THE ENGINEER.

WAGES IN GREAT BRITAIN.

No. I.

Information or statistics as to wages in this country can only be obtained with the greatest difficulty. Employers and employed, as a rule, exhibit the greatest dislike to furnishing the required particulars, and there does not exist any machinery for collecting the necessary data. The various trades unions possess a quantity of information as to wages in the particular industries they represent, but this is practically inaccessible to those who are not members of the organisation. Occasionally some societies may collect particulars as to certain trades in certain localities, but generally the information can only be obtained by the expensive, slow, and tedious process of personal inquiry. Every third year the Board of Trade issues a volume of miscellaneous statistics, among which are tables of wages in many different industries in various localities. These statistics are valuable, but only from a historical point of view, as they are issued two years after the time of collection, and the successive returns are not always from the same places. The importance of having such information led to the establishment by the Government of a Labour Bureau, for the purpose of collecting, arranging, classifying, and publishing the desired facts. The Bureau has been at work for some months, and its first report will be confined chiefly to an historical account of prices and wages during the last fifty years, compiled from information in the possession of the Board of Trade. The institution of the Labour Bureau is a recognition of a national want, and a step towards meeting it. The result must be a question of time; and a long period may elapse before the new office can give the much-needed collective view of all the elements of the labour question, and furnish an intelligent and useful comparison of the true relationship of labour and wages to effective production. One element of failure in the constitution of the new Labour Bureau is the insufficient sum allowed for its maintenance; another is that of depending for information upon answers received in response to circulars issued to employers and manufacturers. At all times employers object to give information regarding the details of their business. In the case of furnishing information to the Government, these objections will be greater, many employers considering that there is a risk of the knowledge being used for other than the purposes indicated. As instances of these objections may be mentioned the cases of the Commission on Depression of Trade, and of the Pennsylvania Board of Industries. The former issued circulars to the various trades unions in the United Kingdom, and did not receive 10 per cent. of replies; the latter, in answer to circulars relating to over 150,000 men engaged in various trades, received sixty-eight replies. Statistics, to be of any value, must be collected in the various localities, thus involving a great expense for competent agents, travelling expenses, &c. In the absence of indispensable data, a comparison of the conditions relating to labour and wages in different parts of the kingdom becomes nigh impossible. The expense is so great as to deter private individuals from attempting it, and none of the societies whose duty it may be said to be have so far done anything towards supplying the much-needed facts.

There have recently been published three works on the subject, each containing information of the greatest value as to the conditions of capital and labour. These works, are, "The Reports of the Commission on the Depression of Trade," "The First Report of the United States Labour Bureau," and "The Details Received from the Several United States Consuls in the various Countries and Districts thereof," in response to the circulars sent to them with the view of obtaining the fullest available information concerning the condition of labour throughout the world, especially in Europe. "The Report of the Commission on Depression of Trade" contains much valuable information as to labour and wages in this country; but its size, and the absence of all arrangement and classification, prevent its being read except by the few who are either compelled or have the necessary patience to thoroughly examine it. "The First Report of the United States Labour Bureau" is principally historical, and devoted to a description of depressions and panics from 1837 to the present time, both in the United States and the manufacturing nations of Europe. It contains much interesting and valuable matter as to present labour conditions. That part relating to the history and theory of depressions is particularly interesting, and is distinguished by its fair and reasonable tone. The details of the consular reports on labour are contained in three octavo volumes, of over 2400 pages, about 630 of which are devoted to this country. The bulk of this work, the difficulty of obtaining it, and the trouble of turning the rates of wages, prices, &c., into English money, account for its being hardly known beyond a few libraries.

From the above-mentioned works and others, supplemented by personal inquiries in various localities, we lay before our readers some account of the labour conditions, rates of wages, cost of living, &c., for such trades as The Engineer represents. Though not exhaustive—for no journal could afford space for that—they are sufficiently representative, applying to between twenty and thirty districts in England, extending from Falmouth to Newcastle-on-Tyne. In Ireland and Scotland the number of districts is about eight and six respectively. A brief description of the labour conditions of each district is given, followed by a table of wages in general trades. This is succeeded by tables giving more in detail the wages in foundries, ironworks, machine shops, railway works, mines and mining, iron shipbuilding, marine engineering, &c.

At the end of the rates of wages will follow the amount of rent for such houses as the working classes occupy, the price of coal per ton and of gas per 1000 cubic feet, these articles being those in which there is most variation. For details of the social condition of the people the reader is referred to the consular reports, which enter into the subject fully, sometimes over a page being given to the habits and mode of life of a single family. This part of the subject, though written for the information of strangers, contains much of interest to natives, as well as being a description of ourselves as others see us. The reports from the various districts differ widely. Some enter into the subject at great length; others simply give the tables of wages without note or comment. In an investigation of this nature, based upon a circular so elastic as to embrace the peculiarities of each district, it it is but natural that the reports should vary greatly, as they are influenced on the one hand by the amount and form of the information obtainable, and on the other by the prominence given to local industries. One district will lay greater stress on one branch of manufacture, such as Sheffield on cutlery, another on a different one, as Tunstall on pottery. It is impossible to tabulate in the same form the wages in the various engineering industries, the circumstances in the several localities differing so much. A comparison of the wages in each district will, to a certain extent, be found in the tables given at the end of wages in the general trades, more detailed particulars being found under the heads of the particular industries in such districts. Another table gives the cost of provisions, coal, gas, and rent in each district, as the rates of wages alone are not sufficient to compare the advantages or disadvantages of various localities. In some districts examples of the amounts spent by different families in clothing, food, fuel, light and rent, obtained from interviews with working men, are given. These, though highly interesting and valuable, must only be taken as examples, there being much difference in them, it often happening that a family small in number expends more upon the necessaries of life than one in the same neighbourhood much larger.

The rates of wages generally represent the amounts paid for the full time of six days in a week, and must not therefore be used, as they have been, as indications of the prosperity of the country. The British workman prefers to work short time and preserve his daily pay rate, rather than work full time and submit to a reduction; and in considering the labour question this phase of it must be constantly kept in view. Some trades, such as house painters, from their nature can only be pursued at certain seasons of the year, and during the remainder employment must be sought in other callings, and is getting yearly more difficult to obtain. The rates of wages given under the head of each district, divided into lowest, standard, and highest, are the average of their respective classes, based on a number of returns in many cases obtained by personal interviews. Sometimes wages paid by a firm large and powerful enough to fix the rates are given. Much greater differences in wages prevail than is generally supposed. Even among trades unionists, their rates vary considerably according to locality. Payment according to ability, industry, and skill, piece and set work, are in some districts common; shops are divided into society and non-society, or both. Any or all of these systems may be carried out in a shop at the same time to any extent. These different systems complicate the question, and render it difficult to arrive at true results. Instances of this are found in the cases of Wednesbury and Coventry, which are not very remote. The same class of mechanics who in the former town are paid 30s. 4d. a week, in the latter receive from 40s. 6d. to 54s.

With the exception of the Factory and Workshop Acts, regulating the employment of children and women, providing for the fencing of machinery, the employers' liability, and the regulation of mines, the conditions of labour and rates of wages are purely matters of contract, and left to the agreement of employer and employed. In many large industries, such as those connected with coal and iron, there are boards of arbitration composed of masters and workmen, who hear and decide all matters in dispute referred to them. This method of amicably settling differences, and so dispensing with lock-outs and strikes, has for some time worked well, but at present is subjected to a great strain, notice of withdrawal from the agreement in some districts having been given. Trade unions are still powerful, but not to the extent they once were, and in many cases their accumulated funds being nearly exhausted.

The general state of the labouring classes, compared with several years back, is one of improvement. Wages, though reduced during the long continued depression we have experienced, are not below the average of the last twenty years. The hours of labour are shortened, and the price of nearly all the necessaries of life considerably reduced. Temperance is advancing, and the influence of education and sanitation slowly but surely extending; though with regard to the latter the improvement has been almost entirely in the urban districts, the rural being left in the state they were at the commencement of the sanitary movement forty years ago. There are, however, signs that this state of things will not be tolerated much longer, and that country districts, often containing a large population, will be placed in sanitary matters in a position similar to the towns.

A comparison of wages in England, Ireland, and Scotland cannot well be made, through the circumstances of each country being different. In England the industries and localities in which they are carried on are sufficiently diffused and numerous, so that a fair average may be made. In Scotland they are fewer, and confined to a comparatively limited area, while in Ireland the industries are not many, and are carried on in so few large towns at great distances apart, that they have not that interest which attaches to the condition of England and Scotland. Each country is therefore treated separately, but a comparison of the tables of wages in general trades in each district of the several countries given at the end will show the rates of wages in each, as far as the different number of localities affords means for an average.

Here it may be interesting to give the instructions furnished to the United States Consuls for preparing their reports. They show what the volumes of the labour reports contain, and supply a model for future inquiries. The heads of inquiry relate to facts alone, without disclosing any line of argument or theory, the aim being to obtain the most comprehensive information concerning the state of labour throughout the world, and to insure simplicity and uniformity in the treatment of the subject, so as to bring the results within popular comprehension, leaving as little as possible for the statistical analyst to disentangle.

The circular was divided into two parts—male and female labour. The principal heads under which information was required were:—The rates of wages paid to labourers of every class, agricultural, domestic, factory, mechanical, mining, public works, &c. The cost of living to the labouring classes—viz., the prices paid for clothing, rent, the necessaries of life, &c. The habits of the working classes, whether steady and trustworthy, or otherwise, saving or otherwise, and the causes which principally affect their habits for good or evil. The feeling which prevails between employer and employed, and the effects of the feeling in the general and particular prosperity of the community. The organised condition of labour, the nature of organisation, and its effect on the advancement and welfare of the labourers. In this connection it would be well to refer to counter organisations of capital, and on the general or local laws bearing on such organisations. The prevalence of strikes, and how far arbitration enters into the settlements of disagreements between employers and employed, and the manner and nature of such arbitration. The effects of strikes on the advancement or otherwise of labour, and the general effect thereof on the industrial interests affected thereby. Co-operative societies give full information concerning their formation and practical working; whether they are prosperous or otherwise; to what extent they have fulfilled the promises held out at their formation of enabling the workpeople to purchase the necessaries of life at less cost than through the regular channels; whether the establishment of co-operative societies has had any appreciable effect on general trade; the general condition of the working people, how they live, their clothes, their food, their homes; their chances for bettering their condition; their ability to lay up something for old age or sickness;

their moral and physical condition, and the influences by which they are surrounded.

In this connection consuls are requested to select representative workmen and their families, and secure the information direct somewhat after the manner of the following questions:—How old are you? What is your business? Have you a family? What wages do you receive per day? How many hours per day do you work for such wages? How much time are you allowed for your meals? Can you support your family on such wages? What do the united earnings of yourself and wife amount to per year? Will you explain in detail the uses you make of this money? Of what kind of food do your meals consist? Are you able to save any portion of your earnings for days of sickness or old age? What are the means furnished for the safety of employés in factories, mills, mines, railways, &c., and what are the provisions made for the workpeople in cases of accident? Slightly different questions were furnished for female labour. These questions were provided as suggestions, it being expected that the reports would embrace every phase of the question calculated to give a comprehensive view of the conditions of labour. How far these instructions have been complied with the various reports show for themselves.

A NEW VIEW OF THE RESISTANCE OF MATERIALS.

By W. C. UNWIN, F.R.S.

IN a previous paper an account was given of the conclusions which seem to follow from Bauschinger's experiments on the variation of the position of the elastic limits. It is proposed now to give as briefly as possible a few of the results, as a sample of the evidence on which those conclusions rest. It is only, however, by examining Professor Bauschinger's own tables in detail that any adequate idea can be formed of the extent of his researches and the accuracy and patience of his work.

First of all, to show the effect of stretching a bar just beyond its yielding point on the position of the elastic limit. The following table is taken from an earlier paper of Bauschinger's, 1881. It will be seen that if the loading of a bar is repeated, immediately after straining it to the yielding point, the elastic limit is lowered. If a period of rest is allowed, the elastic after-effect comes into play and the elastic limit rises, sometimes above the load previously imposed.

Wrought Iron Subjected to Tension. Tons per Square Inch.

Treatment.	Elastic limit.	Greatest load imposed.	Remarks.
Round bar, 1in. diameter—			
Original condition	9·3	14·5	Yielding.
Immediately after	6·55	18·5	,,
,, ...	6·70	22·0	,,
,, ...	7·10	—	—
Round bar, 1in. diameter—			
Original condition	10·5	14·5	Yielding.
80 hours after	14·7	18·7	,,
68 ,, ...	16·3	21·8	,,
64 ,, ...	20·0	22·8	—

The next table relates also to bars strained by tension only, but it indicates the effect of more varied treatment of the bar. It will be seen, in the case of the first bar, that loading again immediately after stretching to the yielding point, the elastic limit is lowered from 11·6 to 8·05 tons. In the case of the second bar, similarly strained but with a period of rest of 69 hours allowed, the elastic limit is raised from 12 to 20 tons. But on reloading immediately the elastic limit is lowered to 4·05 tons. With a three years' period of rest it is raised to 33 tons, just the load with which it had previously been strained. But this artificially produced elastic limit is so unstable that on hammering the bar on the end and reloading it has fallen to 12·5 tons.

Bauschinger's Experiments on the Change of Position of the Elastic Limit.
Bar Subjected to Tension only. Tons per Square Inch.

Treatment.	Elastic limit.	Yielding stress or breaking-down point.	Greatest stress imposed on bar.
Bar of Bessemer steel, No. 939c—			
1. Original condition	11·6	17·4	22·6
2. One day after	—	24·8	26·8
3. Immediately after (2) ...	8·05	27·0	28·3
4. Immediately after (3) ...	—	28·3	29·6
5. One day after (4) ... ... Broke with 34 tons.	—	32·4	34·0
Bar 939b. Same steel—			
1. Original condition	12·0	18·6	21·3
2. 69 hours after (1)...	20·0	24·0	26·6
3. Half an hour after (2); straightened in the lathe	4·05	25·6	32·3
4. 68 hours after (3)	6·9	33·0	33·0
5. 3 years after (4)...	33·0	33·0	33·0
6. 2 days after, and after being vibrated by hammering on end	12·5	32·0	32·0
7. After 2 years, and after heating to cherry-red and cooling in water ... .. Broke at 35·8 tons.	0	24·6	25·2

The next tables illustrate Bauschinger's attempt to find the natural elastic limits by alternating stresses in tension and compression. It will be seen that after a succession of loads in tension which lower the limit in compression, and of loads in compression which lower the limit in tension, the elastic limit settles down—as the loads are diminished towards an amount not greatly exceeding the elastic limit—to a value not greatly different in tension and compression, and markedly below the initial elastic limit. Further, the limits thus obtained, about 8 tons for wrought iron and $9\frac{1}{2}$ tons for mild steel, differ very little from the stresses which Wohler found to be the greatest which a bar would bear indefinitely when subjected to equal alternating stresses.

Bauschinger's Experiments on Alternating Tension and Compression. Tons per Square Inch.

Time between the loadings.	Elastic limit.		Load imposed.	
	Tension.	Compression.	Tension.	Compression.
Wrought iron bar—				
1. Original condition... ...	—	—	13·7	—
2. 6 days	13·7	—	14·5	—
3. 1 hour	—	4·8	—	14·5
4. 5 minutes	—	9·65	—	14·5
5. 20 hours	—	12·9	—	14·5
6. 1 hour	—	—	14·5	—
7. 46 minutes	—	—	—	14·5
8. $30\frac{1}{2}$ hours	—	—	—	6·45
9. $15\frac{1}{2}$ hours	—	—	6·45	—
10. 2 hours	4·8	—	7·25	—
11. 9 minutes	—	—	7·25	—
12. 27 hours	—	—	—	17·3
13. 30 minutes	—	12·7	—	17·5
14. 3 days	—	—	17·5	—
15. 2 days	—	4·8	—	6·35
16. 2 days	—	—	6·35	—
17. 5 hours	—	7·15	—	7·15
18. Next day...	6·35	—	7·15	—
19. 2 days	—	—	—	7·15
20. $2\frac{1}{2}$ hours	7·15	—	7·95	—
21. $4\frac{1}{2}$ hours	—	7·95	—	8·75
22. 1 day	8·75	—	8·75	—
23. 9 hours	—	7·95	—	9·55
Bessemer steel bar—				
1. Original condition... ...	17·7	—	24·0	—
2. 23 hours	—	3·24	—	24·3
3. 5 hours	1·6	—	24·0	—
4. 4 days	—	4·85	—	8·5
5. 2 days	5·55	—	8·5	—
6. $5\frac{1}{2}$ hours	—	8·85	—	9·7
7. $21\frac{1}{2}$ hours	8·85	—	9·7	—
8. 2 days	—	—	—	9·7
9. 4 hours	10·5	—	11·3	—
10. $2\frac{1}{4}$ hours	—	9·65	—	11·3
11. 16 hours	9·65	—	11·3	—
12. 23 hours	—	9·65	—	11·3

The Table A contains a summary of all Bauschinger's experiments on the endurance of a bar subject to repeated stresses. He constructed a machine of the same kind as Wöhler's, in which a bar could be subjected to stresses ranging from 0 to an upper fixed limit in tension. He ascertained both the initial elastic limit and the elastic limit acquired under repetition of stress; the initial breaking strength and the strength after the bar had been broken in the Wöhler machine. It will be seen that the elastic limit rises with repetition of stress to a point which is in many cases a little above the load applied. When that is the case the bar suffers a large number of repetitions of load before fracture. If the elastic limit—observed in about a 5in. length of bar—is very near or below the load applied, the bar breaks with comparatively few repetitions of load.

Now it has been shown that a parabola, known as Gerber's parabola, can be drawn, so as to fit Wöhler's results extremely well. Let the lower stress limit on a bar be denoted, p, and let s be the range of strees to which it subjectedley and f its statical breaking strength. Then Gerber's equation is

$$(p + \tfrac{1}{2} s)^2 + k s = f^2.$$

Bauschinger's results enable us to determine the constants in this equation, and Bauschinger has in fact determined the constants for each of the materials on which he experimented. Using these constants, we can determine the range of stress a bar will bear indefinitely repeated for other conditions of loading. The Table B below has been thus computed and it agrees singularly well with the corresponding results obtained by Wöhler. It is extremely valuable, because Wöhler only determined values of the limiting stresses for three materials, two of them steels of rather high tenacity. Bauschinger's results extend Wöhler's to materials in more common use.

For comparison the corresponding results deduced from Wöhler's experiments are appended in the following table It will be understood that these stresses are the stresses which would ultimately break a bar, with a sufficiently large number of repetitions of loading, apart from any

TABLE A.—*Bauschinger's Endurance Tests. Stresses in Tension varying from 0 to an upper limit.*

Material.	Elastic limit in tons per square inch.		Endurance test.		Tensile strength in tons per square inch.		Remarks.
	Original.	Acquired during repetition of loads.	Load applied.	No. of repetitions before fracture in millions.	Original.	After breaking by repetition of loads.	
Wrought iron plate.	6·84	12·3	7·1	5·17	25·2	23·6	
	6·84	13·2	9·85	5·19	25·2	24·3	
	6·84	14·4	13·1	5·18	25·2	24·5	
	6·84	16·4	16·4	2·28	25·2	—	
Mild steel plate.	15·6	19·4	16·0	6·68	28·5	—	
	15·6	18·0	16·0	3·55	28·5	—	
	15·6	20·0	16·0	11·03	28·5	—	Not yet broken in endurance test.
	15·6	16·4	16·0	7·35	28·5	—	
	15·6	—	19·7	0·67	28·5	—	
	15·6	19·1	19·7	1·01	28·5	—	
	15·6	19·0	23·0	0·32	28·5	—	
	15·6	19·0	23·0	0·76	28·5	—	
	15·6	19·9	23·0	0·16	28·5	—	
	15·6	16·4	23·0	0·44	28·5	—	
	15·6	15·3	23·0	0·62	28·5	—	
	15·6	20·0	26·2	0·34	28·5	—	
	15·6	16·9	26·2	0·49	28·5	—	
	15·6	17·9	26·2	0·07	28·5	—	
	15·6	12·3	26·2	0·11	28·5	—	
	15·6	11·5	26·2	0·04	28·5	—	
Bar iron.	11·8	21·4	13·2	9·11	26·6	28·2	
	11·8	10·7	16·4	7·40	26·6	—	Elastic limit rose to 16·7, and then fell near the end of the endurance test.
	11·8	10·8	19·7	0·64	26·6	—	
	11·8	10·6	19·7	0·24	26·6	—	
	11·8	10·9	19·7	0·84	26·6	—	
	14·8	16·3	13·8	16·48	26·7	27·1	
	14·8	18·6	17·2	9·31	26·7	26·6	
	14·8	11·9	19·7	0·67	26·7	—	
Thomas steel axle.	17·6	20·4	16·3	9·58	40·1	—	Not yet broken.
	17·6	—	26·2	0·62	40·1	—	
	17·6	20·8	19·7	9·04	40·1	41·0	
	17·6	—	26·2	0·22	40·1	—	
	17·6	—	26·2	0·06	40·1	—	
Thomas steel rail.	19·0	24·0	16·4	10·19	39·0	39·4	
	19·0	17·6	19·7	7·91	39·0	37·7	
	19·0	—	26·2	0·57	39·0	—	
	19·0	—	26·2	0·56	39·0	—	
Mild steel boiler plate.	17·6	18·0	18·4	4·85	26·6	—	
	17·6	—	21·0	0·40	26·6	—	
	17·6	—	21·0	0·49	26·6	—	
	17·6	—	21·0	0·88	26·6	—	
	17·6	18·4	16·4	6·34	26·6	—	
	17·6	—	18·7	0·40	26·6	—	
	17·6	18·0	16·4	6·54	26·6	—	Not yet broken.
	17·6	16·0	18·7	4·87	26·6	—	Not yet broken.

TABLE B.—*Bauschinger's Endurance Tests. Tons per Square Inch. Stresses requiring 5 to 10 million Repetitions to cause Fracture.*

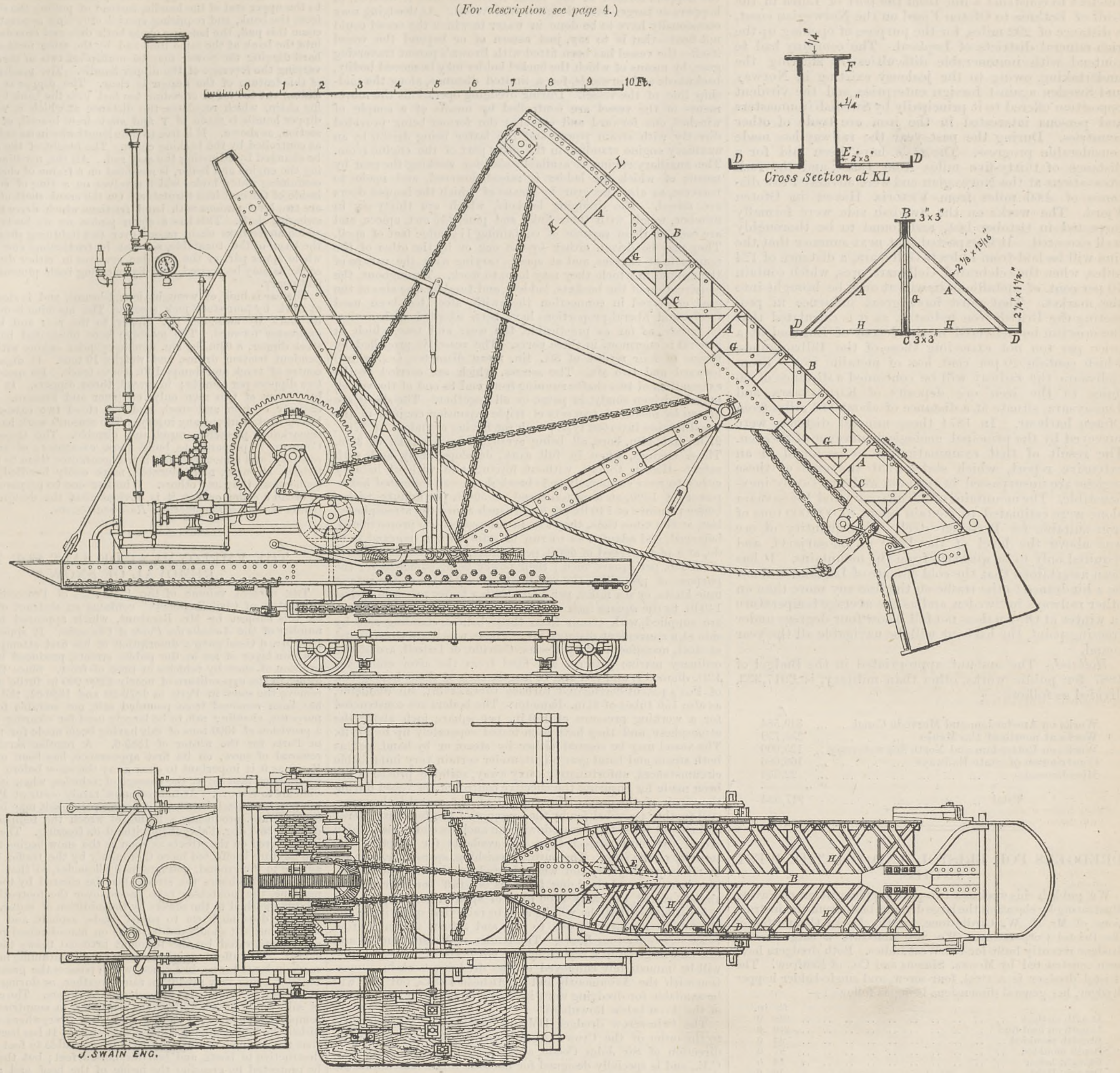
Material.	Opposite stresses.		One stress zero.		Similar stresses.		Range zero. Ultimate statical strength.
	Least.	Greatest.	Least.	Greatest.	Least.	Greatest.	
Wrought iron plate	− 7·15	+ 7·15	0	13·10	11·4	19·2	22·8
Bar iron	− 7·85	+ 7·85	0	14·4	13·3	22·02	26·6
Bar iron	− 8·65	+ 8·65	0	15·75	13·2	21·92	26·4
Bessemer mild steel plate...	− 8·55	+ 8·55	0	15·70	14·3	23·8	28·6
Steel axle	−10·5	+10·5	0	19·70	20·0	32·1	40·0
Steel rail	− 9·7	+ 9·7	0	18·4	19·5	30·85	39·0
Mild steel boiler plate	− 8·65	+ 8·65	0	15·8	13·3	22·55	26·6

TABLE C.—*Limits of Stress from Wöhler's Endurance Tests. Stresses in Tons per Square Inch for which Fracture occurs only after an Indefinitely Large Number of Repetitions.*

Material.	Opposite stresses.		One stress zero.		Similar stresses.		Range zero. Ultimate statical strength.
	Least stress.	Greatest stress.	Least stress.	Greatest stress.	Least stress.	Greatest stress.	
Wrought iron	− 8·6	+ 8·6	0	15·25	12	20·5	22·8
Krupp's axle steel	−14·05	+14·05	0	26·5	17·5	37·75	52·0
Untempered spring steel	−13·38	+13·38	0	25·5	12·5	34·75	57·5

THE OSGOOD EXCAVATOR.

(*For description see page 4.*)



factor of safety. Wöhler proposed that the working stresses should be taken at half these values, and most German writers have proposed to take the working stresses at a little less than a third of these values, Table C.

ABSTRACTS OF CONSULAR AND DIPLOMATIC REPORTS.

WE have made arrangements for the publication of special abstracts of consular and diplomatic reports, which will, we have no doubt, be found to contain much trade information of interest to many of our readers.

Italy.—The Italian trade returns for the year 1885 again show a great excess of imports over exports; but they exhibit an increase of 10 per cent. on the amount and value of commercial operations. The increase of imports in 1885 was £9,250,000; of exports, £1,513,000; while goods in transit showed a decrease of £500,000, or a total increase of more than £10,000,000 over 1884. Great Britain now ranks second in importance of trade, instead of third as in 1884. In heavy imports from Great Britain, such as brass, bronze, and copper manufactures, coal, colonial products, iron—manufactured, pig, and scrap—machinery, tin, zinc, &c., which come by sea, British trade is healthy and prosperous. The commercial operations between Great Britain and Italy for 1885 were—

	£
Imports from Great Britain	12,563,000
Exports to Great Britain	2,950,000
Total	15,513,000
Excess of imports over exports	9,613,000

In imports Great Britain sends 20 per cent., and, including India, over 24 per cent., of the total quantity. In 1884 British and Indian imports were 30 per cent. of the whole, but that whole was in value £10,000,000 less than in 1885. The total value of trade operations between Great Britain and Italy for the four years 1882-5 has remained steady, the amounts for 1882 and 1885 being the same—£15,500,000. During this period the imports into Italy have increased by £700,000, and the exports from Italy decreased by a similar amount. In lead, tin, and zinc manufactures Great Britain is first; also in steam engines, fixed, locomotive, and unenumerated, Belgium, France, Germany, and Switzerland being competitors. Thus in machinery unenumerated and parts of machinery imports from Great Britain are 9400 tons; from Belgium, 3500 tons; France, 3200 tons; Germany, 6800 tons; Switzerland, 3600 tons. Among the chief imports into Italy from Great Britain in 1885 are—

	Tons.
Agricultural implements ... ... France, 26,000; Holland, 6000.	66,000
Coal, 92·5 per cent. of whole coal imported ...	2,716,500
Brass, bronze, and copper, in pigs ... ... France, 5000.	18,600
Iron, pig ... ... Austria, 1300; Belgium, 1300; Germany, 1400.	46,470
Iron, rails ... ... Belgium, 31,000; Germany and Switzerland, 9000; Holland, 18,000.	37,400
Iron, rods (thick) ... ... Germany, 25,720.	20,550
Iron, scrap ... ... France, 5310; Switzerland, 4720.	52,300
Iron, worked ... ... France, 1760; Germany, 1070.	3,980
Scythes ... ... Austria, 127.	60
Ships and boats ... ... Austria, 3,500,000.	5,000,000

The importation into Italy of Austrian iron has decreased from 5800 tons in 1883 to 3900 tons in 1885. During the same period the imports of tin decreased from 900 to 760 tons. On the other hand, the following imports have risen:—Knives, manufactured iron and steel, to five tons; locomotives, from 69 tons to 464 tons; implements, machinery, &c., to 800 tons. Also in 1885 there were imported: Copper manufactures, 276 tons; copper ore, 271 tons; lead, 627 tons; railway carriages, 84 tons; steam boilers, 335 tons; tin, 66 tons; zinc, 139 tons. German imports have increased 80 per cent. since 1881, and in 1885 were in value £4,816,000. This increase is attributed to revised railway tariffs and the opening of the St. Gothard Railway. From Switzerland the imports of metals and minerals have steadily advanced from £160,000 in 1881 to £998,000 in 1885. Since 1881 imports from Belgium have increased over 100 per cent., owing chiefly to improved land transport facilities; the value of iron bars, implements, and rails from that country being in 1885 £647,000. The volume and value of trade between Italy and France are, and have been for years, greater than the trade with any other country, being nearly one-third of the whole commercial operations of Italy. In 1885 the value of metals, including agricultural implements, brass, bronze, and copper machinery and manufactures, wrought iron and steel imported from France was £4,400,000. The past three or four years has been for Italy a period of depression, likewise of transition. Owing to the large importation of foreign grain and flour, the cultivation of cereals is being abandoned and more vineyards planted. Capital is being withdrawn from agriculture to be invested in industrial undertakings, which in Northern Italy begin to show good results, and promise before long to supply manufactured textile articles for home consumption. These factories have the advantage over Great Britain of cheap labour, longer hours of work, water-power, cheap and good machinery from Germany and Switzerland, and being protected by custom duties. [Against these must be set the dislike exhibited by the Italian population to factory employment. Companies are being formed for the working of Italian mines.] The great Terni Works are producing armour-plates and steel rails; they are also about to make pig iron and steel manufactures from native ores, of which the supply is ample. Government orders for marine engines have been given to native firms, or more correctly, to British firms established in Italy. Altogether a great effort is being made to make Italy independent of foreign industry, and the excess of imports over exports is much deplored by the Italian press.

Sweden.—The Lulea Ofoten Railway and the iron mines of Lapland.—The concession for the construction of this railway was granted by the Norwegian and Swedish Governments in 1882, and in the following year a British company was formed for its construction under the name of the Swedish and Norwegian Railway Company. This body entered into a contract with a firm of railway contractors to construct a line from the port of Lulea in the Gulf of Bothnia to Ofoten Fjord on the Norwegian coast, a distance of 292 miles, for the purpose of opening up the rich mineral districts of Lapland. The company had to contend with innumerable difficulties in starting the undertaking, owing to the jealousy existing in Norway and Sweden against foreign enterprise, and the virulent opposition offered to it principally by Swedish ironmasters and persons interested in the iron ore trade of other countries. During the past year the railway has made considerable progress. The rails have been laid for a distance of thirty-five miles from Lulea, and the rock excavations at the Norwegian end were advanced to a distance of 4·66 miles from Victoria Haven in Ofoten Fjord. The works on the Swedish side were formally inspected in October last, and found to be thoroughly well executed. It is expected that next summer that the line will be laid from Lulea to Gellvaara, a distance of 124 miles, when the celebrated Gellvaara ores, which contain 70 per cent. of metallic iron, will at once be brought into the market. That must have great influence in promoting the British iron industry, as it is calculated that the ores can be delivered in the North of England at a price per ton not exceeding those of the Bilbao mines, which contain 20 per cent. less of metallic iron. From Gellvaara the railway will be continued a distance of 56 miles to the iron ore deposits of Kirunavaara and Luosavaara, situate at a distance of about 112 miles from Ofoten harbour. In 1874 these mineral districts were surveyed by the principal geological surveyor of Sweden. The result of that examination is to be found in an extensive report, which states that the ores of these regions are unsurpassed in richness, and practically inexhaustible. The mountains of Kirunavaara and Luosavaara alone were estimated to contain about 84,000,000 tons of iron suitable for Bessemer steel. This quantity of ore was above the level of the Lake of Luosarjarvi, and required only to be quarried from the mountains. It has been ascertained that the cold climate of Lapland will not be a hindrance to the traffic on the line any more than on other railways in Sweden, and as the average temperature in winter at Ofoten does not fall below four degrees under freezing point, the harbour will be navigable all the year round.

Holland.—The amount appropriated in the Budget of 1887 for public works, other than military, is £917,333, divided as follows:—

	£
Works on Amsterdam and Mervede Canal... ...	349,584
Works at mouth of the Meuse	253,750
Works on Rotterdam and North Sea waterway...	125,000
Construction of State Railways	166,666
Miscellaneous	22,333
Total	917,333

DREDGERS FOR BRISTOL AND FOR THE WEST INDIES.

WE publish this week as a two-page supplement, an engraving illustrating by elevation the large dredger built from the instructions of Mr. J. W. Girdlestone, for the Docks Committee of the Bristol Corporation. We also illustrate a barge-loading dredger recently built for the West Indies. Both dredgers have been constructed by Messrs. Simons and Co., of Renfrew. The Bristol dredger is a steel, four-screw, and single-ladder hopper dredger, her general dimensions being as follows:—

	ft.	in.
Length on deck	218	0
Length on load line	210	0
Breadth moulded	43	0
Depth moulded	17	0
Draught laden	14	6
Draught light	10	6
Freeboard	2	6

The vessel is in all respects adapted for the reception of the dredging machinery, engines, and boilers, and is, laden or light, of sufficient strength for the support of the same and of itself in perfect safety, and without undue strain on any part of the whole, whether at sea in rough weather, or at dredging work, or aground on hard shingle. She has been built on the ordinary frame system, but with exceedingly strong keelsons, stringers, &c., and has been constructed throughout of "Hallside" steel, brands "S. B. x x" and "S. B. x," and of scantlings at least equal throughout to the requirements of Lloyd's highest class for iron-built ships; no reduction of scantling having in any part been allowed on account of the employment of steel in place of iron. Various additions in excess of what would be required in an iron vessel of similar magnitude were suggested by Lloyd's, and were for the most part adopted. The adoption of the four-screw system of propulsion necessitated the construction of shafting tunnels in way of the hoppers, and these have been constructed so as to add materially to the strength of the vessel. The ladder well, which is situated in the after part of the vessel, also adds much to the strength of the same. The bottom of the vessel has been protected from injury when grounding by means of four outside bilge keels; and, with a view to protect the vessel from injury on coming into contact either with wharf walls or with another vessel, she has, at a suitable distance above the water line, been surrounded by a steel-faced fender of American rock elm. There are four complete bulkheads extending from side to side of the vessel, besides others extending across the wings running at either side of the ladder well. Taken as a whole, then, the vessel is exceptionally strong, and is capable, as has been stated, of grounding in safety on almost any practicable bottom. The dredging spoil is carried in three hoppers, one of which, termed the "main" hopper, is situated immediately ahead of the well, and extends from side to side of the vessel; the other two, termed the "side" hoppers, being situated immediately astern of the main hopper, one being at either side of the well. The hopper capacity is 25,000 cubic feet, which, with spoil of 1·44 specific gravity—that is to say, with Avon mud—is equivalent to 1000 tons. The dredging machinery is adapted in all respects for dredging readily, per hour, at least 400 tons of stiff clay, mud, silt, free sand, or gravel; also for dredging readily in shingle or other hard ground. It is adapted also for dredging from a depth of 36ft. below the surface of the water, when the vessel is light and the ladder is set at an angle below the horizon of 45 deg., and for dredging in water in which the vessel will but just float, as also for dredging at any intermediate depth; and it is capable of depositing the spoil when raised, not only in the hoppers formed in the vessel itself, but also, if desired, in hoppers or barges laid alongside the vessel. As dredging may occasionally have to be done in water in which the vessel could not float—that is to say, just astern of or beyond the vessel itself—the vessel has been fitted with Brown's patent traversing gear, by means of which the bucket ladder may be moved bodily, backwards and forwards, for a limited distance, along the midship line of the vessel. During dredging operations the movements of the vessel are controlled by means of a couple of winches, one forward and one aft; the former being provided directly with steam power, and the latter being driven by an auxiliary engine standing in the after part of the engine room. The auxiliary engine is available also for working the gear by means of which the ladder is raised, lowered, and made to traverse, as also the gear by means of which the hopper doors are raised. The dredging buckets, which are thirty-six in number, weigh, with their links and pins, 23¾ cwt. apiece, and are each of them capable of containing 17½ cubic feet of spoil. They may be driven either by the one or by the other of the main sets of engines, and at speeds varying with the nature of the ground in which they may have to work. Throughout, the construction of the buckets, ladders, and tumblers, as also of the gear employed in connection therewith, steel has been used freely, and liberal proportions have been adopted with a view to reduce, as far as practicable, the wear and tear, which in general is enormous in these parts. The vessel is propelled by means of four screws of 8ft. 4in. mean diameter, *i.e.*, by two forward and two aft. The screws, which are carried at the extremities of two shafts running from end to end of the vessel, may be driven singly, in pairs, or all together. The shafts are driven by means of two sets of triple expansion engines of the usual marine inverted type; each set having cylinders of 17in., 27in., and 43in. bore, all being arranged for a stroke of 30in. These engines, when in full work, develope easily and with safety—that is to say, without forcing, and without liability either to wear excessively or to break down—an indicated horse-power of 1300, at a piston speed of 500ft. per minute, with a boiler pressure of 140 lb. per square inch above the atmosphere; but, at the same time, they are in all respects so proportioned, balanced, and adapted as to run in safety, when required so to do, at a piston speed of 600ft. per minute, with a boiler pressure of 150 lb. per square inch; their power being sufficient for the purpose of propelling the vessel when fully laden at the rate of nine knots, or sea miles, per hour, with a boiler pressure of but 140 lb. to the square inch above the atmosphere. The engines are supplied with steam from three boilers, standing side by side at a convenient distance aft. These, which are constructed of steel, manufactured by Messrs. Colville, of Dalzell, are of the ordinary marine pattern, are fired from the after ends, are 12ft. diameter, and 9ft. 6in. in length, each of them having two of Fox's patent corrugated furnace tubes of 3ft. 4in. diameter, as also 156 tubes of 3¼in. diameter. The boilers are constructed for a working pressure of 150 lb. per square inch above the atmosphere, and they have been tested separately up to 300 lb. The vessel may be steered either by steam or by hand, yet, as both steam and hand gear might, under certain very improbable circumstances, unfortunately carry away, suitable provision has been made for ensuring the effective control of the vessel during the repair of the gear. The control of the vessel is, however, still further provided for by the presence of the four propellers; and should these last break down, the anchors and cables, which are of the most perfect type, are available for effecting the security of the ship. The outfit, furnishing, spare gear, &c., are in all respects good, and well adapted to the intended ends. She is capable of dredging 500 tons of stuff per hour, and, as already stated, can carry 1000 tons of spoil in her hoppers, and it is estimated that she will be able to raise that quantity in the Bristol Docks, carry it out to sea, and return to her station twice in twenty-four hours. The tender of Messrs. Simons and Co. was, as given in a report by Mr. Girdlestone, £29,050. She will be immediately employed in the dredging work in connection with the Avonmouth and Portishead Docks, but she will be available for dredging work in the harbour and in the fairway of the Avon below Rownham.

The twin-screw dredger Dolphin was recently constructed to the order of the Crown Agents for the Colonies, under the direction of Sir John Coode, assisted by Mr. Wm. Matthews, C.E., and is specially designed for harbour improvements in the West Indies. The dimensions are:—

		Ft.	in.
Length between perpendiculars		130	0
Breadth moulded		30	0
Depth		8	0
ENGINES—Compound surface condensing, I.H.P.	250		
Stroke of pumps		0	14
Diameter of high-pressure cylinder		0	16½
„ low-pressure „		0	33
Length of stroke		0	24
Diameter of air pump		0	11½
„ circulating pump		0	6½
„ feed pumps		0	2½
„ bilge pumps		0	2½

The boiler is of steel, for a working pressure of 90 lb. per square inch. The bucket ladder works through a well formed in the centre of the vessel, and dredges to a depth of 33ft. below the water level, and the buckets are made wholly of steel, and are capable of lifting 250 tons of free soil per hour. Triple-geared winches are supplied at bow and stern for working the mooring chains, the barrels of which can be worked independently or conjointly, as required. The cabins for the officers and crew are of the most complete description; those of the former being fitted on starboard side of well, and consist of rooms for the captain, mate and engineers, also mess-room. All the rooms are large and efficiently lighted and ventilated. A powerful crane is erected at forward end for overhauling the buckets, hoisting gear, &c.

NEW EXCAVATOR, OSGOOD DREDGE COMPANY.

THE engraving on page 3 shows an excavator of an entirely new design in some of its details, recently patented and built by Mr. John K. Howe, secretary and treasurer of the Osgood Dredge Company, of Albany, N.Y. It has been tested by a season of extremely hard work, digging clay in the brickyard of Mr. Hamilton, at Croton, and, we are told, proved itself remarkably efficient and successful.

Its novel points of advantage are claimed to be: (1) A more efficient application of power, enabling the work to be done with a smaller engine. (2) Simpler construction, giving fewer wearing parts. (3) Greater adaptability, as it digs and dumps at any point in a complete circle. (4) Ease and economy of handling, as all the movements are made by one man only. (5) Cheapness, as owing to its lightness and simplicity of construction it can be built for half to two-thirds of the cost of an ordinary steam shovel of equal capacity.

By using the dipper handle as a lever—of course increasing its strength to stand the breaking strain—the heavy and expensive crane is avoided, and the power is applied almost exactly in the direction in which it does the most effective work, *i.e.*, parallel to the cutting face of the dipper, and by fastening the hoisting drum to the upper end of the handle, instead of pulling the dipper away from the bank, and requiring special crowding apparatus to overcome this pull, the hoisting chain both digs and crowds the dipper into the bank at the same time and by the same motion; while in hard digging the power may be multiplied two or three times by varying the leverage of the dipper handle. The mechanical merit of this feature of the design is clear. The dipper is kept from sliding out too far or crowding too fast into the bank by the backing chain, which regulates the distance at which it works. The dipper handle is made of T and angle iron, braced, of triangular section, as shown. It is free to slide lengthwise in its saddle, except as controlled by the backing chain. The height of the saddle may be changed by adjusting the stay rod. All the machinery, including the engine and boiler, is mounted on a frame of channel iron—containing water tank—which revolves on a ring of coned rollers inside of the cast iron turntable. On the crank shaft of the engine are two level pinions with band frictions which drive the upright swinging shaft. This has a chain pinion on its lower end, from which an endless chain passes over two lightning sheaves around the base of the turntable, so that by frictioning one pinion the whole upper part of the machine revolves in either direction and as far as may be desired, and by releasing both pinions it remains stationary.

The car is built of wrought iron I-beams, and is steadied while at work by four steel jack screws. The machine is moved up to its work by swinging the dipper to the rear and kicking the excavator forward. The machine here illustrated has a ¾-yard steel dipper, a 6½in. by 8in. double-cylinder engine with two independent friction drums, and weighs 10 tons. It digs 15ft. from centre of track and dumps 10ft. above track. Its speed in clay is two dippers per minute; in gravel, three dippers. It is handled by a crew of two men only, engineer and fireman. It is built entirely of iron and steel, and has stood two cave-downs of a heavy bank without any injury. The season's work has proved it remarkably powerful, rapid and durable. The Osgood Dredge Company is prepared to build these excavators of any size and capacity, and announces that it will guarantee them to be cheaper, lighter, stronger, more durable, more easily handled, and more economical than any others. Whether one be prepared to accept so broad a claim or not, it is obvious that the design has many points of conspicuous merit.—*Railroad Gazette.*

THE EMPLOYMENT OF SALT FOR THE REMOVAL OF SNOW.

THE current volume of the "Minutes of Proceedings of the Institution of Civil Engineers" contains an abstract of a memoir on this subject by Mr. Barabant, which appeared in a recent number of the *Annales des Ponts et Chaussées.* It appears that in 1880 Mr. d'Ussel gave a description of his first attempts to thaw the thin layer of ice in the public streets, produced by the compression of snow by vehicles in time of frost. Since that period, owing to the expenditure of nearly £200,000 in futile attempts to remove the snow in Paris in 1879-80 and 1880-81, the heavy tax has been removed from pounded salt, not suitable for ordinary purposes, enabling salt to be largely used for clearing away snow, a provision of 4000 tons of salt having been made for this purpose in Paris for the winter of 1885-6. A regular service for the removal of snow, on its first appearance, has been organised in Paris, as it is important to clear away the snow before it has been compressed into ice by the passage of vehicles, when it is far more difficult to remove. As falls of snow rarely occur at Paris with a temperature much below the freezing-point, salt may be sprinkled on the snow, producing a liquid, of which the temperature may descend to 5 deg. Fahrenheit without its freezing. The salt should be scattered on the streets as soon as the snow begins to fall fast; the mixture is effected more thoroughly by the traffic, it does not adhere to the ground, and gradually liquefies, so that at the end of four or five hours the streets may be cleared by the sweeping-machine, the caoutchouc rake passed over the footpaths, and the mixture washed to the sewers by the addition of water. This cold mixture does no harm to paved roads, asphalt, and wood pavements; but salt should not be used on macadamised roads, which are disintegrated by the frequent artificial thaws thereby occasioned. This affords another reason for discontinuing macadamised roads in large towns, in France, which possess the great disadvantages of being very muddy in rainy weather, or during thaws, and of discharging quantities of sand into the sewers. The employment of salt would probably be very restricted in countries where the temperature often falls below 5 deg.; but everywhere else it furnishes the best means of dealing with snow. It has been suggested that the coldness of the mixture is disagreeable to foot passengers, destructive to boots, and bad for horses' feet; but the latter can be protected by greasing the inside of the hoof, and as the mixture should be removed directly it becomes liquid, the inconvenience, both to men and animals, is very short in duration, and very slight compared with the advantages and economy of the system. The salt should be scattered in the proportion of about 1 dram per square foot for each four-tenths of an inch of thickness of snow fallen, or a larger amount if the temperature is low. Formerly each centimetre—0·4in.—depth of snow falling in Paris necessitated an expenditure of over £2400; whereas now the cost is only about £800, or a saving of two-thirds. Moreover the use of salt dispenses with sanding the streets, which, on the arrival of a thaw, produced quantities of mud in the streets, and deposit in the sewers. Further, if the cessation of interruptions of traffic by means of this process is taken into account, the indirect gain to the people of Paris must be reckoned by millions of francs. Several machines have been devised for the removal of snow, but none of them are as cheap as salt; and the author gives a comparative estimate of the cost of melting snow by steam, and by salt, which shows that the method of steam would be much more expensive, besides entailing other disadvantages. The use of salt will probably not be confined to the clearing of streets in towns, but be extended to all paved roads, to tramways, and to the approaches to railway stations, and all large manufactories. Perhaps, even in France at any rate, salt might be used for dealing with snowdrifts in railway cuttings, by spreading it in sufficient quantities and sweeping thin layers successively salted. On all paved roads over which there is considerable traffic, the use of only half the proportion of salt adopted in Paris would enable a track of 6½ft. to 10ft. in width to be dealt with, along which the snow would be prevented from being frozen to the ground, and thus rendering traffic almost impracticable. The small cost of the system, and the advantages to traffic, are sufficient reasons for an early and wide extension of the use of salt for removing snow.

TORPEDO VESSELS OF EUROPE.—The following data show the relative strength of European States in torpedo vessels and boats of all classes and dimensions:—

	Torpedoes.		Tons.	Cost. £.
Great Britain	156,	representing	23,902	1,460,000
France	143,	„	20,450	1,253,000
Germany	150,	„	14,597	900,000
Russia	115,	„	5,104	312,000
Italy	89,	„	7,966	500,000

It appears by the above figures that the average cost per ton—£61—of British and French torpedo boats is the same. The principal difference between Great Britain and France consists in the superiority of the former in torpedo vessels of 38 to 40 metres in length, France possessing boats of only 25 to 30 metres. This inferiority is the more disadvantageous because, as the *St. James's Gazette* points out, twenty-five vessels of the latter class have been added to the French navy since February last.

RAILWAY MATTERS.

THE success of the Pullman cars on the Brighton line has been such that the directors have entered into a contract with the Pullman Company for a further term of ten years.

THE death is announced at Inverkeithing last week of Mr. William Peat, who was nearly thirty years manager on the northern section of the North British Railway, but from which he retired a few years ago.

THE Brazil Great Southern Railway, having obtained satisfactory results in Brazil with two wagons fitted with the "Janny" coupling, has requested, through Mr. A. Rumball, the Lancaster Wagon Company to supply this coupling to all the stock now being manufactured by that firm for the company.

THE Philadelphia correspondent of the *Times* telegraphs:—The Canadian Pacific Railway has been notified that the twelve 80-ton guns, now constructing at Woolwich Arsenal for the defence of Victoria, British Columbia, will be ready for shipment over that railway in April, with large consignments of war material. Special cars have been ordered to be built to carry the heavy guns.

ALL the railway companies have lost heavily by the destruction of telegraph wires and posts, and other carriers. If the posts were placed half the present distance apart it would cost the companies a good deal for posts, but not so much as would be gained by preventing one repetition of the recent destruction. Every alternate post might be merely a carrier, and not necessarily provided with all the usual paraphernalia.

THE Committee formed in Birmingham to resist the passage of the nine railway bills of 1885, and the Brimingham and District Railway and Canal Rates Associations, have amalgamated into one association to be called, "The Birmingham and District Railway and Canal Freighters' Association." For the organisation of the new body a provisional committee, of which Mr. F. Impey is secretary, has been formed.

THE net receipts on the Railways in India for 1885-86 show an increase as compared with those of 1884 of 1,19,66,430r., and the percentage on the capital expenditure, excluding, as is usually done, that on steamboat services, suspense items, and indirect charges, gives a return equivalent to 5·84 per cent., against 5·27 per cent. in the previous year. The summary of merchandise carried on the several Indian railways supports the favourable view of the general traffic taken in last year's report. The total tonnage has increased by 1,887,378 tons, or nearly 15 per cent.; and thirty-nine out of the forty-seven items tabulated show increases, the most marked being that of "grains and pulses," with a rise of 1,159,386 tons.

THE cost of materials used in the repair and renewal of permanent way works and rolling stock it is calculated represent about one-fifth of the entire working expenditures of British railways. More than anything else the economy practised, and the low level of prices of iron, &c., have enabled the companies, by reduction of working expenses last half-year, to counteract diminished earnings, and so pay better dividends than they could otherwise have distributed. In the first half year of 1884 the principal English and Scotch railways spent £2,436,000 on material; in the second half, £2,638,000. The first half of 1885, £2,330,000; the second half of 1885, £2,600,000; and in the first half of this year £2,220,000.

ACCORDING to Mr. Grierson, the manager of the Great Western Railway, it appears that in this country one mile of railway has been provided for every 4·36 square miles, as compared with 10·42 in France, 9·38 in Germany, 7·82 in Holland, 4·2 in Belgium; while for every 1000 of the population the outlay of railway capital, which yields on an average only 4¼ per cent., has been £24,512 in England and Wales; £13,977, in France; £10,593 in Germany; £11,365 in Belgium; and £7252 in Holland. Moreover, wages are much higher at home than abroad. The average per head is in England, £62·10; France, £47·12; Belgium, £41·2; Holland, £34·3. Mr. Grierson supports the proposition of the late Prof. Jevons, "Taking all circumstances into account, England and Wales are better supplied by railways than any other country in the world."

IT is stated that the Union Pacific Railroad Company has completed arrangements to establish a weather service over its entire system similar to that in use by the Federal Government. There are to be thirty-two stations; nine will be first-class stations, equipped with a full set of observing instruments. There will be nine second-class stations. Two observations will be made each day—at 4 a.m. and 4 p.m.—and reported to headquarters at Omaha. Trains will be equipped and operated according to the weather reports. The officer to be put in charge of this system is Lieut. Joseph S. Powell, of the Government Signal Service. His salary is to be paid by the Government. All other expenses will be borne by the railroad company. The Chicago and Northwestern and the Central Pacific have been invited to co-operate with the Union Pacific, so as to make a through railway weather service between San Francisco and Chicago.

THE *Railroad Gazette* record of American train accidents in October contains notes of 63 collisions, 51 derailments, and 4 other accidents—a total of 118 accidents, by which 48 persons were killed and 100 injured. As compared with October, 1885, there was a decrease of 5 accidents, an increase of 17 killed, and a decrease of 28 persons injured. These accidents may be classed as to their nature and causes as follows:—Collisions: Rear, 50; butting, 12; crossing, 1—total, 63. Derailments: Broken rail, 1; broken or defective frog, 1; broken switch-rod, 1; broken bridge, 2; spreading of rails, 10; broken wheel, 3; broken axle, 5; broken truck, 2; accidental obstruction, 4; cattle on track, 3; land-slide, 1; wash-out, 1; misplaced switch, 6; malicious obstruction, 3; unexplained, 8—total, 51. Other accidents: Cylinder explosion, 1; steam chest burst, 1; broken parallel rod, 1; broken axle not causing derailment, 1—total, 4. Total number of accidents, 118. Ten collisions were caused by trains breaking in two, six by fog, five by failure to use signals properly, four by mistakes in orders or failure to obey them, four by misplaced switches, two by cars blown out of sidings upon the main track, and two by wrecks of other trains.

"A LARGE order for steel rails for a Spanish railway was," says the *Leeds Mercury*, "recently withheld from an English maker, who had tendered, and whose rails had given satisfaction previously. His price was abnormally low; but a very much lower tender was sent in by a German maker. The responsible official, sceptical because of the price, and not knowing the German maker, went to see his works. He found them large, well-organised, and complete. He then proceeded to test the sample rail, and to his surprise found it of purer and better quality than the English make, although made from imported English pigs. Pushing his inquiries further, he learnt that, guided by scientific tests, the German maker, instead of using only one quality of pig—as English makers are said to do, according to the district they are in—had mixed two or more qualities together, and so had arrived at his satisfactory result. But it was still plain, and indeed acknowledged, that the price in the tender was under cost price. The German maker, like others of his fellow-manufacturers, was taking orders for export at losing prices. He was resolved to keep his works going, and he looked to recoup his losses on foreign orders out of the higher prices which the protective tariff enabled him to charge his own countrymen. This is an arrangement which may be very convenient to the German manufacturer so long as it can last, but which is not likely to commend itself in perpetuity to the intelligent German consumer."

NOTES AND MEMORANDA.

IN London 2075 births and 1570 deaths were registered during the week ending the 25th ult. The annual death-rate per 1000 from all causes, which had been 21·9 and 18·8 in the two preceding weeks, rose to 19·7.

OF the 8,070,582 tons of coal burned into coke in 1885 in the United States, but 283,126 tons, or about 3 per cent., came from coalfields outside of the Appalachian; 239,958 tons were from the Colorado basin, 21,487 tons from the Illinois basin, 20,781 from the Missouri basin in Kansas and the Indian Territory, 300 tons from Montana, and 600 tons from Washington Territory. The balance was from the Appalachian field.

THE American Iron and Steel Association reports the American pig iron manufacture for this year to have reached 5,600,000 tons, or 1,556,000 tons more than in 1885; that of Bessemer ingots 2,000,000 tons, an increase of 351,000 tons; and that of Bessemer rails 1,500,000 tons, an increase of 530,000 tons. These are the heaviest annual outputs ever reported. The iron ore produced in the country amounted to 10,000,000 tons; and 1,000,000 tons were imported. The iron and steel imports during 1886 were much heavier than in 1885, the excess being 1,000,000 tons. The large increase in railroad building has caused the main demand for more iron and steel.

ON the velocities for solid screw-cutting dies a correspondent, writing to the American *Mechanical Engineer* says:—"The machine and dies I have, for the past three years, been running are of first-class manufacture, and I have had no trouble whatever in their management. The iron used is ordinary rough bar iron, and all threads are U.S. standard. I keep the dies well flushed with the best commercial lard oil, and take only one cut to make a perfect thread. If the iron is $\frac{1}{32}$in. too large I take two cuts over the bar, but if $\frac{1}{64}$in. or less I take it off the first cut. I have found the following rates of speed to give first-class results, both in quantity of work turned out, and with minimum wear and tear of the dies:—$\frac{3}{8}$, $\frac{1}{2}$, and $\frac{5}{8}$, 60 revolutions per minute; $\frac{3}{4}$ and $\frac{7}{8}$, 50; 1in. and $1\frac{1}{8}$, 36; $1\frac{1}{4}$ and $1\frac{3}{8}$, 26; $1\frac{1}{2}$ and $1\frac{5}{8}$, 22; $1\frac{3}{4}$, $1\frac{7}{8}$, and 2in., 10."

ACCORDING to the *Illustrirte Zeitung fur Blechingdustrie*, a greyish black colouring on copper may be obtained by placing the object for treatment, after being well cleansed, in a weak solution of liver of sulphur. When a caustic effect has, after a short time, been produced, the object is rinsed, slightly heated, and brushed with a stiff brush. This coating is said to be very durable. The *Scientific American* says a blackish-brown bronzing can be applied to vases, figures, busts, &c., cast from zinc, by the application of a solution of sulphate of copper. If the projecting portions are then well rubbed with a woollen rag, they assume a coppery red brilliancy, which increases the resemblance to genuine bronze. A solution of verdigris in vinegar also produces an effective bronzing. Brass may be coloured black by repeatedly coating the cleansed metal with a moderately strong solution of nitrate of copper. Heating over a charcoal fire follows. Finally, the tone is heightened by rubbing with olive oil.

MR. DIAKONOW has made experiments which have led him to the conclusions that the production of carbonic acid in the absence of free oxygen is not an invariable property of the living yeast cell, but is dependent on the nutritive matter in which it exists; that the presence of glucose is indispensable; that the production of carbonic acid ceases when the oxygen of a solution is exhausted and when the glucose is exhausted. The dissociation of the molecule of albumin does not produce carbonic acid in the absence of free oxygen, glucose being the only material which furnishes sufficient oxygen for that purpose. The organisms live for a time, but quickly die in the absence of oxygen, and there is a marked contrast between them and others supplied with a sufficiency of it. The intensity of the production of carbonic acid by microscopic fungi diminishes with the increasing acidity of the solution when oxygen is absent, although under normal conditions the existence of the fungi is not affected by this cause.

A CORRESPONDENT in the *Scientific American*, Mr. J. A. Peck, Brewsters, N.Y., sends the following:—"For tempering all kinds of tools, knives, razors and steel dies, take a suitable quantity of muriatic acid, dissolve all the zinc the acid will take. Prepare a tempering bath composed of one part of the above zinc acid and one part water. Heat the steel according to its hardness. If high or hard steel, heat until just red and then temper in the acid bath. If low steel, heat it as hot as you would to temper in water, then temper in the acid bath. After immersing in the acid bath, cool off in water. For lathe and planer tools draw no temper, but for other tools draw temper. Unlike water tempering, the colours that appear under this method give no clue to the hardness. By this process, steel is readily hardened to any desired degree, and may be made to cut glass like a diamond. If desired, an acid bath composed of two parts of muriatic acid and one part water may be used. Mr. Peck, however, prefers the zinc acid, as being more dense. A prominent advantage of this method of tempering is the certainty and excellence of its results. It never fails to yield the temper required. It can be relied upon for every description of steel or tool."

THE following gives a general idea of the lines upon which secondary battery inventors are now chiefly working. It is from a patent specification of S. Farbaky and Dr. S. Schenek, Hungary—Eng. pat. 13,697, Nov. 10, 1885, 8d. The plates consist of lead grids, the interstices of which are packed with a special material; for negative plates this material consists of 95 parts by weight pulverised litharge and 5 parts granulated pumice stone, the grains being from 1 to 1½mm. in diameter. Enough sulphuric acid is added to form a stiff paste; the mass is spread over the lead grids and "stroked with a brass bar until there is a visible sweat on the surface;" the material projecting above the lead frame being pared off with a long knife. The other side of the plate is treated in the same manner. The packing for positive plates consists of 95 parts by weight of litharge, 95 parts minium, and 10 parts powdered coke. The coke and pumicestone give porosity, and thus facilitate the entry and escape of the electrolyte. The plates, when dry, are dipped into a bath of sulphuric acid diluted with 75 per cent. of water, rapidly removed and left to drain; after about twenty-four hours they are again dipped in the bath and left there for twelve hours. This treatment helps to maintain the packing in position. The plates are packed in air-tight cells, the connecting-rods projecting through the cover.

THE actuality of the molecular changes brought about by pressure and changes of pressure in materials, but which do not affect ordinary daily practice, is shown by the care that is to be taken in sending the two great glasses for the double lens for the Lick telescope from Cambridge by express to San José. They will be wrapped separately in fifteen or twenty thicknesses of soft, clean cotton cloth. Next will come a thick layer of cotton batting, and then a layer of paper. The glasses will then be put into boxes of wood lined with felt. No nails will be used near the glasses, and the boxes will take the shape of the glasses. The boxes will be enclosed in two others of steel, each about the shape of a cube, being packed tightly with curled hair. Each steel box will be enclosed in another steel box, the inner sides of which will be covered with spiral springs. Both steel boxes will be made air-tight and waterproof, and the outer chests will be packed with asbestos to render them fireproof. Each will then be suspended by pivots in strong wooden frames, with contrivances for turning each chest one quarter around every day during the journey to California. This is to prevent any molecular disarrangements in the glasses and to avoid the danger of polarisation, it being feared that the jarring of the train will disturb the present arrangement of the molecules unless the position of the glass is daily changed and all lines of disturbance thus broken up.

MISCELLANEA.

THE London address of Messrs. S. Mason and Co., Leicester, is now 13, Cannon-street, E.C.

MR. J. B. GUTHRIE, of Ethelburga House, Bishopsgate, has taken into partnership Mr. Robert Guthrie, his son.

IN the ensuing session of Parliament the Corporation of Sheffield will apply for an Act to vest in them the undertaking of the Sheffield Waterworks Company.

MR. SAMUEL DENISON and Mr. Geo. Hy. Denison have been admitted into partnership with Messrs. Samuel Denison and Son, Old Grammar School Foundry, Leeds.

THE value of the machinery, mainly for the sugar estates, introduced into British Guiana, during the last four years, viz., 1882, 1883, 1884, and 1885, amounted to the very large sum of £532,260.

A RUSSIAN engineer claims to have discovered a process of reducing petroleum to the form of crystals, which may be easily and safely transported to any distance and then reconverted into liquid form.

A TECHNICAL Institute near University College, Dundee, is to be erected and worked in connection with the college, the late Sir David Baxter, of Kilmaron, having left £20,000 for its erection, with a view to the improvement of working men in scientific knowledge.

MM. LESSEPS and Stokes have been making experimental trips by night to various portions of the Suez Canal with the electric light; and in a few days the whole of the canal will be opened for night traffic by aid of the electric light, thus shortening the passage through by twenty-four hours.

THE New Zealand Shipping Company's R.M.S. Tongariro arrived off Port Chalmers early on November 5th, from London, Teneriffe, Madeira, and Cape Town, having made a smart voyage. She had six saloon, twenty-two second-class, and twenty-four steerage passengers for Wellington. She accomplished the voyage out in 39 days 17 hours 30 min., her actual steaming time being 38 days 10 hours 30 min.

AN American paper says the patent "hurricane raiser"—a huge and complicated apparatus that serves to send a gale of wind across the space devoted to the stage with a velocity of sixty miles an hour, and with a roar as if 100 buildings had simultaneously crashed to the ground—is a feature introduced in the cyclone on the prairie that creates a sensation nightly at the Madison-square-garden, New York.

THE New York Board of Aldermen have recently adopted the following resolution by a vote of 17 to 2:—"Resolved, that no steam pipe or main for the conveyance of steam shall hereafter be laid in any street or avenue of the city of New York, in which the steam pressure contained in said pipes or mains shall exceed 50 lb. to the square inch." The *Mechanical Engineer* thinks the aldermen will have a good time finding out what the pressure is in street mains.

THE Brighton Town Council on Tuesday discussed the report of the Works Committee with reference to the foreshore and the denudation of the beach which has been going on since the erection of the new sea wall at Hove, and its attendant groynes. Strong opinions were expressed in favour of concrete groynes as eventually proving more economical than wood, and ultimately it was decided to erect four groynes of concrete on the western foreshore at a cost of £12,000.

THE needle industry of Redditch has been largely revolutionised during the last twenty years by the introduction of machinery, and the stupendous proportions which the trade has assumed—the present weekly make being not less than fifty millions—necessitates an increased employment of the most improved machinery. The latest move has been the introduction of a machine for the grooving of sewing-machine needles, which bids fair to entirely supersede the old stamping process. At the present time there are about 8000 persons engaged at Redditch in the manufacture of needles alone.

AT the City and Guilds of London Institute, Central Institution, Exhibition-road, a course of seven practical demonstrations is to be given in the dynamo rooms and laboratories of the Institution during February and March, 1887, by Professor Ayrton, F.R.S., Assoc. Mem. Inst. C.E. Each demonstration will be given twice, once on the Friday, at 5 p.m., and again on the following Wednesday, at 5 p.m., in order that all who attend the course may take part in the experiments. After Ash Wednesday, on which day the College will be closed, the same demonstration will be given on the Wednesday and Friday of the same week.

THE excavations on the Middlesex side of the Thames, for the erection of the new Tower Bridge, will necessitate the removal of the remains of persons who are interred in a small cemetery at the eastern end of the Tower. In the event of the remains being unclaimed by relatives or executors they will be interred in one grave at the City of London Cemetery at Ilford. It was at first thought that some persons of historic note were buried in the cemetery, but it now appears that the ground was first set apart in 1832, during the first visitation of the cholera, for the interment of all persons who died of that disease in the Tower. Since that period no person has been interred in the ground.

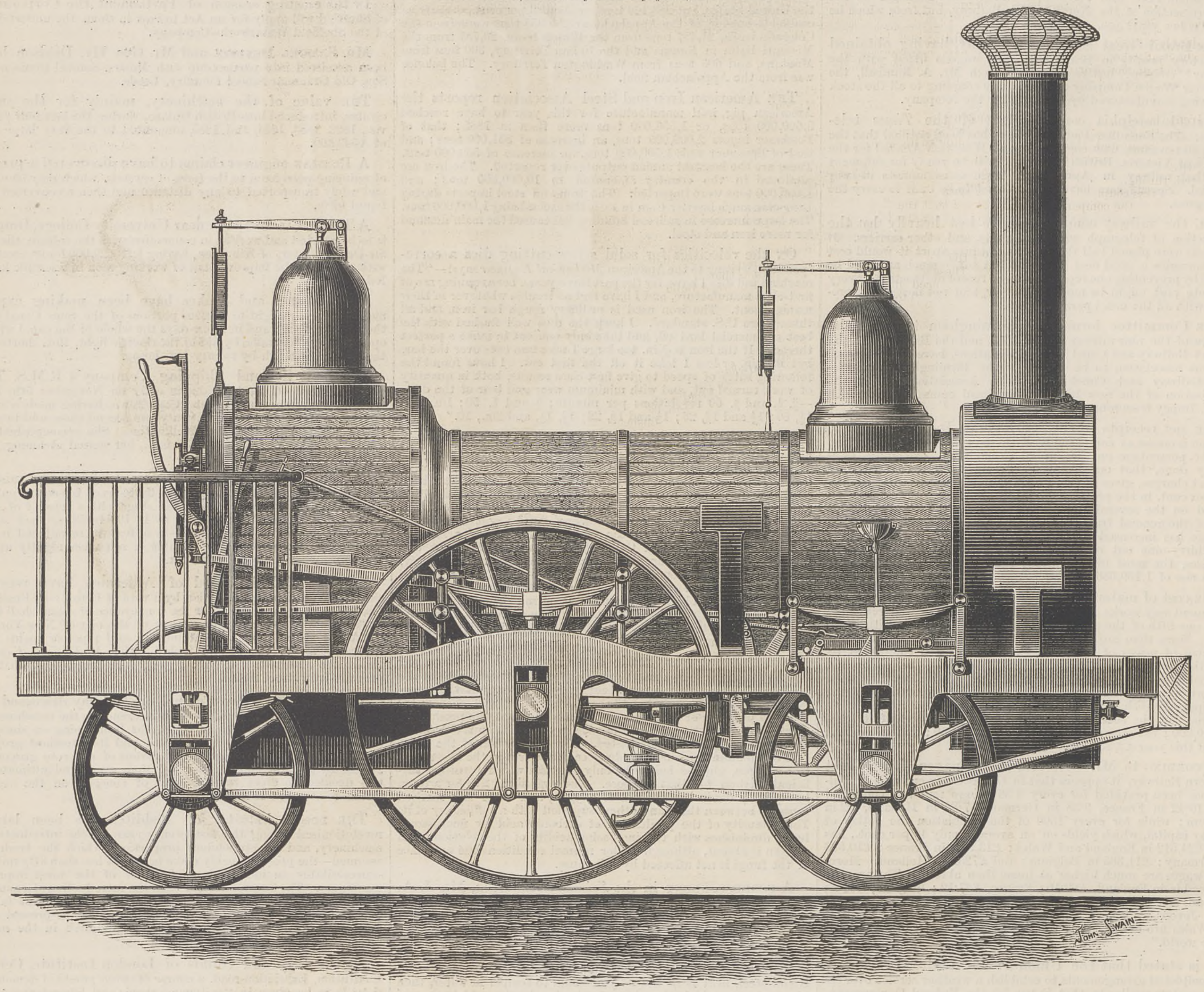
WE regret to learn of the death of Mr. C. Shaler Smith, a distinguished American engineer, at his home in St. Louis, on the 19th ult. Mr. Smith was a native of Maryland, and early exhibited great aptitude in bridge building. The *Engineering and Mining Journal* says he was most successful in all his operations; and when it was decided to bridge the Missouri at St. Charles he was selected to superintend its construction. His management of this difficult undertaking, and the excellent manner in which he adapted means to ends and brought the task to a successful conclusion, attracted general attention. Mr. Smith also assisted Captain Eads in the design and construction of the St. Louis Bridge, and was recently engaged in building the Canadian Pacific Railway Bridge over the St. Lawrence, near Montreal. Some four or five years ago Mr. Smith received a fall, from the effects of which he afterwards suffered and finally died; but his death at the comparatively early age of fifty years was undoubtedly hastened by his indomitable energy, which would not allow him to take needed rest.

THE manufacture of the required number of repeating rifles is so near completion that the whole of the German army will be equipped with that weapon within a few days. This gives Germany again an immense advantage over all other European Powers, which will require at least a couple of years before they can put repeaters into the hands of all their troops. The new rifle, which bears the title "M."—*i.e.*, Mauser—"71, 84," in token that the old model 71 has been adhered to in principle, with some modifications of it made in 1884, is described as being 1·3 m. long without, or 1·8 m. with the bayonet, and weighs 4·6 kilogs. with empty magazine, or 5 kilogs. when the magazine contains its full store of eight cartridges. These are cased with brass, each being 78 mm. long, and weighing 43 grammes. The powder-charge consists of 5 grammes of new rifle powder—"M. 71." The weapon, of which the barrel is of rifled steel, coloured brown outside to protect it against rust, can be sighted for a distance of from 200 m. to 1000 m. It has a calibre of 11 mm. The rifle can be used either as a single shooter or repeater, and is fired in the usual way.

LOCOMOTIVE ENGINE—BIRMINGHAM AND DERBY JUNCTION RAILWAY, 1838.

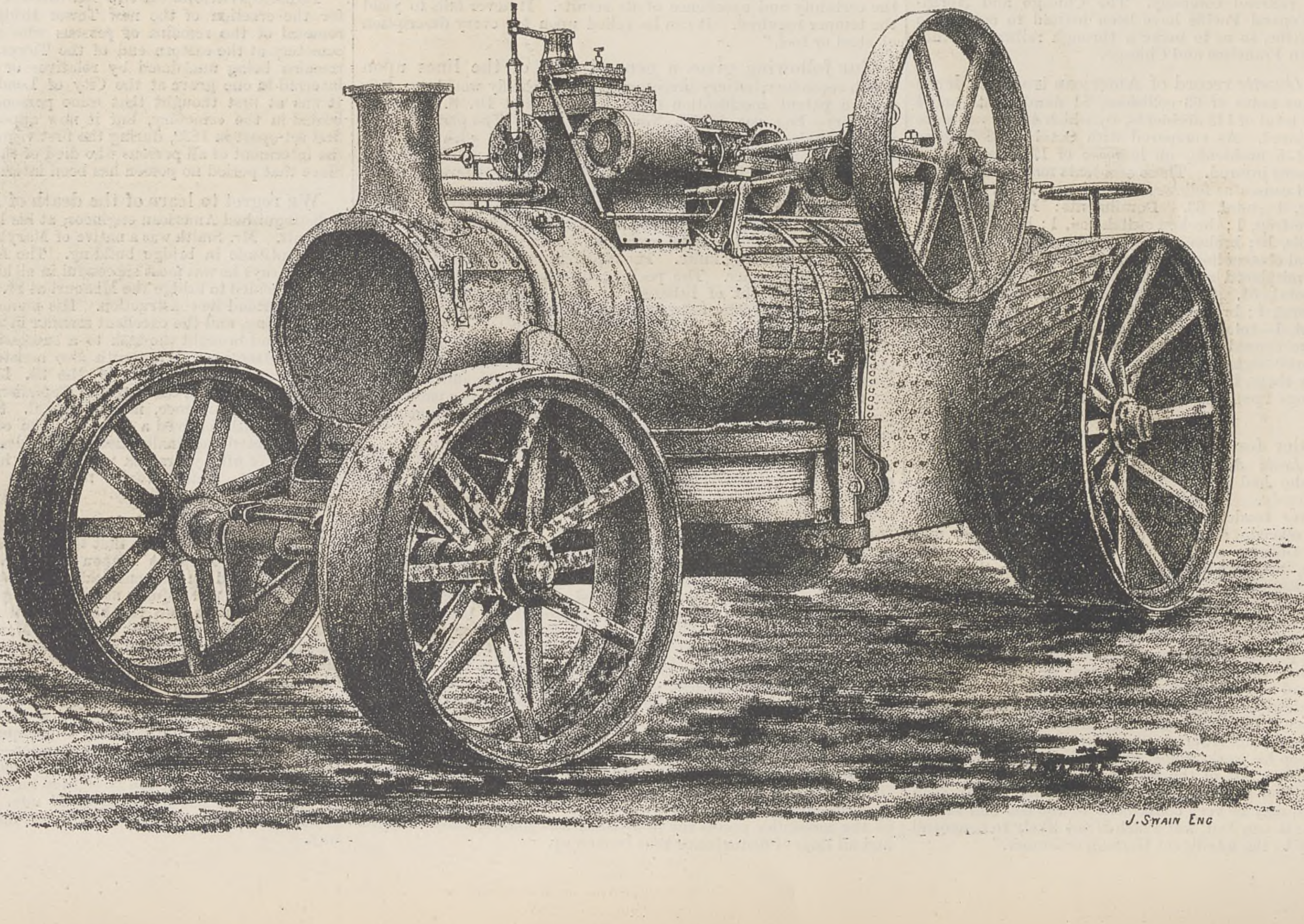
MESSRS. J. P. MATHER DIXON, AND CO., LIVERPOOL ENGINEERS.

(*For description see page* 9.)



AN EXPLODED PLOUGHING ENGINE BOILER.

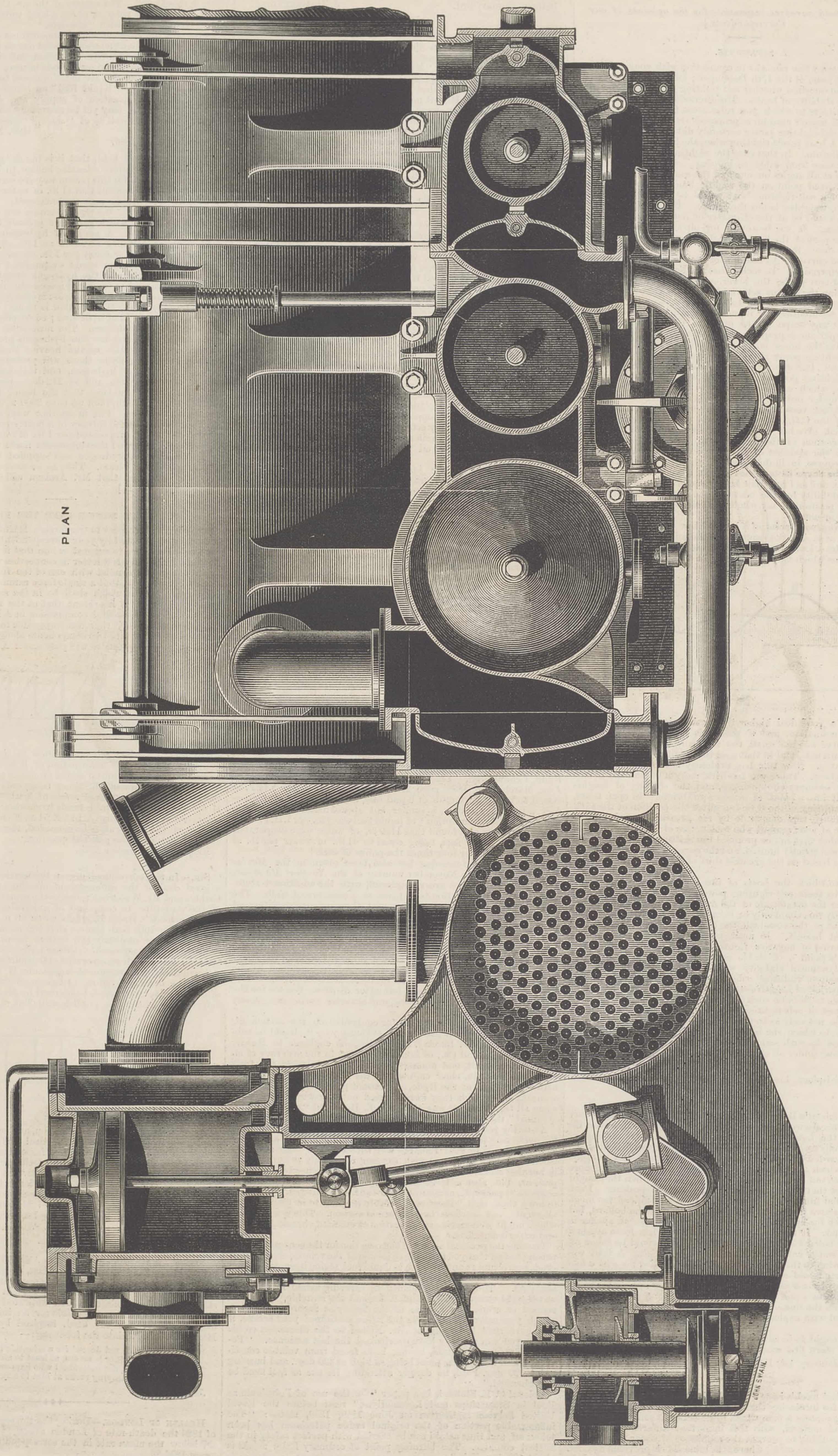
(*For description see page* 9.)



TRIPLE EXPANSION HIGH-SPEED LAUNCH ENGINES.

LA SOCIÉTÉ DES ATELIERS ET CHANTIERS DE LA LOIRE, ENGINEERS.

(*For description see page 9.*)



TRANSVERSE SECTION

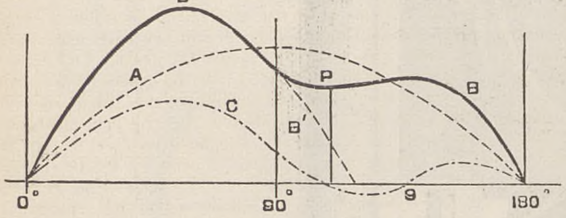
LETTERS TO THE EDITOR.

[*We do not hold ourselves responsible for the opinions of our Correspondents.*]

LIFEBOATS.

SIR,—Allow me a few remarks in connection with your article on lifeboats in the issue of the 17th December; and more particularly in regard to the question whether self-righting power is necessarily detrimental to stability of boats. The discussion in the Institution of Naval Architects to which you refer arose from a paper which Mr. Taylor and myself read on a proposed steam lifeboat, and in that boat the self-righting power certainly did not interfere with her stability. A boat is self-righting when she has only one position of stable equilibrium. In that case the righting arms are positive for the whole range from 0 deg. to 180 deg., *i.e.*, the shifting metacentre remains at all angles on one and the same side of the C.G. relatively to a fixed point on the middle line of the boat. The simplest case of a self-righting boat would be one of a perfectly circular section, weighted below the centre. The curve of stability of that vessel would be of the character of curve A in the accompanying diagram. If we, however, for obvious reasons wish to make the lower part of the boat more ship shape, the curve will be modified and loses its regularity, and its general character becomes that of curve B. An example of such a curve is to be found in the paper referred to. In such a case the boat may be regarded as consisting of two parts, the lower one and the upper one, the latter part giving the means self-righting. The curve of stability of the lower part, considered for itself, would up to a certain angle of inclination, be identical to B and then branch off as shown in B¹. As almost any shape can be given to the lower part of the boat, if the upper one is properly designed to suit it, we have it in our hand to give the lower boat any amount of stability we like, and the self-righting power is simply an addition to the stability of the lower boat. It follows therefore that there is no necessity for the self-righting power to interfere with the stability up to certain angles, which may range even to 70 deg. and more, and the stability under ordinary circumstances depends only on the shape of the lower vessel, and the distribution of the weights, or the position of the C.G. In other words, take those parts of the boat away which give her self-righting power, and compensate for the slight alteration of the C.G. due to this, and you will not interfere with the stability of the vessel under ordinary circumstances. Of course, in ill-designed self-righting boats, *i.e.*, such boats where the curve B¹ branches off at a very early angle, this is not the case, and as I have not had an opportunity of calculating the curve of stability for the boats of the Lifeboat Institution, I am not in the position to say whether their self-righting power is well designed or not.

The most dangerous point of a boat with a curve of stability as shown in B is at *p*, *i.e.*, the point where the minimum righting arm occurs. As the calculation in regard to the C.G. is naturally based on assumptions which may not always be fulfilled in practice, the



C.G. may be a good deal higher than calculated, or it may shift during the inclination, and if then this minimum value of the calculated curve was too small, the real curve would assume the character shown in C, and in that case there will be a point of stable equilibrium at *q*. Now this has evidently been the case of the Southport lifeboat. There was too little margin of stability at the point *p* under ordinary circumstance, and the shifting of weights transformed it into a point of stable equilibrium. In open boats, in which the shifting of the C.G. can affect the position of the C.G. very considerably, this danger is by far greater than in closed boats. Those of your readers who took notice of the paper referred to will remember that in our proposal the shifting of loose weights, such as men, was strictly limited, and the curve of stability which we published was based on the greatest shift of weights which possibly can occur.

The tests to which the boats of the Institution are subjected with regard to their self-righting power cannot possibly indicate the position or the magnitude of the minimum righting lever at *p*. Experimentally this could only be found by progressively increasing the top weight of the vessel till the position is reached when she will not right herself. It must not be forgotten either, that although a period of negative righting arms at certain angles, and consequently a point *q* of stable equilibrium, may exist, still the amount of dynamical stability which the vessel gathers in the periods of positive righting arms may be sufficient to carry her through the period of negative stability, and the tests may therefore even be unable to disclose such points.

A proper test of self-righting qualities of a boat would have to be progressive, not only as to the amount of topweight, but also as to the angle to which she is careened. If the existing lifeboats were subjected to such series of test it would show whether they are self-righting under all circumstances or not.

LUDWIG BENJAMIN, M.I.N.A.

8B, Rumford-place, Liverpool, December 30th, 1886.

SIR,—"Lifeboat's Bowman" is courteous, and I am sorry to say that is not the case with all the Institution servants. However, his remarks on the Lowestoft boats are not logical. In the second place, I am fully aware the Institution is always trying little dodges, and old discarded things. For instance, they have just adopted drop keels, which are peculiarly dangerous things. The longshore boats are often out in hard times, by land and sea, when they ought not to be, but they never come to grief, generally speaking. I can but repeat that lifeboats are deficient in floor, and nipped too much in the bows above the water. A man may veer by the bollard, but it is too much for human nature to stand holding on an anchor in severe weather. If the hawser were rove through a loose eye-bolt between the bollard and the anchor, three turns could be taken off the bollard and a half hitch taken by the eye-bolt. A boat will sometimes swing to the wind with a contrary tide, *but not with a taut hawse*. When I said a rocket, I did not mean the large ones. In the Navy they have a sort of pistol. The man stands with the pistol in one hand and a coil of line in the other; bang goes the pistol and away goes the line. I do not know what they call them; they are connected with explosives. Lifeboats here are hauled up stern first.

Lifeboats ought to have a movable rudder, so as to allow them to be launched stern first when necessary.

J. W.

Sizewell, January 1st, 1887.

SIR,—In last week's issue "Lifeboat's Bowman" condemned my suggestions for increasing the stability of lifeboats when at anchor, and yet he proposes a plan which in its action is somewhat similar to my second method, with this important difference, viz., with his there is nothing to prevent the admission of water through the hawse pipe with the cable, whereas in mine this is provided against. I kept the mouth of the hawsepipe somewhat nearer the keel, to lower as much as possible the centre of gravity of the boat when floating, and to increase the righting powers if overturned.

Belfast, January 3rd. J. H. GREENHILL.

LIQUID FUEL.

SIR,—In your article on the paper on "Liquid Fuel," read before the North-East Coast Institution of Engineers and Shipbuilders, you say, page 509, "Mr. Nichol cites some old experiments of Favre and Silberman on petroleum refuse," and you add further that you "are not certain that Favre or Silberman ever tested the astaki of commerce. Permit me to say that Mr. Nichol never said that they did; he is not aware that Messrs. Favre and Silberman had any knowledge of either petroleum or petroleum refuse. What he did say was—see page 28 of the paper—"that the theoretical evaporative power of petroleum refuse was computed according to the values of the component parts as established by Messrs. Favre and Silberman," *i.e.*, the calorific values of carbon, hydrogen, &c., as proved by their experiments.

JOHN DUCKITT, Secretary.

6, Exchange-buildings, King-street, Newcastle-on-Tyne, January 5th.

SIR,—You were pleased in your leading article on the above subject to notice some remarks made by me, on November 10th, 1886, at the meeting of the North-East Coast Institution of Engineers and Shipbuilders, when the above subject was under discussion; and as you charge me with making a statement, which it may reasonably be inferred from your article I knew to be untrue, I must ask for a few lines of your space for an emphatic disclaimer that I should have contradicted the statement "that the boiler of the steamer Ryde evaporated 41 lb. of water per pound of petroleum."

To begin with, I never stated that in the Ryde's furnaces petroleum was used, "liquid fuel" is the term to be found in the Institution's "Transactions." Green oil and creosote oil, and not petroleum, was employed; but this is comparatively a small matter, although it may be fairly urged that, in reviewing Mr. Nichol's paper and the discussion, you should have at least referred to the use of creosote oil by Messrs. Sadler and Co., at Middlesbrough and elsewhere; seeing you "do not want it to be supposed that we are in any shape or way opposed to the innovation." It is at least remarkable you should only refer to the "old experiments" cited by Mr. Nichol, and pass over in silence the new information he gave as to the analysis of "creosote oil" burnt at Messrs. Sadler and Co.'s works.

You also do not do me justice in the manner in which you drag in my name into your article. Had you stated exactly what I did say as to liquid fuel efficiency, I should have little reason to complain, although even then, seeing the remarks made were not in a carefully written article or paper, they are scarcely in any event open to the severe comments made by you. What I did say, and as given in the "Transactions" is, "He—Mr. Arnison—was of the opinion that in the paper the evaporative power of liquid fuel had not been over stated. In Mr. D. Kinnear Clark's 'Fuel, its Combustion and "Economy"' petroleum is stated to have 27,531 units of total heat of combustion of 1 lb. of combustible, and for ordinary tar an equally good result has been claimed.

"Mr. Edwin Henwood, of London, who is at present arranging for competitive trials of liquid fuel and coal in his screw tug Ruby, with which he intends running two long trial trips, on each occasion taking evaporative results, speed, consumption, and indicated horse-power, claims to have obtained as high a result in the s.s. Ryde as an evaporation of 41 lb. of water per 1 lb. of liquid fuel, apparently accounted for by the utilisation of the hydrogen liberated from the steam used for injecting the oil. This evaporative test is certified to by an independent expert. He—Mr. Arnison—could scarcely agree with Mr. Nichol, that the form of injector was the principal factor in the arrangement of a furnace for a marine boiler using liquid fuel. It seemed to him that it was necessary to have a thorough utilisation of the heating surfaces, and that the supply of air should not be obtained simply through and at the furnace door, but that there should be some means of supplying air to the combustion chamber."

Why I should have contradicted the statement regarding the Ryde, I cannot tell. I have never seen the truth of it denied. In *Iron*, March 26th, 1886, page 276, the consumption per I.H.P. is stated to have been 0·69 lb. of liquid fuel, and in another contemporary a few days earlier, a similar but approximate statement is made, viz., the consumption "of liquid fuel was ¾ lb. per I.H.P." and further, "it was also found that 1130 lb. of water were evaporated by 27½ lb. of liquid fuel, being equal to 41 lb. of water per lb. of liquid fuel, *i.e.*, over four times the power of coal."

Publicity to the foregoing has also been given in the *Marine Engineer*, and in the November number of the *Nautical Magazine*, page 979, these figures are reproduced, with the additional statement that the evaporation took place at a pressure of 65 lb. The same periodical also states, "Amongst those who have witnessed the working of the Ryde with liquid fuel were the naval attachés of the German and United States' Embassies, representatives of the British Admiralty, and Lloyd's Register of Shipping, all of whom were favourably impressed with the arrangements and results obtained." No, I have had no reason for contradicting the statement regarding the Ryde, nor can the result be explained by the quality of oil used, both "green" oil from the Beckton Gasworks, and "creosote" oil, a residuum left after distilling the tar for the production of anthracine, quinone, and alizarine, giving not greatly dissimilar results.

Not only have I had no reason for contradicting the statement, I have also received at least some evidence why it should be substantiated. Mr. W. Barclay, superintendent engineer to Messrs. Arthur Holland and Co., of London, certifies to the accuracy of an even better result, and amongst others who witnessed the tests were Mr. Maudlin, chief engineer of the Royal Navy. I did not witness the trials of the Ryde, and cannot personally testify to the accuracy with which they were carried out, nor was it necessary, when all that I stated was that Mr. E. Henwood "claims to have obtained" the results you quoted.

As to the possibility of utilising the hydrogen present in steam for perfecting the combustion of "astaki," "creosote," &c., a few words in reply to your remarks will suffice. You state: "Now, when hydrogen is burned with oxygen, the result is water;" but in burning steam and oil, there is not only oxygen and hydrogen present, but also a large percentage of carbon—in the case of creosote 91 per cent., as against 9 per cent. of hydrogen. It scarcely follows, then, that "there is absolutely nothing to be gained." At all events, you overlook the presence of carbon. This is a question which might well receive the attention of eminent chemical analysts and experimentalists.

Leaving the personal aspect of the question for the general, it is surprising to find that you raise the objection of the volatile character of crude petroleum as an objection to liquid fuel, seeing it is not proposed to use it, but merely "astaki," or even a heavier class of tar or shale oil. There is no difficulty in carrying astaki in ordinary water-tight compartments, and it has not the searching quality of refined or crude oil; and as to the safety as regards explosion, which you call attention to in the latter portion of your article, if you have read the reply of Mr. Nichol to the discussion on his paper, you can scarcely have overlooked the last sentence. "Petroleum refuse, or astaki, having been freed from volatile constituents, and its flashing point being so high as 320 deg., and burning point 420 deg. Fah., no danger attending its use as fuel need be apprehended."

Colonel C. E. Stewart, in a paper "On the use of Petroleum as Fuel in Steamships and Locomotives," read before the Royal United Service Institution on June 18th, 1886, states: "The inflammable portion of the original crude petroleum has been taken off, and thus astaki can be carried with perfect safety in the hottest climates. The burning point of ordinary Baku astaki is about 422 deg. Fah."

The action of underwriters need not be feared at all when it is known that "astaki," "creosote," &c., is used as liquid fuel—at least, it should not. The owners of the s.s. Cobden could readily throw light on this subject, as for a long time one of that vessel's boilers has been fired with "creosote."

As regards the effect of high temperatures on the boiler plates, I would suggest that you should send out to the Caspian Sea and the Volga a representative to collect information and inspect boilers that have been various periods in use; and this would be a good way of showing you are not "opposed to the innovation."

The taking of the "liquid fuel" on board involves little difficulty, if once the question of supply and demand was solved. This latter question may yet be materially advanced by the using of "tar" proper, as well as of "shale," "green," and "creosote" oil.

GEO. N. ARNISON, JUN.

December 29th, 1886.

[We held, and still hold, that it is the duty of engineers taking part in discussions before scientific bodies to refute error, if they speak at all; and it is for this reason we were surprised that Mr. Arnison suffered the statement that 41 lb. of water had been evaporated by 1 lb. of creosote to pass unchallenged. He asks us why he should contradict it? We reply, because the thing is impossible. Nothing is known which produces greater heat than hydrogen burned with oxygen. A pound of hydrogen will give out 64,000 units, or about 4¼ times as much as 1 lb. of coal. Assuming an evaporation of 10 lb. of water per 1 lb. of coal—which is good work—then 1 lb. of hydrogen would evaporate $4·25 \times 10 = 42·5$ lb. of water. Any addition to the hydrogen would lessen its efficiency. What Mr. Arnison has been told is creosote oil is not true creosote, but no doubt contains some. Creosote is closely allied to carbolic acid, and its formula is $C_{16} H_{10} O_2$—that is to say, creosote contains 16 atoms of carbon to 10 of hydrogen; so its efficiency must be much less than that of hydrogen. The nearer we get to the dead or refuse oil in a still, the less the hydrogen present and the greater the carbon. In 100 lb. of the heavier shale oils, such as that used on board the Ryde, there will probably be about 74 lb. of carbon and 26 lb. of hydrogen, and this would evaporate about 2900 lb. of water from and at 212 deg., provided no heat was wasted or lost. Granting that the boiler has an efficiency of 0·9, which is very high, then we have $2900 \times ·9 = 26,100$ lb., instead of 4100 lb. as stated. Put in another way, unless pure hydrogen had been burned in the furnace of a nearly perfect boiler, 41 lb. of water could not be evaporated per 1 lb. of fuel. Mr. Arnison himself evidently regarded the statements made with some hesitation, for he thinks that hydrogen was supplied to advantage by the dissociation of the steam. This, as we have already explained, is an error. We trust that Mr. Arnison will find this explanation satisfactory.—ED. E.]

RAILWAY BRIDGE OVER THE RIACHUELO.

SIR,—With all respect to the foreign learning—with which I am unacquainted—quoted by your correspondent on the above subject last week, I venture to suggest to him that if he seriously disputes the statement in my last letter in connection with Fig. 4, as under, he will come into conflict with one of the fundamental axioms of statical law, namely, that a single force cannot be resolved into two components, one of which shall be in the same direction as that force itself. For it is evident that at the node A the tension in A K produces a horizontal compression in A B and a vertical compression in A X. It is therefore impossible to resolve this compression at the node X into two components along X H and X I, for the whole of the compression will pass down X I. I was careful to

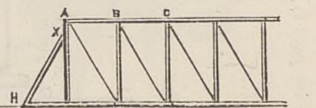


FIG. 4

guard myself against misconstruction by stating that this action would take place until deformation of H K threw strain on X H. I assume it to be the initial action of only a portion of the stress at A, as already explained, the figure being only intended to illustrate the action of that portion of stress at A which is below the axis of H A. Any deflection in I tends to shorten H X, putting it into compression and bending A I at X; but if this initial action of any portion of the stress at A be conceded, the deflection at I will be abnormal which is the point at question.

T. G. GRIBBLE.

Richmond, December 28th.

SIR,—In the correspondence on this matter it seems to me that a good deal of the difference of opinion apparent between Mr. Gribble and Mr. Woodcock is due to the want of a complete definition of the structure, as composed of extensible or inextensible bars. Mr. Woodcock's stress diagrams given on p. 474 of THE ENGINEER of December 10th both assume that the members of the bridge are inextensible or else that the bottom boom H K has no vertical stiffness. It is easy to show, either analytically or by drawing, the triangle A H K with exaggerated extensions and compressions, that A I will be in compression if the points H, I, K, lie in a straight line in the deformed figure. I have no doubt that the indications of compressive stress in A I observed by Mr. Gribble in his model, referred to in his letter published in THE ENGINEER of November

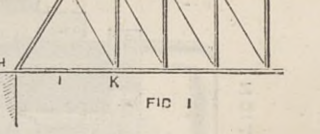


FIG. 1

26th, were stresses due to deformation, and consequently secondary, depending practically on the vertical stiffness of H K. In the actual bridge no stress of practical importance could, I think—but I have only made an approximate estimate—be produced in this manner, and any but very small transverse stresses in H K would be entirely prevented if the connection between the vertical A I and the bottom boom was merely loosely bolted till after the rest of the erection was complete.

MAURICE F. FITZ-GERALD.

Queen's College, Belfast, January 1st, 1887.

P.S.—The lettering refers to Mr. Woodcock's and Mr. Gribble's diagrams.

PATENT-OFFICE AMENITIES.

SIR,—Says the *Times* of Monday last, in an article on the Patent-office:—"Accusations of incompetence are understood to have been made against one another by certain of the officials, and a state of things disclosed which indicated an absolute want of harmony among those responsible for an important branch of the office." Thereupon our bard, inspired by recollections of Bret Harte, broke forth into the following:—

"I hold it is not decent for a scientific gent
To say another is an ass, at least to all intent;
Nor should the individual who happens to be meant
Reply by heaving rocks at him to any great extent."

January 6th. VOLVOX.

HEALTH OF LONDON.—During the thirteen weeks of last quarter of 1886 the death-rate of London averaged 18·8 per 1000, and was 2·7 below the mean rate in the corresponding periods of the ten years 1876-85.

W. E. RICH.

By the death, from brain fever, of Mr. William Edmund Rich, of the firm of Easton and Anderson, of Whitehall-place, London, and Erith, Kent, on the 22nd December last, the profession loses one of its most earnest and hard- orking members, and one who seemed destined from the ability he displayed to attain very high rank among his compeers. Mr. Rich came of an old Wiltshire family, his father being Mr. Edmund Rich, of Willesley, in that county, and was born on May 19th, 1844, so that at the time of his death he was only in his forty-third year. His education was commenced in a private school at Chippenham, and continued at the Cheltenham Grammar School, which he entered in 1858. At Cheltenham Rich displayed those qualities of earnestness and high ability which distinguished him through life, passing with honours in both cases the Oxford Middle and Senior examinations; and his mathematical master, Mr. Jefferies, writing after a lapse of twenty-five years, says, "I had known Mr. Rich from his boyhood onwards, and felt a personal interest and pride in his professional eminence. He gave early promise of rising to the top of his profession from his talents and untiring devotion to it."

In October, 1861, Mr. Rich was articled to Messrs. Palmer, of Jarrow, and went through the usual course in the shops and drawing-office, thus acquiring among the kindly and hard-working sons of the Tyne that knowledge of work, and how it should be done, which was of so much service to him in after years. While at Jarrow Rich did not confine himself to learning the mere practical knowledge of what to do, but strove earnestly to acquire that higher knowledge of what to think, which lies at the root of all real progress in engineering. This striving led him, some time after the completion of his articles, to throw up the appointment he held in the drawing-office at Jarrow, and to enrol himself at the commencement of the winter session of 1866 in the Engineering Classes of the University of Glasgow. Here Professor Rankine, with that kindly thoughtfulness which endeared him so much to his students, proposed to the Senate that Rich should be allowed, in consideration of his professional attainments, to complete his course of study in one year, instead of the prescribed period of two years. This boon, considerable to a man who had already been engaged in practical work, the Senate granted, provided Mr. Rich could pass the examination for admission to the senior mathematical class. He not only passed this examination, but amply justified Professor Rankine's recommendation by carrying off, in addition to the certificate of proficiency in engineering science awarded by the University, the Walker prize for a written examination in engineering, two class prizes in the engineering class, the second prize in natural philosophy, and a prize for work done in the physical laboratory. Concerning his work in the natural philosophy class, Sir William Thomson thus wrote of him, "Mr. Rich was one of the most distinguished students of the class, and the second prize was awarded to him by the votes of his fellow students. Mr. Rich also worked with much perseverance and skill in the laboratory of the class."

At the end of the session Rich was awarded the University medal for an essay on the "Doctrine of Uniformity." Perhaps the best testimonial as to his work at Glasgow is that which he received from Professor Rankine some time afterwards, when candidate for a chair of engineering then vacant. Professor Rankine writes:—"Mr. William E. Rich, C.E., has received from the Senate of this University, and from myself individually, testimonials of the highest order as to his conduct and success when a student of engineering science, but to what is stated in these testimonials, I wish to add the statement of my own conviction, that he is specially well qualified to do the duties of a professor of civil engineering. He possesses in a high degree the talent of expressing his knowledge in a clear, simple, and methodical way, and he has also the character and manners which are best calculated to obtain for him the respect and regard of his colleagues and of the students."

In January, 1868, Mr. Rich joined as assistant engineer the firm —now Easton and Anderson—in which he was to spend the remainder of his life, and in April of the same year passed the examination, no light one for one not educated at the school, and obtained the diploma of Associate of the Royal School of Naval Architecture and Marine Engineering. He was, in fact, the first non-student who obtained this honour.

The work done by Messrs. Easton and Anderson is, and has always been, of a very varied character, and Mr. Rich found ample employment for all the learning he acquired as a student of engineering science. Among other branches geology was found specially useful, and to the study of this science he devoted much time, more especially with reference to its bearing on the question of water supply. In his capacity of assistant engineer he was employed in the more scientific branches of the firm's work, materially assisting in the design of the large sugar mills built in 1870 for the late Khedive of Egypt, and also in the designs for the early Moncrieff gun mountings for naval service. While in this position Rich took much interest in the various trials of machinery conducted by the Royal Agricultural Society, of which Mr. W. Anderson, one the principals of his firm, was consulting engineer, and designed several of the dynamometers used at these trials. These dynamometers were described in a paper by Rich read before the Institution of Mechanical Engineers at the Birmingham meeting in July, 1876.

As might have been expected, Rich obtained rapid promotion, and in June, 1878, ten years after his appointment as assistant engineer, he was admitted as a partner in the firm. Among the more important works undertaken by the firm, upon which Rich had been engaged since his admission to the partnership, may be mentioned the Antwerp and Seville Waterworks, in the general arrangement of which he took an active part. He also took a large share in designing the sewage pumping engines for Buenos Ayres under Mr. J. F. La Trobe Bateman, Past President Inst. C.E.; the pumping engines for the Amsterdam Waterworks under Messrs. Quick; and designed entirely the large hydraulic passenger lift for the Mersey Tunnel under Sir James Brunlees and Sir Douglas Fox. The sewage pumping engines for Buenos Ayres, and many others of the works undertaken by Messrs. Easton and Anderson, are described in a paper by Rich, "On the Comparative Merits of Vertical and Horizontal Engines, and on Rotative Beam Engines for Pumping," read before the Institution of Civil Engineers on April 22nd, 1884, and printed, together with the discussion thereupon, in the "Minutes of Proceedings," vol. lxxviii., 1883-4, Part IV. This paper, written primarily with the view of evoking discussion on the subject of pumping machinery, contains much that is of real and permanent value, and before he died Rich had the satisfaction of knowing that the views advocated by him in that paper were being largely adopted by those engaged in the design and manufacture of this class of machinery. The engines of the Amsterdam Waterworks are fully described add illustrated in THE ENGINEER of November 12th and 19th, 1886.

The hydraulic passenger lifts for the Mersey Tunnel formed the subject of a paper read before the Institut on of Civil Engineers on May 4th, 1886, and which together with the discussion was printed in the "Minutes of Proceedings," vol. lxxxvi., 1885-6, Part IV. For this paper Mr. Rich was awarded the Telford premium of the Institution of Civil Engineers. Mr. Rich took a great interest in the proceedings of the Institution of Civil Engineers and the Institution of Mechanical Engineers, and besides reading the papers mentioned above, frequently took part in the discussions. Towards the end of last year, Mr. Rich's partnership having expired by effluxion of time, it was agreed, as giving greater scope for his abilities, that he should leave the firm, and with the commencement of the new year start in business on his own account as a consulting engineer, his partners considerately allowing him to devote all the time not necessary for the completion of the work he had in hand to such new work as might present itself, and generally to getting himself into working order before the end of the year. Mr. Rich had many offers of work, and among the first fruits of his new venture was the testing, in conjunction with Professor Kennedy, of the Davey-Paxman engines used in driving the electric light installation at the Colonial and Indian Exhibition of 1886, the very able report on which appeared in THE ENGINEER of November 26th, 1886.

This was the last of the good work done by Mr. Rich, and he now rests from his labours, leaving behind him the record of a blameless life, which may well serve as a model to the junior members of the profession. He was a man of high honour, and one who held strong views on personal religion, carrying conscience into all he did; not only in matters connected with his profession, but in the minor details of his daily life. He leaves, besides his aged father and mother, a widow and five children to mourn his loss; and the congregation which assembled at the funeral service held in St. Mary's church, Vincent-square, on the 28th of December, showed the respect in which he was held, not only by his more immediate friends, but by the heads of the profession he served so well.

FRENCH TRIPLE EXPANSION ENGINE.

THE Société des Ateliers et Chantiers de la Loire have just constructed two fast boats of the Scout type, which it has fitted with triple expansion engines. These boats, which measure only 43ft. long, were, according to agreement, to have a speed of 12 knots. This rate has, however, been surpassed, 13 knots having been attained. This very remarkable result has been obtained by giving very little weight to the hull and the engine, and by certain new adaptations which have been patented. Before attempting a description of the engine it will be useful to give some particulars of the boats themselves, and of their hulls. The principal dimensions of the boats are as follows:—Length from end to end, 13·00 m.; extreme width, 2·38 m.; depth, 1·61 m.; draught of water astern, 1·09 m.; displacement, 7·05 tons. The hull is entirely of galvanised steel, and is chiefly remarkable for the suppression of the stern frame. The stern gland is close to the engines, and the screw shaft proper is carried outside the boat. The shaft is supported by two brackets, one at the extreme end against the screw, the other placed about the middle. The bottom of the boat rises gradually up to the water-line from about the middle. This arrangement, it is deemed, is doubly advantageous. Firstly, it diminishes notably the dead weight and the wetted surface of the stern; secondly, it enables the water to flow freely to the screw. The latter is completely immersed in a vein of water without any eddy, and its efficiency is increased thereby. A steel plate turtle back forward enables the boat to preserve her speed in a chopping sea. The ribs are of steel, 50 cm. from centre to centre, and weighing 1·10 kilogs. the metre length. The keel is constructed of two angle irons. The plates of steel are composed of sheets, 2 mm. for the garboard strakes, and of 1·25 mm. for the rest. The boats are furnished with all the accessories necessary to accomplish service they have to render. The entire weight of each vessel and its accessories does not surpass 1·600 kilogs. In the engines of these boats the triple expansion system has been adopted.

The whole of the propelling apparatus is composed of one triple expansion engine, illustrated on pages 528 and 7, supplied with steam by a boiler of the locomotive type. The whole is remarkable for its lightness; the thickness of the cylinders, which are of cast iron, does not exceed 10 mm.; certain parts of the slide valve cases are only 7 mm. The thickness of the frames and of the condenser, which are of gun-metal, is only 6 mm. The pistons are of steel, and of a maximum lightness compatible with a suitable coefficiency of resistance.

The diameters of the three cylinders are respectively as follows: The small cylinder, 150 mm.; the intermedirte cylinder, 230 mm.; the large cylinder, 340 mm. Their length of stroke is 240 mm. These cylinders are cast separately and bolted together. The small cylinder is forward, its valve on the outside. In consequence of the great speed of the pistons—3·20 m. per second for 400 revolutions—the steam pipes are relatively large. The slide valves are of the ordinary type. The frames as well as the condenser are entirely of gun-metal. On the condenser are cast the three supports which sustain the cylinders on one side and form guides, as well as the four plummer blocks of the crank shaft, one of which, of rectangular section, serves as a suction pipe to the air pump. On the opposite side of the condenser the cylinders are supported by hollow steel columns of rectangular section.

The body of the air pump, cast in one with its frame, is situated to starboard. This pump is vertical, and its bucket is worked by a lever as shown, actuated by a separate connecting rod direct by the crank of the intermediate cylinder. The valves are of india-rubber. In order to avoid the waste of fresh water, a small tank is provided, in which the water is stored if for any reason it should be necessary to shut off feed for a few minutes. The feed pumps, two in number, are attached to the air pump, and worked by the same lever. They draw directly from the hot well. The surface condenser contains 202 tubes of 16 mm. in exterior diameter. The two tube plates of the condenser are of copper. The two-bladed screw is of gun-metal, and has a diameter of 1 m. and a pitch of 1·10 m.

The boiler, which works by forced draught, is of the locomotive type. It is, we believe, the smallest generator of this kind which has ever been applied to a boat. The choice of this boiler, the lightest for a fixed production of steam, has been perfectly justified. In spite of its small dimensions the heating surface, due to the small diameter of the tubes—29 mm. inside, and to their great number—200—attains 22·70 m.^{2}. The grate surface is 0·40 m^2. The forced draught is produced by a fan placed in front of the engine, and set in motion by a small independent engine which can run continuously at 800 revolutions. The air given out by this fan is passed into the ashpan under the grate by means of a wind-trunk of sheet iron, which is fitted with a register, by which the intensity of the draught can be regulated or the wind be suppressed. A pipe, furnished with a valve and fixed on to the wind trunk, enables the air to be forced into the furnace over the grate bars, through holes in the door, in order to secure complete combustion. To this very light boiler is largely attributable the success of these small boats. The steel plates of the cylindrical shell are only 7 mm. thick for a diameter of 0·800 m., and a pressure of 9·25 kilogs. The fire-box is of fine iron, and the tubes are of brass. The steam it collects in a small dome placed above the fire-box. The boiler is lagged with felt and sheet iron. The boiler accessories consist of two safety valves of the locomotive kind, a stop valve, a water gauge, three water taps, a pressure gauge, two feed valves, a blow-off cock, a steam blower, and a whistle; an injector is also provided.

We give the principal dimensions in the nearest English measures in the following table:—

Engine:	
Boiler pressure	130 lb. per sq. in.
Diameter of small cylinder	6in.
,, intermediate cylinder	9in.
,, large cylinder	13¼in.
Length of stroke	9½in.
Number of revolutions per minute	400
Piston speed	630ft. per min.
Calculated percentage of admission—	
Small cylinder	0·70
Intermediate cylinder	0·60
Large cylinder	0·70
Horse-power by calculation—	
Small cylinder	30·5
Intermediate cylinder	30·
Large cylinder	31·6
Total calculated power	92·1
Diameter of steam pipe	2¼in.
Diameter of exhaust pipe	4¾in.
Diameter of condensing tubes outside	⅝in.
Length of ditto between the plates	4ft.
Number of tubes	202
Cooling surface	130 square feet.
Diameter of air pump	6¼in.
,, trunk	2⅛in.
Stroke of air pump	4¾in.
Number of revolutions	400
Number of feed pumps	2
Diameter of feed pumps	1⅛in.
Stroke of ditto	3in.
Boiler:	
Grate surface	4½ square feet.
Fire-box	16½ square feet.
Tubes	240 square feet.
Total	256½ square feet.
Diameter of tubes	1¼in.
Number of tubes	200
Length of tubes between plates	4ft.
Weight of the whole machinery, with boiler, shaft, screw, pipes, and water	3 tons.
Weight of fan and its engine	136 lb.

The official trials of the first of these boats took place on the 20th of August, 1886. At the time of the trial the average speed attained during one hour was 13·05 knots, with an average of 483 revolutions per minute. The steam pressure was maintained without difficulty, and the vacuum at 24½in. During the continuous trial the speed attained during three hours was 12 knots. "These boats," says our contemporary, the *Portfeuille des Machines*, to which we are indebted for the preceding particulars, "are certainly destined to render great service to our military marine. Similar boats able to run 13 knots for one hour at least, and 10 knots regularly for a longer time with the greatest ease, fitted with economic engines, would, it appears to us, be of great service as pleasure boats."

LOCOMOTIVE ENGINE, 1838.

IN our impression for February 6th, 1886, we illustrated one of the great engines now working the Midland Railway express traffic. By the courtesy of Mr. Johnson, locomotive superintendent of the line, we are enabled to give on p. 6 an engraving of one of the first locomotives used on what was in 1838 known as the Birmingham and Derby Junction Railway. The driving wheels were 5ft. 6in. in diameter, and from this our readers can deduce further dimensions.

AN EXPLODED PLOUGHING ENGINE BOILER.

WE illustrate on p. 6 a ploughing engine which recently exploded at Shippon, near Abingdon, Berkshire. A man and a boy were severely scalded.

The failure resembles in several respects that of a traction engine which took place some years ago at Maidstone. The engine was constructed by Messrs. John Fowler and Co., Steam Plough Works, Leeds, and the boiler had not undergone a thorough examination for five years, although it had been retubed. Several of the fire-box stays had broken from time to time, and at last the strength of the box was so weakened that it gave way, and a rent was torn in the outer shell at the point marked with a cross on our engraving, while the inside fire-box was driven inwards.

It is noteworthy that the cylinders being fixed right over the manhole, it was impossible to make any examination of the inside of the boiler without taking down the engine.

The explosion was attributed to over pressure, as no means were provided for preventing the safety valves from being locked down by the spring balances. The necessity for the periodical sounding of fire-box stays is demonstrated by this explosion, which narrowly missed having disastrous results.

THE VYRNWY MASONRY DAM—LIVERPOOL WATERWORKS.

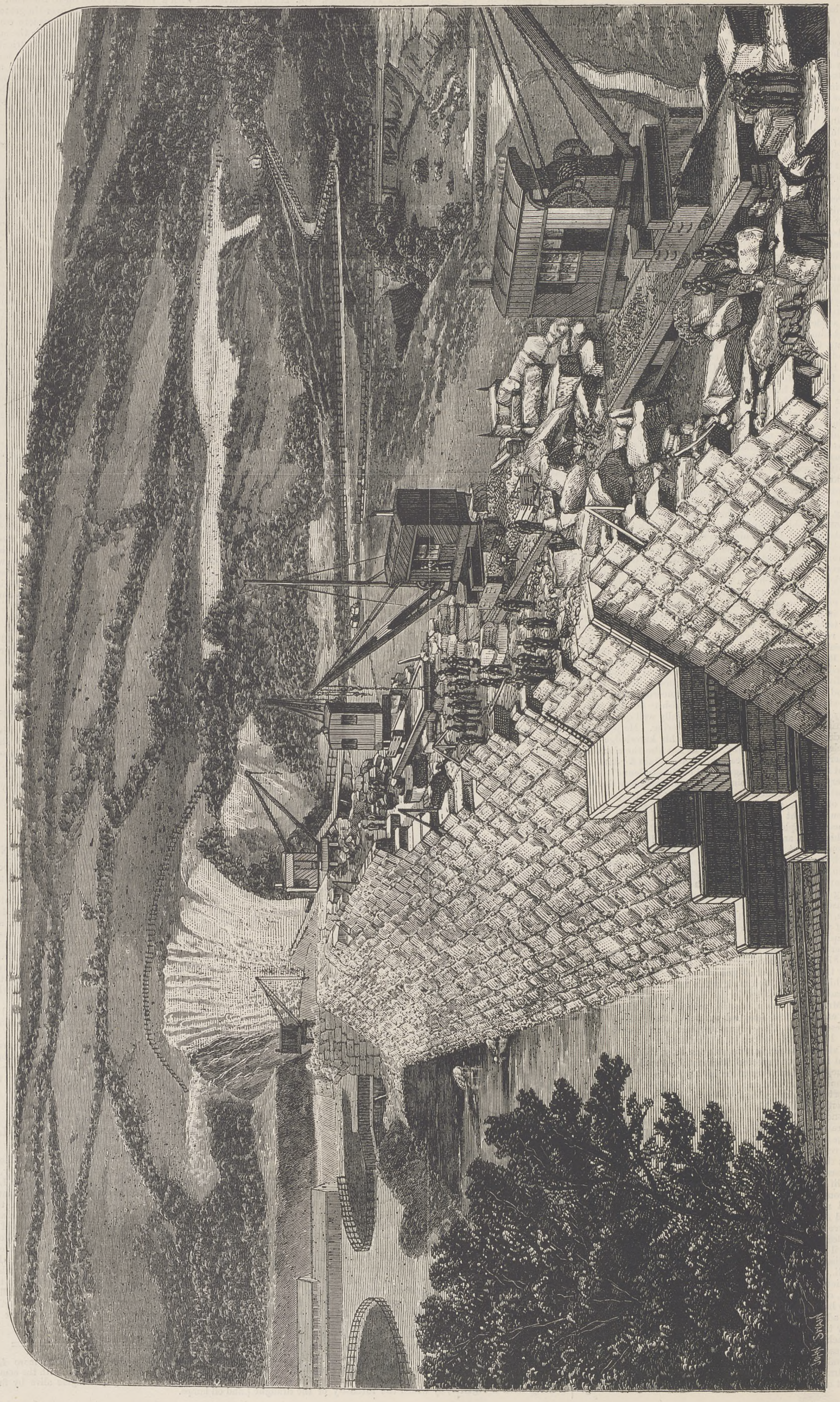
ON page 10 we publish a perspective view of the works in progress in the construction of the great masonry dam across a narrow gorge in the valley of the Vyrnwy, near Llanwddyn. A very large part of the dam is hidden more than 50ft. under the ground, seen in this view, and although the engraving, which is from a photograph by Messrs. Robinson and Thompson, of Liverpool, gives some idea of the magnitude of the structure as far as advanced when the photograph was taken—now about six months ago—it really gives an inadequate idea in this respect. For instance, it would scarcely be gathered from it that the cutting in the distant hill-side into which the end of the dam will be built, is a quarter of a mile from the foreground of the picture, though it is quite that. We shall publish other views in another impression, which will, further illustrate the structure, and we shall at the same time give a general description of the whole.

AMERICAN RAILWAY ACCIDENTS.—Two more fearful railway accidents are reported from the States with the common American accompaniment of roasting passengers alive by fire from stoves and oil lamps.

THE VYRNWY MASONRY DAM IN COURSE OF CONSTRUCTION FOR THE LIVERPOOL WATER SUPPLY.

MR. THOS. HAWKSLEY AND MR. GEORGE F. DEACON, MM. INST. C.E. ENGINEERS.

(For description see page 7.)



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*** *With this week's number is issued as a Supplement a Two-page Engraving of Dredgers for the Bristol Corporation, and for the West Indies. Every copy as issued by the Publisher contains this Supplement, and subscribers are requested to notify the fact should they not receive it.*

CONTENTS.

THE ENGINEER, January 7th, 1887. PAGE

TO CORRESPONDENTS.

Registered Telegraphic Address "ENGINEER NEWSPAPER, LONDON."

*** *All letters intended for insertion in* THE ENGINEER, *or containing questions, must be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever will be taken of anonymous communications.*

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PROVINCIAL PATENT AGENT.—*A letter lies at our office for this correspondent.*

H. H.—*We cannot suggest any book more likely to suit your purpose than Rigg's "Treatise on the Steam Engine."*

J. A. S.—*We have not heard of any triple-expansion land engines. There are, however, many firms who are quite prepared to take orders for them.*

CHINGFORD.—*Whether the boiler is or is not safe depends on the length of the fire-box, which you have not stated. If the box is very short, it will be strong enough; if long, the box must be stiffened by having an angle iron ring put round it.*

E. A. J.—*You can obtain full information about the qualifications of a marine engineer by applying to the Board of Trade. A series of articles on the subject appeared in* THE ENGINEER *some years since, but the numbers containing these articles went out of print long since.*

W. B.—*It would be useless to publish your inquiry, for you might receive fifty replies, all containing different suggestions. There are only two really satisfactory methods of using water heavily charged with lime in a steam boiler. The first consists in heating the water in a separate vessel to a boiling temperature, when the lime, which is insoluble in hot water, will be thrown down. The second consists in purifying the water by Clark's or some such process; that is to say, add quicklime to it, stir well, and allow it to settle. As for the rest, common carbonate of soda is as good as anything else to add to the feed-water, taking care not to use too much.*

LINING CISTERNS.

(To the Editor of The Engineer.)

SIR,—Can any of your numerous readers tell me as to the best preparation for the covering of the inside of hot-water cisterns in which the water is often at boiling heat, so that rust may be counteracted? Will ordinary lead paint serve the purpose? Or will limewash stand the effect of boiling water? The water being required for washing purposes, it is important that nothing should be used that will discolour the same.

Manchester, December 29th. J. D.

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MEETINGS NEXT WEEK.

THE INSTITUTION OF CIVIL ENGINEERS, 25, Great George-street, Westminster, S.W.—Friday, January 7th, 1887, at 7.30 p.m.: Students' meeting. Paper to be read:—"Experiments on Steam Engine Economy," by Mr. Edward C. de Segundo, Stud. Inst. C.E. Tuesday, January 11th, at 8 p.m.: Ordinary meeting. Paper to be further discussed:—"The Use and Equipment of Engineering Laboratories," by Professor Alex. B. W. Kennedy, M. Inst. C.E.

SOCIETY OF ARCHITECTS.—Tuesday, January 11th, at 7 p.m.: Ordinary meeting. Paper to be read:—"Party Walls and Easements," by Mr. Ernest Farman, solicitor.

CHESTERFIELD AND MIDLAND COUNTIES INSTITUTION OF ENGINEERS.—Saturday, January 8th, at 2.45 p.m., at the University Buildings, Nottingham: General meeting. Papers open for discussion:—"Notes upon the Report of the Royal Commissioners on Accidents in Mines," by Mr. A. H. Stokes; "Notes upon Safety Lamp Experiments, 20th November, 1886," by Mr. A. H. Stokes.

DEATHS.

On Wednesday, the 5th January, at 18, Fopstone-road, South Kensington, J. ARTHUR PHILLIPS, M.I.C.E., F.R.S., aged 64.

On the 26th December, the result of an explosion on board the steamer Petriana, at Birkenhead, ERNEST AUGUSTUS FAWCUS, C.E., of Liscard, Cheshire, the ninth son of ROBERT FAWCUS, of Norbiton, Surrey, aged 27 years.

THE ENGINEER.

JANUARY 7, 1887.

1887.

IF we except accidents, few things of engineering importance are hurriedly brought about or accomplished within a year; and hence, at the commencement of a new one, the old year generally seems to have passed away leaving us more concerned with what it has not done rather than with what it has. In looking back upon the year 1886, almost everyone will be most impressed with recollections of an ever present complaint of trade depression. The year has ended, and the new one commences with better prospects, and with proofs that much of the talk about the unemployed is fallacious. So much has, however, been written on trade depression that it is unnecessary to recur to it. Various trade representative bodies have found considerable trouble in giving the Royal Commission on the subject any really satisfactory information, and in many cases inquiry has forced traders to admit that part of the want of trade is due to their own shortcomings, while there are few trades which have not benefitted by the introspection to which depression has given rise. Engineering trades with the rest, and more than some, have been forced to learn the truth of what we have so often dwelt upon concerning a want of readiness to make what foreign customers require, instead of trying to make them require what it has been the British custom to make. Some severe practical lessons have been taught our manufacturers on this subject during the past twelve months; and now that demand is beginning to reach the extended means of supply, it must be hoped that some of these lessons will not be readily forgotten, and that the inertia of manufacturers will not again so soon cause them to give their foreign rivals the advantages which their superior readiness has in recent years secured them.

Leaving trade questions, and turning to those which have more seriously occupied scientific engineers during the past year than formerly, it is noticeable that civil engineers have given much more attention to questions relating to the structural values of iron and steel as employed in bridges, and to the design of bridges as affected by these considerations and by those of method of construction. An important paper showing the tendency of thought on this subject was read before the British Association by Mr. W. Shelford and Mr. A. H. Shield, and as we published this paper in our impression of the 10th September last, we need not do more than allude to it as an exposition of the lines of design and construction, which, as followed to a considerable extent by our competitors abroad, are giving them great advantages over our engineers and constructors, and the neglect of which is yearly reducing the growth of our foreign orders for bridge construction. Not only has the British adhesion to rivetted structures led to the absence of the necessary appliances for the construction of pin and link bridges; but the adoption of these appliances abroad has established great foreign bridge works and a reputation for ability to do what we are supposed to be unable to accomplish. In a measure this is right, too, for English civil engineers are buying bridges abroad for the all sufficient reason that they can get what they want unfettered by adherence to old customs and at a lower price than they can get an inferior article at home. The rivetted system of structures has its place now as ever; but it must be employed with more attention to fitness in design, proportion, and work, and not exclusively, but side by side with other systems. English engineers are also beginning to look more carefully and earnestly into the questions which affect the stability of bridge structures; especially as far as this is affected by the stresses brought to bear upon them by the difference in the nature of the stresses in different parts, and also by change in molecular condition, the result of vibratory fatigue. With the ever-increasing loads and speeds on our railway bridges, and with the necessity for keeping down weights as much as it can be wisely done, it becomes more and more important to study the resistance of their materials as affected by the conditions under which they are employed. These conditions are not what they were forty years ago, and we must therefore recognise the importance of overhauling our rules of construction; and especially does it behove our engineers to insist upon the recognition by the Board of Trade of the necessities imposed by modern development in structural requirements, and the employment of modern materials both at home and abroad. The restrictions at present in force are antiquated, obstructive, and destructive of our reputation and trade abroad. In this connection we must refer our readers to the article by Professor Unwin on the resistance of materials, which we published on the 10th ult. and to that in the present impression.

To the writer of any part of this annual review of the work that has been done, and of that which is in progress, much of the pleasure that might attach to the task is lost by its yearly sameness. This is less noticeable, perhaps, in that part which deals with the more strictly mechanical branches than in that which deals with the work of what has so long been known as civil engineering. This, however, lessens in a small degree year by year, in proportion as the mechanical engineer invades this older branch with new methods of construction, or new machines and appliances with which to execute the work. Even in the construction of docks, harbours, and breakwaters this is specially noticeable; for with the powerful modern machinery now available for executing all these, new methods of construction are adopted, with the result that works are much more rapidly carried out, if not at much less expense. The "Proceedings" of the Institution of Civil Engineers afford indications of this direction of change in engineering. Out of seventeen papers read and discussed during the session 1885-86, at least half were papers more of the mechanical and physical order than of the kind that comprised the work of the civil engineer before civilian engineering became so large a factor in the world's progress and occupation. Some idea of the extent to which engineers afford work for others as well as themselves may be gathered from the fact that on the 2nd inst. the sixty-ninth anniversary of the Institution, there were on the roll 20 honorary members, 1556 members, 2231 associate members, 488 associates, and 929 students, together 5224, or an increase in the past year at the rate of $5\frac{1}{4}$ per cent.

In railway engineering of the past year there has been little to which special attention has been attracted. Probably the most noteworthy piece of completed work is the Severn Tunnel,[1] which has occupied space in our annual retrospect for many years. It has been one of the most interesting of works to engineers, because attended by so many and stupendous difficulties. With all these, however, our readers have been made familiar, and we have here only to mention that the first mineral train ran through it on the 9th of January last, and showed how great is the advantage gained by its completion by landing in Southampton, before nine in the evening, a train load of 140 tons of coal that was cut in the Aberdare Colliery in the early morning of the same day, the train leaving Aberdare at 9·50 in the morning.[2] Regular mineral traffic commenced on the 1st of September last. The first passenger train passed through the tunnel on the 1st of December last,[3] and a passenger train service has been maintained since; but the fast main line through traffic into Wales, *viâ* the tunnel, will not commence until the completion of the connecting lines a few weeks hence. It may be noted that the first sod was cut in the commencement of this work in March, 1873. The Great Western Company commenced the work itself, with Mr. Charles Richardson, M.I.C.E., the projector of the tunnel, as the engineer. Sir John Hawkshaw was appointed consulting engineer some time later, in conjunction with Mr. Richardson. Four times have the works and portions of them been flooded. The Great Western Railway Company had driven the headings from either end to within 120 yards, when, in 1879, they tapped a land spring on the Monmouthshire side of the river, and it flooded the whole of the workings in twenty-four hours. Negotiations were opened with Mr. T. A. Walker, who undertook the work from that time, and with powerful pumps got the tunnel clear of water by November, 1880. The minimum cover or thickness of river bed and rock over the tunnel was then 30ft.—beneath the dip of the shoots—and the maximum nearly 90ft. On the recommendation of Sir John Hawkshaw the level of the tunnel was lowered 15ft., thus increasing the minimum cover between the river bed and the crown of the tunnel to 45ft., and the maximum to nearly 100ft. In April, 1881, considerable progress had been made with the finished brickwork from the sea-wall shaft, when an irruption of water took place, and mastered the pumps. A hole of about 10ft. square was found in the marl at the bottom of the salmon pool near the Gloucestershire shore. This was overcome by filling in with clay puddle, and covering in with a mound of clay puddle in bags, and the pumps rapidly cleared the flooding. The junction of the headings driven from either side of the Severn was made in September, 1881, and progress continued till October, 1883, when the great flooding took place on the Monmouthshire side, where the old spring of 1879 was again tapped, and the water poured in at the rate of 17,000 gals. a minute—4ft. an hour—and flooded a large portion of the completed tunnelling beneath the river. With the aid of four new pumps the works were again cleared, and the great spring dammed back by the masonry and massive brickwork. In the same month a huge tidal wave sweeping over the marsh on the Monmouthshire side, poured down a shaft, and flooded that section; but this mishap was soon remedied, and from that time the engineers successfully contended with the land springs that have added so greatly to the difficulties of this the most remarkable tunnel in the world. Pumping machinery has been erected capable of removing 26,000,000 gals. of water per day. The total cost of the tunnel has been about £2,000,000, the tunnelling alone costing about £100 per yard. Pumping the great influx of spring water now costs the company a large sum, but as the water is good potable spring water, it must be hoped that the company will eventually be able to sell it for the water supply of a town or towns at no great dis-

[1] THE ENGINEER, 26th September, 1884; 11th September, 1885.
[2] THE ENGINEER, 19th January, 1886, p. 47.
[3] THE ENGINEER, 3rd December, 1886, p. 449.

tance. Already some steps have been taken towards the formation of a company for this purpose, and with the object of obtaining the water for Bristol, and ultimately as a Corporation scheme. Negotiations which had some time ago been opened between the Corporation and the present Water Company failed, but it is desired in Bristol that the Corporation should have the control of the water supply of the city, and a Bill which has been drafted with a view to the Severn Tunnel supply contains a clause enabling the Corporation to exercise all the powers of the Act on payment of the cost and expense incident to obtaining it, and sums expended by the company in exercise of its powers, with 5 per cent. interest. The proposed capital is £480,000, in 48,000 shares, with borrowing powers to the extent of £120,000. When, however, at a recent meeting, a resolution in favour of the scheme was moved and unanimously carried, another was carried requesting the Corporation to avail themselves of the provisions of the Bill, and suggesting to them the desirability of reopening negotiations with the existing Water Company, for the purchase of their undertaking by the city upon equitable terms. If the tunnel supply scheme brings the Bristol Water Company down on its knees, will the former be wanted?

The Mersey Tunnel[4] was opened by the Prince of Wales on the 19th of January last,[5] and the traffic it has attracted has very materially reduced that of the great ferries, which developed from a small origin nearly eight hundred years ago. The work was commenced in 1879, and the boring from either side—much of which was done by the Beaumont boring machine—met, and a through passage was made, on the 17th January, 1884, the distance from shaft to shaft on either shore being 1770 yards. The tunnel is of large size, 26ft. in width and 23ft. in height—19ft. above the rails—and is in red sandstone. The tunnel is enlarged for the two shore-end stations, James's-street, Liverpool, and Hamilton-square, Birkenhead, to 50ft. 6in. wide and 32ft. in height, for a length of 400ft. The stations are large, and are reached by stairs and by large lifts, designed by the late Mr. W. E. Rich, and constructed by Messrs. Easton and Anderson. The lift-rooms are 20ft. by 17ft., and lift about 100 passengers at one time. Sir C. Douglas Fox and Mr. James Brunlees were the engineers of the work, and Mr. Waddell the contractor.

Amongst the proposed tunnels is one under the Northumberland Straits,[6] with a view to giving all year round communication between Prince Edward's Island and the Canadian mainland. A survey of its bed has been made, and it is proposed to lay an iron tunnel along this by a method which has been much talked of in America, and which consists in forming a tube across the bed by adding sections within a big shield which is hauled across the bay or river till it reaches the other side. A "submarine tunnel and tube company" in New York undertakes to lay a tunnel across the Straits in this way, and there does not seem to be any difficulties sufficiently great to prevent the construction of submarine tunnels in this mechanical manner. An interesting application of modern refrigerating machinery has been made in constructing a tunnel through the gravel ridge which separates the two parts of Stockholm.[7] Much trouble was met with in consequence of the difficulty of working in loose wet gravel under a hill partly covered with houses which might have been damaged by any settlement; a cold air machine was employed and the gravel frozen some feet in depth every night. By this means the tunnel was successfully completed.

A tunnel under the Sound between Denmark and Sweden is projected, and the respective Governments appear to be favourable to the scheme, but at present nothing has been settled. Several projects for another Alpine tunnel have for some time occupied attention. The object is primarily a new direct route from Paris to Milan. Three rival lines for the tunnel have been pressed forward for support; one the Simplon route, a second the Mont Blanc route, and the third the Great St. Bernard route. This rivalry has delayed the acceptance of either, but the Simplon route seems to be for many reasons, except political, the best, and the choice only now lies between it and the St. Bernard. The latter would be the shorter tunnel, considerably, the length being 9485m. as against 20,000m. under the Simplon, but it would lead to Turin and thence to Milan, and it thus loses what the French desire, namely, the shortest and most direct route in competition with the St. Gothard, which they imagine gives Germany so many advantages. Milan is, moreover, within easy distance of Venice and Trieste on the one hand, and thence, by connecting lines, with Bulgaria and Turkey; and on the other hand it is on the direct route to Brindisi. That in itself is a very weighty consideration, for even at present the goods and passenger traffic *viâ* Brindisi is exceedingly large, and it is easy to see how it would greatly increase if a more direct route were offered into Germany and France than at present exists; and this route the Simplon would undoubtedly supply. The opinion of those who are most competent to give one of any value, is that the Simplon will ultimately triumph; though, owing to the present state of feeling in France, the projectors of the St. Bernard may be able to keep their scheme before the public for some time, so long as they harp upon the strategic value of it over its rival. The construction of both lines simultaneously is proposed, and if the money can be procured there is no reason why it should not be, for each line would have its own particular value, and serve districts that are now unreached by the iron road. The more tunnels Switzerland allows into her territory the more will she be exposed to foreign invasion, and that she knows this is proved by the vast sum of money that is being spent in fortifying the Swiss end of the St. Gothard. The Channel Tunnel Company is still expending money on its project, apparently imbued with Sir E. Watkin's ideas as to the providential concatenation of events which will connect his pre-ordained existence in the world with the time when the silver streak shall be no longer necessary for the protection of England against foreign invasion.

Accounts which reach us concerning the Panama Canal are still very contradictory, but there seems to be no doubt that vast numbers of men are employed on the work, and an enormous quantity of money has already been expended. The United States agent at Panama sent in a much more hopeful report than has hitherto appeared from any of the United States writers.[8] He seems to be fully of opinion that there need be no doubt about the completion of the canal, and considers that, whether completed in 1889, as M. de Lesseps hopes, or a few years after, is, except perhaps to M. de Lesseps, a matter of not much concern, as it will when completed be of so much importance to the world that a few years can have little effect upon so great a result. Rapid progress is being made in the construction of the Isthmus of Corinth Canal,[9] between the bay of Corinth and the Ægean Sea—a very deep cutting, chiefly through chalk, which is being made under General Turr, who expects to get the work completed this year, and the canal opened early in 1888. Arrangements have been completed between the Suez Canal Company and the Egyptian Government, under which the latter receives £80,000 for the land necessary for widening the Canal to 144ft. between Port Said and the Bitter Lakes, and to 213ft. between these lakes and Suez, and it is expected that this work will soon be commenced. The proposed Manchester Ship Canal has passed through some remarkable phases during the past year. A contract for the construction of the canal and all the works connected with it was let in July to Messrs. Lucas and Aird for £5,750,000; but when, a week or two afterwards, Messrs. Rothschild invited public subscription of the necessary capital, practically no response was made, and even Lancashire showed no interest in the undertaking, although permission had been obtained to pay interest out of capital during construction. Another attempt is to be made to obtain the necessary money, but the promoters are reconsidering the whole subject. It is to be feared, however, that unbelief in the financial success of the scheme has obtained strong hold, and much difficulty will be experienced in showing shippers and importers not immediately on the canal that the cost of freight will be less than by railways, the owners of which have up to the present time succeeded in their efforts against the Canal in public influence, though not in Parliament. The twenty-five Manchester capitalists whom the Mayor of Manchester called together to investigate and report upon the soundness of the undertaking were not very likely to be chosen from those who hold the views which are general in Liverpool and many other places, and the Mayor must himself have seen how very transparent was his explanation of the failure of the syndicate to secure money, namely, that the moneyed people of Manchester were not sufficiently conversant with the facts to give them confidence in the undertaking. If the public subscription depends upon a better knowledge of the scheme than that possessed by the capitalists of Manchester, it will take a long time to get it. The arguments of the promoters must, moreover, be modified if anything is to be done. They must argue upon the local and special merits of the Canal itself, and not spoil their case by false analogies to the Suez or other works which are not a bit analogous in any sense, and can afford no data. In almost every country of Europe except Great Britain, inland navigation has received continued support from past times to the present, and as much attention is paid to it now as in years gone by. A proper distribution of traffic makes it possible for railways and canals both to earn profits and for traders to secure much more reasonable rates than can now be had in England for heavy goods. For a large portion of the heavy traffic the extra time consumed on the waterways is a matter of no importance, while the advantages beside the economy of water carriage are numerous. Our inland navigation, our canals, are fortunately the subjects of considerable attention and solicitude, and we may hope that some engineering talent will be brought to bear in conjunction with action of the canal traders, so that the existing canals may be made adequate to modern requirements, that new canals may be made; and the Great Western and London and North-Western, and the Staffordshire railway companies may be led to see the folly of their obstructive action in connection with the canals they control—about 1436 miles—and may be forced to permit traders the advantages which their competitors abroad enjoy. The Railway and Canal Traders' Association may be able to do something towards this. In Brussels it has again been proposed to make that city a seaport by means of a canal, and an English syndicate prepared plans and estimates; but Brussels thinks, if it is done at all, Belgium ought to do it. A new scheme for the old project of making Paris a seaport has been brought before the Minister of Public Works by M. E. Labadie, but without result. The project proposes extensive canalisation of the Seine and numerous new canal works by way of short cuts across the numerous long loops in the line of that river. In France much is being done in canal improvement; and the German Parliament has given consent to the construction of the Rhine-Elbe Canal, which will connect Dortmund and the Lower Ems, and provide water carriage way from a great manufacturing district to the North Sea, thus helping again to strengthen our competitors. The cost of this canal will be about £300,000, and about one-third of it will be provided by the coalowners of the Dortmund district. The canalisation of the Moselle is much talked of, and large sums of money are being expended, and to be expended, in the improvement of the channel of the Middle Rhine.

Canal projects are numerous in the United States, including one 200ft. in width from Chicago to the Illinois River, and affording communication between the Mississippi and Lake Michigan; one to connect Lake Winnipeg with the Canadian lake system, so as to tempt Canadian northwest traffic southward. In this the Red River would be utilised and communication will be opened up from the Mississippi through the lakes to Saskatchewan and Hudson's Bay country. In Europe the ship canal from Kiel to the Elbe mouth, by which German shipping will avoid the Danish coast, is the most important one in hand from a commercial and from strategic considerations.

In the construction of the Preston Docks in connection with the Ribble Navigation works,[10] considerable progress has been made by the contractor, Mr. T. A. Walker, although great complaints are rife concerning the very large expenditure on these docks, whilst comparatively little has been done in the extensive Ribble training and deepening works. There has been a good deal of meddlesome outside discussion and reporting in the matter, and although it may be true that in some respects sufficient experience in such works was not brought to bear on the scheme at its commencement, there can be no doubt that its execution is in the most able hands. The dock is 40 acres in extent, and there is an entrance basin of eight acres, and a lock 600ft. in length, with three pairs of gates, which are being constructed on the spot. The works were commenced just two years ago; the period for completion is two and a-half years from this date. The diversion of the river is about three-fourths finished, a fine channel a hundred yards in width, and much deeper than the old channel of the river, which is to be partly filled in with spoil. A very large portion of the concrete walls for the locks and basin is completed, and the whole is being constructed in concrete. More than half the excavation for the whole of the dock and the river diversion has been done. The only part that is behind is the dredging of the river channel from the dock to the sea, a distance of about twelve miles, and this is the work which it is contended ought now to be nearly finished, because the docks are of very little use until it is done. This work is being done by the Corporation and not by contract. They have purchased two fine dredgers from Messrs. Fleming and Ferguson, of Renfrew, and are getting a large fleet of hopper barges and tugs. One dredger and about half the hoppers are at work. They only commenced work, however, about two months ago, and of course have made little impression on the large quantity—about six million cubic yards—which they have to dredge.

In the construction of railways very little that calls for any special remark has been accomplished in the year. The railway Bills in Parliament in 1885 were fewer than for some time, and those presented in 1886 for the coming session are still fewer; and none of them present any special features. Abroad there are projects which are, however, in the present year not likely to interest English engineers much, except perhaps some of those in our Colonies. In different parts of Austria several lines are in progress, and the transcontinental line still occupies attention; attempts have been made to get the South Australian Government to agree to permit its construction by private enterprise; but before the House of Assembly broke up the following proposition was approved:—"(1) That it is expedient that the Transcontinental Railway should be forthwith continued from its present terminus in South Australia proper to Pine Creek, in the Northern Territory. (2) That it is expedient that the same should be constructed by the State or private enterprise. (3) That an address be presented to his Excellency the Governor, praying him to appoint a Commission to consider the matter and report." As the Government are against the creation of a monopoly, and as the value of the line is admitted, the work of the Commission can be little other than to suggest means of obtaining the necessary money. A good deal of interest is shown in the proposed Midland Railway of Western Australia. Of the country to be traversed by this line, Mr. R. Waddington has published some short but interesting descriptions.

The Winnipeg and Hudson's Bay Railway, which has for its object the better development of Manitoba and the North-West territory of Canada, and the shortening of the route from the great wheat-growing and cattle-producing districts of the United States and Canada to Great Britain, has made some progress. Contracts have been entered into for a considerable portion of the line, and the first forty miles from Winnipeg have been graded. For this length steel rails have been sent out from England and are now being laid under the superintendence of Sir Frederick Bramwell and Mr. W. Shelford.

The Transcaspian Railway was opened in July as far as Merv, and as a strategic line is perhaps of more importance to us than any line opened for some time. There are altogether 63 stations from Michailovsk, on the bay of that name on the Caspian, right through the deserts and oases of the Transcaspian, across the Amu Darya and Bokhara to Samarcand. These do not include the branch of 25 versts, made from Michailovsk along the Caspian coast to Ousun Ada, in order to have deep water for the connecting sea service, and to avoid the reshipment formerly necessary between Krasnovodsk and Michailovsk. The distances between these stations vary from 15 to 33 versts, being in most cases from 22 to 25 versts. The whole distance of the line when completed as far as Samarcand will be 1335 versts. Russians may travel by this new railway right through the Transcaspian Steppes, over the Oxus, and from one side of Bokhara to the other, coming out at Samarcand, in about a day and a-half.

The article in the Treaty of Peace of July, 1885, between France and China, by which it was understood—not demanded—that China should give French contractors the preference when China commenced to construct railways, caused a good deal of stir during the year, and so far led people to think that China meant to begin railway work, that American and German companies sent out representa-

[4] THE ENGINEER, 7th December, 1883, p. 450; 2nd January, 1885, p. 10; 14th August, 1885, p. 124.

[5] THE ENGINEER, 22nd January, 1886, p. 61.

[6] THE ENGINEER, 18th June, 1886, p. 493.

[7] THE ENGINEER, 9th April, 1886, p. 282.

[8] THE ENGINEER, 8th October, 1886, p. 284.

[9] THE ENGINEER, 8th October, 1886, p. 282.

[10] THE ENGINEER, 20th June, 1884, p. 459; 17th July, 1885, p. 54

tives and expended large sums; an American agent, General Wilson, going so far as to make a tour through the Upper Hoangho valley, and to prepare plans for railways, for which he got the thanks of the Chinese ministers and the assurance that they did not contemplate railway construction.

The Euphrates Valley Railway scheme has, as usual, cropped up and been trotted out, but gets no further; while the latest scheme relating to the same country is that of a Frenchmen, M. Eude. It has lately been laid before the Academy of Science. M. Eude proposes to cut a canal through Syria and Persia, and thereby unite the Mediterranean with the Persian Gulf. It would start from Antioch, opposite the island of Cyprus. A portion of the Orontes would be canalised. The most difficult part to execute would be cutting through the mountains leading to the Euphrates, which would also be canalised as far as Babylon. From that town to Bagdad an artificial canal would enable ships to reach the Tigris. Finally, the Tigris and Chatel-Arab would be canalised up to the Persian Gulf. The *Paris*, commenting on the project, fears that England would object to it unless she had command of it. Her jealousy would not allow France to monopolise it. However, "generous France, in the interest of progress and humanity, would probably cede the brilliant idea to England, if she would only consent to carry it out."

The proposed Congo Railway fell through during the year, the Syndicate and the Congo State Government not being able to agree as to terms. There is, however, little doubt that this project will again come forward in London, and before long several other railways in Africa, especially between the Kimberley district, the de Kaap mining district, and the East Coast.

In South America, works of public utility have made considerable progress. In Brazil the Bahia and San Francisco Railway extension to Timbo has been almost completed, the Bahia Central Railway has been finished, and several other railways owned by private companies have also been extended. During the coming year the harbours of Bahia, Pernambuco, and Santos will be commenced. In the Republic of Uruguay, amongst the works commenced during the past year are the new port for the city of Monte Video, and the extension of the Central Uruguay Railway to the Rio Negro. Numerous railway works are projected. In the Argentine Republic, the Great Southern Railway has received an accession of two important branches. The extension of the Buenos Ayres and Rosario Railway has been completed to the city of Rosario. The Buenos Ayres and Pacific Railway has also been opened to public traffic throughout, and its connecting link with the capital is in course of construction. Amongst the works about to be commenced are a harbour for Buenos Ayres, and railways in the Provinces of Entre Rios, Santa Fé, Mendoza, and others. In Peru public works have made little or no progress, the country having as yet not recovered from the influences of the late war. Amongst the works projected are the completion of the Oroya Railway to the celebrated Serra de Pasco silver mines, and railways from the capital to Pasco and Ayacucho. Also the development of the petroleum industry, which is of an extensive and valuable character. In Venezuela, the public works inaugurated during the past year are the La Guayra Harbour Works and the Central Railway of Venezuela. Amongst the public works projected are the Porto Cabello port works, the Bruzual Railway, and other railways.

The great Forth Bridge[11] has made considerable progress during 1886, and it is expected that it will be completed this year. The Tay Bridge is nearing completion, and if opened by the 25th September, it will be the second time in ten years that the Tay has been crossed by the longest bridge in the world. The old bridge was opened on the 25th September, 1877, and wrecked on 28th December, 1879.

The great bridge over the Hooghly,[12] for the East Indian Railway, is nearing completion; the second of the two great 420ft. girders was successfully placed in position on the 13th ult.; and the Sukkur[13] Bridge has had its rehearsal erection on the Isle of Dogs. The latter bridge has the distinction of being the ugliest bridge ever constructed. The Municipal Council of Paris made a choice last June of a metropolitan railway, the route being one which will involve about half its length in tunnelling, about one-third in cutting, and the remainder on viaducts. It includes a line for traffic like that of our underground lines, and other lines for connecting all the main lines.

Tramway constructors have had a good deal of work during the year, though not so much as in 1885 or 1884. There are about 870 miles of tramways in this country, of which there were 752 in 1884. Steam has been put on some lines and taken off others after extended trial. Cable tramways are being laid in Birmingham, and the system is gaining support, although few more lines will probably be worked upon it until more experience has been gained in this country. Experiments are still being made with electrically-worked tram-cars, considerable experience with one form of which has been gained with the Blackpool lines,[14] and on the Bessbrook and Newry Tramways[15] with another system. At present it is difficult to say which of the several systems of working electrically will be adopted—that which employs secondary batteries, or those with conductors on the ground as with the Bessbrook and Newry, or underground as with the Blackpool. The trials carried out last year at Antwerp secured some valuable information relative to different systems of motors, but they were not sufficiently representative of the various conditions and circumstances of tramway working to be of more than comparative value.[16]

11 The Engineer, 1st January, 1886, p. 12.

12 The Engineer, 23rd January, 1885, p. 62; 13th February, 1885, p. 124; and 20th February, p. 153.

13 The Engineer, 30th July, 1886, p. 83.

14 The Engineer, 1st January, 1886, p. 4.

15 The Engineer, 8th January, 1886, p. 29.

16 The Engineer, 29th January, 1886, p. 87.

The Rowan steam car gave the greatest amount of satisfaction and received a gold medal, but the preference and the highest award was given to a Belgian car worked by means of secondary batteries. The latter system has the one advantage that every car is provided with its own motor, and is so far complete and can work on ordinary tramways; but all are not yet agreed as to the ability of secondary batteries of moderate weight to stand the heavy jarring which tramway service involves. Concerning tramways and light railways much might be written. There is no doubt that much might be done in working light railways or tramways with light stock if the system could be carried on with less unremunerative capital than is at present always called for to pay for the expensive promoting and non-paying services. There are many districts in which an economically constructed and equipped omnibus service would be profitable if the cost were represented by that actually paid for construction and working; and many of the little branch lines in this country which are now only suckers on the main lines, instead of feeders, might be made into paying lines if worked as steam tramways.

In the construction of waterworks, and especially for supplying small towns, a good deal has been done in the past twelve months, as our pages have shown, but much more ought to be done, and will be done, in this direction when the Local Government Board is less cumbersome and less desultory in carrying out its work, and when the manufacturers of small motors and pumps are more alive to the simplicity and economy with which villages could be provided with the necessary plant and piping. In towns the pomp and circumstance of the usual mode of procedure is necessary, but in villages almost all this can be dispensed with.

In large towns, and especially in those in which the demand for water is reaching the limit of supply, much remains to be done by judicious application of the waste-prevention system and waste-water meters. The public is gradually learning that this does not in the least mean a reduction in the quantity available for each house, but only a reduction of that which at present goes to waste, chiefly underground. There are towns in which there is at present fear that new sources of supply will have soon to be looked for, but in which that might be postponed for many years by preventing, as has been done at Bradford[17] and elsewhere, the enormous waste which at present goes on. London is one of the most conspicuous examples of this.

During the year a great deal has been heard of the bacteriology of water, and Dr. Koch's method, instead of superseding the volumetric and gravimetric analysis, as it was proposed to do, has been found to be something like a fifth wheel to a coach for most purposes. It has succeeded in creating some alarm, but people will get over this, and estimate the value of its cause much as they do now the "previous sewage contamination" pretensions. The micro-organism method has proved too much, and has shown itself useless in potable water questions. By its aid micro-organisms have been discovered in numerous samples of well water, which could not possibly have been contaminated in any way, and which would have been declared good if judged by the results of a chemical analysis. On the other hand, water which, after a chemical analysis, would have been considered unfit for drinking, and which was, as a matter of fact, polluted with sewage matter, has in some instances been found remarkably free from bacteria that had reached development. The conclusions which might be drawn from such an examination are, in fact, generally the very reverse of those arrived at by the aid of an analysis, and the latter must at present be considered the only criterion in judging of the purity of a specimen of water.

Amongst the works for water supply, that on the largest scale in progress in this country is the Vyrnwy[18] reservoir and dam for the Liverpool supply. Of this we publish this week the first of some engravings and particulars, and need not dwell on them here. In America, some large works are in progress, including extension of the New York supply, involving the construction of a very large high dam, and a new Croton Aqueduct, with which considerable progress has been made during the year, and a good many lives lost.

In the construction of the Cant Clough reservoir dam for the Burnley Corporation a dead-lock has occurred owing to the refusal of the contractor—who will be responsible for the security of the dam for some time—to continue with the work as at present ordered. The trench for the puddle centre of the dam has been sunk to a great depth, 160ft. to 190ft., and an enormously heavy timbering has not only become necessary, but has constantly to be renewed or reinforced. The contractors say that the strata even yet reached is not sufficiently water-tight; and that if the puddle wall be proceeded with the water will permeate and endanger the dam. The engineer is equally satisfied that there are no grounds for such fear, and both contractors and engineer have had reports from outside strengthening their opinions respectively. Meanwhile the works are stopped.

During the year some costly experience regarding sea-wall and groyne construction has been afforded by the heavy storms, and much of it goes to prove the unsuitableness of solid groynes in many situations. In many places the mistake has been made of erecting a few very heavy and costly groynes, when what is really required is a large number of small groynes or a sea wall. Some useful suggestions for new methods of using concrete for harbour and shore works were made in some papers recently read before the Institution of Civil Engineers.

In dealing with the progress of mechanical engineering, it is always advisable to consider the future in the light of the past, for from the past we learn what our wants are, and to the future we look for the means of satisfying them. The history of mechanical science proves unmistakeably that while the progress of the mechanical arts

17 The Engineer, 26th November, 1886, p. 431.

18 The Engineer, 15th January, 1886, p. 42; 5th February, p. 99; 4th June, p. 439.

has been due far more to individual mental capacity than to the results of training or education, yet that, lacking training and education, the men who make advances are very few in number. In other words, great natural abilities will supply lack of book learning; but the man who has small ability and little learning makes no progress whatever. The learning most suitable to the mechanician is a speciality which cannot be derived from books or lectures, although both extend, develope, and supplement it. It is the absence of such a special training which beyond question renders the inventive work of the world at large so unfruitful. Since the Patent Act of 1883 came into existence an average of about seventeen thousand inventions per annum have found their way to the Patent-office. We shall probably be over the mark if we say that 1 per cent. of these inventions has been used for any purpose or in any way. Indeed, it is well known to all those who are familiar with the progress of mechanical engineering that cheap patents have done inventors practically no good. We have always argued that an invention likely to be of service was worth spending £25 in patenting. Nothing has occurred during the last three years to make us alter our opinion. An immense flood of rubbish has been poured into the Patent-office; but the great army of inventors, who we were assured were only prevented by relentless fate and an oppressive patent law from revolutionising the world, have achieved practically nothing. We cannot stop to dwell on this subject now; but we may point out that the failure to win victories has not been due to the want of fields in which to conquer, as will, perhaps, be admitted by most of our readers if they will follow us a little further, even if they are not ready to concede the point now.

The past year has, perhaps, been more remarkable than its predecessors for the energetic attempts which have been made to effect economies in production in every direction. To go at length into the consideration of a subject so widespread and of such tremendous importance would, of course, be out of the question within the space at our disposal. We can do little more than touch the fringe of it.

In railway work the desire of all locomotive superintendents is to reduce working expenses and to maintain efficiency. The demands of the public and the competition for traffic, on the other hand, continually tend to augment these expenses. The public ask for larger and more comfortable vehicles, and higher and higher speeds. The percentage of dead weight augments. It has been found that, on the whole, large and heavy engines are more economical than smaller and lighter machines; and this we say while holding that in many cases weight has been pushed to extremes without securing any corresponding advantage. Steel rails have rendered it possible to use with success and economy weights which without their aid could not have been adopted; such, for example, as 19 tons on a single pair of drivers. Great dimensions secure, as a rule, economy in repairs of engine, and certainty that time will be kept. But they do not necessarily entail economy of fuel; and in pursuit of this the compound system is now being tried on various railways. Concerning the results obtained by Mr. Webb, we have nothing to add to what is already known. Our own personal experience contradicts certain statements made to the effect that his engines cannot run at high speeds. As to their comparative cost for repairs, oil, and fuel, nothing is accurately known outside Crewe. Mr. Webb is satisfied with them, and he ought to know best.

Following Mr. Webb very closely in point of time, Mr. Worsdell, while locomotive superintendent of the Great Eastern Railway, built several compound engines on Worsdell and Borrie's patents. One of these has been illustrated and fully described in The Engineer for May 15th, 1885. Mechanically these engines have been perfectly successful. The coal accounts show that they burn about 4½ lb. less coal per mile than other engines, non-compound, working similar traffic. Mr. Worsdell, since he has assumed the post of locomotive superintendent of the North-Eastern Railway, has built the first compound goods engine constructed. This we regard as a most interesting experiment, because we have always urged that it is in goods engines compounding will do most good. We shall illustrate and describe this engine fully in an early impression. It presents more than one novel feature. We recently rode from York to Darlington on this engine with a load of forty-seven wagons and brake vans, of which seventeen were empty. The distance, about forty-one miles, was done with ease in the allowed time, a little under two hours, with two stops for signals. The performance of the engine left nothing to be desired. Steam was easily maintained at 130 lb., and this with an abnormally large blast pipe. The coal, too, was North-country small, and required careful handling to prevent smoke. The engine has been too short a time taking its turn in regular work to permit much to be said concerning fuel; but roughly speaking, the saving appears to be about a ton and a-quarter per week, as compared with the best goods engines of the normal type doing the same work. Mr. Worsdell has also built a very fine compound express engine, which we shall illustrate; but this engine has only just begun to work the Scotch express from Newcastle to York. On its first regular trip a speed of sixty-nine miles an hour was easily obtained with the regular train, two minutes being saved between Newcastle and Darlington. Nothing more can be said as to economy at present than that the engine keeps steam at 175 lb. with ease, and that it appears to be light on coal.

On the Great Western Railway Mr. Dean has for some months been experimenting with two four-cylinder tandem compound locomotives, but owing to various circumstances, delays have unavoidably occurred; and as the engines are not yet in regular work, it is impossible to say anything about their relative economy. Mr. Holmes, of the North British, has also been experimenting with a tandem locomotive, illustrated in our pages on the 22nd October. He states that this engine is about 2 lb. per mile better than the newest normal engines that he has built, and 5 lb.

better than the older engines. This sums up all that can be said about compound locomotives in this country. Abroad they are being tried under various conditions, but the information we have been able to obtain concerning their performance is too vague and indefinite to possess any value. It is probable, however, that the problem will be solved one way or the other during the ensuing year. It is worth while to quote here the opinion of a very able locomotive superintendent, in charge of a great line in the North; and we do this with the more pleasure that, as will be seen, he endorses our view that it is with heavy goods traffic the advantage, if any, is to be gained by compounding:—"The pioneers of compounding have commenced at the wrong end of their work. I have pointed out from the beginning that, if any gain could possibly be obtained, it would be by constructing an engine to work mineral trains long distances, where the load is constant, and the proportions of the cylinders could be arranged so as to make the best use of compounding; but for passenger express, or trains where the load is intermittent, it is, in my opinion, a delusion and a snare, and I am not inclined to attempt to 'leave the substance and follow the shadow.' I have no hesitation in saying that a simple engine of the modern type, built at the present day, costs less for up-keep, less for fuel, and gives more satisfaction in every way, than any compound that has yet been, or is likely to be, introduced. There is yet considerable room for improving the locomotive engine, but it is not in the direction of compounding."

Many of the railway companies are developing their constructive resources. Thus the Lancashire and Yorkshire Company has in hand a splendid set of shops near Newton Heath, and Mr. Aspinall, recently locomotive superintendent of the Great Southern and Western Railway of Ireland, has been appointed chief mechanical engineer of the line—a new appointment on English railways. For the last four years Mr. Drummond, of the Caledonian Railway, has been busy extending, rebuilding, and reorganising the works of the company at St. Rollox, and they are now completed with the exception of the offices still in progress. During the half-year which ends in January, 1887, fifty new carriages were turned out, fitted with gas, and heated by exhaust steam, with which the company has had several trains running the last two winters, with results so satisfactory that Mr. Drummond is now fitting up the whole of his trains to be heated by this means. It is to be hoped that southern companies will see their way to follow his example. Twelve large engines have been built for goods traffic and six for passenger. The two engines that were on view at the Edinburgh Exhibition have been delivered to the company. The sand blast has proved so successful that its use is being extended. It will be remembered that this sand blast consists in blowing sand under the driving wheel with a small jet of air taken from the Westinghouse compressed air reservoir.

In The Engineer for February 6th, 1885, we illustrated the splendid express engines built by Mr. Johnson for the Midland, with 19in. cylinders and 26in. stroke. These engines have been found deficient in heating surface, and in new engines of the same type Mr. Johnson has given 250in. of extra surface with the best results. It is, as we have pointed out ere now, of no use whatever to give the ordinary class of locomotive engine-driver a big cylinder and tell him to work it expansively. He will not do it; and the result is that, to use a very expressive phrase, he "runs his engine out of breath." We seldom or never hear of an engine failing to do its work because the cylinders are too small for the boiler. On the other hand, all experience goes to show that engines fail continually by having too small a boiler for the cylinders. One of the causes of the continuous success which has attended Mr. Stroudley's locomotive practice on the London and Brighton Railway is that he never spares heating surface. A big boiler means economy of fuel and certainty of working under all conditions of train and weather.

As regards railway carriage and wagon work, there is nothing novel to record. All experience seems to be in favour of the use of iron or steel under-frames in lieu of wood.

A good deal has been heard during the past year concerning automatic couplings for goods wagons, and various experiments have been carried out with different systems. We have said little on the subject, because we do not, we confess, believe in the system. The difficulties which would be encountered in introducing a good coupling, supposing one existed, would be enormous; and as it is very improbable that only one would be adopted out of the scores which are ready for trial, each company—nay, each wagon owner—would adopt something different from any one else, with a result which may be better imagined than described. But beyond all this, the whole problem has been solved long ago on the North-Eastern by the use of an ash pole with a peculiarly-shaped hook on the end. A little dexterity, easily acquired, is needed by the shunter using this simple instrument. As to its success, it will perhaps suffice if we say here that at a recent competition, shunters armed with these poles easily beat the mechanical couplings in time and certainty. It is much to be desired that the use of the pole should be extended. It is, we are happy to say, gradually finding its way on to other lines.

Concerning the progress made in railway brakes, we have little or nothing to add to the information on the subject with which we have kept our readers supplied. All the brakes which enjoy favour have been illustrated in their most recent developments in our pages. We see no reason to alter the opinion we have steadily expressed for years, namely, that while two or three other brakes are capable of doing good service, no brake in use is so perfect, complete, or satisfactory all round as the Westinghouse automatic. The great defect in this brake has been the bursting of the hose pipes, due mainly, we believe, to the "perishing" of the canvas. We understand that this difficulty is in a fair way of being completely overcome by two or three methods. On the North-Eastern the hose is now wrapped with tarred twine, and the results have proved eminently satisfactory. We fancy, although we may be wrong, that the trouble has been from the first more one of money than anything else, the outlay on hose pipes required to fit up a great railway system throughout being considerable.

We have been able to do little more than glance at a few of the more prominent features of the mechanical engineering of railways. We have now to indicate directions in which improvements are needed. First among these comes communication between passenger and guard. It ought to be possible to do this by telephone much better than it is done now. The warming of railway carriages still remains, as a system, wretched in the extreme. Nothing can, perhaps, be worse than the hot-water foot-warmer, save, perhaps, its universal absence on metropolitan lines. We trust that the system of steam heating may be rapidly extended; there is nothing whatever to preclude its universal adoption, save expense, and that is not heavy. Although the block system works well, it is not perfect, and a snowstorm or a fog renders it useless. Improvements are wanted in sound signals, calculated to take the place of visible signals in fogs. Very little has been done in this direction, probably because it has not yet been taken up by any competent railway man. A good sound-signal system would prove of very great value on metropolitan lines, and it does not appear to us essentially necessary that the detonating system should be retained. The labour of working points is very great, and we are surprised that more has not been done with the electrical, hydraulic, and pneumatic systems which have been tried from time to time.

The word "pneumatic" suggests one of the systems of supplying motive power now much discussed. It is quite unnecessary that we should stop to enforce here the truth that a great demand exists for the supply of small quantities of power at moderate charges in all great cities. Three systems are more or less in use—the pneumatic, the hydraulic, and the steam. The electrical system will perhaps be used—some day. It is probable that during the present year the air-under-pressure system will undergo very considerable development both in this country and in France. The most recent development of pneumatic power, however, has taken place in France. On the 24th of December, 1886, at the annual general meeting, La Société d'Ecouragement awarded a prize for small motors to be worked on the vacuum system, to MM. Petit and Boudenoot, who have carried out together the first application of the system in the Saint-Avoye quarter of Paris. Air pumps are placed in a central position, and exhaust the air from mains. It is only necessary to connect a little engine with these mains to have sufficient power for all domestic and small manufacturing purposes, without dust, wet, heat, or smell. The central installation is situated in the Rue Beaubourg. A horizontal Corliss engine, indicating 90-horse power, with a suitable air pump, was started some months ago. Since then two other engines have been added, and the total available power is 300 horses. The total length of the mains is nearly 3000 yards. If we may be allowed to use the word, vacuum is supplied to the houses just as gas is laid on, and it is only necessary to fix an india-rubber tube at one end to the exhaust pipe of a little oscillating engine, and at the other to a small nozzle fitted in the wall, and to turn a tap, and a lady finds her sewing machine driven without trouble. The artisan can run a lathe in just the same way. The system has so much to recommend it, that we believe it will become popular. At all events, we understand that the results obtained so far in Paris are so successful that MM. Petit and Boudenoot are preparing to extend their field of operations.

The bisulphide of carbon engine is again being tried in the United States, under the sonorous title of "the triple thermic motor," and a company has been formed and is working the engine. The vapour generator is simply a cylindrical tubular boiler, having a perforated dry pipe suspended in its vapour space and incased in a shell forming a steam jacket. A condensing engine, having a steam-jacketted cylinder, is used, and even the pipe from the generator to the engine is steam jacketted, but with steam at a higher pressure than that in the jacket of the generator, in order to superheat the vapour. In addition to these, there is a heater containing a coil-pipe, through which the condensed bisulphide is returned to the generator, and around which the exhaust vapour passes on its course to the condenser; a surface condenser, and a small auxiliary, through the tubes of which water first flows, thence through the tubes of the main condenser; a vacuum or air pump; a reservoir, for receiving the liquid from the condenser; a boiler feed pump, which delivers the liquid to the generator; an automatic pressure-regulating valve for controlling the admission of steam from the boiler to the shell surrounding the generator, and operated by the pressure in the generator; an automatic temperature-regulating valve, for controlling the temperature of the steam in the jacket surrounding the conduit and cylinder of the engine; a steam trap and a washer. The volatilised and superheated bisulphide vapour is admitted to the steam-jacketted cylinder as steam would be, and, after doing its work, it is exhausted from the engine through the heater and condenser; from thence it is drawn by the vacuum pump, and delivered through the auxiliary condenser, to insure perfect condensation; thence it runs to the reservoir. Any air that may be drawn from the condenser passes off through the washer. From the reservoir the liquid is again pumped through the coiled pipe in the heater, where it takes up heat from the exhaust vapour; from thence through a secondary heater to the generator, where it is again vaporised, to be again used. The machinery occupies a good deal of space. It is said that it uses just one-half the quantity of fuel required by the same Corliss engine when worked with steam in the usual way; but we cannot learn that the old objections to the use of carbon vapour have been overcome. On this point discreet silence is preserved.

In connection with the subject we may mention a curious statement made in the *U. S. Mechanical Engineer*, which runs as follows:—"It is not generally known that naphtha engines are being used in launches in these waters with safety and success. The vapour of naphtha is used in the engine precisely as steam in ordinary engines. The boiler is a coil, and the heat for it is obtained from the vaporised naphtha in the boiler, a pipe being taken from it and carried under the boiler and ignited, the same as a gas jet. As the specific gravity of naphtha is very low, 65 only, it takes but little heat to vaporise the naphtha. The vapour of the naphtha is condensed the same as steam is, and the condensed vapour is pumped back to a tank from whence it is fed into the coil again. This tank, to guard against accidents, is carried in the bow behind a water-seal. Our informant, who has had much experience with these engines, says that they give no trouble whatever, and are ready for use almost immediately." Our contemporary has muddled up specific gravity and specific heat a little. It is not quite easy to say what is meant by "naphtha," possibly wood spirit which often goes by that name. The boiling point of this is about 150 deg., and the total heat of evaporation about 546; or it may be one of the lighter petroleums with a still lower boiling point.

Scant progress has been made during the past year in improving the quality of steel, but facts are surely if slowly accumulating, which are tending to make the use of steel freer in every way from trouble and disappointment. It is more than ever certain that there is steel and steel. Provided the right sort of steel is used in the right way all will be well. If not, then loss and disappointment must ensue. A keen discussion has gone on between Lloyd's and the Board of Trade. As a result of prolonged experience derived from an intimate acquaintance with the behaviour of steel, Lloyd's lowered their standards. These were for a long time 26 tons as a minimum and 30 tons as a maximum in all plates up to one inch thick. In order to discourage the manufacture of steels with a large percentage of carbon, Lloyd's during the past year altered their standard. Retaining 26 tons as the lower limit, they fixed 29 tons as the major limit for plates up to one inch and a-quarter thick; above one and a-quarter inch the major limit was reduced to 28 tons. But for similar plates the Board of Trade insisted on 27 tons and 32 tons. No one at the Board of Trade possesses the knowledge acquired, as we have said, by daily experience by Lloyd's engineers and surveyors; and there can be no question that the Board of Trade, by stedfastly ignoring the caprices of steel, and assuming that that which is nominally strongest must really be best, pursued an erroneous policy. The result was that steel-makers were practically unable to comply with the conditions laid down by the Board of Trade and Lloyd's, because the lowest limit of the former was only one ton less than the highest limit of the latter; consequently no one would roll plates 1¼in. thick. This was a serious obstacle in the way of carrying high-pressures at sea, and in the end Lloyd's had to give way. The results are not satisfactory. In a great many cases where hard steels have been used, cracked plates have followed. This cracking is partly due, perhaps, to the enormous size of the plates now made, running, as they do, to 25ft. long by 4ft. 6in. wide, and 1⅜in. thick, weighing something like three tons. These plates, as they come from the works, are seldom flat. They are passed through vertical rolls to be bent to shape for boiler shells, and they are thus supposed to be faired; but the strains set up by taking the buckles out of hard plates—which buckles are really the result of a contest of forces in the substance of the plate, pulling this way and that—are such that the plates crack either in the rolls or very soon after they are worked into the boilers. Nothing is heard about these failures, but they take place nevertheless. As an example of the stresses existing in steel, we may mention that Mr. Stroudley, using steel frame plates for locomotives about 1⅛in. thick, in slotting out the horn-plate spaces, &c., bolts six plates together on the bed of the machine. These plates are at the time dead flat. After the slotting operation is over they are found, when taken off the machine, in nine cases out of ten to have cast in various directions, simply because certain stresses have been cut out of them. They are then sent back to the forge to be straightened, and the work of slotting them is then finished. While on the subject of locomotive frames, we may mention that Mr. Fox has put down a splendid plant, and is now stamping out side frames in one piece, flanged all round the axle guards and the edges. It is of course impossible to say as yet how these will answer in practice.

Returning to the question of steel for boilers and ships, we find that Lloyd's have provisionally rejected basic steel for all purposes, whether made by the Bessemer or the Siemens process. This policy is due to the unfortunate circumstance that a considerable quantity of very indifferent basic steel was put on the market at first. This was basic Bessemer, and it is now clear that basic steel plates cannot be made by the Bessemer process, although it is quite possible that with care they may be made by the Siemens process. There is no indication that any change in this respect will take place during the present year. Before taking leave of steel we would call attention to a remarkable letter which appeared in our last impression going to show that in the United States the most satisfactory results have been got as to steel fire-boxes, the metal being almost entirely free from phosphorus. It is well known that phosphorus makes steel cold-short, but it was not supposed to do much harm to plates subjected to heat. However as fire-box plates always crack when the fires are out, it seems clear that it is cold-shortness that ought to be provided against.

In marine engine and boiler work we have little new to record. A great many steamers, some of them in the mail service, are being converted to triple expansion, either by putting a third cylinder on the top of the existing high-pressure cylinder, or by adding another A frame and crank. The work does not go on as fast as it might, because shipowners are afraid of further developments. The change from compound to triple expansion engines has been made too suddenly. A shipowner, speaking on the subject recently, put the matter very clearly: "I had built for me," he said, "about two years ago, a splendid ship. No expense was spared to make her perfect. Now I find her obsolete, and I shall have to spend some thousands of pounds on her to bring her up to the day. Progress is all very well, but we want breathing time; and I have no security at all that at the end of another two years I shall not find my ship again obsolete." It is a serious matter to find the greatest mercantile fleet in the world rendered obsolete by the action of a few engineers. A great outlay of capital becomes necessary, and it is not quite easy to see where the capital is to come from.

Mr. Howden is still working at forced draught, and has now some six or seven steamers fitted or fitting on his system. We understand, however, that he has reduced the air pressure to, in some cases, not much over ½in. of water. He is also using boiler tubes 9ft. long, and only 2¼in. in diameter. This in itself ought to be a source of economy—if only the tubes can be kept clean. For this he depends on obtaining perfect smokeless combustion; and sea-going engineers will always have the steam sweeper to depend on.

The disastrous explosion at Birkenhead will do much to retard the carriage of petroleum to this country in bulk. It is stated that petroleum vapour is very peculiar; not diffusing itself as gas will, but lying about in spots, and not making an explosive mixture with air until it is stirred about. The men on board the Petraina worked with naked lights in the tanks in which the explosion subsequently took place, and it seems probable that no accident would have taken place had not the inspecting engineers stirred up some deposit, so to speak, of petroleum vapour, and mixed it with air. We give this suggestion, which emanates from one who has had a great deal to do with petroleum, its carriage and stowage, for what it is worth. The catastrophe will also do much to retard the substitution of petroleum for coal as a steamship fuel. Very little progress is being made in its adoption in this country, and the extravagant claims put forward for it in certain quarters tend to make men who really possess a little chemical knowledge regard the whole subject with doubt. Under the most favourable circumstances its use must be attended with a certain degree of risk. Even if we assume that the ignition point of astaki is nearly 500 deg., that will not render it safe, nor is there any security that the last fraction of volatile vapour can be extracted. It must not be forgotten that while the successes of those who are trying to solve the problem are freely recorded, nothing is heard about the failures. The following extract from the *Savannah News* is suggestive:—"The experiment of using petroleum for fuel which has been for some time carried on by the Southern Pacific Railroad Company in several of its ferry boats at San Francisco, and also by the Pacific Rolling Mill Company, has been abandoned, and the use of coal has been resumed. The expensiveness of petroleum is given as the principal difficulty. It is also asserted by engineers that neither iron or steel can withstand the flames from petroleum, and that, until some new metal or composition of metals is invented, it cannot be successfully used in place of coal." When coal becomes very dear, or astaki very cheap *and plentiful*, the latter may be freely used as a fuel for making steam, not until then in British ships. The volatile oils will never be used for the purpose save under compulsion; as, for example, in securing some required object in a torpedo-boat or war vessel, when risk becomes quite a secondary consideration.

In the construction of stationary steam engines we have nothing new to record. But something may be said concerning the theory of the steam engine. For many years the fact that condensation, resulting in serious loss, took place in all steam cylinders, because they are not made of non-conducting materials, was entirely overlooked. It was held, indeed, that the separate condenser cured this evil completely. That veteran engineer, Benjamin Isherwood, was the first to state prominently that condensation operated to cause a serious loss when steam was used expansively at sea; and about the same time Mr. D. K. Clark directed attention to a similar evil in locomotives. The preface to Isherwood's "Experimental Researches in Steam Engineering," vol. ii., published in 1865, has never yet been excelled as a treatise on steam and its action in an engine. Further experience has corroborated the accuracy of his deductions. The point to which we wish now to direct particular attention is that in spite of the labours of a great many accurate experimentalists at home and abroad, no such thing as an approach to a quantitative law of condensation has ever been produced, although condensation in steam cylinders is answerable probably for the waste of millions of tons of coals per annum. No one is able to give any idea beforehand of the amount of cylinder condensation which will take place in any particular engine. The very means taken to prevent it seem in some cases to be those which most promote its occurrence. Thus the initial condensation in triple expansion engines is enormously greater than in single-cylinder engines. On the other hand, it would seem that the greater the number of cylinders through which steam is passed the greater would be the whole cooling surface and causes of waste; but, as a fact, the greater the number of cylinders the drier does the steam become; and so while in the first cylinder of triple expansion engines we find that one-third of all the steam supplied by the boiler is condensed, in the low-pressure cylinder we have steam quite dry, the whole, or nearly the whole, of the water being reconverted into steam. We cannot stop to go into details here, but we may say that there is no theory of the steam engine which takes adequate notice of these facts, or pretends to explain them. Indeed, professors who write about steam fight very shy of this question of cylinder condensation, contenting themselves with stating that it takes place, but never attempting to explain it numerically. We may take one point alone. If one-third of all the steam is condensed—Sir F. Bramwell names one instance where 47 per cent. was condensed—whence does the heat come to re-evaporate it? The answer is that it re-evaporates as a result of the fall in pressure; but a very slight knowledge of the laws of the production of steam as usually stated will show that a fall in pressure cannot possibly explain this re-evaporation in certain cases. Steam is an unstable and very peculiar fluid, and the conditions under which it exists are not as well understood as they ought to be, and we venture to suggest that experiments should be carried out to ascertain the conditions under which condensation and re-evaporation take place, without calling in the aid of cold. There seems to be good reason to believe that the presence of water has, in some obscure way, a powerful influence on the condition of steam. It is known that condensation takes place far more rapidly in an undrained than in a well drained cylinder, and the ordinary explanation given to account for this does not satisfy us. At all events, we hold that a good case may be made out for investigation, especially when we remember that in some engines, without any adequate cause, the rate of condensation is very much smaller than it is in others working under much the same conditions.

Concerning guns and armour we need not speak here, because our readers are kept apprised week by week of all that is being done in both. Indeed, we claim with some pleasure to have supplied them during the past year with information concerning work done abroad before it reached our own naval and military authorities. The most recent types of high-speed cruisers—vessels of the "Scout" class—have also been fully illustrated and described in our pages. The torpedo question we do not propose to touch on here, but we must say a few words concerning the wonderful little craft which carry them. A decided advance has been made in torpedo boat construction by Messrs. Yarrow and Co. during the year in successfully obtaining a combination of speed and great turning power far in excess of anything that has been accomplished before. This was shown by the recent trials of No. 79 torpedo boat built for the British Government, when a speed of 22·4 knots was obtained during a run of two hours with 10 tons on board, the boat being also capable of turning within a circle, the radius of which was equal to its length and the time sixty seconds. So important do the Whitehall authorities consider these improvements that Lord George Hamilton, First Lord of the Admiralty, together with several of the leading technical members of the Board, recently spent a whole day testing the capabilities of this boat; and we consider the country cannot feel other than the greatest confidence in the present administration of the Navy when we find the First Lord during the recent inclement weather testing such vessels for himself; and our readers will agree that both the Government and Messrs. Yarrow and Co. are to be congratulated, the one in possessing, and the other in being the contractors of a vessel having a speed, coupled with manœuvring power, never equalled. Torpedo boat construction during the last year has been exceptionally brisk, in consequence of the large order which, it will be remembered, was given out by our Government during the Russian scare eighteen months ago. Now that this order has been completed, things are very dull in this department of shipbuilding. The firm who has turned out the largest amount of work of this class during the year is Messrs. Yarrow and Co., who, in addition to twenty-three 125ft. torpedo boats for the British Government, have constructed three of 118ft., for the Portuguese Government; one of 125ft., for the Dutch Government; one of 125ft., for the Chilian Government; one of 166ft., for the Japanese Government; one of 115ft., for the Spanish Government. They have also nearly completed two of 140ft., for the Spanish Government; two of 140ft., for the Italian Government; one of 135ft., for the British Government; one of 125ft., for the Chinese Government. Messrs. Thornycroft, too, have not been idle. Several firms now build, or try to build, torpedo-boats; but success demands a wonderful combination of skill and experience, and English builders are doing better and better every day. For a considerable period Messrs. Yarrow and Co. have adopted the triple expansion system, with the best results. No. 79, referred to above, indicates nearly 1000-horse power at 412 revolutions—an astonishing performance considering the small weight of her machinery. We understand that this firm now contemplate building the larger class of torpedo catchers, and that they are prepared to guarantee 3500-horse power on a total weight of machinery, boilers, and water of only 85 tons; that is, 54·4 lb. per indicated horse-power—a weight never yet reached by any machinery capable of developing so much power for a reasonable period.

A good deal has been heard about submarine boats, but the only really adequate experiment to test the value of these craft on a proper scale is about to be made by Mr. Nordenfelt, who has been so encouraged by the comparative success of the smaller boats that he has had for some time a large boat in hand.

The new Nordenfelt torpedo boat is rapidly approaching completion, and there can be no doubt that the trials which are to be carried out early in the year before representatives of our Navy, will be closely watched by all who are interested in the welfare of our senior service. It is quite true that during the last few years we have had more or less of a surfeit of so-called submarine boats, few, if any, of which have been worthy of attention; and for this reason there may be a prejudice against the class. The Nordenfelt boat is, however, of so much larger dimensions, and possesses so many and such great advantages over the best of its predecessors, as to place it altogether outside the field of comparison; and this will be conceded as a fact when it is realised that the new boat has a length of 130ft., a displacement of 250 tons, and an estimated speed of eighteen knots with an indicated power of 1300 horses. The Nordenfelt, which has been designed by Mr. Garrett, is of steel, and is circular at the centre line, fining down to a wedge at the forward and after ends, and is pronounced by competent authorities to have all the lines and form of a first-class sea-boat. She is to be fitted with torpedo tubes, and will also carry a couple of Nordenfelt guns on her deck or top. In fact she will be a powerful torpedo boat on the surface, with the power of going under water when desirable. Steam is supplied by two very large marine multitubular boilers at a pressure of 150 lb., to double compound engines—that is to say, two pairs of compound engines driving on to one four-throw crank-shaft. These engines, as we have said, are estimated to indicate 1300-horse power, with full steam-pressure and under forced draught; so that even on the surface the new boat will be a by no means despicable enemy. Besides the main engines she is to be fitted with separate engines for steering, sinking, circulating, pumping, and for driving the fans, and it will be readily understood what a mass of machinery she will be when launched. The launch is expected to take place in about two months. The whole of the machinery, shafts, propellers, &c., has been constructed by Messrs. Plenty and Sons, of Newbury, and is at present being fixed on board at the Barrow Shipbuilding Company's works, where the hull and fittings have been made. The Nordenfelt will be able to remain under water, with all her crew of eight or nine men, and steaming ahead, for at least twelve hours. She will be held down by mechanical means, which have been so designed that should any accident occur to any part of the machinery, or to her captain, she will at once, and by herself, come to the surface. Every precaution has been taken to render the lives of those on board of her as safe as in any ordinary torpedo-boat at the surface; and as she will be capable of steaming a distance of 1500 miles at the surface without calling at any port, she has advantages not possessed by boats which dare not go many miles away from where they can replenish their storage batteries or their compressed air tanks. We hope to be able to give elaborate details of this very formidable vessel when she is ready for her trials.

In minor matters connected with mechanical engineering, little has taken place during the past year worth notice that has not been fully recorded in our pages. Nor does it seem likely that much will be done in the immediate future. We have already called attention to the energies of our own inventors, but they are as nothing to those of the United States. There were 40,678 applications for patents during the year, against 35,688 last year. Twenty-four thousand one hundred and thirty-four patents were granted. We may wonder if there is anything left to invent. Among the few small matters which deserve notice may, perhaps, be mentioned an ingenious method of applying a condenser to pumping engines. This is the invention of a Mr. Craig, an American, whose address we do not know. He introduces the exhaust steam into the suction pipe, in which there is provided an extremely simple automatic device, which on the one hand prevents water finding its way into the steam cylinder, and on the other precludes the exhaust from interfering with the flow of water to the pump. Another device which strikes us as being good, and perhaps new to many of our readers, consists in giving emery wheels a reciprocating lateral motion while running. This cannot fail to add to the utility of such wheels under many circumstances.

The handling of grain is in the present day a matter of great importance, and in Evanston, Ill., the principle of the injector has been applied to a grain elevator. The grain is run from the car to a revolving hopper, through an aperture in the bottom of which is forced a powerful blast of air, which carries the grain a certain distance up a horizontal tube. At intervals in this tube are bends, or horizontal curves, forming relays. These relays act as auxiliary hoppers, a fresh blast of air being admitted at each one, which carries the grain to the next higher relay. In this way the grain may be raised to any desired height. A modification of this device is arranged to raise grain from the hold of a ship or boat. We may say here that in this country various devices of the kind were some twenty-five years ago applied to thrashing machines by the late John Smith, of Coven, near Wolverhampton, and that with so much success that it has always been a matter of surprise to us that the principle has not been more fully utilised.

The dreadful accident which occurred last week at the Houghton Main Colliery, near Barnsley, shows that much yet remains to be done to prevent cage accidents. In this instance, a cage weighing over 3 tons, and conveying at the time ten men to the surface, was overwound, smashed against the pit-head frames, and fell with the men to the bottom of the shaft; the men were literally dashed to pieces. The engine-man says that while at his work he was struck on the head by something which stunned him, and that when he had recovered he saw the mischief was done. The cage was, we understand, fitted with so-called safety appliances, which failed to act. There is no reason why such accidents should be possible unless criminal negligence operates. There is nothing easier than to provide apparatus of the simplest nature which will infallibly stop the engine should the cage be carried, say, 10ft. too high. Then, even if the engine-man left his post while a cage was coming up, no accident would occur. Prevention is better than cure, and it seems to us that it would be better policy to prevent overwinding altogether than to provide for it.

At any time within the last fifty years proposals have been discussed for utilising some of the vast power of the Niagara Falls, but little or nothing has been done to carry such schemes into practice. Recently, however, a company has been formed, known as the Niagara Hydraulic Tunnel and Power Company, which proposes to cut a circular tunnel, 30ft. in diameter, through the solid rock from below to above the Falls. This tunnel is to act the part of a tail race for turbines to be put up alongside the river, and supplied by it through conduits or head races cut at right angles to the river. The tunnel will be about 2½ miles long, and it is expected that it can be completed in about two years. It is stated that the McBeen Tunnel Company has taken the contract at the price of about £1,000,000. It is estimated that 200,000-horse power can be had, or sufficient to drive 400 factories, with 500-horse power each. The average available head for the first half mile, beginning up-stream, is 81ft., and the power 24,000 horses, or 208,600 cubic feet per minute. On the next half mile the average head is 90ft., giving 25,000-horse power, with 195,000 cubic feet per minute. On the third half mile the head is 107ft., giving 60,000-horse power, or 394,000 cubic feet per minute. This is supplemented at Port Day by 10,000-horse power, got on a head of 118ft., with 59,000 cubic feet. The total difference of level between the water above the Falls and at the discharging mouth below them is 214ft. It is said that, large as the volume of water drawn off appears, it is not one-hundredth of the whole volume of the Niagara River.

As this is Jubilee Year, a very great deal will, no doubt, be heard about fifty years of progress in the mechanical arts. As volumes would be required to do this subject even scant justice, we need not further refer to the matter here. It may interest our readers, however, if we give here an extract which will show what was considered good work in marine engineering, not fifty years ago. The extract is from the *Hants Independent*, October, 1842:—"The steamer India, having performed her last voyage from Suez to Bombay in the height of the monsoon—a circumstance unprecedented in the annals of steam navigation—it may be interesting to compare a statement of that steamer's performance on her last two voyages, the first having been made in the fair season, and the second against the strength of the monsoon. On her first voyage the India left Calcutta on the 10th of January last, and steamed to Suez in 25 days and 14 hours, running 4849 miles, or 182½ miles per day, consuming 680 tons of coal, or 7·6 lb. per horse per hour. On her second voyage she left Calcutta on the 9th of May, and steamed in 34 days 4658 miles against the wind, averaging 137 miles a-day, and under sail four days; total distance, 5087 miles, consuming 900 tons of coal, or 7½ lb. per horse-power per hour. This result is most important as showing that communication can be kept up with the eastern side of India at all seasons of the year. On the first voyage the Calcutta letters reached London in 46 days; the second voyage her letters were delayed in Egypt 24 days, waiting a conveyance." The following extract from the *Civil Engineers' and Architects' Journal* for September, 1842, reads very much like what is to be read almost daily now:—"We are glad to see that the Government is beginning to form a fleet of steamers on even an increased scale. We have the Penelope, a 42-gun frigate, now having 60ft. added to her length at Chatham; she is to have a pair of the Gorgon engines of 625-horse power, by Messrs. Seaward and Capel. The total cost of the engines will be £28,000; the vessel is in a forward state. Another vessel of 1650 tons burden is to be built under the superintendence and from the lines of Mr. Oliver Lang, master shipwright, of Woolwich Dockyard, and to have engines of 800-horse power; another vessel of equal magnitude is to be built at Chatham Dockyard, which it was intended to call the Dragon, but we are happy to announce that she is to be called the James Watt. This is as it ought to be. We have here a name revered by every engineer, and we may say by every Briton; she is, we understand, to have the double-cylinder direct action engines of Messrs. Maudslay and Field. We hope that Government will not stop here. We must have, at least, a dozen such vessels; we shall then be only just ahead of the French Government, who, we know, are constructing steam vessels of a larger magnitude than any of our present class. This must not be allowed; we must hold the ascendancy of the ocean. We have both the metal and the men to construct engines upon a large scale, at a *short notice*. They only want the support of the Government, and with such aid we shall be able to keep Old England ahead of all the world."

Sanitary scientific men are responsible for creating at different times undue alarm in the public mind as to the wholesome character of potable waters. The phrase "previous sewage contamination," when first promulgated, gave rise to pungent alarm as to the presence of actual sewage in the water supply of the metropolis. Dr. Frankland ultimately modified the phrase, substituting "animal" for the more objectionable term. But the habit of designating the London water supply as "dilute sewage" has not altogether died out. A little time ago alarm was again excited, on the announcement that a cubic centimetre of London water contained several dozen micro-organisms. The fact was dwelt upon as something terrible, and it was necessary for an official declaration to go forth, assuring the public that there was nothing remarkable in the presence of these microbes, and nothing to be alarmed at. Science thus outstrips the general educational process, and a new order of ideas has to be introduced, so that the public may rightly understand the discoveries which follow new modes of investigation. It is gradually being made apparent that all microbes are not injurious, and that some may even be beneficial. Dr. Klein cites sundry experiments which seem to show that some pathogenic organisms are destroyed by organisms of a septic character. A valuable paper on "Water Purification: its Biological and Chemical Basis," was read before the members of the Institution of Civil Engineers in April last by Dr. Percy Frankland, and was followed by an interesting discussion. The gelatine test is a hobby which is apt to be ridden too hard. It is easily vitiated, and often gives anomalous results. But taken in its broader aspect, it has served to show one thing possibly of certain practical value. It has demonstrated, in the face of much previous doubt, that the filter beds of the London Water Companies are remarkably effectual in arresting the transfer of micro-organisms from the river to the water mains which supply the metropolis. Thus Dr. Percy Frankland reports that the number of micro-organisms in a cubic centimetre of water taken from the Thames at Hampton on November 8th was 56,000, as indicated by the "colonies" developed in the gelatine-peptone medium, whereas the average number per cubic centimetre in the supply furnished by the Thames companies was only 124. In this instance we see a reduction of 99·8 per cent. in the number of organisms. If we take the West Middlesex water, as drawn from a standpipe on a cab rank, the reduction becomes 99·9 per cent. Another result to be credited to the gelatine test is that of showing the presence of micro-organisms in the supply furnished from the deep chalk wells of the Kent Company. The supply thus given to part of Deptford in November contained more micro-organisms than were to be found in the water supply of the New River, West Middlesex, Chelsea, Grand Junction, and Lambeth Companies. As the Kent supply is unexceptionable, the gelatine process cannot be considered as always affording a comparative test of purity, neither can the presence of microbes be always held as condemnatory of the quality of a particular water. The subject is as yet incomplete, and further light is evidently needed. An important series of bacteriological experiments in connection with the water supply has been conducted by Mr. Crookes, Dr. Odling, and Dr. Meymott Tidy. Among the results last reported we find this conclusion arrived at—that, in the struggle for existence, the microbe forms proper to running water outgrow and starve out the introduced morbific forms.

In 1883 the average daily supply of water distributed by the eight London water companies was little more than 145 million gallons. In 1884 it was nearly 153,500,000 gallons. In 1885 it had become 155,287,000 gallons. The river Thames supplies about half this quantity. According to the Conservancy Acts, the quantity of water which may be legally taken from the Thames by the London water companies is 110 million gallons per day. For this privilege the six companies which take their supply from the Thames pay to the Conservators of that river the sum of £2000 each annually. The Conservators are now bringing a Bill into Parliament requiring the companies to pay £3000 each per annum. The reason given for this is, that the present revenue of the Conservators proves to be insufficient for fully carrying into effect the duties entrusted to them by Parliament—these duties being the preservation of the navigation of the river and the purification of its waters. It may be expected that the London water companies will strenuously resist this attempt to add to their burdens. It is satisfactory to find that, so far as possible, they are striving to obtain a supply from the underground waters, in preference to the open stream. The Southwark and Vauxhall Company are sinking a deep well at Streatham, in the hope of reaching the lower greensand. Hitherto this formation has not been found so near London, a large series of strata being missing, so that from the gault there has been a plunge into the primary rocks. Could the Southwark Company obtain all they want by means of wells, they might escape from the liability of contributing to the funds of the Conservators. This, however, is a very remote contingency. Among other incidents affecting the London water companies during the past year, we may mention the quinquennial valuation of rateable property. As these companies are now tied down to rateable value as the basis of their charges, they may be expected to take full advantage of the rise in the assessments. On the other hand, they find their own assessments raised, so that they are compelled to contribute heavily to the revenue founded on local taxation. An attempt was made by the Metropolitan Board to carry a Bill through Parliament last spring, whereby they would have obtained power to purchase some of the existing water undertakings, or all of them, or to introduce a fresh supply; but the Bill was rejected by a large majority on the motion for the second reading. Another indication of the feeling of Parliament is afforded by a refusal to grant power to three of the London water companies to raise fresh capital, except on condition that profits arising from such capital should be confided to the Chamberlain of the City, to furnish a trust fund available for liquidating the capital of the water companies. The object is mainly to prevent the interests of the companies from growing in value, a general expectation being entertained that at no distant period the waterworks will become the property of a great municipal authority. For the present, this exceptional kind of legislation affects three of the London water companies, namely, the Lambeth, the Southwark and Vauxhall, and the East London. With this example before them, there is little doubt that the other companies will abstain from coming to Parliament to seek for further capital powers as long as possible. Connected in some measure with the water supply, we have the Bill of the Metropolitan Board for enlarging the revenues of the Fire Brigade, a reform which has long been needed, as proved by the destructive fires which have lately visited some parts of the metropolis, and which have required for their suppression an undue proportion of the entire force. In regard to provincial operations, Parliament is to be asked to sanction a scheme for supplying Bristol with water derived from the springs of the Severn Tunnel, belonging to the Great Western Railway Company. There is a water company existing in Bristol, and it is proposed that the Corporation shall purchase the existing works upon equitable terms. The Corporation of Sheffield have a Bill for buying up the interest of the water company in that town, in order to furnish a supply at a cheaper rate than the company can afford. The Corporation of Plymouth, after many years of controversy and debate, have a scheme in hand for constructing a new large storage reservoir, of which the town and its vicinity stand greatly in need.

According to the latest returns available on the subject, the gas interest in the United Kingdom continues to make progress. The companies sold more than 52,000 millions cubic feet of gas in 1885, compared with less than 50,000 millions in the year preceding. The local authorities in the year 1885-86 sold more than 25,000 millions cubic feet, compared with less than 24,000 millions in 1884-85. It will be seen that the companies sell fully twice as much gas as the local authorities. The capital employed by the companies is less than double that of the authorities, the amount in the former instance being £35,514,000, and in the latter £19,619,000. The total quantity of coal carbonised in the year was 8,379,000 tons. It is remarkable, as showing the predominance of the Metropolis, that the three London companies absorb nearly £14,000,000 of all the capital employed by the gas companies of the United Kingdom, or one-fourth the total capital of all the gas undertakings. The net profits of the local authorities in respect of the gas supply have declined considerably during the last two years; but presumably this has been to the advantage of the consumer. The growth of the London gas supply has been exemplified in our description of the Beckton Works a few months ago. We may observe that the extended use of gas seems to be accompanied by an increasing number of casualties in the shape of explosions and accidental suffocations. Accidents of the former class are generally due to want of caution; the latter occasionally arise under circumstances beyond the control of the sufferers. The recent disaster at the Portsmouth Barracks is a sad example of an explosion arising from gas leakage. In the gas engine we see the explosive force of combined gas and air turned to useful account. A matter which interests all parties is the provision of a proper standard for measuring the lighting power of gas. An important series of experiments in relation to this subject is now being conducted by Mr. W. J. Dibdin at the offices of the Metropolitan Board, by means of a four-way photometer, specially designed and constructed for the purpose. The object is to obtain a thoroughly trustworthy standard of light, and if the results are such as to demonstrate that a better standard can be obtained than the present statutory sperm candle, we may expect that the Metropolitan Board will take steps to have the law changed accordingly. The question of the London coal dues is a matter of some importance as affecting the metropolitan and suburban gas companies, whose consumption of coal renders them large contributors to the revenue derived from this impost. Unless renewed by Act of Parliament, the London coal duty expires in July, 1889, and a reduction—though a small one—will perhaps take place in the price of gas.

The interest of the sewage question is largely concentrated in the merits of the plan adopted by the Metropolitan Board. In the course of a few days the tenders for the construction of the precipitation works at the northern outfall will be laid before that authority. The project, considering its nature, is gigantic, and criticism is freely exercised in reference to a plan relying upon chemical means for the treatment of the whole volume of the metropolitan sewage. The corresponding design for the works at the southern outfall is not yet complete, but will follow after a necessary interval, and it is calculated that the entire capital outlay for the two sets of works, north and south, including the ships which are to carry the sludge to sea, will not fall considerably short of £1,000,000. The ships are expected to cost about £15,000 each, or with all necessary appliances, perhaps £20,000. Probably five will be required, making the capital outlay for the sludge fleet £100,000. Although the Metropolitan Board is practically committed to the plan of constant precipitation and occasional deodorisation, as devised by Mr. W. J. Dibdin, the Board's chemist, efforts are still being made to press upon the notice of the Board another project, known in connection with Mr. Bailey-Denton and Lieutenant-Colonel Jones as the Canvey Island scheme. That the latter plan is perfectly practicable is apparently beyond doubt. The question is virtually one of estimates, unless it is considered that the chemical plan of the Metropolitan Board is foredoomed to failure. Four eminent chemists, Fellows of the Royal Society, and one of them a member of the recent Royal Commission on this particular subject, have reported favourably of the Board's plan. Looking, therefore, to the question of cost, we find the estimate for the Board's scheme, including 3 per cent. on the capital account, corresponds to an annual charge or outlay of £115,000. Perhaps we might put the figure rather higher, and say £150,000 per annum. On the other hand, Mr. Bailey-Denton reckons the cost of his plan as equal to an annual charge of £198,000, including 3 per cent. per annum on £3,250,000, the estimated cost of constructing the great main sewer to reach from the present outfalls to Canvey Island. It will be seen by some remarks which we offered last week that Mr. Dibdin has been accused of exciting a prejudice against Mr. Bailey-Denton's plan, by stating that it would cost £400,000 per annum. It is only fair to Mr. Dibdin to say that he has published no statement to this effect, and, from what we can learn, we must conclude that the charge thus brought against him originates in some mistake. It is to be hoped and expected that an explanation will follow, such as will properly exonerate all parties. At the same time, estimates are always open to dispute, and we shall not be surprised to learn that Mr. Bailey-Denton is prepared to add considerably to the estimate of £115,000 per annum for Mr. Dibdin's plan. Leaving this rather unpleasant controversy for the present, we find little to say as to the sewage question elsewhere. The dissolution of the Lower Thames Valley Main Sewerage Board has happily been followed by the adoption of what may be termed parochial plans for the purification of sewage before discharging it into the Thames above London. Chemical methods find favour in that region, where land is so hard to obtain, though filtration is added in the case of the Richmond sewage and the parts adjacent. The state of the Lea has been much more satisfactory during the past summer than in 1885, the Lea Conservancy Board being perfectly satisfied with the effect of Mr. Hanson's black ash waste. An Act passed during the session further provides for the purification of the Lea by allowing the Tottenham sewage, after being chemically treated, to pass through a connecting sewer into the metropolitan system, so as to enter the Thames in company with the London sewage at Barking. This arrangement, however, is only legalised for a few months in the year, and for a short series of years. It is expected that the sewage of the Lea Valley will some day be carried away permanently, in conjunction with that of London, to the estuary of the Thames. But if the London sewage is satisfactorily treated at the present outfalls, that which relates to the Lea Valley is not likely to have a more distant point of discharge. Concerning the sewage of rural districts it is not probable that much will be done to improve matters until the Local Government Board does its duty.

THE GREATEST GUNS IN THE WORLD.

WE are in receipt this week of some interesting information on the subject of the four mammoth steel guns manufactured for the Italian Government by Krupp, which were experimentally fired at Meppen during the months of July, August, and November, 1885, and March, April, August, and September, 1886. Some time ago it was reported that one or more of these guns had shown defects in their tubes, and in view of this rumour we inquired of the U.S. Consul at Essen, Hon. J. S. Potter, in regard to the matter. Mr. Potter has forwarded to the State Department a letter received by him from the firm of Krupp, of which the following is the material part:—

"Essen, November 5th, 1886.

"DEAR SIR: . . . In reply to the second part of your valued favour of the 18th of October, from Washington, I beg to send you herewith my reports, Nos. 63 and 64, containing the results of the trials with the 40 cm. guns made for Italy.

"In none of these four guns has the slightest defect been traced; on the contrary, even No. 19,464 of these guns, which has fired eighty-two rounds, partly with considerably heightened charges, is in completely fit state for any service.

"I remain, dear sir, yours very sincerely,
(Signed) "FRIED. KRUPP.
"per KLUSSEL.

"J. S. Potter, Esq., U.S. Consul, Crefeld."

These guns are known as the 40 cm. guns, that being their calibre, which is 15·75in. They are made, as are all of Krupp's guns, entirely of forged crucible steel, and comprise a tube, a jacket, and several rows of hoops. They have no trunnions, but are provided with ring projectiles that connect with the carriage. The fermeture is Krupp's cylindro wedge construction. The principal dimensions are as follows:—Length of bore, 35 calibres, 551·2in.; number of lands and grooves, 92; depth of grooves, ·079 of an inch; weight of gun including breech mechanism, 118 tons.

The features of the trial were prescribed by the contract. The first 40 cm. gun was to be fired at least fifty times with projectiles of 920 kg. (2028 lb.), and an initial velocity of 550 m. (1804ft.) The muzzle energy should not be under 14,000 metre-tons, 45,206 foot-tons. Ten rounds of the above fifty rounds should be fired at a target at 2500 m. (8202ft.), and at least fifteen rounds at 5000 m. (16,404ft.) range. The remainder should be fired at different ranges. It was also specified that the velocities and gas pressure should be measured for twenty rounds, that at 2500 m. range all impacts must be contained in a square of 3·25 m. (10·66ft.) a side, and the longitudinal dispersion at 2500 m. (8200ft.) should not surpass 80 m. (262ft.) about. The three other guns were to be fired only nine times, as customary for this purpose. The Italian Government was to be represented by a commission of officers at the acceptance trials. The selection of the kind of powder was left with the manufacturer of the gun. There were several kinds of powder ordered and delivered from which to select the most suitable powder for these guns. There were sixteen preparatory rounds fired for this purpose, after which the fifty acceptance rounds of the first piece followed. The second piece was fired twelve times, the third eleven times, and the fourth twelve times.

The required energy of 14,000 metre-tons (45,206 foot-tons), corresponding to an initial velocity of 550 m. (1804ft.) for projectile of 920 kg. (2028ft.) weight could be obtained with a charge of 330 kg. (727 lb.) of brown prismatic powder, with a pressure of about 15·74 tons. This charge was consequently retained for all further firings from the nineteenth round up. The velocities were measured at distances of 2474 m. (2706 yards), 3479 m. (3805 yards) and 6416·5 m. (7017 yards) from the muzzle.

The guns do not appear to have been fired to attain the greatest possible range but at the highest elevation that is possible at Meppen they easily accomplished seven and a-half miles. The report of the first trial states that the four guns fulfilled the requirements of the contract in every respect. One of them, No. 19,464, after sixty-six rounds had been fired, showed the beginning of erosions, which were not, however, considered a serious drawback to the efficiency or life of the gun. The latest report covering the trials of August and September last says that the firing of the gun referred to was continued for the purpose of testing several new kinds of powder on hand, which was not possible at the first trial on account of tardiness in the delivery. The trials began August 31st, and were completed September 28th. In these trials the same initial velocity was obtained with less pressure with the new powder than the brown powder formerly used. Charges as high as 793·67 lb. and 826·74 lb. were used, developing a pressure so moderate as to indicate that they can be used as battle charges. On the eighty-first round a charge of 864·67 lb. was used, developing an initial velocity of 1876·6ft. The previous round, with a slightly smaller charge, developed a velocity of almost 1900ft. The important fact was established in these experiments that with the new powder very high velocities can be attained with the comparatively moderate pressure of 15 tons to the inch, promising a long life to the gun. The report states that this gun after having been fired eighty-two times did not show any enlargement at the bore. The powder chamber, which was about 93in. in length, was increased in length ·04in. during the eighty-two rounds. These are the highest results obtained with any existing cannon. With this gun a wrought iron armoured plate of 40·94in. thick can be penetrated near the muzzle, and a wrought iron armoured plate 38·94in. in thickness at a distance of 1093 yards, or more than half a mile from the gun, if the projectile strikes perpendicularly upon the plate. Three of these guns have been delivered to the Italian Government, and the fourth is retained at Meppen for experimental work.—*U.S. Army and Navy Rsgister.*

WATER SUPPLY.—In the report which has been published of the examination made by Colonel Sir Francis Bolton, C.E., of the water supplied by the several metropolitan water companies during the month of November, 1886, the official examiner says that, having regard to the steady increase in the population of the urban and suburban districts supplied with water from the Thames by the metropolitan water companies, the time has now arrived for immediate action to be taken to purify the source of supply. The matter will not admit of any further delay, and the responsibility will be great upon those authorities and towns which persistently neglect to undertake works to free the river from contamination should ever an outbreak of epidemic take place and the fatal words "too late" be said.

THE "UNION" STORAGE BATTERY.—Under the name of the "Union" storage battery a new type of accumulator has been placed upon the market by the Union Electrical Power and Light Company, which shows a marked advance in the construction of secondary batteries. The negative element, or cathode, consists of a plate of pure hydrated peroxide of lead, such as was exhibited at the recent meeting of the British Association. The peroxide is prepared by a special process, which leaves it in a form remarkably hard and durable, and at the same time electrochemically extremely porous, so that it virtually offers an enormous surface to the electrolyte, while the plates do not require to be backed up with any metal. The hydrated peroxide plates are such good conductors that a single slip of platinum foil forms a sufficient connection with the electrode. The mode of connection is ingenious; the platinum foil being laid on the surface of the plate, is covered with a thin strip of celluloid, which is fastened to the plate with two vulcanite bolts. These arrangements, together with the absence of a metallic support for the active material, constitute a special feature of the cell, inasmuch as it enables the total weight for a given output to be very largely reduced. The cells can be charged by a dynamo *in situ* in the usual manner, but we understand that the company also propose to supply cells and to undertake the duty of recharging, for which it will only be necessary to transport the plates.

NOTES FROM GERMANY.

(*From our own Correspondent.*)

THE general situation of the iron markets has remained almost without alteration during the last week. For most articles the improvement before noted has been maintained, and the general view which is expressed is that in the next few months the improvement will become more pronounced. On the Bourse the same opinion seems to prevail, as the favourable trade indications have had the effect of giving all industrial paper a genuinely firm tendency; and in taking a review of all foreign iron markets, it cannot be denied that a healthy development of the iron industry is visible, and would therefore justify the favourable hopes and expectations here entertained. From Silesia the reports are altogether favourable, stocks of pigs are decreasing rapidly, and in consequence prices can be maintained. The rolling mills have full employment with still an increased demand, but the producers are not inclined to contract for long forward delivery. It is in contemplation to raise the ground price to M. 105 for bars for Silesia and Posen, and to 97·50 p.t. for export over the borders to Austria and Russia. Neither in Belgium nor in France can prices be said to be firm, and trade there is consequently slow, without any other noticeable feature to record. The Dillingen Works and the firm of De Wendel, at Hayingen, have raised their prices for tank plates and sheets M. 5 p.t., and as soon as the contemplated convention is complete boiler plates are to follow suit. In Rhenish-Westphalian iron districts ores keep in demand at the full rates recently quoted. In pig-iron no alteration of significance is to be noted. The production for November was 90,053 t. All along the line prices of all sorts of iron for puddling purposes are firm, and as the mills and forges are all well employed, a rise in forge pig must soon again take place. The bar mills are for the moment proportionately the best off, and merchant qualities find a ready sale; prices, therefore, show a continued rising tendency. The same may be said of iron of fancy sections. In sheets there is a very lively demand, particularly for thin sorts, the prices of which are constantly rising. Lots were contracted for, for instance, at M. 132 and 135 p.t., to be delivered this year. Boiler plates alone seem to have been left out in the cold during the improvement in almost all other articles, and they are still neglected; and it is remarkable that, in spite of enhanced prices of forged iron, no rise, or only an insignificant one, in boiler plates has been yet effected. Wire rods are rising in price, with an increased demand; still the price is too low, considering the increased price of forge pig, and the exceptionally large requirements.

Judging from the last tendering at Elberfeld for steel rails, they have risen a little, for the lowest tender was M. 118·70. Again, on the 30th of December last 11,267 t. in 13 lots were tendered for at Berlin, the lowest native tender being M. 118·80, and the highest being M. 126 at works in Westphalia, whilst the foreign tenders were Bolckow, Vaughan, and Co., for 11 lots M. 118·32 at Stettin, and for 2 lots free at Swinemünde, M. 118·16; and the Darlington Iron and Steel Works, for 6 lots, at M. 119·50, free Stettin. It has caused quite a sensation that the State Railway Direction at Altona received M. 64·20 p.t. for a lot of old rails laid alongside the wharf at Hamburg, such a high price not having been obtained for years past. No doubt this was a small speculation on American account. As was to be expected, there was great elation in Westphalia at Krupp having got the Melbourne rail order. It would, perhaps, have been wiser to wait and see at what price the rails are to be delivered, and then ascertain if Westphalian rails can compete with a profit against the English houses. If not, there is not much real cause for exultation. Of the foundries, machine shops, and wagon works, nothing encouraging can be reported; for the prospects are at present not very brilliant, only here and there fresh orders having come to hand. Of the coal and coke trade there is nothing worthy of reporting.

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

(*From our own Correspondent.*)

WE are within a week of the quarterly meetings, and we find ourselves in possession of a firm market, and of good hopes for the new year. It must be admitted that the firmness appears more in the raw than in the finished iron branches. But, considering that this is also the experience of other ironmaking districts throughout the kingdom, no great surprise is occasioned. As the quarter advances manufactured iron will be certain to participate more than at present in the revival. Finished ironmasters cannot be expected to go on selling at the old prices with the pig market steadily advancing against them. The further rapid rise in pigs in Glasgow and Cleveland are factors which this week have a distinct favourable influence upon this market.

The amount of work turned out at the mills and forges this week has been in excess of a week ago. Works have been restarted which did nothing last week on account of the holidays. The extent of orders in hand even at the sheet mills is not very conspicuous, since the galvanisers are hardly buying with so much freedom as a while ago. Still there is plenty of business at the moment, and deliveries are pressed for at the sheet mills. The spring shipping season is expected to add materially to the orders upon the books. The condition of the market early after quarter-day should afford a fair index of the probabilities of the new quarter. Singles are still quoted £5 15s. 6d.; doubles, £6 7s. 6d.; and trebles, £7 7s. 6d. These prices for doubles are an advance in the case of some makers upon the minimum of a few months ago of 7s. 6d. to 10s. per ton.

The position of the best bar makers continues to be much better than for a long time past. The New Year brings with it prospects which are decidedly gratifying for these makers. The competition of second and third-class bars has evidently not yet monopolised the markets formerly occupied by best bars. Orders are being received with increased energy, and the mills are employed with much more regularity. The Earl of Dudley, Messrs. Wm. Barrows and Son, the New British Iron Company, Messrs. John Bagnall and Sons, and Messrs. Noah, Hingley, and Sons, may be particularised as doing more than for some time past. Most of the export orders are arriving from Australia and America, while on home account a fair demand is expressed for Government dockyard and general high-class engineering purposes.

The Earl of Dudley's prices open the year at:—Bars, lowest quality, £7 12s. 6d.; single best, £9; double best, £9 10s.; and treble best, £12 10s. Strips and hoops and angle iron are:—Lowest quality, £8 2s. 6d.; single best, £9 10s.; double best, £11; and treble best, £13. His lordship's rivet and tee iron are:—Single best, £10; double best, £11 10s.; and treble best, £13 10s. Strips and hoops of $\frac{7}{8}$in. and 20 gauge are £9 2s. 6d. lowest quality; £10 10s. single best; £12 double best; and £14 treble best; while $\frac{3}{4}$in. is £10 12s. 6d., £11 10s., £13, and £15 respectively. The above are subject to a merchant allowance of 10s. per ton. These prices are likely to be confirmed at next week's quarterly meetings. The present marked bar standard price is exactly the same as twenty years ago, namely, in 1867. Medium and common bars keep in moderate sale at £5 10s. for general merchant sorts, and £4 15s. to £5 for common. Messrs. Lones, Vernon, and Co. and some other makers have advanced their minimum price for bars 5s. per ton to cover the increased cost of pigs. Hoops and strips are without change at £5 to £5 10s. for the former and £4 17s. 6d. upwards for the latter.

Best thin sheets are in brisk sale, and Messrs. E. P. and W. Baldwin quote upon the open market £12 for Severn singles, and go on to £22 10s. for E.B. charcoal. Messrs. Morewood and Co. for their quality of sheets quote £8 for Woodford singles and £13 for mild steel sheets.

The Australian mail of the past week landed a fair lot of orders for execution in this district, and advices from Melbourne and Sydney describe the business doing as sound, though the demand is somewhat interfered with by the monetary stringency. Heavy shipments were reported to be afloat, and these depress prices a little. The colonial demand for galvanised iron, was quicker and prices showed a firmer tendency. Some large parcels had changed hands, and Staffordshire brands had been sold in rather quick succession, with prices higher than those obtained for any competing qualities. Gospel Oak, Orb, Three Crown, Crown, and Emu —all local brands—were quoted £16 for 26 g.

Pig iron gains in strength rapidly, and the Cleveland advance of 2s. per ton in a single week strengthens sellers' hands here a good deal this week. Vendors of Derbyshire and Lincolnshire makes report that their principals have secured a number of heavy contracts at the furnaces, and they are demanding more money. In sympathy with them the Northampton makers also seek better terms. Some brisk sales are going on in advance of the quarterly meetings, some consumers being still desirous of covering themselves forward.

An advance of 1s. to 1s. 3d. per ton is freely mentioned this week on Midland pigs; 37s. 6d. at stations, or 38s. 3d. at consumers' works, is the minimum now for Derbyshires, and 37s. 9d. at consumers' works for Northamptons. Some sellers were yesterday in Wolverhampton and to-day—Thursday—in Birmingham asking a good deal more than this. 40s. per ton was the open market quotation for one or two special brands of Northampton pigs, but the figure was prohibitive. Lincolnshires were quoted 42s. to 42s. 6d. at works. All quotations of a week and less ago were this afternoon withdrawn by sellers, who would part with nothing except at the advances indicated above.

Hematite pig agents were to-day in receipt of instructions from principals suspending quotations until the quarterly meetings, when higher prices are certain to rule. Those hematites that were on offer were quoted 56s. to 57s. for forge sorts, delivered from the west coast and Lancashire.

In local pigs the current make is not sufficient to meet requirements, and stocks are being drawn upon to fill contracts, with the result that stocks at the furnaces are smaller now than they have been for a long time. Best qualities of forge pig are quoted at 55s. to 57s. 6d., though 52s. 6d. is nearer the general selling price. Medium pigs are 37s. 6d. to 40s., and common forge 28s. 6d. to 30s., and common foundry 30s. to 32s. 6d.

The strong condition of the steel market is reflected in a report which was current on 'Change to-day that the Tin Bars Association, which is composed of Welsh and other steelmasters, have, with the opening of this year, further advanced their prices 5s. per ton. The last advance of 5s. was on November 1st, and by this second advance, if the report is strictly accurate, the Association recover the full 10s. per ton reduction which they declared six months or so ago. The advance now reported has, I know, been in contemplation for a month or more. Bessemer steel tin bars now become £4 15s. at consumers' works in Wales; billets, £4 7s. 6d.; and blooms, £4 5s. For delivery to stations in Staffordshire a further 5s. per ton has to be added.

The comparative statement of ironworkers' wages and "extras" in the various other ironmaking centres, as compared with those paid in South Staffordshire, which has been drawn up and presented to the men by the employers in support of their claim for the abolition of many of the "extras" upon mill and forge tonnage rates, has not met with a favourable reception. The operatives' section of the Wages Board have this week passed resolutions affirming the inaccuracy of the statement, and appointing a deputation to collect from South Yorkshire, Lancashire, and elsewhere evidence in proof of this allegation. Arrangements are also to be made for the holding of a national conference of ironworkers' representatives. The men assert that the improved condition of the iron industry would justify rather an increase than a reduction in wages. The "statement" which has been got out by the masters is a very convincing compilation, and shows clearly that wages here are much higher than in competing districts. The puddlers, for example, receive 6d. per ton extra for each of the following operations:—Cutting through or doubling, making four balls in some cases, and working small coal or scrap. Such "extras" are wholly unknown in other districts, and similar instances occur in other departments of the ironworks.

An alteration in puddling operations which is being introduced into a Netherton works does not meet with favour from the puddlers. Hitherto the iron has been taken to the hammer by those operatives, but it is proposed to replace this method by the introduction of trolleys, the cost of trolleying the iron to be paid out of the office, and the puddlers to be reduced 6d. per ton. The masters contend that the iron will be improved in the manufacture under the proposed altered mode of working. The men strongly oppose the new system, and have raised several objections. Negotiations, however, resulted in their determining to give the practice a trial for a month, but at the last moment the underhand puddlers altered their decision.

The anchor smiths in the employ of a Netherton firm are on strike against a reduction of wages equal to $12\frac{1}{2}$ per cent. Twelve months ago, when trade was depressed, the men voluntarily submitted to a reduction equal to $6\frac{1}{2}$ per cent., making, the men affirm, a total drop in wages in two years of $17\frac{1}{2}$ per cent. If the demands of the firm are acceded to the wages paid will be $17\frac{1}{2}$ per cent. below the established minimum of the trade. The operatives are strenuously supporting the men on strike, believing that if the firm are successful there will be reductions all round.

The Cradley Heath chain-makers are confident that their strike for an advance in wages will terminate in their favour. Stocks are diminishing, and makers find the greatest difficulty in executing orders. The operatives evidently intend to gain as much advantage from the dispute as possible. They have decided not to resume work until the truck system is abolished, and they are agitating for a reduction in the hours of labour, with a view to restricting production, and so prevent the masters from employing what the chain-makers deem arbitrary measures to enforce reductions in wages.

The South Staffordshire Mines Drainage Commissioners have just levied a rate on the mines in the Old Hill district, for the twelvemonth ending the 3rd January next year, of 3d. upon every ton of fireclay and limestone, and 6d. upon every ton of ironstone, coal, and slack. They have also called upon every occupier of a mine within the drainage area to make a return of the number of acres of mine occupied by him, and of the number of tons of mineral raised by him during the half-year ending the 31st December last.

Machinery engineers report a more healthy feeling about trade, and export inquiries are more active than was the case some time ago. Still, new orders cannot be termed by any means abundant, and many machine shops continue only partly engaged. Marine boilers and engines are in improved sale, and steam pumps are on order to a considerable aggregate for mining and irrigation purposes. Hauling machinery for similar uses is also in better call on export account. Portable engines for agricultural purposes are going away freely to Australia and other of the colonies, while the demand for lifting tackle for abroad and for the colonies is fairly satisfactory. Presses, shafting, and metal spinning machinery are in good call at the Birmingham machine shops. In South America, Spain, and elsewhere local makers of machine tools have to compete against the severe inroads of the Germans in the matter of common goods, but for best machinery our houses carry off the orders with hardly any trouble.

Messrs. Tangyes have experienced increased briskness of late in the call for general machinery, and other makers also report somewhat more cheerfully. Messrs. James Archdale and Co. are very busy on contracts for Arsenal tools for the British and the Chinese and other foreign Powers. Torpedo-boat machinery, such as light engines and boilers, compressed-air reservoirs, &c., is keeping Messrs. George Bellis and Co. well on. Messrs. W. and J. Player have secured a good contract for planishing hammers from the

Belgian Government, and other business is expected from the same source.

Gas engines are increasingly to the front, and are taking the place of steam engines for many works' purposes. Makers of these motors are doing a good business, and prospects for 1887 are declared to be very encouraging. Petroleum engines, however, are now competing with gas engines, and Messrs. A. Shirlaw and Co., Birmingham, speak satisfactorily of the demand which they are experiencing for the new motor.

For heating appliances there is a brisk demand, and the firms engaged in the manufacture of engines and dynamo machines for electric lighting purposes have plenty of work before them.

The production of wrought iron tubes for both gas and water-works' requirements is brisk, and the leading houses have more orders upon hand than they have experienced for a long time past.

Hardware factors and merchants are not delaying the placing of contracts for the next quarter, and manufacturers are gratified that some of these are decidedly above the early January average. Good expectations are entertained of a much better demand during this year than was experienced in 1886, and indications continue favourable for the realisation also of higher prices.

I do not yet hear of any alteration in the discounts; but if iron and steel and other raw materials keep strong and see further advances, as is very likely, reductions in discounts will be announced in several branches. The meagre profits of 1886 should gradually become a thing of the past. The year is opening with lighter stocks on the shelves of some manufacturers than have long been observable, and the probabilities are strongly in the direction of stocks being kept down. The smaller hardware makers are receiving orders from the factors, and at the larger establishments there is less necessity than usual at this period to put operatives upon stock.

NOTES FROM LANCASHIRE.

(*From our own Correspondent.*)

Manchester.—Actual business has scarcely yet been fully resumed after the holidays; works and collieries have during the past week been closed for several days, and where there has been anything doing it has been altogether of a special character. The year has, however, opened with a very strong tone in the market for which it is difficult to find any really legitimate justification beyond the fact that America is just now taking a good deal of raw material from this country. So far as local trade is concerned, there is no real improvement in the iron using branches of industry in this district to give any upward movement to prices, but acted upon by outside influences, such as the upward movement in warrants at Glasgow, and the considerable advance which has taken place in the price of Middlesbrough iron, the market here has been thrown into a very unsettled condition. It is true that from the makers' point of view, even at the full advance, the prices which are now being asked have not yet got to the point where they represent any substantial return in the actual cost of production, but they represent so considerable an advance upon the ruinously low prices to which buyers have of late been accustomed that they are not at all readily accepted. The heavy stocks which are still held, and the very large number of furnaces which are still out of blast, have naturally a temporary effect upon any undue upward movement in the market, but there is a decided spring in prices, for which it is difficult at present to assign any sufficient reason.

For the opening market of the year, following so closely upon the holidays, there was a fairly good attendance in the Manchester Iron Exchange on Tuesday, and there would have been no difficulty in booking orders for forward delivery if sellers had been prepared to accept the prices which would have been taken a week or so back. Here and there merchants were prepared to do business at about 1s. per ton above late rates, but representatives of makers in most cases were not in a position to give any open quotations, and where offers were put forward they were, as a rule, only entertained on the condition that they would have to be submitted for acceptance. In local and district brands of pig iron no definite quotations could be got from representatives of makers, and the market can only be described in the general terms that there was a strong upward tendency in prices, with very little actual business doing. In one or two instances sales were reported at 1s. to 1s. 6d. per ton above late rates; but although buyers would no doubt have given out orders on the basis of prices which were being taken a week or two back, there was very little really genuine inquiry in the market. The real position of the market is this—that for their very limited output makers are so fully sold that they are in a position to be indifferent about booking further orders at present, and the only question is whether there has yet been a sufficient advance in price to justify the re-starting of furnaces which are at present out of blast.

As regards hematites, very much the same conditions as those to which I have already referred also apply. Most of the makers are for the present so well supplied with orders that they are holding out for prices that buyers in this market are not disposed to give, and the low sellers are taking advantage of this to ask an advance of 1s. to 1s. 6d. per ton upon the minimum prices which would have been taken only last week.

The advance in the raw materials has placed makers of finished iron in a very difficult position. They have before them plenty of opportunity for doing business, but buyers will not give any advanced price commensurate with the advance which manufacturers would now have to pay for pig iron; for the present forges are fairly well supplied with orders, but there is no new business coming forward, except at prices which makers do not feel themselves in a position to accept.

In times of depression large works have frequently to seek a development of trade outside of what may be regarded as their special line of business, and as an illustration of this I may mention that the Ashbury Railway Carriage Company, of Manchester, has for some time past been largely developing the branch of its works which is more directly connected with the manufactured iron department, and recently it has in this direction been making considerable additions to its already extensive concern. Going through its works the other day, I could not help noticing how its iron manufacturing business and bridge and girder work was pushing itself into prominence, even where new plant was to be seen which had been put down for constructive iron work distinct from carriage building, and the activity which characterised this department certainly seemed to justify the company in the divergence it was taking from the strict line of business with which its name has been so long associated. The company had in hand large home and colonial orders for bridge and girder work, and for this a good deal of special plant had been put down. Amongst the new plant was a powerful steam travelling crane 35ft. high, with a 43ft. span, and capable of lifting twenty tons; in addition to this a number of improved radial drills and Tweddell's portable rivetters have been added to its plant, besides various other improvements to meet the requirements of modern times. In the department which may be regarded as in connection with its carriage building work the company has just set up a powerful hydraulic press of 1500 tons pressure, with other appliances for the manufacture of solid wrought iron wheels.

A curious incident was the other day brought under my notice which may be worth briefly mentioning as an illustration of the extraordinary conditions under which business is just now being done. Messrs. Krupp, of Germany, are executing a steel rail order for the colonies, and the points and crossings are being manufactured by a well-known firm in the Manchester district; notwithstanding the excessively low prices at which steel rails can be bought in England, Messrs. Krupp have actually sent over from Germany upwards of 80 tons of steel rails which have been delivered at the works in the neighbourhood of Manchester, to be there manufactured into points and crossings and again re-shipped for delivery to the colonies.

In the coal trade there is a brisk demand for all descriptions of fuel suitable for house-fire consumption, and the stoppage of the pits during the past week for the holidays has thrown many of the collieries in arrears with their orders. Other descriptions of fuel for iron-making, steam and engine purposes, are also moving off better, and pits have more than sufficient work to keep them fully employed. The present pressure is, however, regarded only as temporary whilst the severe weather lasts, and except that some collieries have put about 6d. per ton upon the price of house-fire coal where they were previously below the full quoted rates, no attempt has been made at any further upward movement in prices. At the pit mouth best coal is now quoted at 9s. to 9s. 6d. per ton; seconds, 7s. 6d. to 8s.; common house coal, 6s. to 6s. 6d.; steam and forge coals, 5s. to 5s. 6d.; burgy, 4s. 6d. to 5s.; best slack, 3s. 6d. to 4s.; and common, 2s. 6d. to 3s. per ton.

For shipment there is only a moderate demand, and steam coals do not average more than 7s. to 7s. 3d. per ton delivered at the Garston Docks or the high-level, Liverpool.

Barrow.—The tone of the hematite pig iron trade of this district is very steady, although, as a matter of fact, very little new business has been done during the past few days. The holidays are, however, chiefly responsible for this. Makers of iron have a large amount of work in hand, and they are well sold forward, both in Bessemer and ordinary qualities of metal. It is fully expected that several new orders will be booked early in the year, as it is known makers have several large requirements which want satisfying before the spring months, either in sales on prompt or on forward deliveries. Stocks are large, and they are likely to continue so, with present prospects of increased values of pig iron. Prices are firmly held at 45s. 6d. to 46s. for Nos. 1, 2, and 3 in mixed parcels, equal weights of all qualities, and at 44s. 9d. for No. 3 forge and foundry iron net at makers' works. The output of pig iron is not only fully maintained, but efforts are being made to bring into blast several of the furnaces which have been out of blast for some time past. It is probable that before the spring the output will be increased by one or two thousand tons a week. The steel trade is busy in all departments save one, and that is that of steel for shipbuilding purposes, for which there is a very limited trade, although inquiries are stronger than they have been. The market for railway material is firm, and makers are not only well sold forward, but they are experiencing a demand which shows that a continuance of activity may be expected at the mills for many months during the present year. The demand comes from all sources, and includes business from America, the Colonies, and the Continent, in addition to a good request on home account. The market for rails is as good as it has been for some years past, and it is probable that contracts will continue to come in on a large scale. Merchant steel is in request, and bars are in improving request. Shipbuilders are not better off for orders, except in one small instance, but the outlook is comparatively good. Engineers are not fully employed, but there are more hopeful signs all round. Iron ore steady at 9s. to 11s. per ton. Coal and coke firmer.

THE SHEFFIELD DISTRICT.

(*From our own Correspondent.*)

THE Staveley Coal and Iron Company, near here, has introduced a large lamp of Scotch invention, which burns a cheap oil produced at the works of Messrs. Kempson. The lamp is made to burn, by steam pressure, coal tar oils, which at the present low price of residuals can be had at a nominal price. A tank, with some twenty gallons of oil, and having a large lamp attached, is placed in mid-air, and when the light is required the steam is turned on through a ½in. or ¾in. pipe. The application of a light causes the lamp to give a flame equal to about 2000-candle power, and consuming about two gallons of oil in the hour. The light has been introduced into the workshops where the large pipes are being made for the Manchester Waterworks.

We have had quite a long spell of frost, which has given the skate-makers a turn. Stocks have been pretty well cleared, and the merchants, who held heavy accumulations having relieved their shelves, are ordering freely. The skate industry is in need of a stimulus, and another fortnight of continual frost in the country would be a great boon to all engaged in the trade.

Messrs. Newton, Chambers, and Co. Thorncliffe, have just opened a large new shaft, for the double purpose of providing more efficient ventilation and as the means of ingress and egress to the workings, without having to descend the shaft from which the coal is drawn. The new shaft is at Barley Hall, near Thorpe Hesley. Messrs. Walker and Foulstone, colliery contractors and engineers, of Barnsley, started the work on June 21st, 1886, and the Silkstone seam was reached on the last day of the year. The new shaft is 13ft. in diameter, 164 yards deep, and is walled with bricks from top to bottom. The whole of the work has been completed without the slightest mishap. The Thorncliffe Ironworks and Collieries are amongst the largest in South Yorkshire, it being estimated that about 20,000 persons—men, women, and children—are dependent upon them for a living. The firm have enjoyed remarkable immunity from the calamities which periodically occur in colliery workings.

THE NORTH OF ENGLAND.

(*From our own Correspondent.*)

THERE are many signs that a real and substantial improvement in the Cleveland pig iron trade has set in. The amount of business actually done during the holidays was not great. Sellers, however, not only held their own, but they substantially improved their position. During the latter part of last week inquiries were numerous, and the price of No. 3 g.m.b. advanced from 33s. 9d. to 34s. per ton. The market held at Middlesbrough on Tuesday last was quite excited, and prices fluctuated considerably. Consumers offered as much as 35s. 6d. per ton for No. 3 g.m.b., for this month's delivery. Sellers were not eager to commit themselves even at that figure, seeing that their prospects are now so promising. Makers, who are for the most part well supplied with orders, ask 36s. 6d. for No. 3, and are unwilling to sell for delivery beyond the end of the month

The quarterly meeting of the Cleveland iron market will be held at Middlesbrough on Tuesday next.

A considerable amount of business is being done at Glasgow in Cleveland warrants. The current price is about 36s. 6d. per ton, and the iron represented is largely being sent into store. At Glasgow on Tuesday transactions took place at 36s. 4½d. to 36s. 6d. per ton for cash, or 3d. per ton more for cash in one month.

Messrs. Stevenson, Jaques, and Co.'s current quotations are:—Acklam hematite, mixed Nos., 45s. per ton; Acklam Yorkshire, Cleveland No. 3, 36s. per ton; Acklam basic, 38s. per ton; refined iron, 48s. 6d. to 57s. 6d. per ton.

There is still but little inquiry for finished iron, but nevertheless, owing to the rise in price of pig iron, makers have been compelled to put up their quotations. They are now asking £4 12s. 6d. per ton for ship plates, £4 7s. 6d. for angles, and £4 12s. 6d. for common bars, all free on trucks at makers' works, less 2½ per cent. discount.

Relative to the threatened strike of blast furnacemen, an important conference between the employers and representatives of the men was held on the 31st ult. The following proposal was ultimately made by the former for submission to the men, viz.:—"That the sliding scale be re-established for the minimum period of two years from the 1st of January, 1887, on condition that the reduction of 3¾, 2½, and 1¼ per cent. obtained during the second, third, and fourth quarters respectively of 1886, in excess of the sliding scale rate, be returned to the men, in the same order, during the first three quarters of 1887, in addition to the wages payable under the sliding scale. Notices for terminating the proposed scale to be the same as under the last scale. Also that the claims of the barrow men and keeper's helpers be referred to a joint committee of employers and workmen."

NOTES FROM SCOTLAND.

(*From our own Correspondent.*)

BUSINESS in the iron and coal trades has been much interrupted this week by the New Year holidays. Work has been either wholly or partially suspended in the principal works for a great part of the week. In some departments the holiday was shortened by the pressure for delivery of work.

The pig iron market was closed from Friday till Tuesday. On the re-opening the feeling was very strong, and prices advanced on Tuesday as much as ½d. a ton, a very large business being done. The market was mainly affected by the news from the United States, which appears to indicate that Scotch iron will presently be wanted there in larger quantities. There is practically no change in the number of furnaces in blast, and no material addition has been made to stocks.

Business was done in the warrant market on Friday up to 44s. 7½d. cash, closing at 44s. 5d. buyers. On Tuesday forenoon transactions occurred at 44s. 10½d. to 45s. 5½d., the afternoon market being at 45s. 6d. to 45s. 2½d., and 45s. 7d. cash. Wednesday's market was excited and strong, with a further advance in prices to 45s. 11d. cash. To-day—Thursday—there was a large and excited business. Warrants began at 46s. 2d., ran up to 46s. 7½d., then declined on heavy selling to 45s. 10½d., recovering again to 46s. 2d., and closing with buyers at ½d. less.

Makers' pig iron was very firm, and they were exceedingly cautious sellers, it being as a rule all but impossible to get quotations for forward delivery. It would serve no good purpose to give makers' quotations this week, as they might be materially altered before they could appear in print.

The past week's shipments of Scotch pigs are about 2000 tons above those of the same week last year.

Considerable additional orders for basic steel are reported from the United States, and the price of Glengarnock steel billets has been advanced by 5s. a ton.

The malleable ironworks of Lanarkshire are in a more promising state with regard to business than for some time past.

The coal trade has been restricted this week on account of the holidays, the collieries having been idle in the early part of the week. But there has been no particular pressure for shipment. Prices of nearly all sorts of coal are firm, and in one or two instances 6d. a ton of an advance has been obtained.

The trade of Renfrew will benefit greatly by an order for six hopper barges which Messrs. Lobnitz and Co. have secured for the Suez Canal Company. This is the second order the firm have got from this company within a few weeks, having now on hand for the Canal twelve hopper barges, four big steamers, and a large and powerful dredger.

WALES AND ADJOINING COUNTIES.

(*From our own Correspondent.*)

IN coal prices remain the same for ordinary sales. There was a rumour a few days ago that prices were moving upwards, but it appears at present to be confined to North Wales, where 6d. per ton advance has been obtained for best kinds of coal. Quotations at port are still 8s. 6d. for the best steam, and 4s. to 4s. 3d. for the best small. For the latter the demand is easy. House coal is in good request, and as much as 8s. 9d. is obtained for best kinds. Small bituminous is sluggish in sale, and may be had at all prices from 3s. 9d. to 4s. 6d.

The transfer of the Bute Docks to a company has been the important event of the first week of the new year.

The rail trade is not sufficiently pronounced to criticise. Ironmasters are going along a little more comfortably, and prices are slightly improved. A good rail trade is daily expected from America and the colonies, and there seems to be a reasonable certainty that the spring market will be larger than the rail trade has been for the last quarter, and that figures will be advanced. Quite a spurt has taken place in the old and rejected rail trade, and the few holders have had so many quotations offered, that they are chary in selling. As soon as the weather improves, and relaying can be carried on, the mills will be busier. At present the steel sleeper trade for home use is not a great one. Foreign customers are still in the market.

The shipping casualty list is still a heavy one. Aberystwith, one of the oldest of the Welsh ports, and Cardiff, one of the latest, have both suffered in proportion. Numerous coal cargoes have been sunk of late.

Tin-plate continues to command the greatest attention, and speculation is rife as to the course the men mean to adopt. Saturday next has been named at Swansea for time and place for organised action. In the meantime those employers who have been successful in completing arrangements with their men are doing well. Prices are firm and steadily advancing, and though the total exported last week was smaller than usual, on account of the holidays, the business in hand and ready is very satisfactory.

The total shipments from Swansea last week of tin-plate amounted to 13,650 boxes, principally to Germany, France, and Spain. The shipments from America were *nil*, but this will soon be made up. The American trade is rapidly increasing, as the monthly totals show. The present prices are 12s. 9d. to 13s. 6d. I.C. for cokes, 13s. to 14s. for Bessemers, and 3d. more for Siemens. These two are most in demand. Best charcoals touch 17s., and for best ternes as much as 14s. 6d. can be had. For coke wasters the enquiry is brisk, and quotations are 12s. 9d., or even higher than was only lately quoted for good brands.

Pitwood is in demand at 16s.

SOUTH KENSINGTON MUSEUM.—Christmas week free. Visitors during the week ending January 1st, 1887:—On Monday, Tuesday, and Saturday, free, from 10 a.m. to 10 p.m.: Museum, 9164; mercantile marine, Indian section, and other collections, 3578. On Wednesday, Thursday, and Friday, from 10 a.m. to 10 p.m.: Museum, 4080; mercantile marine, Indian section, and other collections, 2979. Total, 19,801. Average of corresponding week in former years, 32,709. Total from the opening of the Museum, 25,339,304.

NAVAL ENGINEER APPOINTMENTS.—The following appointments have been made at the Admiralty:—John W. Midgley, engineer, to the Goshawk, additional, when recommissioned; Charles M. B. Dyer, engineer, to the Swinger, when recommissioned; John Armstrong, chief engineer, to the Britannia; Edward Crawley, chief engineer, to the Pembroke, for reserve; Edward G. F. Moffett, engineer, to the Narcissus; George J. Gorfett, engineer, to the Porpoise; Cornelius H. Steward, engineer, to the Vernon, additional, for torpedo school; and Edward Gallery, assistant engineer, to the Benbow.

A NEW THAMES EMBANKMENT.—Arrangements for the construction of a new embankment along the south side of the Thames, from the new dock of Putney Bridge to the parish boundary at Barnes, have now been completed by the Wandsworth District Board of Works, under the direction of their local surveyor, Mr. J. C. Radford, C.E. The embankment will be 45ft. wide, and consist of a 12ft. footway and a carriage way of 33ft. The foundation will be of concrete. The footway is to be fenced from the water by massive iron railings of a handsome design. The total cost is estimated to be close upon £5000. Towards this sum the Thames Conservators have promised £800. The remainder of the required amount will be equally borne by the Metropolitan Board and the Wandsworth District Board. The work will probably be begun next month.

AMERICAN NOTES.

(*From our own Correspondent.*)

NEW YORK, Dec. 24th.

BROKERS are about closing negotiations for large lots of English pig iron, billets and slabs. They have orders in hand to-day for from twelve to fifteen thousand tons of old rails and scrap, but do not expect to meet buyers' requirements at present. Bessemer pig is quoted at 25 dols. 50c.; blooms, 29 dols.; billets, 30 dols.; spiegeleisen, 28 dols., all with an advancing tendency. Steel rails are quoted at 36 dols. at mill, but makers are unwilling to book orders. An advance to 37dols. or even to 38 dols. will be sure to follow if prices improve abroad. Tin is quiet and steady at 20 dols. 20c.; copper, 11 dols. 75c.; lead, 4 dols. 40c.; spelter, 4 dols. 10c. Inquiries are in hand this week for large quantities of Lehigh foundry and forge, and offers have been made for southern iron which have helped to stiffen prices 25c. Inquiries are in the market for large blocks of structural iron and prices are firm at 2 dols. 20c. for angles and 3c. for beams; tank is 2½; plate, 2¼ to 2½. The mills in all sections of the country are full of business, and furnace capacity is being improved by better appliances.

NEW COMPANIES.

THE following companies have just been registered:—

Aldeburgh Pier Company, Limited.

This company proposes to acquire the property and rights acquired by Mr. John Hazel Fuller, from the Aldborough Pier and Improvement Company, Limited, and all rights and title vested in him under the Aldborough Pier Order, 1884, together with the portion of Aldborough Pier which has been already constructed and the site thereof, and the land belonging thereto. It was registered on the 24th ult., with a capital of £12,000, in £1 shares, with the following as first subscribers:—

	Shares.
G. S. Goodman, 9, Stanthorpe-road, Streatham, warehouseman	1
J. H. Williams, 18, Upper Gloster-place, Dorset-square, warehouseman	1
E. Hornsby, 25, Old Change, Packer	1
J. C. Hayes, 14, Friday-street, warehouseman	1
Thomas Gumm, 92, Watling-street, merchant	1
Robert Bedford, 11, Woronzow-road, N.W., agent	1
E. J. Thomas, 79, Mark-lane, architect	1

The number of directors is not to be less than three, nor more than five; qualifications other than the first, 100 shares; the company in general meeting will determine remuneration.

Charles Brown and Company, Limited.

On the 24th ult. this company was registered with a capital of £100,000, in £100 shares, to purchase all the estate and interest of Charles Brown, Joseph Rickett and Edmund William Rickett, in the Waddon Flour Mills, Croydon, the Stanley Bridge Flour Mills, Chelsea, and the Sun Flour Mills, Waltham Abbey. The subscribers are:—

	Shares.
*Charles Brown, Bush House, Croydon, miller	303
*J. Rickett, East Hoothly	222
*E. W. Rickett, 2, Oakley-street, Chelsea, miller	111
*J. Compton Rickett, Burleigh House, Croydon	75
*W. R. Rickett, Sunnyfield, Hampstead	50
*C. S. Brown, Bush Hill Park, Enfield	30
*G. Cutt, Stanton House, Nightingale-lane, Clapham	27
John Lea Smith, Ormonde-terrace, Regent's Park	27

All male members of the company holding not less than 25 shares will be entitled to a seat at the board. The subscribers are the first directors.

James Gibbs and Co., Limited.

This is the conversion to a company of the business of manufacturers of and dealers in sulphuric acid and chemical fertilisers, importers of Peruvian guano and nitrate of soda, seed crushers and feeding cake manufacturers, carried on by James Ford and Alex. Ellis Ford, in co-partnership, trading at 16, Mark-lane and elsewhere under the name of James Gibbs and Co. It was registered on the 24th ult., with a capital of £90,000, in £10 shares, with the following as first subscribers:—

	Shares.
H. E. Broad, 1, Walbrook, accountant	50
*J. W. Dresser, Phillimore, Beckenham	50
*W. T. H. Radford, 2, Fenchurch-avenue, merchant	50
*James Ford, 16, Mark-lane, chemical manufacturer	50
*A. E. Ford, 16, Mark-lane, chemical manufacturer	50
F. Spiers Price, 50, Hopton-road, Streatham, accountant	50
W. G. Allen, 36, Seething-lane, steam tug owner	50

The number of directors is not to be less than four, nor more than six; qualification, 50 preference shares; the first are the subscribers denoted by an asterisk; remuneration, £1000 per annum, or such further sum as the company in general meeting may determine. Mr. Alex. Ellis Ford is appointed first managing director. The articles of association stipulate that the first business of the company will be to make arrangements for the purchase of the business on the basis of the payment of a sum of £162,000—of which £142,000 shall be paid in cash, and £20,000 in fully-paid deferred shares—but no explanation is given as to how this payment is to be made from a nominal capital of £90,000.

Norwich Tramways Company, Limited.

On the 23rd ult. this company was registered with a capital of £30,000, in £5 shares, to construct and lay down tramways within the city of Norwich and county of Norfolk. The subscribers are:—

	Shares.
Louis Striem, 4, Copthall-buildings, secretary to a company	1
F. Mannelle, 101, Leadenhall-street, merchant	1
J. W. Alison, 4, Copthall-buildings, accountant	1
J. Kincaid, C.E., 11, Great George-street, S.W.	1
W. Barfoot, Leicester, merchant	1
Leslie McIntosh, 262, Goldhawk-road, Shepherd's Bush, shorthand writer	1
G. Exall, 70, Winston-road, Stoke Newington, clerk	1

The number of directors is not to be less than three, nor more than five; the subscribers are to appoint the first; qualification, 50 shares or equivalent stock, but this will not apply to the directors appointed by the subscribers; the remuneration of the board is to be £300 per annum.

Venezuela Docks and Public Works Company, Limited.

This company was registered on the 23rd ult., with a capital of £225,000, in £10 shares, to acquire and carry into effect a concession dated 9th August, 1886, from the President of Venezuela to Don Miguel Tejera, for the establishment of a shipbuilding yard and floating dock on the Island of the "Libertador Fort" at Puerto Cabello, power being also taken to construct other private and public works. The subscribers are:—

	Shares.
John Collinson, 8, Great Winchester-street, merchant	1
James Alexander, 3, Great Winchester-street, merchant	1
J. O. Chadwick, 24, Budge-row, chartered accountant	1
F. W. Pixley, 24, Moorgate-street, chartered accountant	1
J. Price, C.E., Jarrow-on-Tyne	1
G. H. Benson, Barnet, Herts, merchant	1
W. G. Blakemore, 10, Rona-road, N.W., chartered accountant	1

The number of directors is not to exceed seven; the subscribers are to appoint the first, and act *ad interim;* the company in general meeting will determine remuneration.

Water Primary Battery Company, Limited.

This company was registered on the 23rd ult., with a capital of £100,000, in £5 shares, to enter into an agreement to be made between Paul Raoul D'Fancheux d'Humy and the company, and to carry on the business of an electric company in all branches. The subscribers are:—

	Shares.
P. R. F. D'Humy, 2, Carlton Mansions, Clapham Rise, electrical engineer	1
H. Chaplin, 19, Lincoln's-inn-fields, solicitor	1
F. C. Allingham, 28, Rowan-road, Brook-green, accountant	1
A. Balderson, 18, Carlton-square, New-cross, clerk	1
A. W. Peckham, 9, Duke-street, Portland-place	1
E. Sage, Stanley House, King's-road, Richmond, architect	1
A. Nord, 22, Grays-inn-road, clerk	1

The number of directors is not to be less than two, nor more than seven; qualification, 100 shares; the subscribers are to nominate the first. Out of the net profits remaining in each year, after payment of 5 per cent. per annum dividend, the directors will be entitled to such sum, not exceeding £75 each, as such remaining profits will admit, and in addition thereto 10 per cent. upon any further profits made in any year.

NAVIGATION IN CENTRAL ASIA.—M. Sokoloff has contributed an article on the subject of the navigation of Central Asian rivers to the *St. Petersburg Gazette*, and the following is a translation of its principal passages:—"General Peroffsky's expedition to Khiva forty years ago was accompanied by eight small vessels, and he describes these as the first Russian vessels to make their appearance in the Aral region. Kazalinsk on the Syr Darya became some years later the head-quarters of a squadron of five steamers and several barges. These vessels were employed for a long time almost exclusively in navigating the Syr Darya, and rarely visited the Aral sea itself. During the conquest of Turkestan the fleet rendered most useful service in conveying troops and provisions. After the end of the war they were employed in the carriage of passengers, &c., which was opposed to their original character. Nor was this task remunerative, as the receipts were no more than one-tenth of the cost of maintenance. In 1883 General Tchernaieff ordered the fleet to be abolished. With regard to the Amu Darya, it used to be thought that steamers could not ascend it for any distance. General Kaufmann was the first to practically expose this error. The restoration of navigation by the ancient Oxus opens a new era for commerce in Central Asia. The goods of Khiva will be sent up it to meet the Trans-Caspian Railway, and in a very short time two steamers will be found too few for the commercial and military requirements. By that time the magnitude of the trade will have justified the increase of the fleet."

AN EARLY RAILWAY.—In 1806 Arthur Young made a survey of the agriculture of the county of Essex for the Board of Agriculture, then in existence as a Government Department. He describes the great chalk pits of Mr. Whitbread, the grandfather of Mr. Whitbread, M.P., as follows:—"The lime-kiln establishment of Mr. Whitbread at Purfleet is one of the most interesting that is to be found in Essex; upon that gentleman's estate there is a bold cliff of chalk covered by many feet of surface loam; from the magnitude of the excavation it has probably been wrought for many years; but the present possessor gave a new appearance to the place, and a fresh vigour to the works, by laying down iron railways, for every purpose of carting; 25 horses were constantly employed; since these ways have been made four do the work, and 21 have been dismissed, which ate each half a bushel of oats per diem the year round. The loam which covers the chalk is sold to shipping for ballast at 1s. 1d. per cart-load of one ton and a quarter; chalk is delivered into the barges at 2s. 6d., flints the load—one ton and a half—at 14s., and lime at 19s. 6d. One horse draws five or six wagons, loaded. The disposition of the railways is complete—they lead to the bottom of the cliff to receive loam, which is shovelled down to large wooden hoppers, which pour it at once into the carts, by means of the skeleton chalk rock being left in forms that conduct it. Ways lead hence also for delivering the broken chalk directly to the kilns, which for this purpose are built in a deeper excavation; and coals are also distributed by other ways. From the kilns distinct iron roads lead also to shipping for delivery of the lime. The wagons are backed up to the ship or barge side, and unloaded at once by tilting them up." The plates give an illustration of one horse drawing six loaded wagons upon a railway, an enlarged view of the wagon used, as well as the rails, the chairs, and the sleepers—in fact, we have the modern railway in a crude form.—*Bedford Times.*

THE PATENT JOURNAL.

Condensed from the Journal of the Commissioners of Patents.

Application for Letters Patent.

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

28th December, 1886.

16,945. STOVE GRATES, C. Swindell, Sheffield.
16,946. SOLES and HEELS for BOOTS, J. Horrocks, Southport.
16,947. HOT WATER HEATING APPARATUS, S. Pearson, Bradford.
16,948. TIRES for WHEELS of BICYCLES, &c., J. Hudson, Birmingham.
16,949. MOUNTING, &c., SMOOTHING IRON, J. Redman, Halifax.
16,950. DOG BISCUITS, R. Glover, Stratford.
16,951. FORMING DEEP CORRUGATIONS in STEEL, &c., J. J. Robins, Derby.
16,952. LAMPS for VELOCIPEDES, C. A. and F. J. Miller, Birmingham.
16,953. CURTAIN RODS for DOORS, &c., F. R. Baker, Birmingham.
16,954. RAISING LAMP GALLERIES of HYDROCARBON LAMPS, F. R. Baker, Birmingham.
16,955. AUTOMATIC OIL GAS, &c., A. Eckford, Edingburgh.
16,956. VENTILATING, &c., WATER-CLOSETS, W. J. Stevens, Wiltshire.
16,957. LAWN-TENNIS NETS, D. and W. Dalglish, Burnfoot.
16,958. COMBINED SCRAPER, &c., F. James, Dresden.
16,959. CARRIAGE LAMPS, R. P. Dodd, Birmingham.
16,960. INHALING APPARATUS, H. A. B. Huguet, London.
16,961. HAND TRUCKS, A. H. Reed.—(*D. S. Wing and W. A. Cameron, United States.*)
16,962. SECURING BROOM HANDLES to their HEADS, F. Chamberlain and S. Naylor, Sheffield.
16,963. PLATING of SADDLE-TREES, &c., S. Edwards, Balsall Heath.
16,964. SHIP'S GANGWAYS, &c., J. McConachy, Glasgow.
16,965. SEPARATING POSTAGE STAMPS, J. J. Allen, Halifax.
16,966. STEAM MOTORS, A. G. Brown, Glasgow.
16,967. WATCHMEN'S TIME RECORDERS, A. C. Howard, United States.
16,968. GAS OVEN, S. W. Wilkinson, J., W. R., and R. Green, Ecclesfield.
16,969. LETTER COPYING BOOKS, P. M. Justice.—(*L. E. Whiton, United States.*)
16,970. LOOMS for WEAVING, J. Jucker, Manchester.
16,971. RIVETS, L. O. Dion, London.
16,972. DRAFTING CHARTS for PATTERNS, E. Gartland, London.
16,973. LOOMS, R. E. Lester and J. A. S. Biernatzki, London.
16,974. DISPLAYING FIGURES in HIGH RELIEF, W. H. Power, London.
16,975. STRIPED VELVETS, R. S. Collinge, Manchester.
16,976. SPINDLES, G. H. Milward, Manchester.
16,977. ADJUSTABLE TRACING WHEEL, T. Wood, London.
16,978. LAMPS, W. Harris, London.
16,979. EXTRACTING OILS by VOLATILE SOLVENTS, A. W. MacIlwaine, London.
16,980. COMBINED HAND SAW, &c., A. Millar, Glasgow.
16,981. CLEARING SNOW, E. Burton, London.
16,982. UMBRELLA RUNNERS, T. A. Crabtree and B. Morrill, London.
16,983. STUFFING BOXES and PACKING, A. Mackie, London.
16,984. ENGINE TELEGRAPHS, G. Smith, Glasgow.
16,985. REMOVING CREASES, &c., D. Freeman, W. H. Foster, and H. Bentley, Birmingham.
16,986. RUBBING POINTS on LEAD, &c., PENCILS, M. P. Pettigrue, London.
16,987. STEEL WIRE, &c., BOLT ROPE, J. C. Peterkin, Glasgow.
16,988. PLANING, &c., SLATES, W. P. Thompson.—(*F. Shenton, United States.*)
16,989. HATS, T. Webb.—(*T. W. Bracher, United States.*)
16,990. HAT SWEAT BANDS, T. Webb.—(*T. W. Bracher, United States.*)
16,991. COAL MINING MACHINES, A. J. Boult.—(*J. Walton, United States.*)
16,992. CARBURETTERS, &c., R. S. Lawrence, London.
16,993. TOOLS, P. A. Newton.—(*T. G. Roebuck, United States.*)
16,994. FILTERING APPARATUS, H. E. Newton.—(*W. M. Deutsch, United States.*)
16,995. COPYING PRESS, &c., J. Lewy, London.
16,996. PERFECTING LETTER-PRESS PRINTING MACHINES, J. H. Buxton, D. Braithwaite, and M. Smith, London.
16,997. AUTOMATIC DOOR CURTAIN RAISER and DRAUGHT PREVENTER, A. Deslandes, Greenwick.
16,998. LUBRICATOR, J. Wildemann, London.
16,999. CANDLE LAMP for TRAVELLERS, R. Imray, London.
17,000. UTILISING URINE as MANURE, A. W. Carlson, London.
17,001. PROPULSION of SHIPS, S. Taussig, London.
17,002. ELECTRIC ARC LAMP, N. Marischler, London.
17,003. TYING and CARRYING PARCELS, A. M. Clarke.—(*C. W. Benedict, United States.*)
17,004. CAR GEARS, W. S. G. Baker, London.
17,005. SEWING MACHINES, J. S. Edwards, London.
17,006. OIL-LIGHTED BEACONS and BUOYS, J. M. Foster, London.
17,007. REGENERATIVE GAS LAMPS, J. M. Foster, London.
17,008. WATERING and LAYING DUST in MINES, T. Archer, jun., and T. O Robson, London.
17,009. KEYLESS WATCHES, E. de Pass.—(*Messieurs Favre Frères, Switzerland.*)
17,010. BUTTON-HOLE SEWING MACHINES, H. H. Lake.—(*J. E. Wheeler, United States.*)
17,011. FELTING HAT BODIES, H. H. Lake.—(*J. T. Waring, United States.*)
17,012. SPINNING, M. Stinglwagner, jun., London.
17,013. FLUSHING CISTERNS for WATER-CLOSETS, &c., J. Alston, Glasgow.
17,014. ANIMAL TRAPS, E. S. Hotchkiss, London.
17,015. CENTRIFUGAL MACHINES, C. A. Backstrom, London.
17,016. WINDOW CONSTRUCTION, O. Flagstad, London.
17,017. LIQUID EXTRACT of COFFEE, M. Samelson, London.

29th December, 1886.

17,018. TRANSMITTING ELECTRIC CURRENTS, M. H. Smith, Halifax.
17,019. BUILDING HOLLOW WALLS, G. M. Henley, Cornwall.
17,020. GAS PURIFIERS, G. Tolson and J. Illingworth, Halifax.
17,021. ARTIFICIAL FUEL, W. C. and A. A. Haigh, Manchester.
17,022. STOVES HEATED by GAS or OIL, W. Lord, Middlesbrough-on-Tees.
17,023. FIRE-ARMS, G. O'C. Holloway and J. Reeves, Birmingham.
17,024. JACKS of LOOMS for WEAVING, R. Curtis, Halifax.
17,025. VELURING HATS, &c., J. Ashworth and G. C. Taylor, Manchester.
17,026. LEATHER POLISH, J. H. G. Langenhagen, Liverpool.
17,027. WRINGING MACHINES, P. Burt, Glasgow.
17,028. SEWING MACHINES, R. W. Anderson, Liverpool.
17,029. SELF-REGISTERING WEIGHING MACHINES, W. M. Preston, Bangor.
17,030. ADVERTISING GOODS, &c., in the DARK, J. Smith, Birmingham.
17,031. CANDLE HOLDERS, &c., G. Brewer.—(*T. Tucker, Turkey.*)
17,032. TOOLS, J. Dennison, Armley.
17,033. CATCHES, &c., for PINS in BROOCHES, &c., M. Cross and H. Antrobus, London.
17,034. SCORING CARDBOARD, &c., J. Perry, London.
17,035. BLASTING CARTRIDGES, J. Boag, Glasgow.
17,036. GAME and PUZZLE COMBINED, W. Wells, Newcastle-on-Tyne.
17,037. PRESSURE GAUGES, W. J. Thomas, London.
17,038. TRAVELLERS, G. H. Smith and B. Cooper, London.
17,039. CONNECTING WOVEN WIRE, &c., MATTRESSES to the FRAMES of METAL BEDSTEADS, G. A. Billington Liverpool.
17,040. STUFF TAP, H. Schofield, Sheffield.
17,041. TRIPLE EFFET EVAPORATING STEAM VACUUM PANS, R. Campbell.—(*J. Foster and J. Campbell, Java.*)
17,042. SPIKE FASTENINGS, W. and S. Bayliss, and R. Howarth, London.
17,043. FOAMING WINES, N. Browne.—(*A. Braconier, France.*)
17,044. GLOVE FASTENINGS, A. Richter, London.
17,045. REMOVING SOOT from CHIMNEYS, &c., C. F. W. Dœhring, London.
17,046. FOOD for CATTLE, &c., J. P. Larieux and H. Gregoire, London.
17,047. ROLLING MILLS, E. H. Martin and J. Beavis, London.
17,048. TOBACCO PIPES, E. D. Skelton, London.
17,049. TREATING SLAG, K. W. E. Maruhn, London.
17,050. SOLES or SOCKS, T. Coates and H. W. Call, London.
17,051. STENCILS, E. Edwards.—(*F. Riedel, Germany.*)
17,052. SUSPENDED OVERHEAD TELEGRAPH, &c., WIRES, A. E. Harris, London.
17,053. NIP, G. F. Redfern.—(*F. J. Maizier and F. J. W. Reitz, Belgium.*)
17,054. HEEL PADS for STOCKS of RIFLES, H. A. Silver and W. Fletcher, London.
17,055. COMPOUND for FACINGS of CONCRETE STRUCTURES, J. Tall, London.
17,056. DYNAMO-ELECTRIC MACHINES, G. Kapp, London.
17,057. PREVENTING ESCAPE of GAS, H. W. and A. F. Cole, London.
17,058. CHAFF CUTTING MACHINERY, &c., J. Oliver, London.
17,059. WASTE PRODUCTS of BREWERIES, W. Gerdes, London.
17,060. MECHANICAL TELEPHONE APPARATUS, H. H. Lake.—(*G. W. Lord and H. E. Townsend, United States.*)
17,061. LAYING OFF, &c., GEOMETRIC, &c., FIGURES, E. M. Goldsmith and E. Reizenstein, London.
17,062. FILLING BOXES with MATCHES, H. H. Lake.—(*The Citizens Match Company, United States.*)

30th December, 1886.

17,063. PRINTING MACHINES, H. M. Nicholls, London.
17,064. TELESCOPIC SIGHTS, P. Brodigan, Dublin.
17,065. WHEELS, J. Aylward, Coventry.
17,066. FUSTIAN CUTTING FRAMES, J. R. Meanock, Manchester.
17,067. OPENING BOTTLES, A. C. Farrington, Shelfanger.
17,068. EXTINGUISHING PARAFFIN, &c., LAMPS, C. E. Gibson, Birmingham.
17,069. SUBMARINE INCANDESCENCE, J. A. McLellan, Glasgow.
17,070. BRACES, &c., R. J. Gibson, Dundee.
17,071. BOXES, &c., D. and W. Dalglish, Lochwinnoch.
11,072. SUPPLYING AIR to BARRELS, E. and J. Holding, Lancashire.
17,073. PANELS for LETTER RACKS, &c., F. R. Silk, Birmingham.
17,074. COMBINED SADDLES, &c., G. Townsend and C. A. E. T. Palmer, London.
17,075. PREPARATION of FOOD PRODUCTS, C. S. Boynton and W. J. van Patten, London.
17,076. INFUSION of TEA, D. S. Batchelor, London.
17,077. CLOCKS, &c., F. Bosshardt.—(*S. Chambon and R. Francois, Italy.*)
17,078. CASTORS, W. H. Morton, Leeds.
17,079. HEATING WATER, W. B. Thompson.—(*M. Fuld, Holland.*)
17,080. WATERPROOF VEGETABLE &c., FABRICS, J. Obozinski, Liverpool.
17,081. PROPULSION of SHIPS, J. Monteith, Glasgow.
17,082. SHEETS for INVOICES, W. H. Ronald, Glasgow.
17,083. AZO DYES, J. Y. Johnson.—(*Farbenfabriken vormals Friedrich Bayer and Co., Germany.*)
17,084. MOUNTING TELEPHONIC SWITCHES, &c., A. R. Bennett, Glasgow.
17,085. WATERING POT, B. Bratt, Old Swinford.
17,086. SECRET RECEPTACLES, J. Edwards, London.
17,087. REFRIGERATING MACHINERY, A. B. Imrie, Glasgow.
17,088. CARBON, P. Ward and W. S. Oliver, London.
17,089. WEIGHING MACHINES, P. Ward and W. S. Oliver, London.
17,090. WEIGHING MACHINES, P. Ward and W. S. Oliver, London.
17,091. COMPASSES, C. C. Hearsey, London.
17,092. EXTINGUISHING LAMPS, W. K. Parkinton, London.
17,093. JUBILEE BANGLE, &c., C. C. Atchison, South Hampstead.
17,094. LOOM, A. M. Clark.—(*La Société Devigne et Durand, France.*)
17,095. HORSESHOE, T. Hardwick, Bradford.
17,096. RAPID-FIRING BREECH-LOADING CANNON, C. C. Engström, London.
17,097. ROTATING the DOFFER and CYLINDER of a CARDING ENGINE, W. T. Cheetham.—(*T. Leach, Russia.*)
17,098. PORTLAND CEMENT, W. Sonnet, London.
17,099. VENT PEGS, F. Baker, London.
17,100. PURIFYING APPARATUS, A. Dervaux, London.
17,101. CAUSTIC SODA, G. Kamensky, London.
17,102. ELASTIC TIRE for CARRIAGE WHEELS, J. U. Burt, London.
17,103. LOCK BOLTS and NUTS, S. De la G. Williams, London.
17,104. STEEL EYE-BARS, R. W. Smith, London.
17,105. BRAIDING MACHINES, H. H. Lake.—(*F. L. Veerkamp, C. F. Leopold, and W. Darker, United States.*)
17,106. GAS-BURNERS, R. and O. Pintsch, London.
17,107. MACHINERY for ROCK TUNNELLING, H. N. Penrice, London.

December 31st, 1886.

17,108. VERNIER, E. S. Norcombe, Birmingham.
17,109. DRIVING BELTS, S. Rowbottom, London.
17,110. INDICATING, &c., the DISTANCE TRAVELLED by TRAMCARS, &c., J. C. Claxton, Liverpool.
17,111. CLEARING APPARATUS, J. Vaughan and J. Walker, Manchester.
17,112. BUTTONS, E. B. Tillarn and J. T. Gibbins, Manchester.
17,113. BREECH-LOADING ORDNANCE, G. Quick, Gloucestershire.
17,114. CLOTHES PIN, A. J. Morcom, Cornwall.
17,115. PLATE GLASS, J. L. Napier, A. D. Brogan, and A. M. Malloch, Glasgow.
17,116. CURING DAMP WALLS, E. C. S. Moore, Dover.
17,117. COMBINED RULE and LETTER BALANCE, W. A. Brooke, Dublin.
17,118. REVOLVING MACHINE, J. W. Mills, Coventry.
17,119. TRAPPING DRAINS, &., P. F. Richards, London.
17,120. DYNAMO-ELECTRIC MACHINERY, R. E. B. Crompton and J. Swinburne, London.
17,121. MAGAZINE FIRE-ARMS, B. Burton, London.
17,122. SETTING OFF a RIGHT ANGLE, &c., F. Marriott, London.
17,123. TUBULAR BOILERS, G. Durr and H. Conrad, London.
17,124. RING without a TRAVELLER, J. Lisle, Lancashire.
17,125. KITCHEN RANGES, G. Paxton and J. Turnbull, Falkirk.
17,126. FLOATING BREAKWATERS, &c., F. W. Jones, London.

17,127. LIGHTING TIMEPIECES, &c., F. Marriott, London.
17,128. RAIL JOINTS, W. Marshall, Sheffield.
17,129. SCREENING, &c., COAL, A. B. Southall and J. H. Clegg, Sheffield.
17,130. PLASTER BOARDS, A. Mack, London.
17,131. COMBINED BRACELET and BROOCH, T. Brown, London.
17,132. BLUE COLOURING MATTERS, J. R. Geigz, London.
17,133. VALVES, D., D. C., and A. H. Hancock, London.
17,134. FIRE-IRONS, W. E. Heath, London.
17,135. EVEN SURFACE BOTTOMS, R. Slazenger, London.
17,136. STOPPERING BOTTLES, &c., G. F. Redfern.—(*J. Petit, France.*)
17,137. BUTTON MAKING MACHINES, J. C. Schott, London.
17,138. ELECTRICALLY SIGNALLING on RAILWAYS, E. Delfieu, London.
17,139. AUTOMATICALLY OPENING and CLOSING DOOR, A. Layer, London.
17,140. PURIFYING GRAPHITE, A and A. Bessel, London.
17,141. CLIPPING ANIMALS, H. Shedden, London.
17,142. RUBBER-PAD COVERS, J. T. Dickey and E. H. Rogers, London.
17,143. HEATING APARTMENTS, G. A. Skinner, London.
17,144. LIFTING JACKS, A. Sommer and A. Kluge, London.
17,145. SUPPORTING, &c., CENTRIFUGAL MACHINES, C. G. P. de Laval, London.
17,146. COMPOUND MARINE STEAM ENGINES, J. Tweedy, London.
17,147. SAFETY APPLIANCES, &c., J. C. Thexton, London.
17,148. LACE, &c., J. Y. Johnson.—(*C. Juncker, France.*)
17,149. PUMPING and MOTIVE-POWER ENGINES, J. Tangye and R. J. Connock, London.
17,150. MOTIVE-POWER ENGINES, &c., J. Tangye and R. J. Connock, London.
17,151. PUMPING and like ENGINES, J. Tangye and R. J. Connock, London.
17,152. COMPRESSING AIR, &c., J. Tangye and R. J. Connock, London.
17,153. WATCHES, A. Guye, London.
17,154. REELS, &c., for SEWING THREAD, A. M. Clark. (*H. Rogez, France.*)
17,155. ASCERTAINING the DRAUGHT of STEAMSHIPS, &c., T. Dobie.—(*J. G. Dobbie, India.*)
17,156. MACHINES for MEASURING a PERSON'S HEIGHT, R. C. Annand, London.
17,157. POCKET LOCK-STITCH SEWING MACHINES, S. Isaac, London.
17,158. BRIQUETTES, S. P. Wilding.—(*Messrs. Stamme and Co., Germany.*)
17,159. DRYING STRAWBOARD, &c., N. Browne.—(*J. Scherbel and T. Remus, Germany.*)
17,160. PRINTING in COLOURS, W. H. Turner, London.
17,161. COUPLING and UNCOUPLING SHAFTING, A. J. Boult.—(*C. S. Higgins, jun., United States.*)
17,162. REGULATING the PASSAGE of HEATED AIR through the TUBES of BOILERS, J. G. Galley, London.

1st January, 1887.

1. WALKING-STICK and UMBRELLA PIPE CASE, E. G. Such, London.
2. PREPARING PILE FABRICS, O. and E. Drey, F. J. Simpson, and E. Platt, Manchester.
3. MOORING LIFEBOATS and other BOATS, B. A. Freeman, Penryn.
4. TREATING PARAFFINE WAX, R. Tervet, Glasgow.
5. CHAIRS for the RAILS of RAILWAYS, J. Dervyshire, Longton.
6. THRASHING MACHINES, E. Foden, Manchester.
7. VENTILATING RAILWAY, &c., CARRIAGES, J. Anderson, Glasgow.
8. CONVERTING RECIPROCAL into ROTARY MOTION, J. R. Turnock, Longton, R.S.O.
9. COUPLING for RAILWAY CARRIAGES, &c., H. Loxley, Sheffield.
10. GRINDING and POLISHING DISCS, H. Wiktorin, London.
11. PRESERVING PICTURE FRAMES, &c., S. Challoner, Salford.
12. COUPLING RAILWAY, &c., VEHICLES, T. Yates, Birmingham.
13. EARTH CLOSETS, T. Hawksley, London.
14. PUMPS for PETROLEUM OIL, &c., M. Beaumont, Sheffield.
15. ROLLER MILLS for REDUCING GRAIN, J. Donaldson, Liverpool.
16. ANGELIC CUTICLE and WASHING SOAP, R. Wright, Chesterfield.
17. RAILWAY POINTS and CROSSINGS, J. W. Hartley, Stoke-upon-Trent.
18. POWER LOOMS for WEAVING HOSIERY, J. Mercer, Blackburn.
19. PROPELLING OCEAN-GOING VESSELS, J. E. Chappell, Tattershal.
20. KEYS for SECURING RAILWAY RAILS, G. F. Williamson, Wellingborough.
21. BED FRAMES and BEDSTEADS, I. Chorlton and G. L. Scott, Manchester.
22. COUPLING of RAILWAY, &c., CARRIAGES, G. W. Moon, London.
23. HANSOM CABS, &c., W. H. Carmont, Manchester.
24. SAFETY LAMP, R. Oswald, Talk-o'-the-Hill.
25. TESTING of PIPES, DRAINS, &c., E. G. Banner, London.
26. COUNTER CHECK MEMORANDUM BOOK, M. H. Spear, London.
27. CLEANING TRAMWAY LINES, S. Strange, J. Norton, and T. Henry, Liverpool.
28. VENTILATORS for RAILWAY CARRIAGES, &c., R. Bradshaw, Liverpool.
29. INJECTORS for COCOAINE, &c., J. Ramsden, Halifax.
30. CABLE TRAMWAYS, &c., J. J. Butcher, Newcastle-upon-Tyne.
31. WINDOW FASTENERS, F. Beauchamp, London.
32. TRAVELLERS for RING SPINNING, &c., MACHINERY, T. Coulthard, London.
33. FRONT BARS of DOMESTIC FIRE-GRATES, J. Starkie, London.
34. BLOCKS of FUEL, &c., J. A. Yeadon and R. Middleton, Leeds.
35. ENVELOPE, H. Agar, London.
36. FANCY PILE FABRICS, G. Chivalla, London.
37. GLUE ELECTROTYPING, J. Husnik, London.
38. EXTRACTING IRON, &c., from CHINA-STONE, &c., A. Gay, London.
39. COLLATING, &c., STRIPS of WOOD, W. O. Wedlake, London.
40. ARRANGING "DRAG" GROOVE CLEANERS of TRAM RAILS, H. J. Jordan, London.
41. FASTENING APPLIANCE for BOOTS, &c., G. Seagrave. (*A. Combault, H. J. Rohde, and F. F. Delpy, France.*)
42. SLIDE VALVES of ENGINES or PUMPS, J. W. Restler and A. Turner, London.
43. DOMESTIC FIRE-GRATES, W. H. H. Marten, Bradford.
44. CRICKET BATS, J. O'Connor and H. O'Connor, Nelson-in-Marsden.
45. TOOLS, W. Bendall, Birmingham.
46. TROUSER STRETCHERS, R. Eunson and J. Goode, Birmingham.
47. MAKING COMPOUND BUTTONS, A. Akeroyd.—(*W. W. Wade, United States.*)
48. RUG STRAP and TROUSER STRETCHER, W. A. Brooke, Dublin.
49. INVALID BED LIFT, R. W. Roberts, Alglesey.
50. ARTIFICIAL FLOWERS for the ORNAMENTATION of FANCY GOODS, R. Wheatley, Birmingham.
51. ARTIFICIAL BAIT for taking FISH, A. Morriss, Redditch.
52. DISINFECTING SURGICAL INSTRUMENTS, &c., C. Ferbach, Germany.
53. TUBULAR PNEUMATIC EXHAUST ORGAN ACTION, M. Hetherington, London.
54. MALT GERMINATING APPARATUS, P. Weinig, London.
55. MACHINE GUNS, J. Sturgeon, London.
56. PERAMBULATORS, J. Simpson and S. T. Fawcett, London.
57. SAVING LIVES from WRECKS, &c., J. D'Arcy-Irvine, London.
58. OIL LAMPS, J. Roots, Orpington.
59. AUTOMATIC BARRIER, C. H. Bingham, London.
60. BUTTON-HOLE ATTACHMENTS for SEWING MACHINES, F. C. Hall, London.
61. PIPES for SMOKING TOBACCO, &c., R. Jeantet-David, London.
62. HYDROCHLORIC ACID GAS for the PRODUCTION of CHLORINE GAS, W. Donaldson, London.
63. ALUMINIUM and COPPER for OBTAINING ALUMINIUM GOLD, &c., W. H. Beck.—(*M. Marcus and C. Finaly, France.*)
64. CONDUIT for WIRES CONVEYING ELECTRICITY, J. A. Stirton, London.
65. SEWING MACHINES, G. R. Holding, W. G. Attree, and G. E. Smith, London.
66. ECONOMISING HEAT in STEAM ENGINES, &c., M. Prior, London.
67. WHEELBARROWS, &c., K. Proctor, London.
68. PROJECTILES, J. Taylor, London.
69. PROJECTILE for ORDNANCE, &c., J. G. Surenne, London.
70. SCORING CARDBOARD, L. Gunn and J. Perry, London.
71. CARDBOARD BOXES, &c., L. Gunn and J. Perry, London.
72. ELECTRIC MEASURING INSTRUMENTS, W. T. Goolden and S. Evershed, London.
73. ELECTRIC INDICATORS, A. J. Boult.—(*J. Ferrer, Spain.*)
74. ELECTRIC TELEGRAPH, &c., R. A. Scott, London.
75. SAFETY AUTOMATIC SELF-EXTINGUISHING LAMP, E. Patterson and W. H. Strype, London.
76. PREVENTION of HORSES SLIPPING, S. A. Johnson, London.
77. PIPES on RAILWAY TRAINS, A. P. Kapteyn, London.
78. AUTOMATIC DOOR HOLDER, J. B. Gray, London.
79. ARRANGING and CARRYING DRAG GROOVE CLEANERS, J. Record and H. J. Jordan, London.
80. FIXING MOULDINGS, D. M. Balsar, London.
81. STIRRUPS, W. Booth, Lond n.

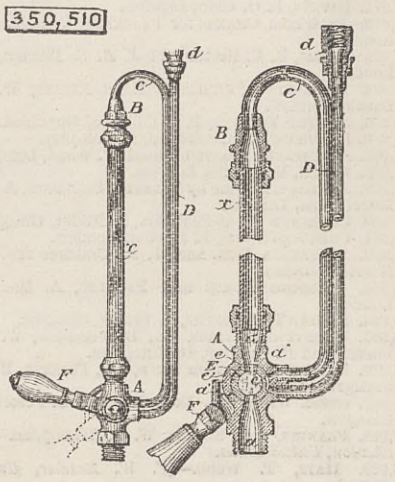
SELECTED AMERICAN PATENTS.

(*From the United States' Patent Office Official Gazette.*)

350,510. STEAM AND WATER GAUGE, *Robert Stretch, Chicago, Ill.—Filed May 12th*, 1886.

Claim.—(1) In a steam and water gauge, a coupling having a stop-cock placed therein, with ways in said coupling and stop-cock, forming when open a straight way for the passage of water into one end of the glass tube used in said gauge, in combination with steam pipes forming a way into the other end of said glass

350,510



tube, and steamway being opened and closed in the movement of said stop-cock by a groove or depression on the periphery of the same, all substantially as described, and for the purpose set forth. (2) In a steam and water gauge, the combination of coupling A having ways a a a' a'' a''', with stop-cock E, having ways e e' e'', glass tube X, and pipes C and D, all substantially as described, and for the purpose set forth.

350,520. KNIFE FOR WOOD-WORKING MACHINERY, *Joseph B. Wood, Chicago, Ill.—Filed March 16th*, 1886.

Claim.—As a new article of manufacture, a wood-working knife having formed in its blade a rounded

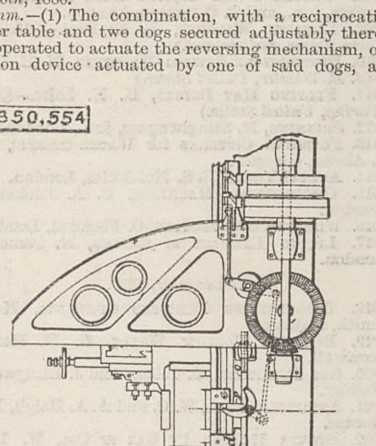
350,520

groove or concaved chamfer, the same being situated on the side opposite the basil, as set forth.

350,554. PLANING MACHINE CUSHIONING DEVICE, *Franklin Phillips, Newark, N.J.—Filed January 26th*, 1886.

Claim.—(1) The combination, with a reciprocating planer table and two dogs secured adjustably thereto and operated to actuate the reversing mechanism, of a cushion device actuated by one of said dogs, and

350,554

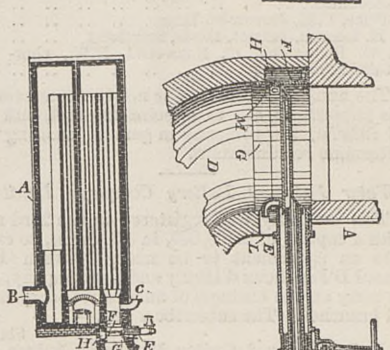


thereby operated before the end of the stroke, be the same longer or shorter, substantially as shown and described. (2) The combination, with a moving table and stationary bed, of a sliding carriage movable upon the bed, adjustable dogs upon the table to shift the carriage, and a cushion mechanism applied to the carriage and operated by the longitudinal movement of the latter, substantially as described. (3) The combination, with a planer table, of dogs d and e, attached to the table, toes actuated by the dogs to reverse the table driving mechanism at opposite ends of the stroke, and a cushion device actuated by one or both of the dogs in advance of the reversing mechanism, as and for the purpose set forth. (4) The combination, with a planer table, of dogs d and e, attached to the table, toes actuated by the dogs to reverse the table driving mechanism at opposite ends of the stroke, and a cushion device having a lug or arm projected in the path of the dog at one side of the reversing toe, substantially as shown and described. (5) The combination, with a planer table, dogs d and e, attached to the table, toes actuated by the dogs to reverse the table driving mechanism at opposite ends of the stroke, and a cushion device actuated by one or both of the dogs in advance of the reversing mechanism, and means for adjusting the resistance of the cushion when actuated by the dog, substantially as shown and described.

350,568. VALVE FOR HOT-BLAST OVENS, *Victor O. Strobel, Philadelphia, Pa.—Filed March 29th*, 1886.

Claim.—(1) In a chimney-blast for hot-blast stoves, a metallic valve body connected to the shell of the stove and provided with an outwardly projecting male portion, and a masonry chimney flue encircling and surrounding said male portion of the valve body, combined substantially as and for the purpose set forth.

350,568

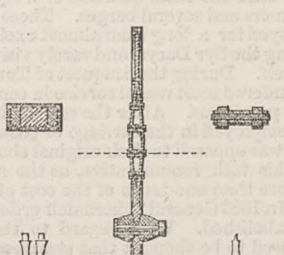


(2) In a chimney valve for hot-blast stoves, a valve body disposed in a chimney flue, a chamber surrounding the valve body exteriorly, an opening from the atmosphere to such chamber, and an opening leading from such chamber to the chimney flue, combined substantially as and for the purpose set forth. (3) In a chimney valve for hot-blast stoves, a valve body connected to the stove, a chimney flue connected to the stove and engaging the valve body by a slip joint, a chamber surrounding the valve body exteriorly, an opening leading from the atmosphere to said chamber, and an opening leading from the chamber to the chimney flue, combined substantially as and for the purpose set forth. (4) In chimney valves for hot-blast stoves, a chimney flue, a valve arranged therein and disposed horizontally with the nose-cap of its body projecting outward, and a dust valve arranged in the outer projection of the nose-cap, combined substantially as and for the purpose set forth. (5) In chimney valves for hot-blast stoves, a valve body, a valve seat fitted therein, provided with a cooling channel, a hollow valve, and a cooling passage exterior to the valve body, combined substantially as and for the purpose set forth.

350,572. SPOKE FOR VEHICLE WHEELS, *Samuel Toomey, Canal Dover, Ohio.—Filed November 27th*, 1885.

Claim.—A spoke for carriage wheels, formed with two sides separated and spread apart for a portion of

350,572



its length, and provided with cross struts between the separated sides, whereby a trussed spoke is made, substantially as and for the purpose herein specified.

350,631. SHAFT COUPLING, *Thomas Leaman, Erie, Pa.—Filed June 8th*, 1886.

Claim.—(1) In a shaft coupling, the combination of flanges B B on the shaft sections, flanges C C, bolted to said flanges B B, and oppositely-coiled springs D D′, one within the other, as shown, and attached to said flanges C C, so as to resist both longitudinal and torsional strains, substantially as set forth. (2) In a

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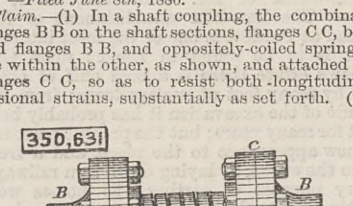

shaft coupling, the combination of oppositely-coiled springs D D′, one within the other, and having their ends bent to lie parallel with their axes, and screw-threaded to receive nuts thereon, and flanges C C, having sunken seats c, and perforations c', for receiving the ends of said springs, substantially as and for the purposes set forth.

350,569. CLEANING APPARATUS FOR HOT-BLAST OVENS, *Victor O. Strobel, Philadelphia, Pa.—Filed April 30th*, 1886.

Claim.—(1) The combination, substantially as set forth, with a hot-blast stove having a cleaning opening and a support thereat, of a crane arm articulated to such support and adapted to have its free end adjusted to and from said opening, and a cleaning pipe connected with and supported by the free end of said crane arm. (2) The combination, substantially as set forth, with a hot-blast stove having a cleaning opening and a support thereat, of a crane arm articulated to such support and adapted to have its free end adjusted to and from said opening, a limb articulated to the free end of said crane arm, and a cleaning pipe articulated to the free end of said limb. (3) The combination, substantially as set forth, with a hot-blast stove having a cleaning opening and a support thereat, of a cleaning pipe connected articulately with such sup-

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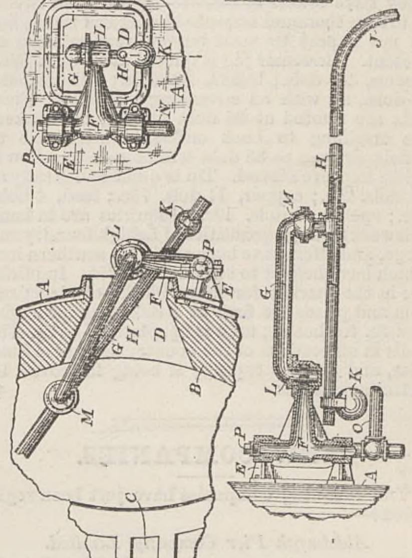
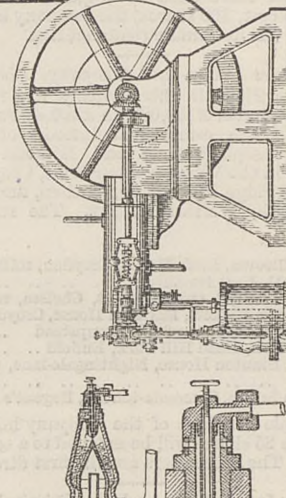


port, and with a source of supply of fluid at an intermediate point in the length of said pipe, and having its outer free end counterbalanced and adapted to serve as a handle for the manipulation of the pipe. (4) The combination, substantially as set forth, with a hot-blast stove having a cleaning opening, of support bracket E, hollow crane arm F, hollow limb G cleaning pipe H, joints L and M, and pipe N.

350,769. PETROLEUM AND GAS MOTOR, *Gaston Ragot and Guillaume Smyers, Brussels, Belgium.—Filed July 2nd*, 1886.

Claim.—(1) The combination, with a gas or vapour engine, of a vaporiser provided with vaporising chamber and a heater, respectively connected with the admission and exhaust of the engine, and an injector connected with the volatile liquid supply and the vaporising chamber, and operated from and controlled by the movements of the piston, substantially as and for the purpose specified. (2) The combination

350,769

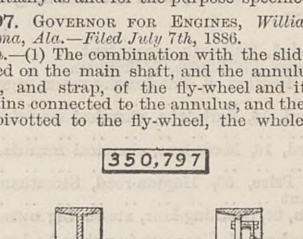


with a gas or vapour engine, of a vaporiser composed of an outer conical casing and an inner hollow conical heater, the two forming between them a vaporising chamber, connections between said chamber and heater with the admission and exhaust of the engine respectively, and a connection between the vaporising chamber and the source of supply of volatile liquid, substantially as and for the purpose specified.

350,797. GOVERNOR FOR ENGINES, *William Arnot, Selma, Ala.—Filed July 7th*, 1886.

Claim.—(1) The combination with the sliding sleeve mounted on the main shaft, and the annulus secured thereto, and strap, of the fly-wheel and its pulleys, the chains connected to the annulus, and the weighted levers pivotted to the fly-wheel, the whole arranged

350,797



to operate substantially in the manner specified. (2) The combination, with the main shaft, of the sliding sleeve and annulus, the strap mounted thereon, the fly-wheel, and mechanism for operating the sleeve, and the spring interposed between the sleeve and fly-wheel for holding the parts in normal position, substantially as specified.