are fairly engaged in some of their departments. Their gas engines continue to secure considerable favour, and so do their pumps. They have recently made two pairs of Tangye's continuous flow pumping engines for the Newcastle and Gateshead Water Company. This machinery is capable of delivering 3,000,000 gallons per day. The firm are supplying also two 18in. centrifugal pumping engines to the Edwards Shipbuilding Company, for use on one of the pontoon docks of the Manchester Ship Canal.

I am indebted to the Oldbury Railway Carriage and Wagon Company for particulars of some of the work on hand, briefly alluded to in last letter. The company have in hand for the Great Indian Peninsular Railway 1000 sets of automatic vacuum brake fittings for their coaching stock. They are supplying all the gear complete, and it will be sent out and fitted to the existing carriages in India. These fittings are made of the highest quality of Yorkshire iron. They have also an order for the Assam Bengal Railway, including completely equipped samples of first-class lavatory and sleeping carriages, of passenger brake vans, and of horse-boxes. Accompanying them are the necessary materials for the erection in India of eight first-class lavatory and sleeping carriages, and for ten passenger brake vans, and six horse-boxes. This rolling stock will be fitted with the vacuum automatic brake. The firm are making eight carriages for a narrow gauge Norwegian line of only 2ft. 5½in. gauge. These comprise second and third-class composites, third-class carriages, and third-class luggage vans. They are on steel underframes, and run on small two-wheel bogies. They are constructed with end platforms and gangways down the centre, and they have central buffing and draw gear. The firm lately completed a large contract for cattle wagons for the Cape, with special brake arrangements.

Considerable dissatisfaction is expressed in Birmingham at the latest reply of the War-office to the representations made to them from this city in opposition to the proposal to remove a large portion of the machinery from the Government rifle factory at Sparkbrook, Birmingham, so as to permit of the repairing work being executed there now that the Bagot-street repairing factory has been closed. The Department announce that they are unable to agree to the proposal from Birmingham to make an addition to the present Sparkbrook buildings, and that the original intention will have to be carried out. It is feared that the result will be a considerable curtailment of Government work for Birmingham.

More work for Midland minting machinery has just been secured from Europe. Advices from Rome state that the Italian Government has concluded a contract with Mr. Otto Haupt, the representative of an English firm in Birmingham, for the coinage of half of the new nickel money recently authorised. Of the total 20,000,000 of lire, 10,000,000 will be coined in Birmingham, and 10,000,000 in Italy.

Midland manufacturers note with interest the endeavours which Sir Alfred Hickman continues to make in Parliament on behalf of trade. This week he asked the Secretary of State for India whether the De Baume and Marpent Company, of Belgium, have supplied 10,000 axle-boxes to the Indian State Railways, and whether he would use his influence with the department to induce them in future to secure their supplies of such articles in this country. The new Secretary of State for India — Mr. H. H. Fowler — replied that so far as he could ascertain no order for axle - boxes for the India State Railways had been given to the Belgian company mentioned. He added, "I am informed that according to existing practice, general preference for business orders is always given to firms in this country." Midland manufacturers reading this episode in the papers are expressing the wish that the preference really was as stated. Unhappily there has of late been reason to think the opposite. The matter derives additional interest from the recent questions in Parliament as to steel sleepers and steel tires being placed in Belgium instead of in this country. It is noteworthy that the attention of Parliament to this last-named matter—tires and sleepers—was called in response to a complaint emanating in the first instance from the Patent Shaft and Axletree Company, of Wednesbury, who objected to work going abroad.

A very serious situation has arisen in the iron and steel, engineering, and manufacturing industries of Wolverhampton and the district, by reason of a new assessment which has just been made by the Union authorities of the manufacturing properties of the borough. Upon the old assessment, which was made twenty-five years ago, the valuations have been enormously increased, in many cases being doubled and trebled, and in some even quadrupled. The course which the overseers have taken has aroused great alarm among manufacturers, and at an important meeting, held in Wolverhampton on Wednesday, a committee consisting of some of the most influencial firms of the district was appointed to take steps to oppose the new rating. It is declared that the present state of trade warrants nothing like the increases which have been made.

NOTES FROM LANCASHIRE.

(*From our own Correspondent.*)

Manchester.—The outlook is gradually losing that hopeful tone which prevailed at the commencement of the year, when the general impression seemed to be that the engineering, iron, and allied branches of industry were on the eve of rapidly reviving activity, and users in all directions were anxious to buy. Although it cannot be said that trade has gone worse, the anticipated improvement has not been realised, and there is not nearly so sanguine a tone as to the future; with the result that users of iron are very cautious about further buying, and prices are gradually receding from the advance which the temporary rush of business enabled makers to put on. Another significant feature in the situation is that the coal trade is steadily drifting into a state of depression, which threatens to bring prices back to almost as low a point as ever, and for the present forward contracting for fuel is for the most part held in abeyance.

The Manchester Iron Market on Tuesday was fairly well attended, but there seemed to be more sellers than buyers, and the weight of business put through was again very small. Users of pig iron are holding back from buying further, in the expectation of still lower prices, and, as far as possible, are going on with deliveries that have yet to come in on account of contracts already placed, whilst iron in second hands is being pushed upon the market at under makers' quotations. Lancashire makers are still holding with firmness to their late rates, but these are only being got where they have favourable rates of carriage, such as Warrington and the neighbourhood, where they are enabled to deliver forge qualities at about 43s. 6d., less 2½, but in the Manchester market they are again being cut out by district brands, makers of which are rather weakening in their prices, forge Lincolnshire being now obtainable at 41s. 6d. to 42s., net cash, delivered Manchester. Foundry brands, both of local and district iron, are maintaining their price better than forge qualities, and local makers are getting about 45s. 6d., Derbyshire about 51s., less 2½, and Lincolnshire is quoted at about 43s. to 43s. 6d., net cash, delivered Manchester. Outside brands offering here are a shade easier, and can be bought through merchants at about 3d. to 6d. under last week's prices. Good foundry Middlesbrough does not average more than 44s. 6d. to 45s., net cash, delivered Manchester, and Eglinton can now be readily brought at about 47s., net cash, delivered at the Lancashire ports.

Finished iron makers are in the position that although they have a moderate weight of work to keep them going, there is very little new business coming forward, and the immediate outlook is anything but satisfactory. There is no actually quoted reduction in prices, but these are scarcely so firm as they have been where anything like favourable specifications are concerned. Delivered in the Manchester district, £5 12s. 6d. remains the average figure for Lancashire bars, with £5 17s. 6d. quoted for North Staffordshire qualities. Lancashire sheets remain at £7 5s. to £7 7s. 6d.; Staffordshire, £7 7s. 6d. to £7 10s.; Lancashire hoops, £6 for random and £6 5s. for special cut lengths, delivered Manchester or Liverpool.

Nut and bolt makers report trade in a very depressed condition, and there is a keenness in competing for any orders to be got that is forcing back prices to as low a point as ever.

In the steel trade raw material continues quiet and weak in price, good foundry hematites scarcely averaging more than 53s. 6d. to 54s., less 2½, whilst ordinary steel billets are scarcely fetching £4 2s. 6d. net cash, delivered Manchester. Manufactured steel, however, is firm with a hardening tendency, £6 12s. 6d. being the minimum for steel boiler-plates of good quality, with tank and bridge-plates quoted at £6 7s. 6d., and good qualities of steel bars £6 10s. per ton, delivered here.

There is still no very appreciable change to report as regards the engineering industries, any improvement being only very slow in development. The returns as to employment issued by the Amalgamated Society of Engineers for the past month seem, however, to indicate that even the very limited increase of activity in this district is more than equal to the improvement which is reported from other industrial centres, except, perhaps, one or two of the large shipbuilding districts. Throughout the Society generally there has been no appreciable reduction during the month in the unemployed members in receipt of donation benefit, the number remaining at a little over 9 per cent. of the total membership; but in the Manchester district there has been a fairly substantial reduction of out-of-work members, and, as regards the percentage of unemployed to the local membership, this immediate district is in rather a better position than other districts of the Society. Generally, the reports from various districts continue hopeful as to improvement in the future, although nothing tangible is set forward in this direction. With regard to the eight hours' movement, voluntary concessions by firms here and there continue to be reported, but, so far as the Society itself is concerned, no steps are at present in contemplation for attempting to force a general adoption of the eight hours' day.

A noticeable feature in the discussion at the meeting of the Manchester Association of Engineers, on Saturday, on Mr. Webb's paper on "Steel, and its Manufacture," a summary of which has already been given in THE ENGINEER, was the very general recognition of the importance and superiority of this branch of manufacture in the United States. With regard to the American output, referred to in the paper, Mr. Saxon thought the large production in America was due to the greater amount of money spent on the plant, in order to obtain the maximum output as compared with English practice. Mr. Adamson remarked that in America they had excellent material, richer ores, &c., whilst the blast furnace practice there was much superior to the English, both as to the material turned out, and the plant. Mr. Percy, of Wigan, said his views were entirely in accordance with those expressed by Mr. Adamson as to the quality of the American production. Mr. Webb, in replying upon the discussion, said notwithstanding the improvement in steel castings referred to by some of the members, he thought he was quite right in his words of caution as to the indiscriminate use of steel castings. As regards aluminium used in steel castings, anything beyond a small quantity of aluminium was undesirable, as it made the steel very brittle. It should not be used in castings which had thick parts; it was useful in small castings which cooled quickly, there neutralising the crystallisation.

At a meeting of the Northern Society of Electrical Engineers, held in Manchester on Monday, the important question of underground electric light mains, and the best methods of laying these, was discussed in a couple of papers read respectively by Mr. John H. Rider, electrical engineer of Bolton, and Mr. S. B. Clirehugh, of Manchester. Mr. Rider, in the course of his paper, divided the two systems of laying mains into "drawn in" and "built in," the former having the advantages of easy inspection and readiness with which cables could be added or withdrawn, whilst the "built in" required less space, was easier to lay, and there was no danger from gas or water, whilst the prime cost was less. He was of opinion that a combined system of "drawn in" for the feeders and "built in" for the distributing mains offered a number of advantages, and a properly constructed and ventilated subway system under the streets would much simplify the question of laying electric mains; but the danger arising from gas and water pipes bursting, to say nothing of the enormous cost, stood in the way of its adoption. Mr. Clirehugh divided the systems of underground mains into insulated cables in conduits, armoured cables, and bare copper in culverts. Armoured cables might, however, be dismissed very briefly. The principal object in their use was their supposed cheapness, which, however, was over-rated, whilst the bare wire system was only suitable for low tension. The conduit system seemed to combine most of the desired qualities, but it had its drawbacks like others; firstly, in great cities it was impossible to find room, and then recourse was had to insulated cables; secondly, the bursting of a water main might possibly cause a stoppage of the supply; and thirdly, gas was apt to accumulate in the conduits, giving rise to explosions.

At the quarterly meeting of the Manchester Association of Engineers held on Saturday, the following gentlemen were elected members of the Association:—Messrs. A. Collins, Tangyes' Limited, Manchester; T. Horsfield, Kendall and Gent, Salford; T. Hilditch, Sir Joseph Whitworth and Co., Manchester; J. S. Miles, and E. G. Wrigley, G. Richards and Co., Broadheath; G. H. Sowter, Pagefield Forge, Wigan, ordinary members; Messrs. J. Donnelly, Journal Box Company, Pendleton; F. H. Carter, Oxford-street, Manchester; B. R. Rowland, Luke and Spencer, Ardwick; and R. B. Creak, Manchester, honorary members of the Association.

The position in the coal trade is gradually getting more and more unsatisfactory; all descriptions of round coal are bad to sell, and with plentiful supplies from local collieries, notwithstanding they are working scarcely more than four days per week, and surplus supplies competing from other districts, prices are gradually being forced back to very much the level at which they stood prior to the protracted stoppage of the collieries. Since the commencement of the month there has been a general reduction of quite 9d. to 1s. per ton, and, as compared with the prices quoted when the pits resumed work, there has been a giving way of quite 2s. 6d. to 3s. per ton. Generally there is such a weak, irregular tone throughout the market that it is difficult to give really definite prices; but the best qualities of Arley may be said to range from 12s. 6d. up to 13s. 6d.; Pemberton four-feet, and second qualities of Arley, 11s. up to 12s.; common house coals, 9s. 6d. to 10s.; with steam and forge coals obtainable from 8s. per ton upwards. The very restricted production of slack, owing to the depressed condition of the round coal trade, of course has the effect of limiting the supplies of engine fuel in the market, and consequently hardening prices for these, good qualities of burgy being quoted at 8s. to 8s. 6d., best slack 6s. 3d. to 6s. 9d., with some special sorts fetching 7s. to 7s. 3d., and common sorts 5s. to 5s. 6d. per ton, at the pit mouth.

The shipping trade remains in a very depressed condition, with exceedingly low prices ruling. The official quoted rates of the Lancashire Coal Sales Association are now 9s. to 9s. 6d. per ton for steam coal, delivered at the ports on the Mersey, and these may be taken as representing the maximum prices in the market.

Barrow.—There is no change to note in the hematite pig iron trade. The business done during the week by makers of pig iron has been far from all, and the orders booked are for the most part for steel makers in the district. The inquiry on general home, continental, and foreign account lacks life, the business offering being small, and it does not appear at present, at all events, that there will be much change for some time to come from these sources. Prices are unchanged, and makers are quoting 46s. per ton net, f.o.b., for parcels of mixed numbers of Bessemer iron. The price of warrants is 45s. 2d. per ton net cash. The orders in hand, in some instances, are fairly good in some cases, but in others little is in hand, and in West Cumberland the production has been decreased to the extent of one furnace, leaving thirty-one furnaces blowing in the district.

For the first week this year there has been a decrease in stocks of hematite in warrant stores. Every week there has been an increase in stocks, which are now 32,315 tons more than on the 23rd of December last year. The reduction in stocks this week amounts to 3815 tons, and there is now in hand 126,938 tons. Of course, makers hold large stocks as well. But it is evident, as there are no pressing requirements for pig iron, purchases are being made in view of a rise, and this may be taken as an indication of better trade in the immediate future.

In the steel trade there is not much doing in the way of new business. The demand for rails is only quiet, and makers are not in receipt of new orders. Heavy sections are at £3 15s. per ton, light sections at £5 10s., and colliery rails, £6. Ship-plates are quoted at £5 7s. 6d., angles at £5 10s., and boiler-plates at £6 per ton. Makers are having some inquiries for shipbuilding material, but little business is offering. The rail mills at Barrow are pretty well employed, and are making good outputs. The plate mills are also working. The demand for general sections is quiet, and prices are unchanged. Hoops are at £6 15s.; blooms, £4; billets and slabs, £4 5s. each; tin bars, £3 17s. 6d.; and wire rods, £6 12s. 6d. to £6 15s.

The demand for iron ore is quiet, and average sorts are quoted at 8s. 6d. to 9s. 6d. per ton net at mines.

Coal and coke are in good consumption.

Shipbuilders are gradually becoming more and more busy every week. No new orders are reported, but the work in hand is considerable, and the progress which is being made with it is satisfactory, considering the difficulty which exists of getting supplies of material—one of the results of so many shipbuilding orders being placed at one time. The British and Irish Channel steamer Lady Wolseley will be launched from the yard of the Naval Construction and Armaments Company, at Barrow, on the 22nd inst. Marine engineers and boilermakers are very busy, and orders for repair work are receiving much attention.

Shipments of hematite pig iron from West Coast ports during the past week show an improvement, being 8405 tons against 6945 tons in the corresponding week of last year, an increase of 1460 tons. The shipments of pig iron this year to date represent 69,857 tons, compared with 54,653 tons in the corresponding week of last year, an increase of 15,204 tons. The shipments of steel last week amounted to 7607 tons, compared with 5474 tons in the corresponding week of last year, an increase of 2133 tons. The total shipments of steel this year to date represent 64,266 tons, compared with 84,496 tons in the corresponding week of last year, a decrease of 20,230 tons.

THE SHEFFIELD DISTRICT.

(*From our own Correspondent.*)

THE total weight of coal sent to Hull by Yorkshire collieries last month was 145,120 tons, an increase of 23,550 tons on the corresponding month of 1893, although a considerable falling off when compared with the second month of 1892, when the quantity was 153,272 tons. For the two months the tonnage was 290,128, as against 255,232 tons in the corresponding period of last year, and 321,080 tons in the similar months of 1892. The north-country coalfield, having obtained part of the Yorkshire trade during the sixteen weeks' stoppage, seems likely to keep it, as Durham still ranks in the return for 5640 tons. Denaby Main heads the list of collieries sending to Hull, its weight having been 12,616 tons, an increase of 4256 tons. In the export trade, the principal customer at Hull was Sweden and Norway with 16,973 tons, Germany coming next with 6287 tons. Russia had evidently obtained all she wanted in January, as nothing was sent there last month. The total exports reached 37,415 tons, against 25,144 tons in February of last year.

The coal trade is going from bad to worse. Several of the collieries are working four days a week, but the rule is about three. Prices are falling. Competition for orders is excessively keen. One Derbyshire colliery company is advertising good house coal at 11s. 6d. and 9s. 6d. per ton, delivered free 1½ miles from Sheffield and Heeley stations, the latter a suburban station. Messrs. Newton, Chambers, and Co., Thorncliffe Collieries, have issued a reduced price list this week. Best Mortomley is now at 17s. 6d. per ton; Mortomley Brights, 14s. 2d.; Mortomley nuts, 15s. 5d.; seconds, 12s. 6d.; thin seam, 15s. 10d.; Brazils, 14s. 7d.; Tankersley house, 12s. 11d.; Parkgate softs, 10s. 10d. The coal sent to London is at present under the average; the supplies are now much in excess of the demand. Pit prices are as follows:—Silkstones, 12s. 6d. to 13s. 6d. per ton; Barnsley house, 11s. to 12s.; seconds, 9s. 6d. to 10s. Steam coal, in rather firmer request, at 11s. to 12s. per ton for Barnsley hards, other sorts making from 9s. 6d. per ton. Manufacturing fuel as before, good slack fetching from 5s. to 6s. per ton; small coal, 2s. 6d. to 3s. per ton; coke, 11s. 6d. to 13s. 6d. per ton. A quiet business in coke.

No change is reported this week in iron or steel. Hematites are about 53s. to 54s. per ton at Sheffield; Derbyshire pig, 47s.; Lincolnshire, 43s. 6d.; Bessemer billets realise £5 10s.; bar iron from £5 12s. 6d. to £5 15s. Crucible steel is in better demand, some good orders having come in from the Continent. The railway material firms are fully employed, and fresh armour plate work is expected soon.

WALES AND ADJOINING COUNTIES.

(*From our own Correspondent.*)

AMONGST the many benefits conferred upon the colliery district by Sir W. T. Lewis, none exceed in importance that of the Miners' Provident Society, and I am glad to note that the last quarterly meeting, held in Cardiff on Saturday, and presided over by the originator, showed most satisfactory results. The membership now totals 63,182, an increase of 4187 for the quarter. The contributions from ordinary members amounted to £11,561, and proprietors' percentages £2809. It was announced that £575 had been paid on the death of members, £2050 to widows, £1859 to children, and £5275 to disabled members. The working of the society is admirably managed, and the only requirement is that there should be annual collections at churches and chapels on the plan of "Hospital Sunday." Only those who know the working of the society are aware of the relief it has afforded to the ratepayers of the colliery district, and this should be practically acknowledged.

Moderate business and tolerably firm prices for best coals continue to be indicated at Cardiff. Some days a "slightly easier tone," is the comment one hears on 'Change, followed by firmer quotations. Large, best steam, is now at 12s. 9d. to 13s. 3d., and best small quite in full demand up to 7s. 3d., while ordinary small realises 6s. 6d. to 6s. 9d. It is in seconds that a slight weakness is shown, some kinds selling as low as 10s. 6d. Monmouthshire coals are quoted at 11s. 3d. to 11s. 9d., and Cardiff seconds best up to 12s. 6d. In house coals there is little or no change; No. 3 Rhondda is selling at 12s. to 12s. 3d.; brush, 10s.; small, 8s.; No. 2 Rhondda, 9s. 3d. to 9s. 6d.; through, 7s. 9d. to 8s.; small, 5s. 3d. to 5s. 6d.; anthracite, Swansea, 9s. to 13s. 3d. Good cargoes of this left for San Francisco last week.

Taking quantity into consideration, and the gales, the coal exports from Monmouthshire and South Wales have been well maintained, and the compilers of statistics say that the totals so far promise more than an average year. January and February totals show an advance of 12 per cent. over corresponding months of '93, and the forecast—somewhat illusory with nine months in front, it must be admitted—is 15 million tons for the total of '94 from Cardiff ports alone.

One of the largest, if not the largest steamer which has ever put into Cardiff, is now in Roath Basin. This is the Maroa, one of the fleet of Crome, Rudolph, and Co., Liverpool. She is chartered to take out 9000 tons Powell Duffryn coal for Bombay, and 2000 in bunkers. Local agents are Guthrie, Heywood, and Co., Bute Docks. It shows favourably for systematic output, railway arrangements, and mechanical appliances at docks, to add, that coaling began Wednesday, and before the week ends the vessel will be on her way to India.

A slight improvement is taking place in the iron and steel works in at least a few branches. Dowlais Cardiff, for example, is now delivering large quantities of excellent Bessemer into the Swansea district at prices, I hear, which shut out imported iron.

I have all along regarded the full development of the Cardiff works as the trying epoch in the duration of many competing works. With ore delivered from the sea to the furnaces, and railway rates of twenty-six miles saved on the raw and manufactured article, the company will have enormous advantages over others. This week, at Old Dowlais, an important steel sleeper order is being run off, and some ship-plates and rails; and the fact that the large blast furnace No. 3, at the lower works, was started on Monday after a long inaction, and that No. 19 at the Ivor works is being put in order, promise well. Cyfarthfa continues an average make of tin bar, and prospects are hopeful if the expected revival in tin-plate takes place, and which the advance of block tin by £4 suggests.

Any one who had the pleasure of seeing the Ebbw Vale exhibits of steel manufacture at the Manchester Exhibition will not be surprised to hear that there has been no falling off either in the quality or variety of make at these works, and I am glad to find that the management has gone in vigorously for steel bars, and is well placed for orders.

The pig iron and steel bar make at Briton Ferry last week was quite up to average, and the demand is well sustained. On Monday three mills out of six were started, and Vernon, Baglan Bay, and Gwalia have been busily employed. I am glad to see that the long-desired siding connection with the Rhondda and Swansea Bay Railway has been completed this week.

In the Swansea district larger shipments have taken place of tin-plates, the total last week being close upon 60,000 boxes. Make is, however, in excess, and stocks are now 282,495 boxes.

That there is still faith in the certain revival of the trade is shown in some districts, though alarmists are predicting that unless an improvement sets in speedily, more mills will be "laid off." One favourable sign is the starting of the "National Tin Plate Company," with a capital of £25,000 in £5 shares. The subscribers are prominent men at Swansea, Morristown, and Neath. Latest metal quotations at Swansea Exchange were as follows:—Glasgow pig, 43s. 1½d.; Middlesbrough, 36s. 1½d.; hematites, 44s. 7½d.; steel rails, heavy, £3 15s. to £3 17s. 6d.; light, £4 10s. to £4 15s.; Welsh bars, £4 15s.; Bessemer steel bars, £4 2s. 6d. to £4 5s.; Siemens, £4 5s. to £4 7s. 6d.; sheet iron, £6 10s. to £6 15s.; steel, £6 10s. to £7 10s. Tin-plates: steel coke, 10s. to 10s. 3d.; Siemens, 10s. 3d. to 10s. 6d.; best charcoal, 11s. 9d. to 12s. 9d.; ternes, 28 by 20 C, 20s. to 24s. Block tin has advanced, £67 17s. 6d. to £68. The lowest price quoted for this article was £52 10s. in October, 1878.

A resident from Cornwall visiting Wales lately commented on the fact that though great districts there present an exhausted condition, some are still in a vigorous state. The duration of our coalfields has been the subject for surprise, a century having left some valleys still in moderate work; but what shall be said of our tin wealth, which has been worked since the time of the Greeks, two thousand years ago?

Pitwood prices are maintained, and quotations in Cardiff are 15s. to 15s. 6d. for best wood. Coke is in better demand. Cardiff prices this week were: Furnace, 16s. to 16s. 6d.; foundry, 17s. 9d. to 18s. 3d.; while special foundry touched 21s. Swansea prices: Coke from 13s. furnace; 18s. best foundry. Pitwood, 16s. 3d. to 16s. 6d. into trucks. Patent fuel from 11s. Iron ores, Tafua, 11s. 6d. The patent fuel trade continues to be moderately good. Last week Swansea shipped 3450 tons to France, 1000 tons to Italy, and 1215 tons to Algiers.

The Lady Margaret Collieries, Treherbert, the property of the Marquis of Bute, was re-started this week after a stoppage of two years.

At Treorky a colliery dispute on the question of timber has been settled amicably.

The coal trade in the Forest of Dean is in anything but a satisfactory state, and a reduction of wages is threatened. The sale of the Severn and Wye Railway has prompted an agitation amongst traders and the general public in the Forest, to promote improved railway arrangements, by which it is thought the coal trade will be benefited.

Land subsidence in the colliery districts is on the increase. Both in the Taff and Cynon Valleys it is very marked, and this week it occurred at Abercarne, affecting the Great Western Railway near Cilynen Colliery.

The Taff Vale Railway management has now carried out effectively the arrangements for doing away with overtime, and though at first attended with some apparent losses to employés, it is expected to work satisfactorily in the long run, an average work of sixty hours per week being secured per man.

The annual meeting of the Monmouthshire and South Wales Coalowners' Association was held on Tuesday at Cardiff, Mr. Ogilvie, Powell Duffryn, in the chair. Mr. James Lewis, of the Abernant Collieries, was elected one of the trustees *vice* Lord Swansea, resigned, and Mr. John Roberts, mining engineer, member of the Sliding Scale, instead of the late Mr. Nettle, Mr. Edward Davies, Ocean, taking the vacancy on the Finance Committee. The following was the output of the Associated Coalowners for 1893:—Cardiff districts, 16,244,783; Newport, Mon., 6,425,848; Swansea, 1,227,808; total, 23,898,439, or an increase of 1,077,501 tons over that of 1892.

It has been arranged that the new branch railway between the Great Western Railway station, Cardiff, and the dock, shall be opened April 2nd. The Great Western extensions, contract for levelling the ground, and for the foundation of the new lines, necessitated by the increase in the Bute Docks traffic and the new industries, such as Dowlais-Cardiff works, have been let to Messrs. Pauling and Elliott, Victoria-street, Westminster.

Large consignments of iron ore have come in this week for Cyfarthfa, Dowlais, Ebbw Vale, and Blaenavon. Messrs. Crawshay imported from Bilbao and Dudda.

THE NORTH OF ENGLAND.

(*From our own Correspondent.*)

ON the whole a more favourable report can be given this week with respect to the metal and allied trades of this district than was possible last week, business appears to be recovering after the lull which followed the spurt, which was so marked a feature in the early weeks of the year, and the tone of the market is cheerful, buyers in general exhibiting more confidence. That lower prices for pig iron are not likely is the almost universal opinion, for the dullest period of the year is past, and with the opening of the shipping season a time of considerable briskness will be experienced. The improvement in trade is shown very well in the receipts of the railway company which has the monopoly of the carrying traffic of the North-East of England, for their receipts so far this year are £54,971 greater than those of the corresponding period of last year, when trade was not interfered with by any strikes.

In addition to this the exports are much above the average, there have been nothing like them in March for many years, especially to oversea ports; in fact, our foreign trade in pig iron this month has been double what is usual at this time of the year. The mildness of the weather is allowing of the earlier re-opening of the ports of the Continent that have been closed during the winter, and already a considerable quantity of iron has been sent to Baltic ports, and continental consumers and merchants are distributing their orders more freely than since last autumn. On this account the shipments of pig iron from the Tees this month to Wednesday night reached 36,477 tons, against 34,231 tons last month, 27,960 tons in March, 1893, and 30,450 tons in March, 1892, all to 14th. A smaller quantity is being sent to Scotland, but that was to be expected when the Scotch furnaces resumed operations. The decrease in Scotch requirements has been chiefly of hematite qualities. A satisfactory feature of the market is that stocks in the public stores after increasing almost without any interruption for months past, have during several days been decreasing.

The increase in the production of pig iron in this district has not now the detrimental effect upon the market that it had, for its extent can be estimated, seeing that all the furnaces that are likely to be re-lighted for some time to come are now at work, with, perhaps, one exception, and there, if one furnace is blown in, another will be blown out. It is calculated, with the shipping business in full swing, that makers will have no difficulty in disposing of the increased production. Three furnaces have been blown in this month, viz., one at Tees Bridge Works, one at Newport Ironworks, and one at Clarence Works; and if one is re-started by Messrs. Bolckow, Vaughan, and Co., another will be blown out which has been in operation some twenty years and needs relining. Altogether, since the year opened, eight furnaces have been re-lighted, and the output of pig iron in the district will have been increased by between 4000 and 5000 tons per week. Recently Messrs. Palmer's Shipbuilding and Iron Company blew out for re-lining the large furnace at Jarrow which they built after the American system.

The prices of pig iron have been firm all the week, and the lowest that has been taken for prompt f.o.b. deliveries of No. 3 Cleveland, G.M.B., has been 36s.; but very little can be had at that now, either from merchants or makers. In fact, the latter seldom accept less than 36s. 3d. for this month, and 36s. 6d. up to the end of April; but from second hands, a little could be had for next month's delivery at 36s. 3d. Generally buyers' and sellers' prices are very near, and there is a distinct desire shown to do business. Cleveland warrants have been in more request, and the price has on the whole ruled higher than last week, the lowest being 36s. 1½d. cash, while the closing figure on Wednesday was 36s. 3d. In Connal's warrant stores on Wednesday the stock of Cleveland iron was 111,042 tons, the increase for the month being only 781 tons, so that the comparatively large increase in the first week has been neutralised by the better return this week. No. 4 Cleveland foundry pig is quoted 35s. 9d., and grey forge 35s. 6d.; but a good many firms hold out for 3d. more than these rates and can get it, because the supply of these qualities is very small, and it is reported that the total stock of grey forge in the district is not over 3000 tons.

The demand for East Coast hematite pig iron is good, for though undoubtedly a quieter state of business is reported by the steel manufacturers, yet orders booked are so plentiful that the consumption of pig iron is as great as ever. Not less than 44s. 9d. per ton f.o.b. will be taken for mixed numbers of hematite iron, but the general quotation is 45s. The higher price of Spanish ore is maintained, 50 per cent. Rubio being quoted 12s. 9d. per ton delivered Tees, which means 7s. 3d. per ton f.o.b. Bilbao, the freight from that port to the Tees being 5s. 6d. per ton, and the tendency in freights is upward, because steamers are finding work in other trades now that the Black Sea and Baltic ports are being re-opened. Average quality Durham blast furnace coke is steady at 12s. 6d. per ton delivered on Tees-side, the blowing in of more furnaces having strengthened the position of coke makers, for they are called upon to supply to the Cleveland ironmasters alone 4000 tons per week more than were being sent towards the close of last year.

Both for finished iron and steel the demand has become quieter, and prices are generally easier. In a great measure this is due to the intelligence respecting the shipbuilding industry, it being reported that orders for a number of steamers have been cancelled —thirteen in the Tyne district alone, these orders being given out by owners who expected to get the necessary capital subscribed by the investing public, but finding that they were not to be drawn, the vessels are not now to be built. The prices of plates and angles are lower in consequence; steel ship plates can be got at £5 2s. 6d., less 2½ per cent. f.o.t., and even less, though £5 5s. less 2½ per cent. is still generally quoted, while iron ship-plates may be bought at £4 17s. 6d., less 2½ per cent. Iron ship angles have been sold at £4 12s. 6d., less 2½ per cent. f.o.t., and steel at £4 17s. 6d., less 2½ per cent. Bars are not affected, and the price for common bars is still £5 2s. 6d., less 2½ per cent. f.o.t., with £5 12s. 6d., less 2½ per cent. for best.

The Darlington Forge Company has just completed the second of two steel rams which they have constructed for the first-class British war vessels Majestic and Magnificent. Each ram is 40ft. long, and weighs 27 tons. Messrs. Haggie Brothers, of Gateshead, have completed what is claimed to be the longest wire rope ever made for underground purposes. It is upwards of six miles long, weighs 34 tons, and has a circumference of 3¼in. Messrs. Doxford, of Pallion-on-the-Wear, have this week launched the s.s. Turret Bay, the third vessel of the turret-deck type built by the patentees. She has a deadweight capacity of 3800 tons, with a gross register of about 2200 tons. Messrs. Doxford also supply triple-expansion engines, 23in., 37in., and 60in., by 42in. The vessel is for the Guildford Steamship Company, Newcastle-on-Tyne.

A series of addresses on the "Extension of Indian Railways" is being delivered to the Cleveland miners by Mr. Joseph Walton, of Middlesbrough, and the miners are practically unanimous in urging the Government to proceed much more rapidly with the development of railways in India, both in the interests of India itself and also in our own interests. Mr. Walton is to deliver an address on "Indian Railway Extension: its Relation to the Trade of India and of the United Kingdom," before the Society of Arts, at the Imperial Institute, on Monday evening next, the chair to be taken by Sir James Kitson, Bart., M.P.

The traders on the Stockton and Darlington section of the North-Eastern Railway held a meeting on Tuesday to consider the question of presenting a testimonial to Mr. Wm. Smith, of Darlington, late district manager, on his retirement after fifty years' service. Mr. G. W. Bartlett, Mayor of Darlington, presided. It was decided that a testimonial be presented, and that the contributions from individual firms should not exceed £5. A committee was appointed, which included Sir Raylton Dixon, Mr. W. Anderson, Mayor of Thornaby; Lieut.-Col. J. G. S. Davies, Bolckow, Vaughan, and Co.; Major Ropner, and Mr. Thomas Wrightson, M.P. Mr. Wm. Hanson, of the Newport Ironworks, was appointed chairman, and the Mayor of Darlington treasurer.

The engineering and ironfounding industries are maintaining the improvement that has been recently noted. Another considerable order for locomotives has been placed in this district, and generally the prospects in this branch are very fair. Complaints continue to be made of the scarcity of trucks on the North-Eastern-Railway, notwithstanding that the coal trade is much less brisk than it was. At the annual meeting of the Middlesbrough Chamber of Commerce an ironmaster said his firm had to ship their iron, as they could not get trucks to convey it inland. When they asked for twenty trucks they got five. No doubt they asked for more than they really required, in order to get something like the number they wanted. The President said that so long as they sent coke to the furnaces in coal wagons, the supply could not be considered satisfactory. The company have ordered 2000 new wagons, but it is contended in the district that this is not nearly enough to meet the needs of their district.

The death took place a few days ago of Mr. John Readhead, of South Shields, a well-known shipbuilder. He was the principal of the firm of Messrs. John Readhead and Sons, West Dock, South Shields. The business was established in 1865, and was carried on for years by Messrs. Readhead and Softley. When the partnership was dissolved Mr. Readhead continued to conduct the business as an engineer, boilermaker, and shipbuilder. The shipbuilding yard is now very extensive, and includes a graving dock, &c. The firm construct all their own engines and boilers, and employ over 1300 hands in the various departments. The late Mr. Readhead took his sons into partnership a few years ago, all of them being practical men.

NOTES FROM SCOTLAND.

(*From our own Correspondent.*)

THERE has been a considerable business in the pig iron market. At the beginning of the week an easier feeling prevailed, but the market subsequently improved and a large quantity of warrants changed hands. Scotch warrants sold from 42s. 11½d. to 43s. 2d. cash; Cleveland, 36s. to 36s. 2d.; and Cumberland hematite, 45s. to 45s. 1½d. Middlesbrough hematite was done from 44s. 6d. to 44s. 7½d. cash, being afterwards quoted at 44s. 4½d. cash buyers.

The market prices of makers' pig iron are as follow:—G.M.B., f.o.b. at Glasgow, No. 1, 44s. 3d. per ton; No. 3, 43s. 3d.; Carnbroe, No. 1, 46s.; No. 3, 45s.; Clyde, No. 1, 49s. 6d.; No. 3, 46s. 6d.; Gartsherrie, No. 1, 51s.; No. 3, 47s. 6d.; Summerlee, No. 1, 53s.; No. 3, 48s.; Coltness, No. 1, 56s. 6d.; No. 3, 51s.; Calder, No. 1, 52s.; No. 3, 48s.; Glengarnock, at Ardrossan, No. 3, 47s. 6d.; Dalmellington, No. 1, 47s.; No. 3, 45s.; Eglinton, No. 1, 46s. 6d.; No. 3, 45s.; Shotts, at Leith, No. 1, 54s. 6d.; No. 3, 50s.

The shipments of pig iron from Scottish ports in the past week amounted to 6425 tons, compared with 8639 in the corresponding week of last year. There was dispatched to France 431 tons, Germany 380, Australia 360, India 113, United States 25, Italy 50, Holland 80, Spain and Belgium 40 each, China 50, other countries 305, the coastwise shipments being 4551 tons, against 3382 in the same week of 1893.

There are 65 furnaces in blast, as compared with 69 at this time last year, and of the total 39 are producing ordinary and special brands, 23 hematite, and three basic iron. As many of the furnaces were improved during the time they were out towards the end of last year, it may be taken for granted that the aggregate output of pig iron is now about as large as it was twelve months ago, and there is a prospect of it becoming greater soon. Several of the special brands are still practically out of the market, and for the better class of iron it is thought that good prices will continue to be obtained. The consumption of hematite pig goes on increasing, but as the supplies are well kept up, and the competition between English and Scotch makers fairly active, prices scarcely show any movement. The tendency, such as it is, indicates a little more strength.

In the steel trade there is very little change to note, but it is satisfactory to be able to say that whatever variation has occurred has been in a favourable direction. The demand on the part of home consumers is steadily expanding, and is chiefly for mild steel to be used in shipbuilding. Of this material very large quantities will be required, but the capacity of the works is so great that it is thought all demands will be readily met at reasonable if not moderate prices.

The finished iron trade is still in a somewhat halting condition. Both the home and export branches are lacking in firmness. Makers are not without hope, however, that an early revival may be experienced.

The shipments of manufactured goods from Glasgow in the past week included locomotives worth £1500, sewing machines £11,200, general machinery £13,740, steel goods £13,048, and miscellaneous iron goods £28,650.

The coal trade is displaying a considerable amount of weakness in various directions. Merchants have been disappointed with continental business, and they are holding back on account of the markets abroad being so well supplied that fairly remunerative prices are practically unobtainable. The past week's coal shipments are 11,000 tons better than in the corresponding week of 1893. Compared with the preceding week, however, they show a decrease of 13,848 tons. At the same time, the decrease has been quite recent, for in the past ten weeks of the current half-year the shipments of coals from the whole of the Scottish ports show an increase of 292,376 tons. Prices are easier, the quotations at Glasgow harbour being as follows:—Main, 7s. 3d. to 7s. 6d.; ell and splint, 8s. 3d. to 8s. 6d.; and steam, 9s. 3d. to 9s. 6d. per ton.

NOTES FROM GERMANY.

(*From our own Correspondent.*)

THE reports that come in from the various iron markets state that a more hopeful feeling prevails, not only in the finished iron trades, but also in the pig iron department. A fairly steady tone generally characterises prices; for some specially favoured articles quotations have even been slightly raised.

On the Silesian iron market the tone of business this week is less despondent than it has been during previous weeks; indeed, it may be said that there is some improvement noticeable, which is partly caused by the more favourable prospects regarding the German-Russian commercial tariff. There is decidedly more doing in the pig iron department, forge and foundry, pig being in lively request. In the malleable iron trade bars and sheets meet with a fairly good inquiry, while plates remain neglected. There is also not much doing in the steel trade, and quotations remain depressed.

Foundries as well as wire mills are again in satisfactory employment, orders coming in regularly. At the Tarnowitz Ironworks another blast furnace will be blown in next week. Only a moderate amount of business has been done this week on the Austro-Hungarian iron market, but as producers are generally well situated for contracts, prices have been well maintained and the position of the trade may be considered as fairly satisfactory. In the malleable iron department the demand for bars and plates has considerably decreased; prices are fluctuating. Girders have been reported in somewhat better request.

The iron industry in France continues to be in a quiet but generally satisfactory position. Pig iron is regularly inquired for, and the finished iron and steel manufacturers are also doing fairly well. The condition of prices is reported to be a pretty favourable one, considerable firmness being exhibited in almost all branches. On the Belgian iron market the slight improvement which had been noticeable here and there during the last weeks has passed without having in any way influenced prices. On the contrary, there is again much depression noticeable in quotations, makers being compelled to grant concessions if they wish to get their order-books filled.

At a recent tendering for 105 freight cars 42 were offered at 3209f., another lot of 42 was offered at 3280f., while for the remaining 21 3390f. were asked; in November, 1891, a similar order was given out at 6500f., which shows a difference of about 50 per cent. There is not much business doing on foreign account at the present moment. In the beginning of the year there were rather more orders coming from abroad, the returns for January showing an increase in export for almost all articles.

On the Rhenish-Westphalian iron market the business that is at present being transacted in the iron and steel trade is but small, although inquiries are coming forward more freely, especially in the finished iron department. Prices are, on the whole, pretty firm. The shipbuilding and engineering industries are but irregularly employed just now, but they will soon improve to some extent, as a large volume of business is expected in the beginning of next quarter. For pig iron there is but a moderate demand coming forward, but prices are, with few exceptions, pretty firmly maintained. There is nothing specially interesting to note concerning the different sorts of pig iron; the belief is generally entertained that a further stiffening in prices will soon take place.

The finished iron and steel manufacturers report only a small amount of orders to be coming in, while the condition of prices is universally complained of. Bars are in quiet request. Except a fair inquiry on home account, there has also been but little doing in the girder trade during the week, and prices are still very low, and in no proportion to those of the raw materials. The same may be told of hoops, which continue in dull request; if the prices for that article have not changed, it is simply because they cannot possibly go down further, while an improvement is quite out of the question under present circumstances. A fair activity is being maintained at the plate and sheet mills; and although there have been but few orders of importance coming in lately, demand and inquiry are considered as pretty satisfactory, and decidedly better than present notations, which in most cases leave almost no profit. The wire trade remains neglected, both drawn wire and wire nails being weekly called for. Business in the iron and steel trade continues extremely dull, and quotations are still much depressed. Just recently some rail orders have been secured, but the prices stipulated are far from satisfactory. An order for 6000 t. rails for the Dutch railways has been secured by Krupp, Essen, at 50 florins, free Amsterdam. The rolling stock for the Anatolian railways has likewise been granted to Rhenish-Westphalian works.

The value of mining products which Germany exported during the year 1893 was, in million marks:—

Export.

	1893.	1892.
Coal and coke	142·7	131·2
Iron and iron manufactured goods	263·2	234·4
Ores and precious metals	202·4	237·1
Copper and copper ware	64·3	56·2
Zinc and zinc ware	37·8	32·9
Tin and tin articles	4·7	4·5
Instruments, machines	121·9	119·7

Value of import was:—

	1893.	1892.
Coal and coke	98·8	95·1
Iron and iron manufactured goods	32·1	33·1
Ores and precious metals	298·3	317·8
Copper and copper ware	57·0	52·2
Zinc and zinc ware	6·0	5·9
Tin and tin wares	20·4	17·0
Instruments, machines	32·2	32·8

NAVAL ENGINEER APPOINTMENTS.—The following appointments have been made at the Admiralty:—Engineers: David Peacock, to the Gannet, to date March 6th; Charles W. Bolt, to the Snapper, to date March 9th. Assistant engineer: John Bowing, to the Hawke, to date March 6th. Probationary assistant engineer: Raymer Davis, to the Victory, supernumerary, to date March 1st.

THE CIVIL AND MECHANICAL ENGINEERS' SOCIETY.—A paper on the subject of "Electric Lighting in Country Houses" was read by the author, Mr. Sydney A. Court, A.M.I.C.E., at an ordinary meeting of the Civil and Mechanical Engineers' Society held on Thursday, the 15th inst., at the Society's rooms in Delahay-street, Westminster. Commencing with the consideration of the various sources of power suitable for generating electricity, the author referred to an interesting installation at the private residence of Mr. H. C. Brush, in America, where a self-regulating windmill is in use, charging a huge battery of storage cells. Motive-power derived from water, gas, and oil engines was discussed; and attention drawn to the necessity for the proper training of the electrician in charge of works, who, although as a rule in sole charge of plant and apparatus costing from £1000, is often not paid more than 30s. a week, while his want of knowledge or carelessness in attending to the storage battery alone—an expensive item—may occasion its loss in a very short time. The design of small installations was next considered, and stress laid upon the necessity of their being under the control of a consulting engineer; who by his independent position, and freedom from connection with manufacturers and contractors, is able to consider each case strictly on its local requirements and conditions. Examples of the annual cost and working expenses of small installations were given, and attention drawn to the advisability of using incandescent lamps of high efficiency, as the doing so effected a considerable economy in the yearly cost of working.

HULL AND DISTRICT INSTITUTION OF ENGINEERS AND NAVAL ARCHITECTS.—On Monday evening, the 5th inst., the members of this Institution assembled to hear a paper by Mr. W. Pemberton on "Boiler Management and Inspection." The lecturer dealt with the respective systems that are at present in practice, and rule boiler management and inspection; how far it was desirable for the State to interfere with steam users, on the ground of safe working as a mitigation of loss of life from explosions; the magnitude of the surrounding interests involved, and the best means to be taken to insure the most efficient and satisfactory system of management, &c., and the responsibility of issuing certificates of the safe working pressures. He maintained that existing Boiler Insurance companies who had in their employ practical and scientifically trained inspectors, and at their head, chief engineers who, from a varied experience were enabled to deal with the fixing of pressures in a prompt and considerate spirit, were the most likely to give satisfaction to steam users generally. By means of graphical illustrations of the number of boiler explosions and accidents and corresponding death rates for the last forty-three years, it was shown that systematic inspection by competitive companies was the best means to prevent accidents. The lecturer upheld that whilst it was desirable that all boilers should be under inspection, in the interests of efficiency and safety, steam users should retain the full control over their boilers, in preference to compulsory inspection, which would be extremely harassing; but at the same time, in cases of explosions and accidents that could be traced to negligence or ignorance, he would impose very severe penalties. In conclusion, he ventured to hope that the further adoption of the conditions that are in force under the present boiler inspection and insurance companies would benefit steam users in particular and the nation in general, through the further minimisation of accidents and consequent loss of life. A hearty vote of thanks was accorded Mr. Pemberton at the close of his lecture.

LAUNCHES AND TRIAL TRIPS.

The s.s. Maroa, built by Messrs. Wm. Doxford and Sons, Sunderland, for Messrs. Crow, Rudolf, and Co., Liverpool, left the Wear on Wednesday 7th, completed a satisfactory trial trip, and sailed for Cardiff on the 8th, where she will load for Bombay. She has a capacity of 9560 tons deadweight.

On the 7th inst. the Montrose Shipbuilding and Engineering Company launched the remaining two of six barges named Jupiter and Neptune, which they have been building to the order of Mr. Joseph Constant, London. The Company has just concluded contracts to build three cargo steamers, 130ft. by 25ft. by 12ft., with engines with 15in. and 32in. cylinders, with 24in. stroke.

The s.s. Turret Bay, the third vessel of the turret deck type, built by the patentees, was launched from their yard at Pallion on Thursday, the 8th inst. She has been built to the order of the Guildford Steamship Company — Messrs. Petersen, Tate, and Co., managers. She has a deadweight capacity of 3800 tons on 19ft. 7in. draught, with a gross register of about 2200 tons, and net about 1375, and is fitted with triple-expansion engines of 23in., 37in., and 60in., by 42in., with two large boilers by the builders, Messrs. Wm. Doxford and Sons. During construction the vessel has been under the special survey of the British Corporation and Bureau Veritas, and will receive the highest class in both registries.

On March 8th Messrs. Furness, Withy, and Co., launched from their shipbuilding works at Hartlepool a large steel screw steamer, the Manningtry, built to the order of Messrs. Sivewright, Bacon, and Co., of West Hartlepool. The vessel is a very substantial type of a modern cargo boat, measuring over 300ft. in length, and built throughout of Siemens-Martin steel, with a large measurement and deadweight capacity, and built to the highest class at Lloyd's. To get as much strength as possible the greater portion of the shell plating is in 24ft. lengths, this plating being efficiently backed up by strong sectional framing carrying the strength to the top of the vessel all fore and aft, the topside plating being extra thick to withstand the heavy Atlantic trade, also the bottom plating is thicker in way of all ballast tanks to allow for the vessel lying aground whilst taking in cargo. To allow for corrosion the whole of the weather decks, tank tops, floor plates, &c., are of extra thickness, there being practically no thin steel in the ship. She has extra large sized hatchways, which will take the bulkiest descripton of cargo, and would be especially suitable for carrying machinery, large guns, torpedo boats, &c. A new design of bilge intercostal keelson is fitted in the holds—Sivewright's patent. By this new arrangement very much of the dunnage and damage to bag cargo is avoided, there being no pockets or receptacles for loose grain, coals, dirt, &c., consequently these keelsons can be much more rapidly cleaned down when discharging cargo. The vessel will be rigged as a polemasted schooner, and to make her available for bridge and canal work the topmasts are telescopic. The machinery has been constructed by Messrs. T. Richardson and Sons, Hartlepool, and are of the triple-expansion type, with two large high - pressure single - ended boilers. To get economy and to prevent condensation of steam the high-pressure cylinder is jacketed by Morison's patent arrangement. On leaving the ways the vessel was named Manningtry by Mrs. W. J. Sivewright, wife of the senior partner of the firm.

On Saturday, the 10th inst., Messrs. Wigham, Richardson, and Co. launched the s.s. New Londoner from their Neptune Works, Newcastle-on-Tyne, which they are building to the order of the Tyne Steam Shipping Company, for their passenger service between the Tyne and London. The steamer is 270ft. in length, 33½ft. beam, and 18ft. in depth. She has an upright stem and an elliptical stern, and will be rigged as a three-masted schooner. She is also amply supplied with water ballast, having 170 tons. She will have two complete decks, viz., the main deck and lower deck, and also a long poop deck. The last will form a spacious promenade for the first-class passengers, whilst those of the second class will have the forecastle. Numerous improvements in the nature of the passenger accommodation have been introduced, which we expect will be much appreciated by intending travellers. The first-class accommodation will be situated amidships, on the saloon and main decks. On the saloon deck will be a house containing a ladies' saloon, smoke-room, and the staircase leading to the remainder of the first - class accommodation, besides the captain's room and the chart-room. The ladies' saloon will be of polished mahogany, with richly decorated panels. It will have sofas, swing chairs, mahogany tables, mirrors, &c., and the upholstery will be of tapestry of an olive green tone, with gold-coloured curtains. The smoking - room, in the same house, will be upholstered in green morocco leather, with curtains like those in the ladies' saloon. Between these two rooms is situated the entrance to the dining saloon, the panelling of which will be of polished teak, and the staircase will be of the same material, the newal posts being very handsomely carved. The dining saloon will be on the main deck, and will consist of a large and airy saloon, capable of seating fifty-two people at dinner at the same time without any crowding, and containing two handsome sideboards and a good piano. This saloon will be furnished with armchairs, and sofas with spring backs and seats, which, like those of the ladies' room and smoke-room, can be converted into very comfortable berths at a moment's notice. The upholstery here will be of grey Utrecht velvet with cream coloured tapestry curtains, and the walls will be of beautifully figured oak with tastefully carved panels. The floor will be covered with thick Axminster carpets. Aft of the dining saloon, and on the same deck, come the first-class state rooms, each containing two mahogany fronted berths, and furnished with sofas like those in the dining saloon, lavatories, mirrors, &c. The upholstery here will be of Utrecht velvet, with curtains like those in the dining saloon. On the same deck, in the forward part of the ship, is part of the accommodation for the second-class passengers. It will be divided into two parts, one for men, and the other for women, as also is the remainder of this accommodation on the lower deck. The woodwork of all this quarter is to be neatly painted, grained, and varnished, and the upholstery is to be of handsome figured rep. The officers and engineers will be placed in very comfortable quarters on the main deck aft, close to the engines, where also the firemen will be, whilst the sailors will be berthed on the main deck forward of the second-class accommodation. The propelling machinery will consist of a set of very powerful triple expansion engines, constructed by Messrs. Wigham, Richardson, and Co., placed aft, and supplied with steam by three large single-ended multitubular boilers by the same builders. In these engines all the most improved appliances for facilitating their working are being provided. Amongst the other comforts to be provided for the passengers on board this vessel, may be mentioned a complete installation of electric lighting, the dynamo being placed in a convenient position in the engine-room, steam heating throughout, efficient ventilation, electric bells, and an ice-room of ample size. Attention has also been paid to the efficient handling of the ship and of the cargo. For the former, a steam windlass, steam steering gear, and a warping winch will be provided; and for the latter, four powerful steam cranes, two at the forward hatch and two at the main hatch. The launch was witnessed by a large number of visitors, amongst whom were Alderman Stephens, Stephenson, and Holmes, Mr. R. Welford, Mr. James Leathart, Mr. J. T. Dobson, Mr. W. W. Pattinson, and many others. The vessel was named by Miss Stephenson, daughter of Alderman W. H. Stephenson, Newcastle.

THE PATENT JOURNAL.

Condensed from "The Illustrated Official Journal of Patents."

Application for Letters Patent.

*** When patents have been "communicated" the name and address of the communicating party are printed in italics.

1st March, 1894.

4316. Braces, Belts, and the like, T. Barker, Manchester.
4317. Pneumatic Cycle Spring, R. Harrington, Wolverhampton.
4318. Improved Taps for Barrels, J. A. West, Huddersfield.
4319. Railway Permanent Way, W. D. Hodkinson, Nottingham.
4320. Holders for Candles, W. Godfrey, Nottingham.
4321. Displaying the Pages of Books, F. E. Suddard, Germany.
4322. Flushing Cisterns of Water-closets, R. Holt, Liverpool.
4323. Preventing Accumulation of Dust, P. Hookham and A. Fennings, Birmingham.
4324. Transparent Photographs, J. C. Shannon, Birmingham.
4325. Electro-deposition of Aluminium, A. H. Harris, Birmingham.
4326. Improved Lamps, T. Bamber and O. Bamber, Accrington.
4327. Handle for Reaping Machines, S. Peace and Sons, Sheffield.
4328. Pneumatic Cylinders, W. F. and W. A. Garbutt, Gateshead-on-Tyne.
4329. Casing Boilers, W. G. Todd and A. Borchert, Birmingham.
4330. Match-striker to be Fixed on Umbrellas, W. F. Garbutt and W. A. Garbutt, Gateshead-on-Tyne.
4331. Fastener for Sunshades, C. A. Pfenning, Manchester.
4332. Sight-feed Lubricators, W. H. White, Manchester.
4333. Electric Light Fittings, W. H. Johnson, Bournemouth.
4334. Conveying Material, A. T. Fletcher and M. Graham, London.
4335. Producing Aluminium, J. Stuart and J. Mason, London.
4336. Apparatus for Measuring Liquids, J. Tabel, Berlin.
4337. Pneumatic Beds for Ships, &c., S. Dawes, Rugeley.
4338. Horizontal Sifting Machine, W. Bunge, London.
4339. Compressed Air Motor, A. W. O. Hampe, London.
4340. Horseshoes, W. L. Wise.—(*R. Zapp, Germany.*)
4341. Manufacture of Ammonia, &c., G. Fouler, London.
4342. Improved Laths for Roller Blinds, C. Chipps, London.
4343. Flower-pot and Sauce Cover, J. R. Collins, London.
4344. Bronchotomy, &c., Tubes, J. E. Arnold, London.
4345. Mechanism for Sewing Machines, V. Witte, London.
4346. Photographing in Colours, F. Slavin and S. Pollastrini, London.
4347. Danger Signals for Mines, F. Slavin and S. Pollastrini, London.
4348. Boots for Shop Window Dressing, J. Hill, London.
4349. Rope Checks for Window Blinds, P. Robertson, London.
4350. Apparatus for Condensing Water, A. Normandy, London.
4351. Manufacturing Pneumatic Tires, C. K. Welch, London.
4352. Race Ball Bearing for Cycles, F. Haselock, London.
4353. Re-producers of Phonographs, A. W. Carter, London.
4354. Carbonaceous Filtering Media, J. Wetter.—(*M. Weinrich, United States.*)
4355. Water Circulation in Houses, A. W. Hussey and S. W. Kelsey, London.
4356. Clinometer, T. Oblein, A. W. and V. E. Hall, London.
4357. Projectiles or Torpedoes, L. Gathmann, London.
4358. Protecting the Backs of Books, G. B. Hayward, London.
4359. Apparatus for Lifting Weights, W. Seeling, London.
4360. Improved Supports for Pipes, J. N. Greenhall, London.
4361. Couplings for Railway Vehicles, L. A. Beckmann, London.
4362. Drawing Liquor, F. H. and H. Nalder, C. W. S. Crawley, and A. Soames, London.
4363. Sharpening the Blades of Shears, &c., N. L. Willard, London.
4364. Pedal Crank for Bicycles, &c., H. P. Boyd, London.
4365. File Cutting Machines, J. Béché, jun., London.
4366. Dynamo-electric Machines, A. J. Boult.—(*Compagnie de l'Industrie Electrique, Switzerland.*)
4367. Frames of Bicycles and the like, C. Binks, Liverpool.
4368. Appliance for Sharpening Scissors, M. Barr, Manchester.
4369. Type, E. S. Biggins and H. C. Jenkins, London.
4370. Apparatus for Corking Bottles, A. Hindle, Manchester.
4371. Cardboard Boxes, A. J. Boult.—(*C. David and Son, Austria.*)
4372. Hooks for Ladies' Dresses, M. A. Keeling, London.
4373. Colouring Matters, H. E. Newton.—(*The Farbenfabriken vormals Friedrich Bayer and Co., Germany.*)
4374. Improved Petroleum Lamps, P. Bonnet, London.
4375. Road Locomotives, T. L. Aveling, London.
4376. Night-lights, H. Palmer and E. Spain, London.
4377. Constructing Fire-proof Floors, R. Astley, London.
4378. Manufacture of Steel Files, J. Smillie, London.
4379. Improved Bed Table and Rest, C. J. Stocker, London.
4380. Washing Coal, W. O Wood and C. Burnett, London.
4381. Ventilating Grids or Gratings, C. Kite, London.
4382. Picketing Horses, H. R. Newburgh-Stewart, London.
4383. Connecting Drains to Lead Pipes, A. T. Carley, London.
4384. Lamps for Heating Purposes, A. T. Carley, London.
4385. Rendering Block Ice Severable, H. V. Wayde, London.
4386. Transmitting the Power of Air, A. Heupel, London.
4387. Trace Attachments, G. G. M. Hardingham.—(*E. C. Hawkshaw, India.*)
4388. Stringed Instruments, &c., H. Lindemann, London.

2nd March, 1894.

4389. Inlet Ventilator for Sewers, M. Martin, Eastbourne.
4390. Tipping Bucket for Coals, &c, W. T. Andrews, London.
4391. Preservation of Lime, &c., Juices, J. B. Rose, London.
4392. Instrument Keys for the Blind, W. R. Larkins, Bromley.
4393. Spring Tires for Cycles and Vehicles, J. Barlow, Nottingham.
4394. Carding Engines, J. Haley, G. Blamires, S. Jackson, and H. E. Hodgson, Halifax.
4395. Boxes for Bottles, J. Nall, Halifax.
4396. Floor-cloths, J. S. Farmer and H. L. and I. H. Storey, Manchester.
4397. Toy, A. Roberts, Manchester.
4398. Pneumatic Tire for Bicycles, W. F. Bowen, Bolton.
4399. Gas Lamps, R. Brown, Bradford.
4400. Boilers, F. and A. Craven, W. and F. Pinder, and P. H. Stansfield, Bradford.
4401. Show-case for Photographs, &c., J. Hetherton, York.
4402. An Electricity Meter, H. G. Rea, Richmond, Surrey.
4403. Window Weights, J. Clegg and G. Parkinson, Stockport.
4404. Fuel Economiser and Water Heater, J. Pimbley, Lancashire.
4405. Twist-lace Machines, F. R. Radford, J. Cutts, jun., and W. Parker, Notttingham.
4406. View Finder with Removable Mirror, W. Tylar, Birmingham.
4407. Theatre Chairs, A. R. Dean, Birmingham.
4408. Gaslight Spreader, T. B. Jack, London.
4409. Reservoir Pens, E. L. Blake, R. H. Platt, and S. Taylor, Manchester.
4410. Water-closet Cisterns, G. Hunt and D. Sutcliffe, Burnley.
4411. Adjustable Sunshine Excluder, E. Johnson, Stockton-on-Tees.
4412. Water-tube Boiler Attachment, W. Marriott, Gosport.
4413. Rotary Steam, Air, or Water Motor, R. C. Mollon, Exeter.
4414. Wheels for Manure Distributors, W. Anderson, Glasgow.
4415. Safety Valve for Kitchen Boilers, W. Parker, London.
4416. Hat Suspender, H. Wilkins and T. Vaun, Birmingham.
4417. Filing of Papers and Documents, H. S. Perkins, London.
4418. Chimney Cowls, W. McCaig, Glasgow.
4419. Method of Fastening Envelopes, E. J. Lloyd, London.
4420. Construction of Iron Water Pipes, W. Moore, London.
4421. Axle Grip and Spring Platform, J. Wicks, London.
4422. Life-saving Appliances, T. W. Bewers and A. Glaser, London.
4423. Preparation of Hydrogen, R. Wolffenstein, London.
4424. Method of Hinging Metal Grates to Stoneware Gullies, J. Duckett and Son and A. Duckett, London.
4425. Braces for Turning Bits, E. Alpaugh, Birmingham.
4426. Oil Engines, J. P. Lea, London.
4427. Movable Dolly Suspender, A. S. Anderson, Newcastle on-Tyne.
4428. Mixing Machines, W. G. G. Sharp and W. Sharp and Sons, London.
4429. Electrical Switch Manufacture, A. Metzger, London.
4430. Air Propellers, C. Groombridge and W. A. South, London.
4431. Pad Frames, W. W. Smith and W. W. Smith and Co., London.
4432. Portable Mud Guard for Cycles, B. Hobbs, London.
4433. Transit Evaporator for Saccharine, J. McNiel, Glasgow.
4434. Apparatus for Coaling Steamers, A. Thomson, Glasgow.
4435. Dutch Ovens, W. J. Porter, Birmingham.
4436. Round Bars for Fire-grates, G. P. Uhlenbroich, London.
4437. Cruets, J. Crombie, London.
4438. Lock-stitch Sewing Machines, J. Graham, London.
4439. Boiler Furnaces, S. Bond and J. Pickerill, London.
4440. Cravat Fasteners, P. d'Espagnat, London.
4441. Construction of Glass Roofs, &c, S. Deards, London.
4442. Appliance for Cultivating Land, C. A. Ash, London.
4443. Apparatus for Steering, &c., Ships, G. Sollitt, London.
4444. Manufacture of Felt Hats and Caps, R. Forge, London.
4445. Rams, J. Molas, London.
4446. Mowing and Reaping Machines, S. B. Bamford, London.
4447. Drain Pipe Support, H. C. Jury and H. E. Cockell, London.
4448. Metallic Buttons, G. F. Cotton, London.
4449. Tension or Suspension Wheels, C. K. Welch, London.
4450. Polishing Precious Stones, A. Neydeck, London.
4451. Sausage-filling Machines, W. Scheffel, Germany.
4452. Nails, Tacks, and Screws, A. T. Fullicks, Great Marlow.
4453. Printing Machines, G. and A. E. Watson and A. McLaren, London.
4454. Plates for Mezzotint Engraving, R. S. Clouston, London.
4455. Whirls for Sole Sewing Machines, F. W. Farr, London.
4456. Preventing Tires from Puncture, H. Foster, London.
4457. Geyser Heating Apparatus, J. Winterflood, London.
4458. Air Boots and Shoes, W. Howard, London.
4459. Salts, S. B. Boulton, T. B. Heywood, H. E. Boulton, and H. Fergusson, London.
4460. Colouring Matters, O. Imray.—(*The Society of Chemical Industry in Basle, Switzerland.*)
4461. Receptacles for Preserving Jam, A. Fjelstrup, London.
4462. Machines for Cutting Grass, T. Eichhorn, London.
4463. Depôt for Exposing Sample Goods, H. Bristow, London.
4464. Vessels for Boiling Liquids, F. Chavand, London.

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4465. Power Tilted Machine Hammer, C. Marshall, Wakefield.
4466. Valves for Pneumatic Tyres, R. Harrington and J. W. Holland, London.
4467. Combined Hygienic Douche, &c., M. Herbert, Nottingham
4468. Gas Generator, H. and S. H. Hawkins, Portsmouth.
4469. Dabbing Brushes, J. P. Heaton, J. H. Beaver, and A. Bailey, Keighley.
4470. Arithmometers, J. Williams, Keighley.
4471. Can Opener, T. Littlehales, Birmingham.
4472. Electrolytic Processes, T. Parker, Wolverhampton.
4473. Magnetic Compass, W. J. Turner, London.
4474. Fastenings for Gloves, &c, T. Banford, Birmingham.
4475. Sewing Machines, D. Jones, Birmingham.
4476. Inside Plate, &c., for Locks, J. Waine, Willenhall.
4477. Automatic Regulator, J. and T. Hesketh, Blackpool.
4478. Flyers of Slubbing Frames, G. Paley, Preston.
4479. Fog-signalling Apparatus, W. A. and G. A. Stephens, London.
4480. Safety Receptacle, F. Taylor, Manchester
4481. Treating Dyed Textile Fabrics, A. Drew, Burnley.
4482. Horse-hair Cloth for Garters, &c., W. Aimes and H. W. Loads, Norwich.
4483. Detachable Reflector for Lamps, J. A. Hartley, Daubhill, near Bolton.
4484. Electro-magnetic Switching, G. Michaelson, Berlin.
4485. Correction of an Electric Bell, G. Michaelson, Berlin.
4486. Menu Cards, Programmes, &c., T. Mason, London.
4487. Curtain Rods, E. H. Heideloff, Edinburgh.
4488. Tills for Registering Payments, J. Baker, Birmingham.
4489. Surgical Operating Chairs, H. G. Leisenring, London.
4490. Chimney Tops, G. Housden and F. J. Pateman, London.
4491. Sluice Valves, R. Blakeborough, Brighouse.
4492. Sash-bars for Glass Roofs, H. C. Lassam, London.
4493. Paper Fasteners, A. W. Montgomery-Moore, London.
4494. Window Frames, G. S. Henderson, Glasgow.
4495. Looms, J. Gregson, Preston.
4496. Refrigerating Butter, Lard, &c., J. C. Reese, Glasgow.
4497. Belting, J. Tullis, jun., Glasgow.
4498. Centrifugal Machines, J. Laidlaw, Glasgow.
4499. Reversing Gear for Washing Machines, J. W. Crabtree, Bradford.
4500. Velocipede Tires, E. A. Gerard and A. J. Picon, London.
4501. Pocket for Breeches or Trousers, H. J. Tautz, London.
4502. Oil Stoves, J. H. Ross, Birmingham.
4503. Water Pipes, S. W. Meyer, Leeds.
4504. Gas Meters, W. J. Warner and W. Cowan, Glasgow.
4505. Composition for Varnishing or Polishing, J. S. Macarthur, Glasgow.
4506. Treating and Utilising Gases, R. Dunlop, Glasgow.
4507. Oven Dish Stand, D. Lewis and F. W. Oaten, Cardiff.
4508. Metallic Buckets, C. W. Roberts and E. A and D. W. Cooper, Birmingham.
4509. Buckles for Braces, &c., H. Halladay, Birmingham.
4510. Boot and Shoe Fastener, E. A. Mepham, London.
4511. Windows, A. E. Wynn, Harrogate.
4512. Construction of Spring Hooks and Swivels, P. Bull, Walsall.
4513. Bicycle Tire, A. Meyer and F. W. Klipper, London.
4514. Paper - making Machinery, D. N. Bertram, Glasgow.
4515. Safety Door for Carriages, R. K. Wood, Oldham.
4516. Golf Club, W. and D. Auchterlonie and A. W. Crosthwaite, St. Andrew's.
4517. Stoves for Heating Purposes, J. G. Calvert, London.
4518. Apparatus for Rearing Chickens, C. E. Hearson, London.
4519. Lighting and Heating Apparatus, J. F. Foveaux, London.
4520. Sliver Cans and Milk Churns, J. W. Mills, London.
4521. Turbines and Centrifugal Pumps, G. T. Seydel, London.
4522. Electrical Clocks, A. J. Boult.—(*H. Campiche, Switzerland.*)
4523. Inflation of Footballs, &c., R. W. Francomb, Liverpool.
4524. Mechanical Stokers and Fire-bars, A. T. Cass, Manchester.
4525. Kilns for Burning Bricks, W. P. Sheppard, London.
4526. Metallic Roofing Tiles, W. P. Thompson.—(*F. and T. Koch, Germany.*)
4527. Straight-bar Knitting Frames, G. A. Cartwright, London.
4528. Vapour Bath Kettle, C. H. Coles, London.
4529. Appliance for Inside of Hats, &c., J. McKay, London.
4530. Ventilating Appliances, J. Chadwick and E. J. Preston, London.
4531. Fixing Stands for Golf Caddie-bags, J. W. Price, London.
4532. Lubricators, W. Grimes, London.
4533. Moulds for Casting Compound Ingots, T. Hampton, Sheffield.
4534. Flyers for Slubbing Frames, J. Sparks and J. Moorhouse, Manchester.
4535. Valves for Pneumatic Tires, N. Knowles and W. Philipson, London.
4536. Cotton Spinners, T. Perks, W. E. Perks, and E. Perks, Birmingham.
4537. Manufacture of Butter, T. Bradford, London.
4538. Lime Kilns, J. Hall, London.
4539. Joint for Wires, W. Dieselhorst and Siemens Brothers and Co., London.
4540. Contact Bars, Siemens Brothers and Co.—(*Messrs. Siemens and Halske, Germany.*)
4541. Wheels for Velocipedes, C. H. Worley, London.
4542. Manufacture of Colouring Matter, R. E. Evans, London.
4543. Smokeless Explosive Compound, E. de Poorter, A. Walton, and T. H. Andreal, London.
4544. Air-guns, M. Pulvermann.—(*F. Langenhan, Germany.*)
4545. Bellows, J. J. Harvey, London.
4546. Manufacture of Twist Lace, &c., E. Cope, London.

4547. Valve for Regulating Steam Traps, W. Burley, London.
4548. Substitutes for Butter and Lard, J. Raschen, London.
4549. Evaporating Liquids, W. Smethurst and The Smokeless Heat and Light Syndicate, Ld., London.
4550 Treatment of Ores, P. M. Justice.—(*E. F. Ayton, Mexico.*)
4551. Artificial Flies for Fishing, W. and J. J. Hardy, London.
4552. Bottle for Holding Liquids, J. S. Wood, London.
4553. Double Board for Pianoforte, O. von Straalen, London.
4554. Telephony, C. A. Randall. London.
4555. Watch Protectors, W. F. Smith and G. Harman, London.
4556. Projecting Machines, W. F. Smith and G. Harman, London.
4557. Tapping and Screwing Machines, F. H. Royce, Manchester.
4558 Field Gun-mountings, H. H. Lake.—(*J. B. G. A. Canet, France.*)
4559. Cartridges, C. Bonnardeaux, London.
4560. Stoppering and Opening Bottles, C. A. Dainesi, London.
4561. Looms, H. Schürmann, Germany.
4562. Starting Carriages, A. de la Rochefontenilles, London.
4563. Cleaning Bottles, T. Wendling, London.

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4564. Buffers for Railway Purposes, C. Walton, Sheffield.
4565. Ring Golf, F. Kinloch, Edinburgh.
4566. Waterproof Leggings, J. Salisbury, Barrow-in-Furness.
4567. Cutting-off the Heads of Bolts, L. E. Clark, London.
4568. Circular Knitting Machines, W. I. James, Stafford.
4569. Poacher and Thief Scarer, G. R. Bray'shay, South Wales.
4570. Chairs, T. Ashman, Frome.
4571. Bottle-filling Machine, A. Niel and J. Coats, Glasgow.
4572. Telephonic Transmitters, C Adams-Randall, London.
4573. Manufacture of Caustic Soda, W. Garroway, Glasgow.
4574. Valves for Pneumatic Tires, F. Creassey, Nottingham.
4575. Electrical Tramways, E. E. Vaughton, Birmingham.
4576. Automatic Candle Holders, J. Farmer and J. Purcell, Birmingham.
4577. Locking Bottles in Spirit Stands, &c., M. W. Millett, Southsea.
4578. Training Horses to Step, J. A. and G. C Elliott, Lancashire.
4579. Football Toy, G. Wright, Sheffield.
4580. Excluding Dust from Axle boxes, R. Hyde, Sheffield.
4581. Handle-bars for Cycles, W. P. Theermann, W. Crookell, and G. C. Elliott, Manchester.
4582. Inflators for Cycles, W. P. Theermann, W. Crookell, and G. C. Elliott, Manchester.
4583. Securing Handles to Brooms, W. H. Haslam, Manchester.
4584. India-rubber Solution Injectors, W. Bown and G. Capewell, Birmingham.
4585. Brake Apparatus for Road Vehicles, G. Peet, Manchester.
4586. Golf Hole for use on Lawns, M. W. Skinner, Colchester.
4587. Steering Mechanism of Canoes, H. Hayes, Scarborough.
4588. Making Cans, J. Banbury, Oxfordshire.
4589. Means of Illuminating Clocks, S. Goldstone, Manchester.
4590. Filing Cases, C. Chivers, London.
4591. Cooking Ranges, T. Bamforth, Glasgow.
4592. Lead Weight, J. H. Allcock, Redditch.
4593. Wheels for Rolling Stock, R. N. D. Bruce and A. Norton, London.
4594. Bib and Stop Cocks for Water, J. H. Jefferies, Wolverhampton.
4595. Traction Engine Wheels, I. W. Boulton, Ashton-under-Lyne.
4596. Hydraulic Locomotive Engine, A. E. L. Lheureux-Bouron, France.
4597. Telescopic Sights for Ordnance, L. K. Scott, Farnborough.
4598. Cleaning Miners' Safety Lamps, B. H. Halstead and L. Kershaw, London
4599. Process for Improving Mustard, J. Bland, London.
4600. Ovens, R. Poore, London.
4601. Counterbalance Blind-cord Holder, J. Court, London.
4602. Photographic Cameras, E. C. Hawkins, London.
4603. Driving Belts, T. H. Wainwright and G. A. Williams, Liverpool.
4604. Shirts, L. Adler, London.
4605. Fabrics, E. de Pass.—(*J. C. McLauchlin and A. A. Hand, United States.*)
4606. Sensitive Plates and Films, C. E. Pettitt, London.
4607. Brake Apparatus for Railways, R. Mitchell, London.
4608. Baggage Saddle and Packing Straps, J. Murphy, London
4609. Manufacturing Hollow Metal Goods, F. Andé, London.
4610. Temperature Regulating Device, E. F. Moy, London.
4611. Steam Turbine Wheel, E. Seger, London.
4612. Supporting Windows, H. C. Willings and E. Eaton, London.
4613. Pneumatic Tires, G. C Bond and F. Saddler, London.
4614. Skate and Golfing Sole Fastenings, F. W. Hilliard, London.
4615. Preventing Water Pipes Bursting, W. Flavell, London.
4616. Platen Printing Machines, S. Thacker, London.
4617. Rope Grips for Haulage Purposes, J. H. Craven, London.
4618. Baskets for Dogs and other Animals, A. M. V. Clavering, London.
4619. Skeleton Packing Cases and Crates, H. Sutton, London.
4620. Sails and Masts of Vessels, G. B. Vassallo, London.
4621. Latches, T. E. Bonnar, London.
4622. Apparatus for Purifying Liquids, R. Andrew, London.
4623. Chimneys and Ventilating Shafts, T. Lishman, London.
4624. Cycle Handle Bars, C. A. Jensen.—(*F. Hofmeister, Germany.*)
4625. Wheel Tires for Velocipedes, F. T. Moison, London.
4626. An Explosive Composition, A. Maurette, London.
4627. Manufacture of Photographic Films, T. H. Blair and The European Blair Camera Company, Ld., London.
4628. Construction of Clothes Hooks, C. Feldbacher, London.
4629. Colouring Matters, H. Imray.—(*Basle Chemical Works Bindschedler, Switzerland.*)
4630. Colouring Matters, H. Imray.—(*Basle Chemische, Fabrik Bindschedler, Switzerland.*)
4631. Measuring Liquids, W. A. G. Schönheyder, London.
4632. Asbestos Cement Coverings, H. Kuhnewein, London.
4633. "Ferris" Recreation Wheel, W. B. Basset, London.
4634. Shearing, &c., Animals, C. and H. Burgon, London.
4635. Galvanic Batteries, H. Wehmann, London.
4636. Preventing Spontaneous Combustion of Coal, H. H. Lake.—(*J. H. C. Behnke and The Chemische Fabrik in Billwärder vorm. Hell and Sthamer A.G., Germany.*)
4637. Buckles, J. Smith and G. E. Fletcher, London.
4638. Raising Sunken Ships by Air, W. Howard, Essex.
4639. Dovetailed Toy Brickwork, M. L. Tucker, Chesham.
4640. Peel Blade and Holder, G. A. Oliver, Guildford.

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4641. Regulating Temperature of Kilns, G. Reynolds, Burton-on-Trent
4642. Stretcher for Carrying Persons, J. H. Boyce, Sandown.
4643. Ventilation of Water-closet Pans, E. Cotton, Longport
4644. Needle-threader, H. C. Davidson, Wrotham.
4645. Curtain Hook, H. C. Davidson, Wrotham.
4646. Locks, J. Kaye and T. Emmott, Bradford.
4647. Electric Lighting, T. R. Burrell and F. Fowkes, Ambleside.
4648. Mandolins, G. M. Tarrant and W. Birkbeck, London.
4649. Valves, C. F. Gough, Redhill.
4650. Bottle Seals, G. A. Boyden, London.
4651. Hat Sweat Bands, &c., W. F. Beardslee, Manchester.
4652. Woven Wire Mattresses, S. I. Whitfield, Birmingham.
4653. Brushes, H. G. Benwell and E. N. Kent, London.
4654. Draught Excluder, F. Harrop and W. Boyles, London.
4655. Coloured Mosaics, S. M. Collyers, Moreton-hampstead.
4656. Enabling Cyclists to See Objects behind Them, W. P. Theerman, W. Crookell, and G. C. Elliott, Manchester.
4657 Shears, W. P. Theerman, W. Crookell, and G. C. Elliott, Manchester.
4658. Machine for Distributing Manure, T. Evans, Bristol.
4659. Douche, D. Jackson, London.
4660. Whip Holders, G. Sargent, London.
4661. Coal-gas and Water-gas, A. M. Laine, Belfast.
4662. Fruit Stand, J. H. R. Paterson, Edinburgh.
4663. Preparing Machinery for Flax, T. J. Porter, Halifax.
4664. Machines for Feeding Fibre, J. Erskine, Halifax.
4665. Gig or Cab Saddle Outside Skirt, T. Hill, Sheffield.
4666. Mail Carts, &c., E. D. Currall and T. Harris, Birmingham.
4667 Device for Retaining Scarves, A. J. Morris, Birmingham.
4668. Disinfector, C. Tyrell, London.
4669. Preparing Heels of Boots, W. H. Dodman, Stafford.
4670. Brick Kilns, S. Holgate and L. Whittaker, Liverpool.
4671. Wheelbarrows, H. Houldsworth, Junior, Keighley.
4672. Woven Wire Mattresses, J. H. Moorhouse, Manchester.
4673. Bits for Horses, J M. Verity, Leeds.
4674. Miners' Picks, Hammers, &c., F. J. Hute, Manchester.
4675. "Veneering" Felt Hat Bodies, J. Radcliffe, Manchester.
4676. Wash-stand, W. Wardell, Halifax.
4677. Reels for Fishing-rods, G. Bailey, Leeds.
4678. Window-cleaning Devices, W. C. Morison, Lympstone.
4679. Currying Skins, H. Walker and J. J. Wilson, Leeds.
4680. Supplying Disincrustants to Boilers, J. A. Morris and W. T. Hatch, Manchester.
4681. Wheels for Bicycles, &c., J. L. Corbett, Glasgow.
4682. Broad-cast Sowing Machines, R. G. Garvie, Glasgow.
4683. Machine for Screwing Studs, A. Green, Glasgow.
4684. Shoe Clips for Portmanteaus, &c., C. Maude, London.
4685. Rollers for Window Blinds, F. Smale, London.
4686. Fastening Gentleman's Collars, C. Sears, London.
4687. Fasteners for Boxes, &c., C. A. McEvoy, London.
4688. Gas Brackets for Walls, &c., E. Goddard, London.
4689. Packing Chemical Compounds, J. R. C. Gale and J. W. T. Cadett, London.
4690. Improved Boxes for Letters, A. Campbell, London.
4691. Connecting Electrical Circuits, A. P. and G. C. Lundberg, and G. Pegg, London.
4692. Joints for Pipes, J. B. Leclaire and A. E. Thomine, London.
4693. Sash Fastener, E. J. Lording, Westminster.
4694. Hand Covers or Bath Gloves, J. H. Nunn, London.
4695. Knives, G. Sharpe, E. and J. F. Atkinson, Sheffield.
4696. Testing Gelatinous Matter, A. Zimmermann.—(*The Chemische Fabrik auf Actien vormals E. Schering, Germany.*)
4697. Treating Tissues, A. Zimmermann.—(*J. Holfert, Germany.*)
4698. Gloves for Applying Embrocation, J. J. Stone, London.
4699. Apparatus for Hanging Mails, B. J. Mills.—(*P. M. Point, France.*)
4700. Converting Ordinary Burners, L. B. Burnett, London.
4701. Velocipedes and other Vehicles, C. A. Ives, London.
4702. Fluid Meter and Engine, W. A. Schönheyder, London.
4703. Method of Fastening Aprons, E. Andrew, London.
4704. Brakes for Cycles, A. J. Boult.—(*H. Rothmann, Germany.*)
4705. Shaping Strips or Bands of Felt, E. Gaiser, London.
4706. Sharpening Tools or Instruments, J. Dyson, Liverpool.
4707. Removal of Floor Boards, A. H. Bagnold, London.
4708. Improved Chimneys and the like, J. Chadwick, London.
4709. Soldering Lamps, W. P. Thompson.—(*Verbeeck, Briquet, and Co., Belgium.*)
4710. Cycle Steering Locks, G. Bailey and J. E. Fletcher, London.
4711. School or similar Skates, J. W. Williams, London.
4712. Scarves, &c., W. P. Thompson.—(*E. L. Koch, Germany.*)
4713. Tobacco Pipes, S. F. Saint-Jermain Steadman, London.
4714. Polishing Machines, W. P. Thompson.—(*The Moore Carving Machine Company, United States.*)
4715. Gas, Air, and Oil Burners, R. Pemberton, London.
4716. Machines for Edging Nuts, G. Dunham, London.
4717. Dust Collectors, W. P. Thompson.—(*G. S. Wilson, United States.*)
4718. Jacquard Apparatus, J. Verdol, London.
4719. Purification of Gas, E. Fleischhauer and M. Bernstein, London.
4720. Overcoats, T. Burberry, London.
4721. Roasting and Mixing Coffee, &c., A. Pavitt, London.
4722. Cigar Holders and Smokers, R. D. Gates, London.
4723. Fire-extinguishers, H. H. Lake.—(*G. T. MacLauthlin and J. Nalor, jun., United States.*)
4724. Secondary Batteries, O. March, London.
4725. Bottle-stoppers, H. H. Lake.—(*N. F. T. Hunt, United States.*)
4726. Plant for Purifying Water, H. Riensch, London.
4727. Purifying Waste Waters, E. H. L. Ostermann, London.
4728. Dredging Apparatus, R. Haddan.—(*C. Gullmann, United States.*)
4729. Unloading Railroad Cars, G. H. Hulett, London.
4730. Postal Wrappers, H. E. Hudson, London.
4731. Device for use with Pneumatic Tires, J. H. Tattersall, London.
4732. Hoods of Incandescent Gas Burners, L. K. Böhm and T. C Crawford, London.
4733. Fan, J. Ettlinger, London.
4734. Scape-wheels, J. C. Fell.—(*E. A. Locke, United States.*)
4735. Binoculars, W. H. Wood, London.
4736. Valve-gear for Steam Engines, H. H Lake.—(*P. Aunay, Russia.*)
4737. Preventing Friction on Ships, J. Thomas, London.
4738. Removing the Tops of Eggs, A. C. Granville, London.
4739. Screw Propellers, G. F. Redfern.—(*C. Meissner, Germany.*)
4740. Portable Flooring, E. A. Keen and J. Goddard, London.
4741. Packing of Tea, J. H. Moore and J. Inger, London.
4742. Portable Forges, M. Méhu, London.
4743. Decortication of Plants, H. H. Lake.—(*J. J. Girard, France.*)
4744. Furnaces, H. H. Lake.—(*E. Jolicard, France.*)
4745. Feeding Mechanism for Drills, B. Ljungström, London.
4746 Ratchet Braces, B. Ljungström, London.
4747 Valves for Steam Engines, O. Wynn, J. Smith, and W. H. R. Saunders. London.
4748. Jewellery, T. W. Offin, jun., London.
4749. Dress Tires, T. W. Offin, jun., London.
4750. Boots, T. W. Offin, jun., London.
4751. Carriage Lamps, T. W. Offin, jun., London.
4752. Velocipedes, P. J. Molliet, London.
4753. Medicinal Mixture, G. Gale, London.

7th March, 1894.

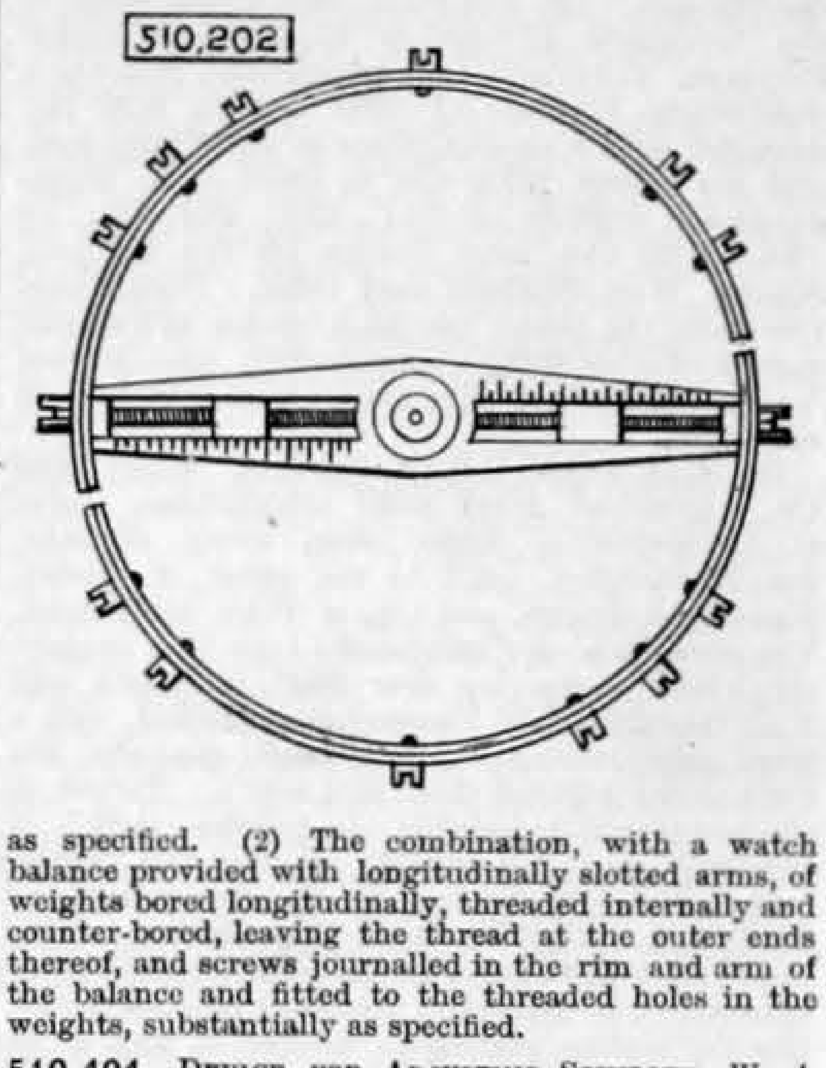
4754. Apparatus for Raising Liquids, S. H. Adams, York.
4755. Gloves, F. W. Burnham, Leicester.
4756. Bolsters, G. Leek and H. and G. E. Walker, Radcliffe.
4757. Military Screen and Tent, C. T. V. Fosbery, Lowestoft.
4758. Stoppers, G. D. Harrison, W. D. Parr, E. H. Crapper, and W. Horrox, Sheffield.
4759. Mortice Locks, T. Benton and J. W. Benton, Birmingham.
4760. Bobbin or Reel for Cotton, &c , W. Bush, Birmingham.
4761. Deposition of Metals, C. T. Oppermann, Manchester.
4762. Mincing and other Machines, W. Hartcliffe, Manchester.
4763. Machines for Coiled Wire Fabrics, A. Siddall, Halifax.
4764. Improved Waist Belts, A. A. F. Kennett, London.
4765. Apparatus for Recording Time, O. Schulze, London.
4766. Reversible Safety Window, E. H. Francis, Nottingham.
4767. Cycle Saddles, G. Salter and J. Walker, Birmingham.
4768. Obtaining Motive Power, R. J. Urquhart.—(*D. Browne and J. B. Steinfort, Belgium.*)
4769. Boxes, W. Stenning. London.
4770. Reversing Cycle Gear, W. P. W. Weatherill, Manchester.
4771. Paper-making Machines, D. N. Bertram, Glasgow.
4772. Improved Locks for Doors, J. McAllister, Glasgow.
4773. Motor Engines, J. D. G. Thomson and J. Sturgeon, London.
4774. Velocipedes, C. W. Wheeler and W. H. Parkes, Coventry.
4775. Neckties, Brooches, and Bracelets, J. Cass, Manchester.
4776. Furnace Fire-bars, L. Delaney, Bradford.
4777. Diaphragms, T. Morton and J. A. Spragon, Birmingham.
4778. Knitting and other Machines, G. H. Milward, Manchester.
4779. Lithographic Printing Press, E. T. Beal, London.
4780. Coin-freed Apparatus, R. A. Sloan and J. E. L. Barnes, Liverpool.
4781. Camera-bag and Changing-bag, C. Thompson, Birmingham.
4782. Adjusting Drilled Articles, A. Hatton, Birmingham.
4783. Fans, E. R. Storr, London.
4784. Double-draught Pipe, G. R. Bray'shay, Langharne.
4785. Domestic Fireplace Apparatus, J. Robinson, London.
4786. Roof Gutters, C. Berger and J. Thywissen, Birmingham.
4787. Curling Hair Pin, C. J. Croft and B. Perkins, London.
4788. Boxes, F. H. and H. Nalder, C. W. S. Crawley, and A. Soames, London.
4789. Children's Carts and Perambulators, W. Head, London.
4790. Tobacco Pipe Purifier and Cleaner, T. Wilkes, London.
4791. Bleaching Preparation, &c., H. Wächter, London.
4792. Hair Curlers, E. M. Gaskell and S. Lawrence, London.
4793. Horseshoes, F Cavill, London.
4794. Turning over Leaves of Music, H. D. Corbett, London.
4795. Charging Explosive Shells, J. W. Graydon, London.
4796. Charging Explosive Shells, J. W. Graydon, London.
4797. Charging Explosive Shells, J. W. Graydon, London.
4798. Shades for Light, M. T. King, London.
4799. Boot and Shoe Lace Tag, &c., A. E. Davis, London.
4800. Signals Instruction Board, H. Harris, London.
4801. Brooms, W. H. Bennett, London.
4802. Valves, J. E. Foxlee, London.
4803. Tobacco Smoking Pipes, S. H. Davey, London.
4804. Hair Pins, L. H. Cockburn, London.
4805. Electric Cycle Lamps, J. M. Klingelsmith, London.
4806. Raising Venetian Blinds, W. Deag and D. L. Knight, London.
4807. Suspending Pencils from Button-holes, W. J. Sparks, London.
4808. Preventing Withdrawing of Drawers, R. W. Milne, London.
4809. Air Valve for Tires of Cycles, W. Caie, London.
4810. Fog Signals, J. W. Dyer, Kent.
4811. Cardboard Boxes, A. J. Boult.—(*A. David, Austria.*)
4812. Apparatus for Separating Gases, W. P. Thompson, Liverpool.
4813 Storing of Hydrocarbon Oils, S. G. Homan, London.
4814. Umbrellas and Parasols, S. J. S. Bucknall Liverpool.
4815. Chimney Pots, G. L. Lavington and E. A. Wright, London.
4816. Couplings for Railway Vehicles, G. L. Lavington and E. A. Wright, London.
4817. Chisel, A. Forster, London.
4818. Spring Butt Hinge, M. Hirschfeldt, London.
4819. Preparing, &c., Mixed Powders, A. Blackie, London.
4820. Machines for Crushing Rock, J. Culley.—(*L. J. Cadwell, United States.*)

SELECTED AMERICAN PATENTS.

From the United States' Patent Office Official Gazette.

510,202. Watch Balance, *G. H. Smith, Lancaster, Ohio.—Filed January 19th, 1893.*

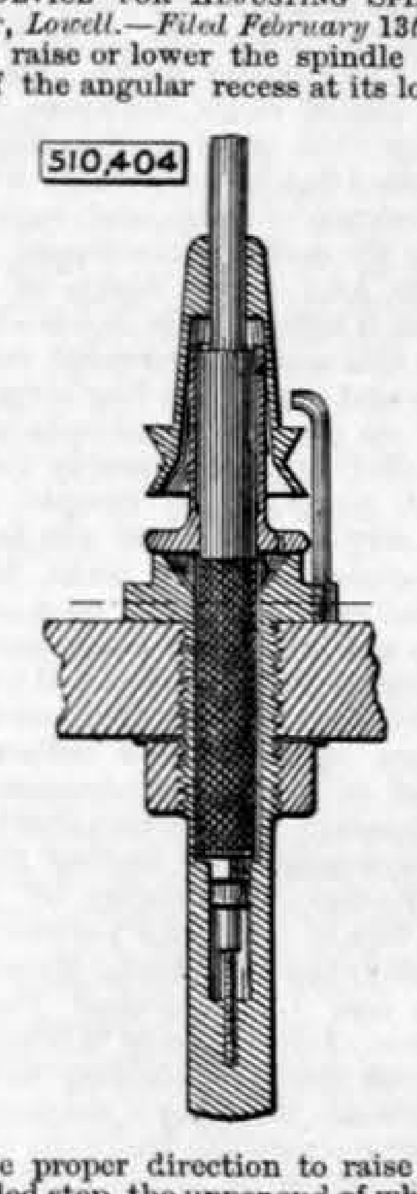
Claim.—(1) The combination, with a watch balance having slotted arms, of sliding weights placed in the slots of the arms and fitted closely to the sides of the slots, and a screw journalled in the slotted arms and fitting threaded holes in the weights for adjusting the weights lengthwise of the slotted arms, substantially



as specified. (2) The combination, with a watch balance provided with longitudinally slotted arms, of weights bored longitudinally, threaded internally and counter-bored, leaving the thread at the outer ends thereof, and screws journalled in the rim and arm of the balance and fitted to the threaded holes in the weights, substantially as specified.

510,404. Device for Adjusting Spindles, *W. A. Chandler, Lowell.—Filed February 13th, 1893.*

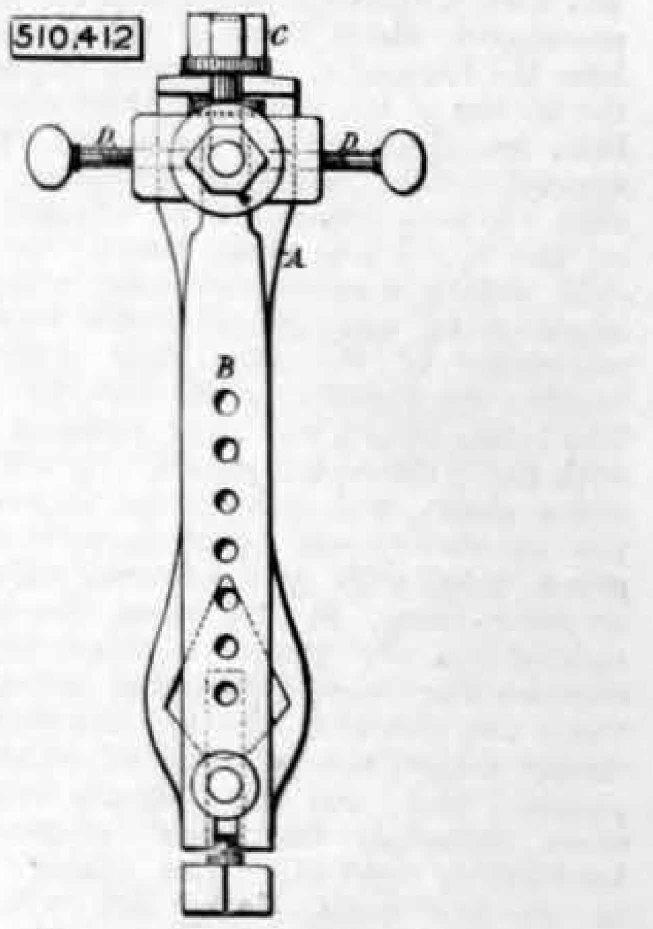
Brief.—To raise or lower the spindle the bolster is raised out of the angular recess at its lower end and



turned in the proper direction to raise or lower the screw-threaded step, the upper end of which is received in the angular aperture at lower end of the bolster.

510,412. Lathe Dog, *E. C. Derby, Portland, Mich.—Filed February 25th, 1893.*

Claim.—In a lathe dog the combination of a clamp A, with aperture, for holding shaft, a centering bar B, secured thereto by set screws in lower end of centering



bar B, and adjustment nut C, with collar working in groove in clamp A, with thumb screws D D for making necessary adjustment, and holding centering bar B in position, substantially as described.