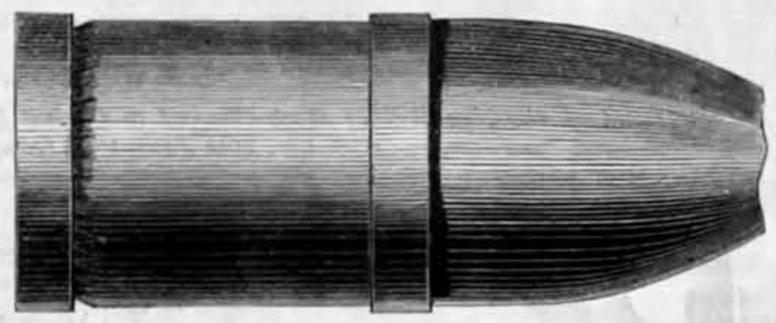
THE NEW 12-POUNDER FIELD GUNS.

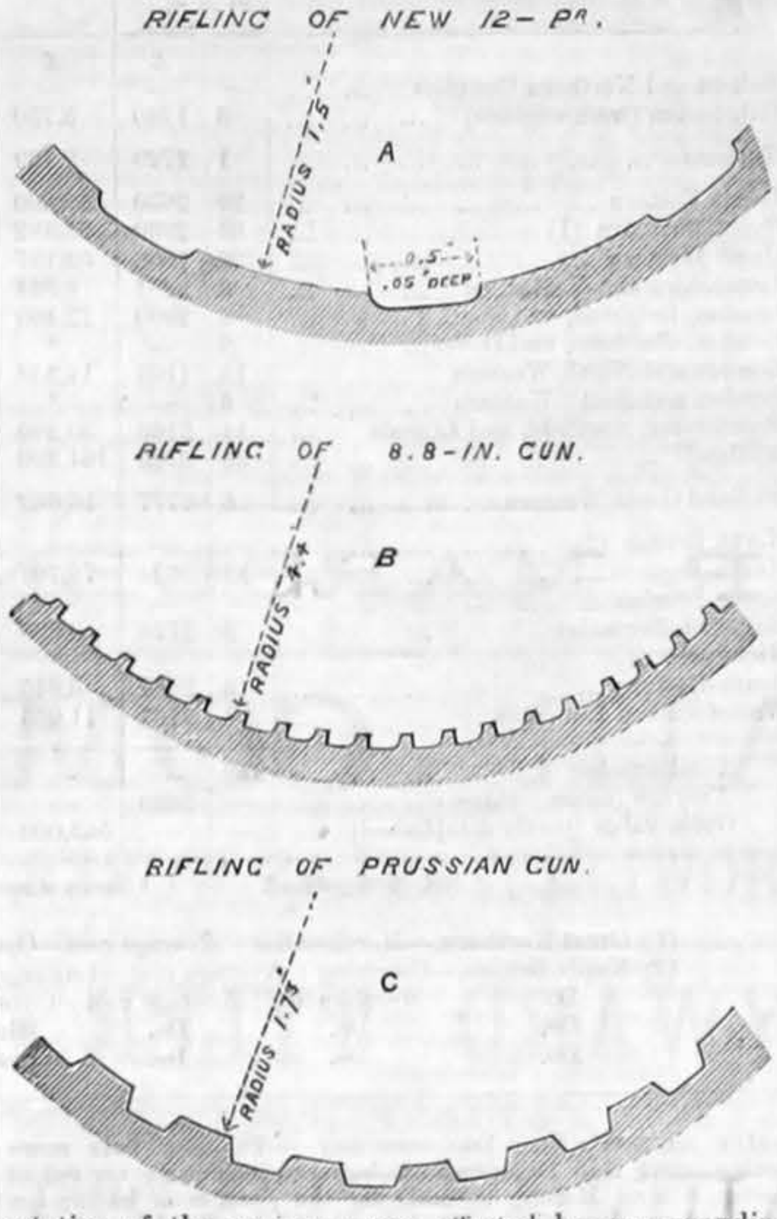
Rather more than two years ago a brief description appeared in the columns of The Engineer of an 8·8in. gun on the muzzle-loading principle, which had been manufactured about that time at the works of Sir William Armstrong and Co., at Elswick, and which had been forwarded to the School of Gunnery at Shoeburyness for experimental trial. It was of peculiar construction, as although a "muzzle-loader," it was, notwithstanding, polygrooved, and so contrived as to require no "studs" upon the projectiles employed. But instead of its having a shell or shot, lead-coated, to take the rifling, the base of these, which was coned slightly, was surrounded by a ring of soft copper, that was driven tightly into the windage space—between the projectile and the inner surface of the gun—and into the grooves, by the expansive force of the powder gas, upon the shock of discharge. The more perfect "centreing" of the projectile in front was secured by a copper band some 2in. broad encircling it. The ammunition, which consisted of common and chilled shells, presented the following appearance :—The irregular incisions made radially along the coned portion of the base caused the ring of copper to grip the projectile tightly, and as the former absolutely fitted the grooves by the "set up" consequent on discharge, rotation during flight was thus effected. The rifling, which was of the character marked "B" in the accompanying sketch, had a twist increasing from 0 at the breech to 1 in 35 calibres at the muzzle. The results obtained during practice with this gun were very remarkable, windage being completely interrupted, and the effectual rotation of the projectile on its axis being satisfactorily accomplished. The initial velocity was, moreover, considerable. The 100-ton guns in course of construction at Elswick, one of which was completed in June last, are on this principle. A trifling difference exists in the nature of the rifling, however, that of the 100-ton guns for the Italian war vessels Duilio and Dandolo having a twist increasing uniformly from 0 at the breech to 1 turn in 50 calibres at the muzzle.

During the two years which have elapsed since the introduction of Sir William Armstrong's 8·8in. gun several series of experiments have been made at Shoeburyness with shells fitted with copper "gas checks," on plans submitted by Major Lyon, R.A., and on others submitted by Major Maitland, R.A., Assistant-Superintendent of the Royal Gun Factories. These gas checks were simple discs of copper screwed on to the base of the projectile, and in some cases attached to it by undercut projections in order to prevent its spinning off by the centrifugal force brought into play. They were of varying thickness for the different nature of guns, ranging between $\frac{1}{8}$in. and 1in. But Major Maitland's gas check was so contrived with the undercut projections alluded to and corresponding orifices in the base of the shell, also with "feathers" or projections to fit the grooves, that the grip of the gas check upon the projectile being rigid, and the set up of its soft metal into the grooves upon the shock of discharge being complete, rotation was consequently so very greatly assisted that the studs of the projectiles were found to be hardly injured at all by pressing against the "driving edges" of the grooves. In point of fact, during a subsequent trial with a 16-pounder, the shell, which was fitted with a copper gas check thus constructed, took the rifling so effectually that the studs proved to be unnecessary. Hence the application of gas checks, which was only intended to prevent "erosion" of the bore and to concentrate the effect of the powder gas, opened up a new question as to studs and rifling. And as a marked superiority had been obtained in initial velocity by the employment of these gas checks, owing to the improvement in centreing in the absence of windage, &c., it was determined to rifle a field gun in a manner suited to the application of a soft metal gas check, and to rid the projectiles for this experimental gun of the encumbrance caused by the projecting studs altogether. The form of rifling obviously suitable for this purpose was that of a polygrooved character. An incentive was given to these proceedings by the result of certain comparisons between English and German field guns, which were drawn in autumn last year by a clear-headed artillery officer, Lieutenant S. C. Pratt, in a paper submitted by him to the Royal Artillery Institution. The accompanying table compiled by him speaks for itself as to the superiority of the German to the English weapon, both in regard to the armament of the horse artillery and to that of the field batteries.

	English.		German	English	German
	Horse artillery 9-pr. M.L.	Light field battery, 9-pr. M.L.	Horse artillery 7·5c. B.L. (officially 8c.)	Field battery 16-pr. M.L.	Field battery 8·8c B.L. (officially 9c.)
Weight of gun	6 cwt.	8 cwt.	7·68cwt.	12 cwt.	8·86 cwt
Calibre	3in.	3in.	3·09in.	3·6in.	3·46in.
Preponderance	10 lb.	7 lb.	99 lb.	10 lb.	99 lb.
Number of grooves	3	3	24	3	24
Length of rifling	62·3in.	59·8in.	60·2in.	58·04in.	58·8in.
Twist in calibres	1 in 30	1 in 30	1 in 50	1 in 30	1 in 50
Weight of gun-carriage packed	2057 lb.	2320 lb.	1966 lb.	2957 lb.	2163 lb.
Charge	1·75 lb.	1·75 lb.	2·75 lb.	3 lb.	3·3 lb.
Initial velocity (ft. per second)	1391ft.	1381ft.	1522ft.	1352ft.	1460ft.
Common shell (full)	9·1 lb.	9·1 lb.	11·2 lb.	16·2 lb.	15·4 lb.
Bursting charge	7·5 oz.	7·5 oz.	6·5 oz.	18 oz.	9½ oz.
Shrapnel (full)	9·8 lb.	9·8 lb.	12·21 lb.	16·4 lb.	17·9 lb.
Number of bullets in shrapnel	63	63	122	119	209
Rounds carried (gun & limber)	40	40	40	18	34
Total rounds (gun and wagon)	148	148	154*	100	136*
Weight behind gun team	3778 lb.	4051 lb.	3936 lb.	4768 lb.	4222 lb.

The German field-battery gun is 3 cwt. lighter than our 16-pounder. Yet it consumes a far heavier charge of powder, fires a more effective shrapnel, and has a superiority of 100ft. per second in initial velocity. Again, the German horse artillery weapon is slightly heavier than our own, but the total weight behind the gun-team is less than in our equipment; furthermore this 8-centimetres German gun consumes 1 lb. more powder than ours, fires a shrapnel 2½ lb. heavier, and gives no less than 130ft. per second additional initial velocity! The German guns are of cast steel, strengthened at the breech by a wrought iron jacket. The grooves are V-shaped, twenty-four in number, and diminish in size towards the muzzle.* The breech is closed by a soft metal gas-check tightened up by a cylindro-prismatic gas-check. It is needless to say that a sensation of profound chagrin was aroused in the minds of British artillerists by the publication of this report, and the able superintendent of the Royal Gun Factories, Colonel Younghusband, R.A., was instructed to manufacture an experimental weapon intended to eclipse that of the German artillery. A 9-pounder muzzle-loading rifled gun was converted by adding about 14in. on to its chase, giving it a total length of 85in., with a bore of 82in. The powder chamber was made slightly larger in diameter than the calibre of the bore, that is to say, the gun was "chambered," to the extent of 3·6in. in diameter, with a length of 10in., in order to consume a greater charge of powder. The nature of rifling was polygrooved, the old Woolwich form being adhered to, to a great extent; only the grooves were very shallow and but ten in number. Their appearance was as delineated in the cut marked "A." The twist was an increasing one, from 0 at the chamber to 1 in 30 at the muzzle, thus differing from the ordinary 9-pounder of 8 cwt., which has a uniform twist of 1 in 30 calibres. The charge of powder was 3 lb., and the shell weighed 12·75 lb. The weight of the gun was 8 cwt. The





rotation of the projectile was effected by an expanding disc of copper or gas-check, having a shallow rim projecting backwards, the shock of discharge being sufficient to drive this entirely into the ten shallow grooves. The copper was from $\frac{1}{8}$ to $\frac{3}{10}$ of an inch thick. The results obtained with this weapon were astonishingly good, both accuracy of aim and range being excellent.

1 deg. of elevation gave 1230 yards range.
3 deg. of elevation gave 2150 yards range.
5 deg. of elevation gave 3000 yards range.
At 1 deg. of elevation there was a mean error of 8 yards.
3 deg. of elevation there was a mean error of 15 yards.
5 deg. of elevation there was a mean error of 17 yards.

The velocity at the muzzle was nearly 1700ft. per second, and the maximum pressure on the surface of powder chamber only 30 tons per square inch.

The report upon this experimental weapon being so exceedingly satisfactory, it was determined to manufacture forthwith a new gun upon the same principle, and to try it at Shoeburyness in conjunction with two other 12-pounder field guns, one constructed in the ordinary Woolwich manner with three grooves, and the third gun being a pair-groove plan invented by Major Maitland, R.A., this gun being, like the polygrooved one, chambered to receive a heavy charge. The powder is put in a paper bag instead of a serge cartridge, and is rammed into the chamber by a slight blow, filling it entirely. The result of experiments so far with these 12-pounder guns told rather favourably for the ordinary Woolwich one, but as they are still in progress it would be unadvisable to hazard an opinion as to their ultimate tendency.

It appears almost vexatious that the question of rifling should again be brought forward, as our artillery are now armed exclusively with the ordinary Woolwich muzzle-loading gun of three grooves, and to re-equip the whole of our batteries would be a most tedious and expensive process; nevertheless, to remain contented with a weapon inferior to that of any other continental Power would be a most suicidal policy. Artillery, in these days, takes a very prominent part in every general action, and it would certainly be a weak point in our "lines of defence" if the Royal Artillery had guns of smaller powers of range, and throwing less effective projectiles, than those of nations with whom we might be at war to-morrow.

We propose to give subsequently a brief report upon the results obtained with each of the experimental 12-pounders now under trial at Shoeburyness.

* Eight ammunition wagons to each battery.

* See engraving marked "C."

LITERATURE.

The Cry or National Harbours, and its connection with our defective system of Public Harbour Legislation. By Captain E. K. Calver, R.N., F.R.S., &c. London: P. S. King. 1876.

The intrinsic importance to England of the welfare of her sea-going community, the affection which the nation in general manifests for its sailors, and the universal desire that everything possible should be done to lessen the many perils of their calling, as well as the conviction that the war supremacy of Great Britain must be, as it ever has been, principally maritime, have all conduced to the national admission that harbours of refuge are necessary and of great importance; and although the estimates for such harbours have frequently shown that they would involve the expenditure of such very large sums of money as to preclude the possibility of any but remotely indirect return, that consideration has been outweighed by the importance otherwise attached to their acquisition. Nothing can be said but in praise of the skill and ability with which most of these works have been carried out; but it must be remembered that while orders to proceed with their construction have been based upon the reliability of the estimates of their probable cost, these estimates have in many instances afforded no indication whatever of what has in the end turned out to be their actual price. Notwithstanding this, however, probably little dissatisfaction would be expressed were the promised results attained as the return for a large expenditure; but experience is proving that, though the designs for some of the more important harbour works have been carried out in a manner that leaves nothing to be desired, the designs themselves are more or less faulty, and have been prepared hastily or without sufficient local examination, observation, or consideration of the circumstances in general, which may contribute to, or render less probable, the success of the proposed work, and indicate the correctness or otherwise of the selection of its site. Had a reliable estimate accompanied the designs of some of the existing harbours, it does not seem likely that they would have been carried into effect; and the postponement which would have been consequent upon the rejection of those designs would have given time for the reconsideration of the projects, and the elaboration of more economical plans, based upon extended examination of the relative advantages of different sites, and consideration of the natural conditions involved. It cannot be doubted that, though sufficient data exist to enable designs and estimates to be correctly prepared for efficient harbours, these have been, in some flagrant instances, either ignored or used with much less wisdom than usually characterises the work of our foremost engineers. The *brochure* before us, written by Captain E. K. Calver, R.N., F.R.S., who was for thirty-six years in the Surveying Service of the Navy, is directed principally against the proposed extension of Dover Harbour. The subject of the pamphlet is considered under three heads, namely, "Our Failures," "The Cause," and "The Remedy." Under the first head the author commences by placing before his readers a string of facts which justify its title, and which refer to the Alderney and other harbours. The works at Braye Bay were commenced in 1847, their estimated cost being £400,000, but this expenditure, owing to alterations and extension of the designs, gradually rose "to £1,300,000" at the time of the practical completion of the work in 1864. No less than 4,360,000 tons of stone had been used in its formation, which includes over three thousand yards in length of masonry breakwater, the head of the work being built "in the extraordinary depth of 130ft. below the level of low water spring tides." In consequence of the exposed situation of the breakwater, its history during and after its completion is one of disaster; "in 1870 it was breached completely through in two places," and in reporting upon this Captain Evans writes, "all the conditions favourable to a port, so constructed, are wanting—the shores are rocky and jagged—the water in which the breakwater is built is deeper than in any similar work in the world, the tides in the neighbourhood run with unusual velocity, whilst its position is exposed to very heavy seas, and to the stormiest winds of the Atlantic Ocean;" and he adds that "in the strict sense of a harbour of refuge, Alderney must be considered as wanting nearly all the essentials—the bottom enclosed; is rocky, with only a few scattered spots of good anchoring ground." In 1871, after over £44,000 had been paid for damage alone, and the abandonment of the outer part of the breakwater had been proposed, the vote for its maintenance was struck out of the Government estimates, and the breakwater left to its fate. Competent authorities agree that the place is "useless as a refuge," and "of no value for keeping Cherbourg in check," for which it was built. Since 1872, during which year the Lords' Committee "entertained the idea of blowing up the breakwater, dispersing the foundations, and filling up the harbour as the proper solution of the question," disaster has followed disaster, and tremendous breaches have been made by the sea, which "would probably increase the cost of repairing to £25,000 or £30,000, with the prospect of a similar expenditure" "at uncertain intervals;" and, "like Sinbad with the old man upon his shoulders, we are permanently burdened with the maintenance of Alderney Harbour and fortifications" only "to prevent their falling into the hands of a hostile power." The history of the works at Braye Bay, says Captain Calver, is "more or less typical of what has taken place elsewhere." He then notices St. Catherine's Harbour, Jersey, the first estimate for which was £700,000, and which was aban-

doned as useless when it had cost £234,000. Holyhead Harbour, the original estimate for which was £628,063, has cost £1,285,000, and the author concludes his remarks upon this harbour by saying, "It is humbling to observe, upon a study of the site, that a breakwater of a different flexure, and 900ft. shorter than the existing one, would have covered in sixty-eight acres of additional deep water space, and, at the same time, have rendered the harbour far more accessible for purposes of refuge. Dover Harbour, the last example brought forward, is of present importance as having been lately—as it will probably be again in a few months—brought prominently before the public. At this port there is an area of about thirty acres covered by ancient defensive works and modern fortifications. In 1844 a Royal Commission recommended a harbour to be formed at Dover of not less than 520 acres of area outside low water-mark, and the present Admiralty Pier, begun in 1848, is a portion of the western arm of this work. It was completed in accordance with the recommendation of a committee sent to Dover in 1865, to decide the extent to which the pier should be carried out. Here the matter rested until 1874, when it was announced that the Government intended to construct a national harbour at Dover, and apparently upon such designs that it seemed, says Captain Calver, "that all the experience we had gained about such matters since 1844 appeared to have been completely thrown away." Three special advantages were claimed for this national harbour, viz., that it would serve the purpose of international communication, that ironclads could coal in it, and that troops intended for continental operations could embark from it. But, adds Captain Calver, "most people will hold that it was not enough to show that these things could be done at Dover, but that to avoid the chance of needless expenditure the very first stage of the inquiry should have been to prove that it was impossible to effect these several purposes in its near neighbourhood; but it occasioned surprise when it appeared that this crucial point was not effectively inquired into." The proposed harbour provides for this in the worst possible form, "as it has the radical defect of confining the track for large steamers to a comparatively narrow and frequented entrance which would have a rapid tideway running across it, and the vessels keeping up the communication, especially after dusk, would be continually exposed to risk, detention, and damage." But it is pointed out that an arrangement which would supply all requirements under this head without interference with the public pier for purposes of war, consists "in a modification and extension of the existing inner harbour, with a workable and sheltered entrance and passenger mole near to the heel of the Admiralty Pier." It is also suggested that international communication, as far as Dover is concerned, will become a matter of small import if it is found possible to carry out the Channel Tunnel.

As to coaling, it is said that all that can be required is to be found in the inner Downs, where there is ample depth, room, and security in all states of the tide and weather, for sixteen swinging berths for ironclads, and where small coasters ride out the heaviest gales in safety. "A fleet stationed here, being removed from the highway of the Downs, would cause no interference with its navigation, and it could slip, on an emergency, and proceed on service by day or by night, and at times under circumstances when in a close harbour at Dover it would be locked up in a trap without the power of moving. The ironclads would be supplied with coal by screw colliers from the Welsh or North-Eastern coal ports, or from floating depôts—supplied by railway—to be at their moorings in the inner Downs when the fleet was present and at Dover, Ramsgate, or other places of security, when it was absent. As small colliers years ago had to pass half loaded over the shallow bars of their several harbours and fill up their cargoes in the roadsteads outside exposed to every casualty, and did it, it would not be very flattering to the resources of the naval officer of the present day to say that he must have his ironclad, with steam on board to command her movements, sheltered by a stone mole to enable her to go through the same operation."

With regard to the embarkation of troops, "we have, at the present moment, connected with the military centres of Canterbury, Maidstone, Chatham, Sheerness, Woolwich, London, and Colchester, invaluable embarking places with from 18ft. to 50ft. at low water, at Sheerness, Gillingham, and Chatham on the Medway, at Southend, Thames Haven, Gravesend, Greenhithe, Erith, and Woolwich on the Thames, and at Harwich in Essex," where all that is needed to make them fully and at any time available might be supplied in a few days in the form of short tramways and pontoons formed of the flat-bottomed barges always to be found at all these places. But a harbour at Dover, packed with vessels conveying an expeditionary army, would supply an enterprising enemy with a chance that he would not let pass by.

The silting up of the proposed Dover Harbour is dwelt upon at considerable length, and on this part of his subject the author makes one of his most important points. After instancing, amongst others, Ramsgate Harbour, originally as deep as Dover Bay is now, but which has long enclosed nearly a dry waste of sand and mud, and Holyhead Harbour, which in 1857 had been reduced by 15in. to 18in. in depth, the author gives the results of some experiments carried out at Dover and elsewhere, from which he estimates that the amount of accretion within the proposed harbour would not be less than 9in. per annum; but to be within the mark he takes it, in estimating the annual cost of keeping the harbour open, at 6in., and this would cost £14,000 per annum, exclusive of plant, to remove.

As "the cause" of the failures, the author points to the present harbour legislation, and says, "It is in fact the direct result of our foolish custom of allowing these matters to be decided by persons who have a personal stake in the proposals, and who, from circumstances, are unable to deal with them," and who are thus placed in a position unfair to themselves and to the public. As regards competency of those to whom these matters are usually referred, the author says, "We all know that the selection of a proper site for a national harbour, with its projection, is a complex question, embracing as it does military, naval, strategical, nautical, and physical considerations of the highest importance, all of which ought to be thoroughly sifted and weighed in the light of experience before a decision is arrived at. Such is the problem to be solved, and it is contended that no engineer, be he civil or military, is fitted to deal with it single-handed; it is not his province, and experience conclusively proves that it is not within his power." In private bill legislation, the public interested in the proposal know all about it; but in these more costly measures the public are not in court, for they are decided substantially by the Government authorities and their advisers, over whom there is an entire absence of proper control "except that which may haply be supplied by the imperfect and uncertain ordeal of votes in the Houses of Parliament." And whatever may be the desire of the authorities to know the truth about the schemes pressing for their support, there being no board or cognate authority possessing the necessary theoretical and practical information to which the case may be referred, they can only employ for the purpose the defective machinery which custom has established.

As to "the remedy," our author says that "improvised committees and commissions ought at once to be given up. . . . . When the members of such bodies are selected for this duty not because of their fitness for grappling successfully with the questions submitted to them, but only for their accidents of place and name, need we wonder that crude schemes are promoted at times with only a bare chance of successful challenge." The subject is of public importance, and as it embraces all the conditions above referred to, as well as that of maritime construction, each of these branches of professional knowledge ought to have two or more representatives in a permanent body to be termed the "Referees for Government Works," to be called together, and to be paid only at such times as it might be necessary to submit questions for their consideration." This, Capt. Calver says, would not be a lucrative appointment, but would be regarded as an honourable position and an acknowledgment of professional standing. The Dover scheme is characterised as worthless, and one which would probably sink a million and a-half sterling before it was completed, and would be followed by demands for similar unnecessary harbours, while it would be vastly better for the nation were such a sum as the above "advanced at low interest to supplement local efforts for the improvement of our small, but numerous, harbours, especially as it is becoming increasingly apparent that it is upon these harbours, and these only, that we shall (by preference) eventually depend as stations for effective means of national defence."

We have thus touched upon some of the more important points, and in many instances given the author's concise sentences, from this pamphlet, which covers fifty-one pages upon a subject of national interest.

NEW ROLLING STOCK.

Statement of the New Rolling Stock Charged to Capital by the Principal Railway Companies in the Half-year ending 30th June, 1876 (compiled from official sources).

	Locomotive.			Coaching.			Merchandise.			Machinery, &c.	Total charge to capital.
	Number.	Average cost.	Amount.	Number.	Average cost.	Amount.	Number.	Average cost.	Amount.		
		£	£		£	£		£	£	£	£
Belfast and Northern Counties	—	—	—	—	—	—	33	145	4,778	—	4,778
Caledonian (tank engines)	3	1250	3,750	20	163	3,259	2143	60	127,798	—	134,807
Furness	1	2729	2,729	—	—	Open ... 238 / Covered. 100	98 / 118		35,124	—	37,853
Great Eastern	20	2630	52,600	111	341	37,888	207	130	26,926	4,079	121,493
Great Northern (1)	33	2230	73,582	15	599	8,995	377	82	30,770	5,277	118,622
Great Western	20	1608	32,157	71	364	25,809	125	80	10,068	—	68,034
Lancashire and Yorkshire	3	2281	6,844	4	236	942	358	96	34,517	2,170	44,473
London, Brighton, and South Coast	8	2800	22,400	36	—	*	454	—	*	†1,658	89,944
London, Chatham, and Dover	6	—	*	—	—	—	80	—	*	—	26,205
London and North-Western	13	1103	14,338	70	359	25,130	291	77	22,222	—	61,690
London and South-Western	6	—	*	17	—	*	56	—	*	—	21,404
Manchester, Sheffield, and Lincoln	14	2163	30,280	16	472	7,550	253	115	29,132	—	66,962
Midland	65	2529	164,290	217	415	90,162	117	74	8,642	26,476	289,570
Midland Great Western	6	2777	16,662	—	—	Covered 100 / brake. 6	125 / 203		13,718	—	30,380
North British (2)	—	—	—	13	226	2,932	1049	74	77,700	110	80,742
North-Eastern	33	2324	76,701	78	255	19,848	1198	118	141,292	—	238,541
North London	—	—	—	—	—	Cattle.	25	125	3,125	—	3,125
North Staffordshire	5	2778	13,890	—	—	—	—	—	—	800	14,690
Rhymney	—	—	—	15	235	3,530	—	—	—	1,362	4,892
South-Eastern	3	2282	6,845	22	557	12,254	—	—	—	383	19,482
Waterford and Limerick	4	2764	11,055	—	—	—	100	117	11,694	‡484	23,233
Total number	243	—	—	705	—	—	7310	—	—	—	—
Average (mean) value	—	2320	—	—	380	—	—	87	—	—	—
Gross value (partly established)	—	—	563,000	—	—	268,000	—	—	629,827	42,799	1,503,626

* Not distinguished. † Seven steam cranes. ‡ Engine weighing machine.

(1) Great Northern.—Merchandise: Average cost—Open, £82; brake, £132; and ballast, £74 per wagon.
(2) North British.—Coaching: Average cost—Luggage vans, £247; covered carriage truck, £153.
Do. Merchandise: Average cost—Covered goods ... £92
Do. Do. Do. Mineral ... 72
Do. Do. Do. Brake vans ... 170

Her Majesty's Ship Dreadnought. — The new twin screw double-turret ship Dreadnought, built at Pembroke, arrived at Portsmouth on Monday morning for the purpose of having her hydraulic gun gear fitted and to be generally completed for sea. She left Pembroke at about half-past three on Saturday afternoon, and had good weather all the way until near her destination, when she encountered a heavy wind, which put her seaworthiness to a test with very gratifying results. Though escorted by the Valorous, Captain Jones, she made the voyage entirely by means of her own machinery, which is by Messrs. Humphreys and Tennant, and was found to work in a very satisfactory manner. The engines are constructed on the inverted direct-acting plan, each having three cylinders, the high pressures having a diameter of 60in., and the low pressures a diameter of 90in. The stroke is 4ft. 6in. The tube plates of the boilers are $\frac{3}{4}$in. thick, the shells being of the same thickness, and the back plates $\frac{1}{2}$in. The contract price of the engines is £70,000, while the boilers will cost over £30,000 more. During Sunday the engines were tested with a pressure of 30lb. to the square inch, or one-half the full pressure at which the boilers are intended to be worked. A maximum of 54 revolutions was obtained, the horse-power developed being 4900, or considerably over one-half the contract power. The greatest speed realised was close upon 13 knots. A splendid vacuum was reached, the gauges indicating 28lb. and 29lb. in the condensers. This vessel was originally named the Fury.

Mr. Juggins upon the Nut and Bolt Trade.—Mr. Juggins is a great man amongst the operative nut and bolt makers. He is the general secretary of their Union, and exercises immense influence over the men. His views are, therefore, of no little interest, and they relate to the industry of which he professes to know so much. Speaking at a meeting of his craft, held at Darlaston a few days ago, Mr. Juggins, whilst he admitted that there was some ground for alarm at the cry as to foreign competition, contended that it was due in no way to the alleged immoderate demands of the operatives, but rather to the large profits that the masters were alone satisfied with. Referring to Belgium, he said that while operatives there were content with lower wages than English operatives, Belgian masters were satisfied with smaller profits. He denounced the use of machinery in the making of nuts and bolts, saying it took employment from the workmen, who were bound to be well paid for the comparatively small amount of work they did. The machine-made articles were not nearly so good as the hand-made, and to that inferiority were due destructive and fatal accidents. It was often attempted by the firms who made these nuts and bolts to get their workpeople to file them up and make them resemble the hand-made goods. He called upon all present to do no such thing. Referring to the strikes, the speaker said there were many disputes in their trade now on in different places, and they had spent between £200 and £300 in supporting the men who were out. It was the interest of the trade to do so, and keep those disputes at a distance, away from the places where the bulk of the trade was.

New Steam Excavator.—Messrs. Alex. Chaplin and Co., of the Cranstonhill Engine Works, Glasgow, have just constructed a very powerful "steam navvy" or excavator, which they have been exhibiting under steam in their premises during the past week. The frame is entirely of malleable iron, with angle irons welded at the corners, plated with $\frac{3}{16}$ plates, and weighs 4½ tons. Underneath the frame are two steel axles, each having four wheels, the outside ones double flanged for the purpose of working the machine, and the inside ones single flanged, so as to go on a 4ft. 8½in. railway gauge. The front part of the machine is supplemented by two wings, one on either side, having screws so as to give lateral stability to the machine, when the digger is required to work at right angles to it. The motive power consists of a pair of 8in. cylinders of the inverted type, with pinion and crank shaft, working into a larger wheel in the barrel, which is grooved to receive the chain. Near the front of the machine is a very strong cast iron column, round which the jib, which is of malleable iron, is made to revolve for one half of a circle. Two men are required to work the machine, one having entire charge of the engine for hoisting and slewing, and the other man, who stands upon a little platform, regulates the out and in motions of the digger. This latter, by the use of a friction clutch and friction brake, has the entire control of pushing the digger out and in to the material to be excavated. Simultaneously with the hoisting or shoving out action, the bucket or spoon is drawn by pitch chain wheels, and it scrapes up the face of the bank, taking a cubic yard of material at every lift. Alongside the machine there must be accommodation rails for the wagons to come and receive the soil; and as soon as the bucket is filled, it is slewed round by the attendant at the engine, either to the one side or to the other, right over the empty wagons, and a trigger being drawn, the contents of the bucket fall into the wagon. While the bucket is returning to the working place, it shuts automatically at the bottom, and so is prepared to rake up another fill. The frame is long, broad, and remarkably stable, and by having placed on one end of it the boiler and engines, and at the other the jib, gear and bucket, the whole machine presents the appearance of being admirably balanced, and certain to sit like a rock with an immense strain upon it. The machine is of such a size that it will carry a cutting down to a depth of twenty feet while it is stationed in one level, and it is calculated that by its use the labour of eighty men will be superseded. The one exhibited last week has been built for a limestone quarry near Edinburgh, where it will be employed in tirring off the strata overlying the limestone.

RAILWAY MATTERS.

The Baldwin Locomotive Works have just completed the first locomotive for street cars made by them, in which the boiler and machinery are separate from the car. A trial trip will soon be made on the Market-street railway, Philadelphia, and we have little doubt that we shall be able to record it a complete success.

The new passenger station at Alexandria, built on the site of the former one, which was destroyed by fire in September, 1875, is now nearly completed. On the up line there are a commodious booking-office, general waiting-room, 38ft. by 16ft., ladies' and gentlemen's first-class waiting-rooms, porters' room, and private office for the station agent. On the down line a general waiting-room only, with booking-office attached, has been put up. The platforms are covered with verandahs—the one at the principal station being roofed with glass. The platforms have been elevated and lengthened, and the road leading to the main station is to be widened to admit of carriages driving up to the booking-office door—a thing that has not been the case hitherto. We understand that about 2½ acres of ground in a contiguous field have been taken off for the formation of additional sidings, for additional accommodation for goods traffic.

Latest advices from China state that the first fatal accident has happened on the Woosung Railway. The general opinion among the natives is that no blame attaches to the company, but that the man deliberately committed suicide. A correspondent, writing to the *Times*, says that the railway continues to work quietly and without interference, but he considers that the line is by no means altogether safe from official hostility. He says:—"The Viceroy of Nankin is said to view it with great dislike and to regard its inauguration as a slur upon his government. He has, I am told, sent two mandarins to make a careful survey of the line and to find out accurately what can be said against it. It is reported that the Taotai wants to resort to the old device of inciting the people to tear up the rails, and that the object of a visit he has lately paid to Nankin was to obtain the consent of the Viceroy to the scheme. My informant does not know what view the latter took of the proposal, but it is of opinion that some measures will be taken before long of decided hostility."

The Midland station at Bedford has just left the hands of the contractor. For some time it has been manifest that the growing importance of Bedford as a centre of traffic would speedily necessitate the enlargement of the station, and accordingly in the autumn of last year the directors ordered the down platform to be considerably lengthened, and the whole of the station to be redecorated. The contractors selected were the well-known firm of Messrs. T. and H. Skevington, of Derwent-street, Derby, and under the management of Mr. Stratford, of Gloucester, the clerk of the works, the covered portion of the station has been largely increased, and the whole building, including waiting-rooms, &c., has been finished off in a style worthy the firm engaged and the increasingly important town of Bedford. It is worthy of note that though during the four months in which the contract has been in progress, the whole of the roofing and rooms have been at one time or another under repair, the work has been so ably conducted that the convenience of the travelling public has not been in the slightest degree interrupted. The work was completed on Friday morning, and the station now presents a light and most pleasing appearance.—*Bedford Mercury.*

The Maenclochog Railway was opened on Tuesday, the 19th September. The line commences at the Clynderwen station of the Great Western Railway, and passes through a most interesting district in Pembrokeshire. The length of line from its commencement to Rosebush is about eight miles and five furlongs, and its construction—which has occupied nearly three years—has called into exercise considerable engineering skill. The line of country between Prescelly and Clynderwen is very steep, and its ascent over, in some instances, very treacherous ground. The line was chiefly designed for the conveyance of the slates and slabs obtained at the quarries of Rosebush, the supply of which was restricted because of the want of communication. The line of railway runs directly to the quarries, and there is no doubt that their produce will now find its way in greatly increased quantities to various parts of the kingdom. It is intended to run fast coaches from Rosebush to Fishguard—a distance of nine miles—by which passengers will be conveyed at very reasonable rates. Some of the gradients of the line on account of the nature of the country are heavy, but the line will be worked with engines of great power, and the carriages are provided with Heberlein brakes. The line was constructed by Messrs. Jones and Jepson, of Neath, who have devoted great attention to the work, the whole of which, even to the most minute detail, has been well and carefully done.

One of the extensions of the North-Eastern Railway is the branch now completing which traverses Wensleydale from the western terminus of the Bedale and Leyburn branch, and forms a junction at Hawes with the branch diverging for that purpose from the Settle and Carlisle line of the Midland. The Wensleydale branch was commenced about the beginning of 1874, and its estimated cost, accomplished and expectant, is £211,570. Avoiding the little town of Leyburn by a long cutting through the limestone rock between it and the river Yore, it crosses the main road up the dale before reaching the ancient village of Wensley, from which the dale derives its name, passes on nearer the foot of the natural terrace called Leyburn Shawl by the lead mines and smelting mill at Keld Heads—the first station on the branch accommodating the mining village as well as the village of Wensley. It leaves the grand hall of Bolton to the south; after another limestone cutting, passes the ruins of Bolton Castle, the second station at Redmire serving that village as well as Bolton. Running south-west towards Carperby, the third station is close to the beautiful, if broken, waterfall at Aysgarth. Higher up the valley at Askrigg, is the last station on the branch for that place and the ancient little town of Bainbridge, and crossing the river Yore by an iron girder bridge, it reaches the junction station at Hawes. The country traversed is not a rich one, industrially considered. Lead mining in it seems to have passed its meridian, for the whole output of the dale appears not to exceed five hundred tons, the chief mine being that at Keld Heads; but it is possible that facilities of transport may revive the industry. Wool-combing, flax-dressing, and other allied trades carried on some years ago in the dale, seem to have died out, except at Hawes; but the agricultural wealth of Wensleydale has of late years been greatly developed, and its herds are notable. The district, also, is rich in natural advantages—in beautiful scenery, in many magnificent views, and in romantic historical associations. Thus, the new line will probably derive more advantage from the passenger and cattle traffic than from goods or minerals, and whilst they will be probably a fair through traffic between the eastern and western railway systems of the North, of which it forms a connecting link, it is probable that one of the chief sources of traffic will be that drawn to it by the desire to see its natural beauties. The length of the line, it may be stated, is close upon seventeen miles. The four stations are neat and commodious ones, built of local greystone, and tolerably conveniently placed for a population not dense. The engineering obstacles have not been very numerous. The bridges are, as might have been expected from the nature of the county, very numerous, but not of a character to need special note, the chief being the one crossing the river, to which reference has been made. Two of the cuttings through limestone rock and boulder clay are of some extent, the first causing the excavation of some fifty thousand yards of rock, and the second, 22ft. deep, extending for half a mile, and demanding the excavation of between fifty and sixty thousand yards. A long retaining wall has also been necessary near Aysgarth. The contractors for the new line have been Messrs. Gibbs and Son, and the engineers, Mr. Bevan and Mr. Riddell. The line is single, but the bridges nnd other works have been constructed to allow of after duplication, if necessary. The opening of the line is anticipated this year.

NOTES AND MEMORANDA.

The bath usually employed for imparting the colour of fine gold to jewellery and coins consists chiefly of an alkaline nitrate and common salt, to which is added some acid sulphate, like alum, or ferric oxide, so that a dilute aqua regia is produced. R. Wagner attempted to substitute dilute aqua regia, but without success. He accomplished his object, however, by using a solution of one gramme of bromine and twenty-five grammes calcic bromide—or thirty grammes potassic bromide—in one litre of water. The articles are left in the bath three to five minutes, then removed and rinsed with clean water. Alloys of silver and gold are to be rinsed with a solution of sodic hyposulphite.

The following details are given of the utilisation of raw lignite in the blast furnaces in Styria:—In 1874 the furnaces of the Styrian Eisenindustrie Company were daily producing 800 cwt. dark gray Bessemer pig, from ores containing 46 to 50 per cent. iron. Per cwt. of iron the consumption of coke was 150 lb., and of limestone 30 lb., the temperature of blast about 400 deg. Cent. The coke burden was 30 cwt., carrying 40 to 42 cwt. ore. The furnace possessed six tuyeres of 3in. diameter, and the pressure of blast was about 2½ lb. In April, 1875, the manager had been able to replace 50 per cent. of the coke by raw lignite. He considers as essential to the success of this charge an increased pressure of blast, an increased temperature of hot blast, and the ore being in pieces and not in dust.

The following extract from a Nevada newspaper appears in the New York *Army and Navy Journal*:—"While in this (Virginia) city Lieut. Wheeler called on I. E. James, the well-known civil and mining engineer. In the course of the conversation Lieut. Wheeler referred to a certain section of Lower California in which Mr. James made surveys in 1873 for a certain purpose. In making these surveys, Mr. James mapped a large area of country. Lieut. Wheeler had one of James' maps with him while in that region this summer. On the map was marked a large lake—a lake one hundred and fifty square miles in extent. All that Lieut. Wheeler found of this lake was a small pond. The indications are that in one or two years this will have disappeared. The lake that is thus rapidly becoming extinct is situated between Signal Mountain, Cocopah range, and the Coast Range Mountains. Mr. James found the lake very shallow about the shores, it being not more than a foot in depth one hundred feet from the shore. Mr. James filled a canteen with water from the lake and brought it home with him. He found it to be a saturated solution of salt. In drying up, the waters of the lake have left a large deposit of salt."

The following note on the cause of discrepancies in the estimation of silver in pig lead, by Dr. Paul Schweitzer, is interesting:—I had occasion, he says, some years since, to determine the silver in a lot of bullion lead from one of the Western States, and took two samples for this purpose from a kettle which contained about 10 tons of melted metal. The mean of the two assays indicated 81·62 ounces of silver, inclusive of 0·36 ounces of gold, to the ton of lead, while other parties who assayed it at the same time, but took their samples from one or more slabs cut out of the middle of the pigs, reported somewhat less. Thinking it not at all unlikely that there might be a difference in the composition of the metal derived from different parts of the pig, I cupelled seventeen samples, each weighing about fifteen grammes, and taken from a pig of about eighty-five pounds in weight, under as nearly uniform conditions as I could obtain, and found figures which clearly prove the existence of such difference. The silver collects in larger quantity on the outside than in the interior of the pig, in greater proportion on the upper than on the lower side, and in fact more in all those parts which solidify before the rest of the metal, which contains them correspondingly less.

More than nine-tenths in value of the exports in the year 1875 of the produce of the United Kingdom was shipped at twelve ports. From London went merchandise of the value of £57,923,927; from Liverpool, £79,460,771; from Hull, £23,273,231; from Grimsby, £10,149,580; from Glasgow, £9,128,372; from Southampton, £8,652,933; from Newcastle, £4,882,433; from Leith, £3,848,466; from Cardiff, £2,837,747; from Harwich, £2,806,149; from Hartlepool, £2,484,648; from Folkestone, £2,253,678. These amounts together exceed £207,000,000 of the £223,465,953, which is the total value of the British and Irish produce exported in the year. Liverpool takes the lead in its vast exports of cotton, linen, and woollen goods, and the exports of coal materially raise the totals at Newcastle and Cardiff. The twelve principal ports of entry for imports of foreign and colonial merchandise are not exactly the same as the chief ports of departure above named. The imports into the port of London in 1875 reached the value of £135,102,452; Liverpool, £105,095,188; Hull, £18,456,334; Folkestone, £11,822,742; Southampton, £9,236,460; Glasgow, £8,987,005; Leith, £8,084,081; Bristol, £6,911,963; Newhaven, £6,143,741; Greenock, £5,869,997; Dover, £5,409,042; Newcastle, £5,151,115. The sums together exceed £326,000,000, and constitute nearly nine-tenths of the £373,939,577; the total value of the imports of merchandise into the United Kingdom in the year. That total was never before equalled in any year, and the value of the exports of British produce in 1875 was never exceeded or equalled, except in the three years next preceding 1875. The imports of the year comprised articles of the value of £139,047,488, being in a raw state and to be used in manufacture; articles partially manufactured, of the value of £28,568,206; articles wholly manufactured, of the value of £39,552,176; articles of food, of the value of £162,274,950, or ten millions more than in the preceding year; and other miscellaneous articles, £4,496,697.

Some valuable experiments have been made with petroleum oil by Mr. H. B. Cornwall, who has read a paper upon this subject at a recent meeting of the American Chemical Society. A report of this paper is given in the *American Chemist* for June last. From these experiments the following conclusions may be drawn:—1. The naphthas distilled were comparatively heavy, 59 deg. to 64 deg. B., technically known as benzines. 2. The removal of about 10 per cent. of these naphthas from an average unsafe oil raised the flashing point 2·27 deg., and the burning point 1·6 deg. F. for each per cent. removed; the addition of the same proportion of naphtha of equal specific gravity lowered the flashing point in very nearly the same ratio. 3. A paying amount of a light naphtha, above 70 deg. B., could not be added to even a very high grade oil without making it conspicuously bad, while as much as 10 per cent. of a heavier naphtha—benzine—of 65 deg. B. could be added to an oil of little above 100 deg. F. flashing test, and make it no worse than much of the oil now in the market. 4. When a small amount of naphtha of above 70 deg. B. is added to a good oil the flashing point is lowered much more rapidly than the burning point; if the oil is of very high grade and the naphtha moderately heavy, 65 deg. B., the burning point of the oil is lowered almost as rapidly as the flashing point; while the addition of a naphtha of 65 deg. B. to a moderately good oil, flashing at 104 deg. F., lowers the flashing point 35 to 40 per cent. more rapidly than the burning point. 5. The burning point is not a reliable test of the safety of an oil, since oils, when spilled, will ignite instantly on the approach of a flame, when heated a degree or two above their flashing point, even although the burning point is 10 deg. or 20 deg. F. higher. This fact has been so often shown to be true, and especially in the earlier volumes of the *American Chemist*, that it seems scarcely necessary to repeat it. 6. Experiments show that an oil flashing at 86 deg. and burning at 107 deg. F., can be made to flash at 100 deg. F. by removing 6 or 7 per cent. by distillation. This corresponds nearly with the estimate furnished to Mr. Cornwall by Mr. H. N. Rogers (Charles Pratt and Co., refiners), that average petroleum yielding 75 per cent. of 110 deg. F. "fire test"—burning test—oil, would probably yield 69 per cent. of 100 deg. "flash" oil; in other words, 8 per cent. of the 100 deg. "fire test" oil would have to be removed to make a 100 deg. "flash" oil. The average flashing point of eight oils given in Dr. Chandler's report as burning at 110 deg. F. was 89 deg.

MISCELLANEA.

The death is announced of Mr. Thomas Baker, C.B., late Chief Inspector of Machinery at Chatham Dockyard. He died at his residence, Lewisham High-road, New Cross, on Friday, in his sixty-ninth year. Mr. Baker was made a Companion of the Bath in 1869, in recognition of his services. He was also a Knight of the Legion of Honour, and of the 5th class of the Turkish order of the Medjidie. He retired from the service in 1866.

The Brazilian ironclad Independenzia was to have been floated out of dock at Woolwich on Saturday afternoon, but the tide did not prove so favourable as was expected, and the attempt was deferred until the next spring tides. The ship has been in the dockyard under repair for a year and nine months, and she is now stated to be thoroughly sound, and none the worse for the strain she underwent during her long detention on the launching ways at Blackwall.

The shareholders of the Eastern Telegraph Company met on Monday under the presidency of Mr. Pender, M.P., and, after a long discussion, passed almost unanimously a resolution sanctioning a convention with the French Government to lay a cable between France and Algeria, and also a wire through France from Marseilles to Havre. It is estimated that the new cable will cost £100,000, and that the net traffic receipts will amount to £8000 a year, equivalent to 8 per cent. upon the expenditure.

A trial trip has been made over the new Australian line, the Deniligan and Moama Railroad, at a speed of thirty miles per hour. Mr. Green, C.E., of the Victorian Government Railways, who recently inspected the line, came to the conclusion that sixty miles per hour could be run over it with safety. The length of the line is forty-five miles, and its cost thus far has been something under £120,000, that amount including stations, officers' dwellings, a temporary bridge over the Murray, rolling stock, &c. Additional rolling stock and some more station buildings are expected, however, to carry the capital account to £135,000 before the close of the first year's traffic.

The Lords of the Admiralty have granted a boon to the men employed in the royal dockyard and victualling departments which has created the greatest satisfaction. Their lordships have ordered that upon the death of any man employed in the naval establishments after twenty years' service and upwards his full pay for the whole time he may have been ill will be paid to his widow or orphans. Should his death have been the result of an accident in the service, and in case he received half-pay while incapacitated, the remaining half of his pay will be paid to those entitled to receive it. Hitherto the widow and orphans have received nothing.

The Dublin papers report a serious burst in the Vartry pipe, about a half a mile from Enniskerry. The pipe passes under the river which flows between Enniskerry and Bray, and the burst has taken place right in the centre of the stream, a troublesome place to get at by reason of the swollen condition of the river. Large stones were driven aside, and the water issued from the pipe in great volumes, considerably adding to the size of the stream. On Wednesday the pipe was uncovered at both sides of the river, and half the Enniskerry road was cut across. Great energy is being displayed to grapple with this, perhaps the most serious of all bursts which has yet happened to the pipe. The Enniskerry river is the largest stream under which the Vartry pipe passes on its way to Dublin from Roundwood. If heavy floods come, there is reason to fear that Dublin will be short of water.

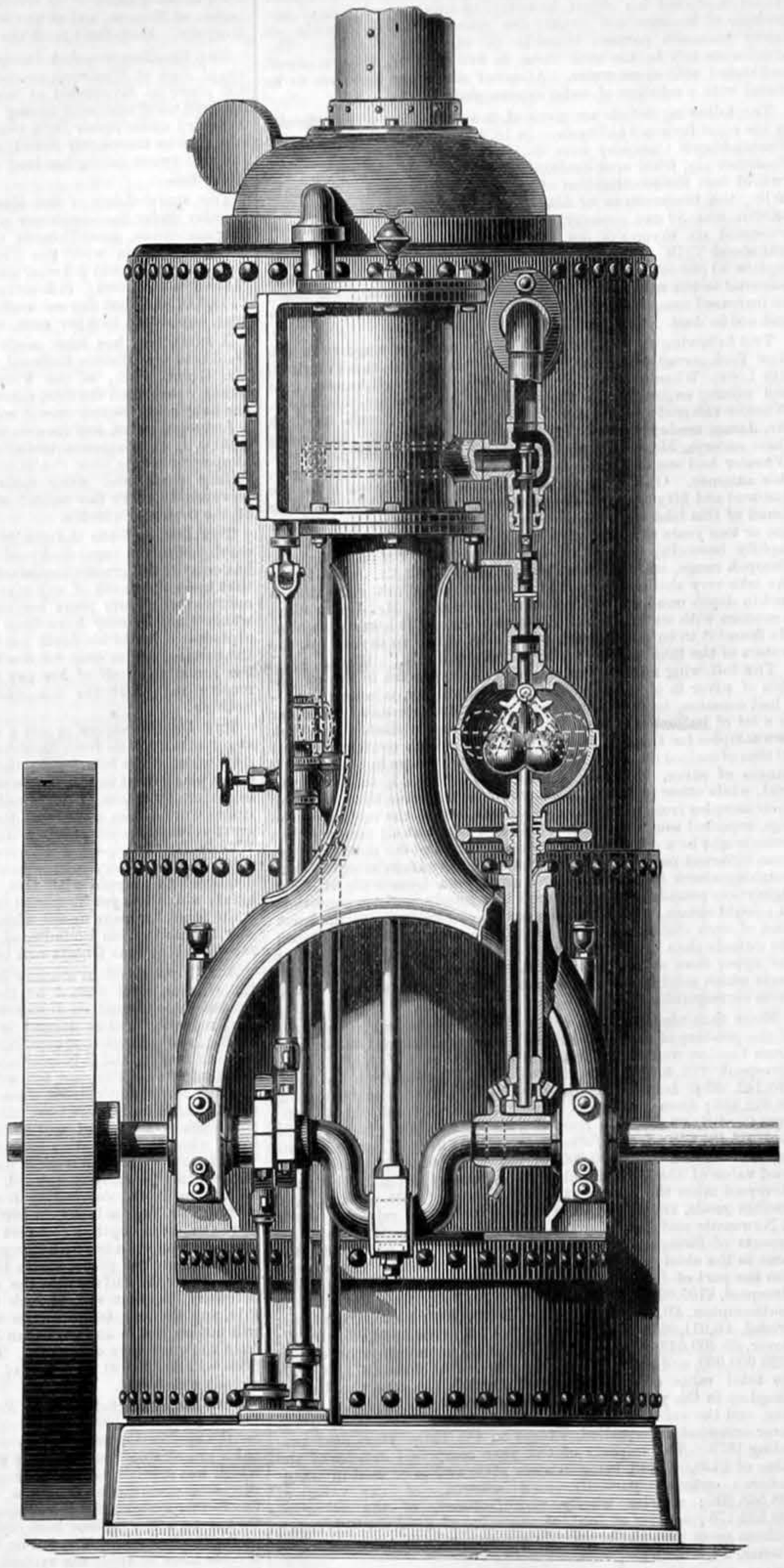
Active preparations are now in progress for the construction of the Hudson river tunnel on the Jersey shore. The entrance to the tunnel is located on Jersey-avenue, near Fifteenth-street, and the excavation will be carried in a north-easterly direction, terminating in Washington-square, New York. The tunnel will be two miles in length, and it is calculated the cars will pass through it in three minutes. The road bed will be 23ft. in width. The shaft at the foot of Fifteenth-street, Jersey City, is 100ft. in circumference, and the brick wall is 3ft. 4in. thick. The shaft has been sunk to the depth of 20ft., and will be further excavated to the depth of 62ft., when the excavation beneath the river will be commenced. The machinery for the work is now in position, and the excavation of the shaft is nearly completed. The eastern grade of the tunnel is 2ft. in 100ft., descending from Jersey City, then ascending on the New York side 2ft. in 100ft. As soon as the shaft is sunk to the required depth, a few feet will be excavated in the tunnel, when an iron cylinder with hinged doors will be inserted so that the labourers can proceed with the work. Compressed air will be forced from the surface into the cavity. Very little blast will be necessary, the first vein of rock being 1100ft. from the New York side, and the rock is soft. The depth of earth over the masonry will not be less in any part than 35ft., so that no injury can occur from the anchorage of vessels. The cost of this stupendous enterprise will be 15,000,000 dols., of which 10,000,000 dols. has been already subscribed.

Says the Springfield, Mass., *Republican*: It is rather remarkable that the prize of 100,000 dols. offered by the State of New York for the application of steam to canals, has utterly failed to bring out a practicable device, while the Belgian cable-towing system, which was specially excluded from competition for the prize, is in successful operation on the canal. The State awarded 50,000 dols. to the Baxter system, but the company which undertook to introduce that system has become bankrupt, and its effects have been sold under the hammer. The failure was inevitable, from the fact that it costs more to apply the system to a canal barge than it would to build a new boat, thus doubling the first cost of the craft. On the other hand, the Belgian cable-towing system has been in successful operation between Middleport and Buffalo, forty-two miles, for several weeks. Since the middle of June, two tow-boats have towed 250 barges with their cargoes, averaging 200 tons of coal each, against a strong current, without injury to the canal and with satisfaction to the boatmen. On the 9th of July, seven boats, with 1500 tons of coal, were towed against a three mile current from Tonawanda to Buffalo at three times the speed of double the usual animal power. One boat consumes a ton of coal in twenty-four hours, and can be operated at an expense of 25 dols. for that time. The charge to boatmen is the same as for horse-power, but the speed is two or three times as great. Altogether, we do not see why this system does not achieve all that can be asked for in the application of steam to canals.

The destruction of oil by lightning this year, says *Stowell's Petroleum Reporter*, has been remarkable, amounting to 242,412 bbl., from January 1st to July 31st of this year, or rather from April to August; there were no fires from this cause in January, February, or March, two in April, none in May, four in June, and five in July. It is scarcely necessary to inform our readers that the oil destroyed is in closed-top iron tanks, and the lightning striking these, explodes the gas that collects in the space above the oil, scatters the oil, and sets it on fire, and in this way often communicates to other tanks in the immediate vicinity. The theory most commonly received in the oil regions of the cause of such frequent lightning "strikes" is that the gas, which, it is well known, is continuously escaping from the oil in these tanks, rises to some distance above the tanks, acts as a conductor, attracts the lightning and the damage is done. One peculiar feature in the history of these accidents is, so far as we have been able to learn, no iron-top tank has been struck, but in every case wooden-top ones. Special inquiries have been made on this point, with the uniform result given. So far, attempts to protect tanks with lightning rods have been failures; at Dilks station a number of rods, supposed to be ample protection, were placed about the tanks, but they were no protection against this summer's bolts. It may be interesting to those not acquainted with the oil business to state that in case of losses occurring in this way all the oil in the pipe line to which the tanks belong is assessed *pro rata* for the loss; that is, the law of "general average, so well known in marine law, is applied in this case.

VERTICAL ENGINE AND BOILER.

MESSRS. E. R. AND F. TURNER, ENGINEERS, IPSWICH.



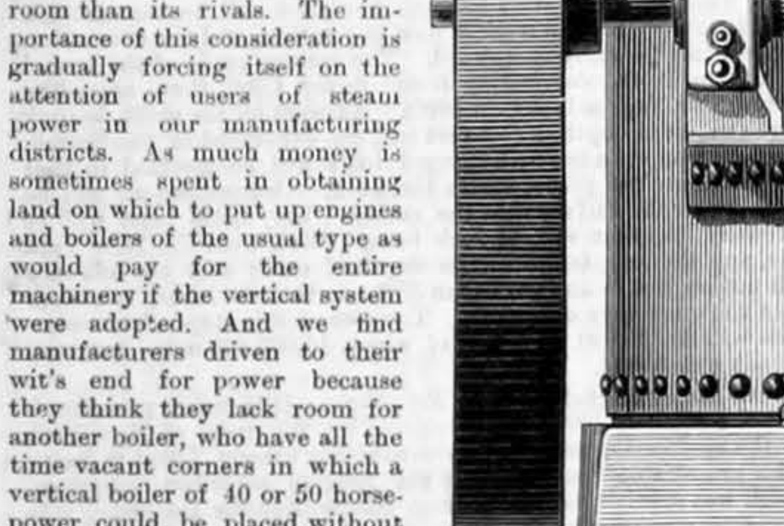
In the accompanying engraving we illustrate a very handsome combined vertical engine and boiler, constructed by Messrs. E. R. and F. Turner, of Ipswich. An engine almost precisely identical, and the first one made by the firm, was shown at Birmingham last July, when we commented upon it in favourable terms. The engraving is practically fully explanatory, so that little description is requisite. The dimensions of the engine are about the same as those adopted for portable engines of the same nominal power. One of the most noteworthy features about the engine is the extremely neat arrangement of the governor, which is completely enclosed in a polished cast iron ball, shown in section in our engraving.

All the proportions of the engine have been carefully studied, and the diagram will, as a whole, repay inspection. It is hardly necessary to add that the finish of the machine is everything that can be desired. We believe we are correct in stating that this is the first vertical engine and boiler combined made by Messrs. Turner as a speciality, and the circumstance that so influential a firm should adopt this system affords additional evidence as to its growing popularity.

It is a remarkable fact in mechanical engineering that very few years have elapsed since vertical engines and boilers combined were regarded as the most imperfect combination of machinery in the market, whereas at the present moment the sale of such engines is enormous, and on the Continent they appear to be specially appreciated. No engines or boilers have received more attention of late years, and the consequence is that in finish, safety, economy of fuel, and moderate price, they compare favourably with any other form of steam machinery, while the vertical system possesses above all others, the great advantage that it occupies less room than its rivals. The importance of this consideration is gradually forcing itself on the attention of users of steam power in our manufacturing districts. As much money is sometimes spent in obtaining land on which to put up engines and boilers of the usual type as would pay for the entire machinery if the vertical system were adopted. And we find manufacturers driven to their wit's end for power because they think they lack room for another boiler, who have all the time vacant corners in which a vertical boiler of 40 or 50 horse-power could be placed without the least difficulty. The efforts of such firms as Messrs. Turner will do much to dispel the prejudice which has hitherto existed against a system which has so much to recommend it.

THE STRENGTH OF CAST IRON FITTING BLOCKS.

Cast iron fitting blocks are used freely by boiler makers under the impression that such blocks while of small diameter compensate for the weakness caused by the hole which the block goes over. There is, however, reason to believe that this



impression is erroneous, and Mr. Fletcher, of the Manchester Steam Users' Association, deprecates the use of such blocks very strongly.

In our impression for March 24th, 1876, we referred at considerable length to the experiments carried out by Mr. Fletcher with a boiler specially constructed for experimental purposes by Mr. Beeley, of Manchester, and we illustrated the boiler in question. In all eleven bursting tests were applied up to last March in order to ascertain the weakest portions.

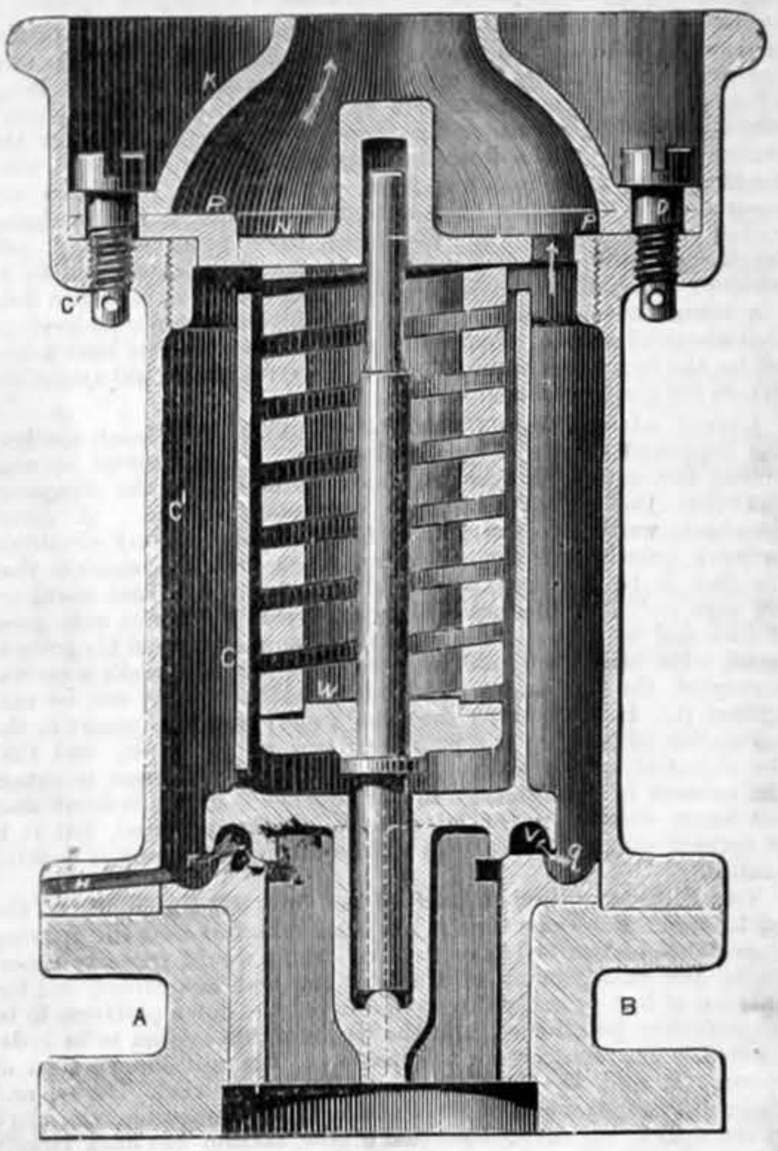
In the accompanying engraving we illustrate from a photograph the fracture of a cast iron mouthpiece or fitting block at the base of a 6in. steam stop valve. The casting was very good and sound. The pressure was 275 lb. on the square inch. The plates of the 7ft. boiler shell were $\frac{7}{16}$ thick, double riveted, and carried 342 lb. before giving way. It is evident from this that the cast iron fitting piece did not compensate for the loss of strength in the plate caused by cutting a 6in. hole in it. A point worth notice in cutting holes in boiler shells has never received the attention which it deserves. These holes are very frequently left ragged at the edge, and if closely examined, it will be found that minute cracks radiate from them into the plate. The weakening influence of such cracks, however small and short, is well understood. In all cases the edges of holes in boilers should be cut off clean and sharp, and the general use of some modification of the rose cutter which would smooth off holes up to 6in. in diameter would be a very good thing.

ADAMS' SAFETY VALVES.

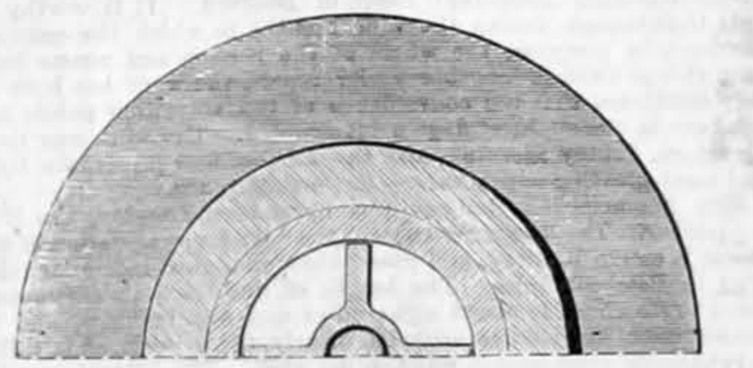
Among all the various safety valves that have been produced within recent years none perhaps has attained so much popularity as that invented by Mr. Thomas Adams, of the works of the Ant and the Bee, West Gorton, Manchester. Much of the favour which the valve enjoys is due no doubt to the fact that Mr. MacFarlane Gray, of the Board of Trade, is always willing to pass it when fitted to marine boilers. The consequence of this adoption by the Board of Trade is that it has now been fitted to the boilers of the Peninsular and Oriental Company's boats. The Cunard, the Guion line, and the Royal Mail Company have also adopted it for almost all their steamers. Private firms have followed suit, and, thanks to the favour of the Board of Trade officials and the inherent excellence of the valve, it is probable that in a little time all steamships carrying passengers will be fitted with it.

We show the valve in its original form, Fig. 1, and its latest form, Fig. 2. In Fig. 1 A B is the seating bolted to the boiler; P is a species of ornamental hood secured by the pins on top; these pins can be locked to prevent access to the valve; C^1 is a casing inclosing C, a second casing in which is fixed the spring loading the valve, which bears on the collar W.

Fig. 1.



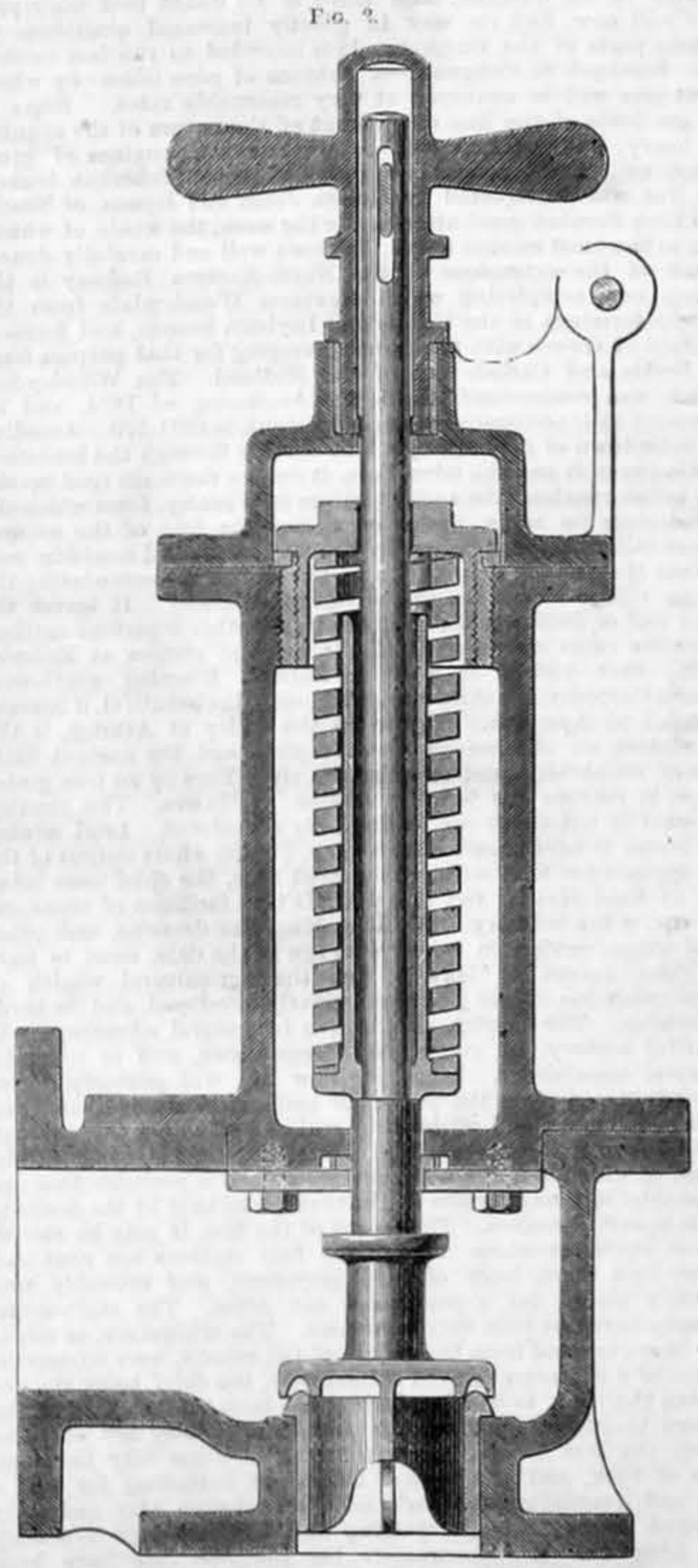
SECTIONAL ELEVATION



HALF SECTIONAL PLAN THROUGH VALVE

The peculiarity of the valve consists in the grooved seat V made in the valve, and the effect of this is that the area of the valve is practically augmented at the moment the valve lifts.

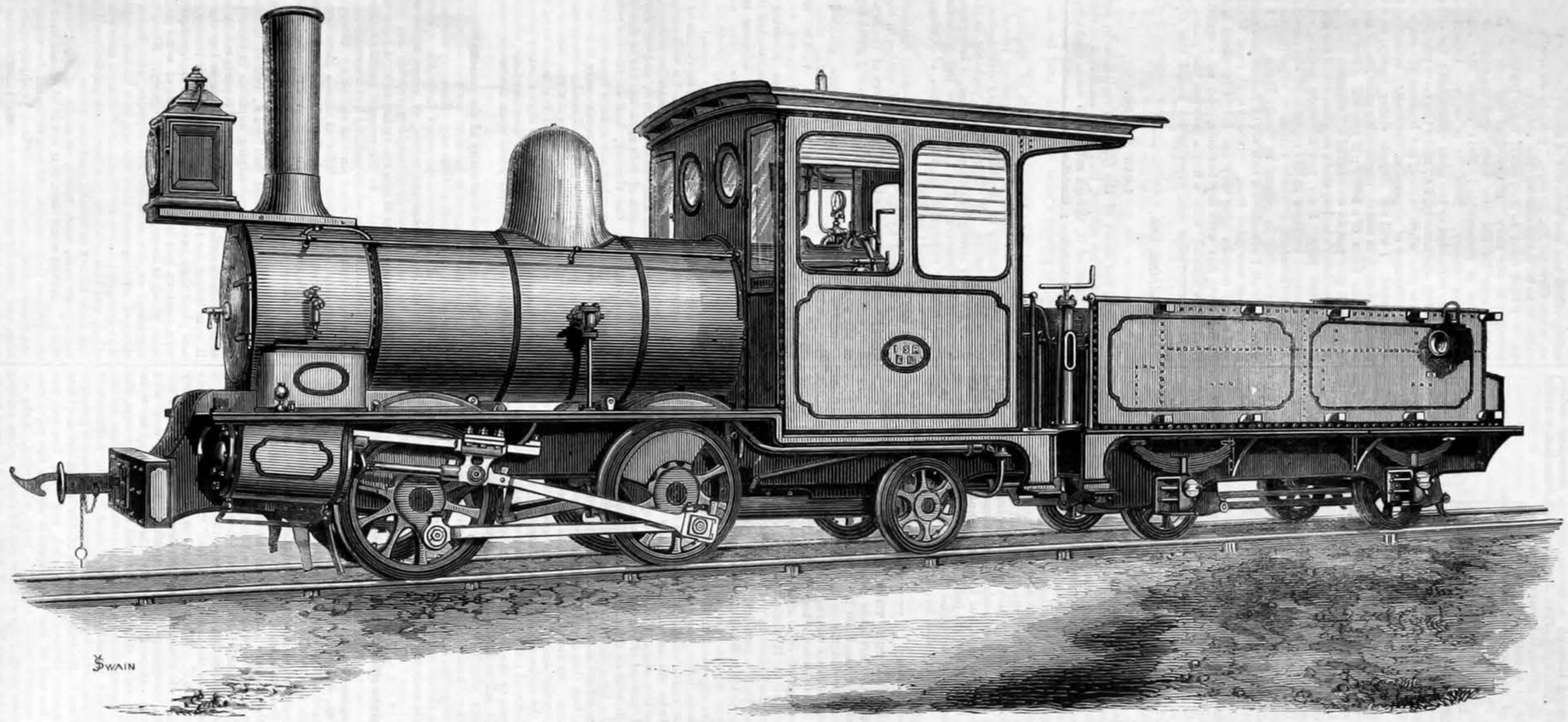
Fig. 2.



The result is that the valve will blow off to its maximum capacity with an increase of but 2 lb. or 3 lb. pressure in the boiler, and will close dead tight the moment the pressure falls a couple of pounds below that to which the valve is loaded.

NARROW-GAUGE LOCOMOTIVE FOR THE INDIAN STATE RAILWAYS.

THE VULCAN FOUNDRY COMPANY, NEWTON-LE-WILLOWS, ENGINEERS.



SWAIN

THE above illustration is taken from a photograph of a new class of engines for the Indian States Railways, of which twenty have been built by the Vulcan Foundry Company, Limited, Newton-le-Willows, Lancashire.

The principal dimensions of these engines are as follows, viz. :—Gauge of railway, 3ft. 3⅜in., or what is generally known under the designation of metre gauge ; diameter of cylinders, 11½in. by 17in. stroke ; wheel base of engines, 11ft. 3in. ; ditto of tender, 7ft. 6in. ; extreme wheel base, 25ft. 4in. ; diameter of boiler, inside, 3ft. 1⅜in. ; length of boiler, 7ft. 10in. ; length of fire-box, inside, at top, 3ft. 2½in. ; breadth of ditto, at top, 2ft. 5½in. ; number of tubes, 116 ; outside diameter of ditto, 1⅜in. ; length, 8ft. 3½in. ; superficial area of tubes, 398·5 square feet ; superficial area of fire-box, equal to 45·75 square feet, or a total heating surface of 444·25 square feet ; area of fire-grate, 6·9 square feet ; distance between frames, 2ft. 9½in. ; diameter of leading and driving wheels, 3ft. ; diameter of trailing and tender wheels, 2ft. 1⅜in. ; capacity of tender tank, 800 gallons ; fuel space, equal to 64 cubic feet.

The principal points of interest in connection with the specified details are as follows :—All the valves throughout, and cocks are fitted with stuffing boxes and glands for ordinary packing ; the axle boxes are of cast iron in two parts, the gun-metal bearing being a circular flanged bush.

The boiler is supplied by two injectors, Friedmann's patent, No. 6 size.

The cylinders were tested by hydraulic pressure to 250 lb. per square inch ; the tender tanks to 3 lb. per square inch ; the boiler tests, hydraulic 200 lb., and steam to 140 lb.

The awning cab has been made as commodious and airy as possible, and on either side is a door, the upper part of which is glazed with thick plate glass.

With the view of facilitating the replacement of details, the principle of duplicates has been carried out to the fullest extent, even the cylinders are so arranged that they are adapted for either right or left hand-side.

These engines, which we understand are intended for British Burmah, are designed in accordance with specification supplied by Mr. A. M. Rendel, C.E., of 8, Great George-street, Westminster, consulting engineer to the Indian State Railways.

LETTERS TO THE EDITOR.

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

CONDENSATION AND THE ECONOMICAL LIMIT TO EXPANSION IN STEAM CYLINDERS.

SIR,—I shall be glad to make a few more remarks on this subject, and briefly to reply to the more pertinent suggestions of your correspondents. As the point in question has been somewhat lost sight of in the discussion, it is necessary here to repeat it. As by all engines the quantity of steam consumed is much in excess of that theoretically required, may not this loss be due, in part at least, to the refrigeration attendant upon expansion, when the range is large ; and may not this refrigeration be similar qualitatively, but not quantitatively, than with air under similar ranges of expansion? Air under expansion loses heat per unit of volume to a greater extent than is represented by the ratio of expansion. May not this obtain with steam, more or less? though theory, based upon present knowledge of the action of steam under expansion, shows that the loss of heat per unit of volume is very nearly expressed by the ratio of expansion. It is impossible to say whether this excess of refrigeration does or does not take place with steam ; but as there is a large loss of steam unaccounted for, there seems, in the absence of proof to the contrary, some reason to consider it probable that it does.

Referring now to what I have advanced in former letters, and first as to terminal pressure. It is evident that this cannot be as as great as $\frac{P}{R}$, P being initial pressure and R the range of expansion, because this does not take into consideration the difference in the total heat of the steam at the higher and lower pressures, nor the difference in the relative specific volumes at the respective pressures. These conditions may be taken into account either by the total heat and weight per unit of volume or by the specific volumes at the respective pressures, or by all these; but the latter alone will be sufficient, though rather less accurate.

If S = specific volume of steam at initial pressure, s = specific volume of steam at terminal pressure, and R = range of expansion, then R S = s. Thus, with steam at 75 lb. absolute expanded four times S R = 353 × 4 = 1412 = s the specific volume at the terminal pressure, or a little over 17 lb., while by the ordinary method of calculation it would be 18·75 lb. There is considerable variation in the tables of the properties of saturated steam. I have four by me of recent date, three of which give different values under the different heads for any one pressure, but I will use that in the "Encyclopædia Britannica" as being a mean of all. Referring now to the maximum economical range of expansion. (1) It will be conceded that the range of expansion must not be greater than that which will increase the initial volume to that corresponding to steam of the lowest admissible terminal pressure. (2) That the range of expansion must not be greater than that which will reduce the total heat per unit of volume to that of steam at the lowest effective pressure. (3) The admissible range of expansion is therefore much larger for condensing than for non-condensing engines, as the increment of specific volume and the decrement of total heat are relatively greater per pound of reduction in pressure, at pressures below the atmosphere, than they are per pound reduction at higher pressures.

Taking now the case of the non-condensing engine. The lowest practicable terminal pressure will be determined by that necessary to overcome friction of all kinds and back pressure ; it will vary with the size and other conditions of the engines. But we may assume it to be as low as 3 lb. above the atmosphere, or 18 lb. absolute. The proposed initial pressure is, say, 75 lb. The maximum economic range of expansion practicable then is that which will increase the initial volume to such a volume at the lower pressure as is due to that pressure, and that can be supported at that pressure by the heat in the initial volume. If then H = total heat of steam at higher pressure, h = total heat of steam at lower pressure, W = weight of one volume — 1 cubic foot—at higher pressure, w = weight of one volume — 1 cubic foot — at lower pressure, S = specific volume at higher pressure, s = specific volume at lower pressure, R = maximum economic range of expansion, then $R = \frac{H W}{h w}$ or $\frac{H s}{h S}$. Taking the above limits for initial and terminal pressures, we have H = 1207·2, h = 1181·2, W = 0·1759, w = 0·0459, S = 353 and s = 1357, and

$$R = \frac{1207{\cdot}2 \times {\cdot}1759}{1181{\cdot}2 \times {\cdot}0459} = 3{\cdot}918 \text{ or } \frac{1207{\cdot}2 \times 1357}{1181{\cdot}2 \times 353} = 3{\cdot}9$$

If now we take an initial pressure common in locomotives, viz., say 120 lb., the terminal pressure being as before, we shall have R = 6·192. Thus for the highest pressure in common use in mills, &c., the greatest economic range of expansion is much less than a four-fold one, while with such high pressures as are carried by the locomotive the limit is reached when steam is expanded about six times. The above ranges would, by the usual method of calculation, be respectively 4·17 and 6·66, showing a difference of from 6½ to 8 per cent when the above quantities are taken into consideration.

Turning now to the condensing engine, here the terminal pressure giving in practice the best results is about 10 lb. Proceeding as before, and taking the initial pressure at 75 lb., we have in this case R = 6·84 ; or for condensing engines using a pressure much higher than is yet in use at sea, a maximum economic range of rather more than 6¾. Even if the loss due to imperfect vacuum and friction be put at only 8 lb., the maximum range cannot be more than 8·48. But if we put the initial pressure at 45 lb. absolute, as in common use in the navy, and taking the lowest practicable terminal pressure as before at 8 lb., R then equals 5·2, or about a five-fold expansion is the maximum economic range for such high pressures as are at present most common at sea. With the ordinary method of calculation these ranges for condensing engines would be respectively 7·5, 9·375, and 5·62, or ranges too high by 9·65, 11·6, and 8 per cent. Without going further into this very

long question, it may be remarked that ranges of expansion very little larger than those here referred to (8·25 for instance) give an approach to a terminal temperature very little in excess of the temperature that might be obtained by condensing in the steam cylinder, as was done prior to the days of separate condensers. But the fact is that in practice, whatever the range of expansion used, the terminal pressure in the cylinder will be about the same, or somewhere between 7 lb. and 10 lb. Now except by admitting that a very much larger quantity of steam enters the cylinder during admission than is represented by the capacity of the cylinder up to the point of cut off, this fact is impossible of explanation. The new steam enters the cylinder, which is at a temperature at least as low as that of the steam at the termination of the previous stroke, and until the cylinder and piston are heated up to the temperature of the new steam, steam is condensed, and as the temperature of the water so formed is nearly that of the new steam by the time cut off is effected, sufficient of it is re-evaporated as the pressure falls during expansion, to give rise to the steam which presents itself at the termination of the stroke at a pressure otherwise wholly without explanation. The quantity of steam thus condensed at the commencement of the stroke will be greater or less as the range of expansion is so, and will be self-correcting until the amount of heat supplied by excess of steam is equal to the heat lost by refrigeration due to expansion. As steam is not and never can be used in non-conducting cylinders, there is a point beyond which the gain attending the application of its expansive force is counteracted by the loss of heat necessary to restore the cylinder to the temperature of the initial steam after it has been reduced in the previous stroke to that of the terminal steam. In what precedes I have given the maximum range of expansion between two pressures that could be used with a non-conducting cylinder, but it remains yet to be ascertained what is the maximum economic range considered with reference to fall of temperature in a cylinder of ordinary material, or to what extent this limit will reduce that of the range of expansion as previously given. With an initial pressure of 75 lb. and a terminal pressure of 10 lb., the new steam at each stroke enters a cylinder 114 deg. below its own temperature, even if it is assumed that the condenser has no cooling effect on the cylinder, so that it is a question whether the loss of the steam required to restore this 114 deg. to the cylinder does not greatly nullify the gain supposed to attend such ranges of expansion. The experiments with the machinery of the U.S. steamship Gallatin prove that it does, for, taking one illustration from many, it was found that with a boiler pressure of 86 lb., and a ratio of expansion of 7·78, the consumption of steam was 25·03 lb., while with even a less boiler pressure, viz. 78·75 lb., and the range of expansion reduced to 4·46, the consumption of steam was reduced to 24·35 lb. Thus the gain which should attend the use of the higher pressure steam was more than nullified by the large range of expansion adopted. The relation between gain by expansion and loss by refrigeration which attends it, requires experiment to determine; it cannot be calculated, because the distance of the isothermal *couche* from the cylinder and piston surfaces cannot be estimated except by rude approximations.

A few words now in reply to the correspondence since my last letter, and first with reference to that of Mr. Longridge. There are only one or two points, besides those already touched upon in the foregoing, that call for any remark: First, with reference to the water mechanically suspended in and carried by the steam to the engine; this is a point of much importance, and undoubtedly the loss from this cause is often very considerable. But although M. E. Cornut, chief engineer of the association referred to by Mr. Longridge, found, in the experiments quoted, that the loss under this head was as much as 12·1 per cent., it has been found in some instances by Hirn to be very much less, and by Professor Thurston as low as 4 per cent. This carriage of water by steam may be looked upon as a mild form of priming, and probably will be greater with any one boiler as the quantity of steam drawn from it is greater, and will be greatest in boilers too small for their work, or which have limited steam spaces. With reference to loss by clearance spaces, when this has been fully allowed for, the waste by the engine has not been very much reduced, and as a ratio of expansion of 10 is very uncommon, clearance space amounting to as much as 1 per cent. of the capacity seldom entails a loss of 10 per cent. Badly designed nor worn-out engines, or engines out of repair, are not being here at all considered; and as properly designed and well-made pistons may be, and often are, almost perfectly steam-tight, the loss by pistons not so made, or by badly bored cylinders must not be considered.

With reference to Mr. Northcott's letter, a reader might be led to imagine that the subject of steam engine economy was a thoroughly settled one, and indeed, that the requirements of theory were continually realised in practice. No indicator diagram affords a true measure of the steam supplied by the boiler to the engine from which the card is taken; it only in reality gives us the pressure and its fluctuations throughout a stroke, from which may be deduced, though not with exactness, several other quantities. The diagram will show how much steam, if any, has been produced by re-evaporation, but it tells nothing as to the quantity of steam that has really been admitted up to the point of cut-off, and, therefore, nothing as to the quantity not re-evaporated of that which was condensed at the commencement of the stroke in heating up the cylinder and piston, &c. In the paragraph marked (1) Mr. Northcott says, "that whatever the ratio of expansion . . . . the quantity of steam used may be practically identical with the calculated quantity." Although the two quantities may be practically identical, they never are, and with reference to "the expansion curve," it must be remembered that it is only obtained by the consumption of a quantity of steam much in excess of, and "not identical with the calculated quantity." When taken in connection with the words, "whatever the ratio of expansion," this statement is less admissible, for, generally speaking, the higher the ratio of expansion the greater is the difference between the quantities actually and theoretically required; and in his calculation at the latter part of his letter, Mr. Northcott has put (with 75 lb. steam and a four-fold expansion) the latter quantity as 15·17 lb., while he further states that he should expect an unjacketed engine to use 24 lb., so that he expects a difference of 51 per cent. between practice and his own calculation. In (3) it is stated that "a final pressure less than that given by Boyle's law is seldom met with in practice;" this is true for reasons herein already given. It is suggested too that I have "lost sight of the fact that heat abstracted by the metal of the cylinder from the entering steam . . . . is wholly returned to the steam during expansion and exhaust." As I have in both my previous letters said that the quantity of heat in the cylinder is only the same at the end of the stroke as at the point of cut-off, it seems difficult to understand that the fact has been "lost sight of." The remainder of this paragraph is simply in confirmation of what I have expressed, except that, as though for the purpose of bearing out the suggestion as to the insufficiency of my figures, the steam consumed in the performance of work is added to that theoretically required per capacity of cylinder, making the latter appear much greater, because I have separated the two quantities in the usual manner, afterwards crediting the engine with both, thus placing the several items so that they may be read off at a glance (col. 3, Engineer June 30, p. 483).

In reply to Mr. West, I have only to repeat that, according to experiment and the formula in common use, viz.:

$$\text{Log. } T_2 = (\log. R \times \cdot 408) + \log. T_1,$$

R being the ratio of expansion or compression $\left(\text{or } \frac{V_1}{V_2}\right)$, four volumes of air at 60 deg. compressed into one volume will have a final temperature of 456 deg., and if the pressure at this temperature and volume be 103 lb. per square inch, and the one volume be allowed to re-expand to atmospheric pressure, the temperature will fall again to 60 deg., or through a range of 396 deg. What Mr. West means when he says that one volume of air at a pressure of 105 lb. per square inch will not expand at all, can only be known to himself. I have omitted "the condition that the temperature must remain unaltered," because, under the conditions, the temperature changes, and as the volume of air was increased fourfold, I must neglect to observe the condition that the "volume must be kept constant."

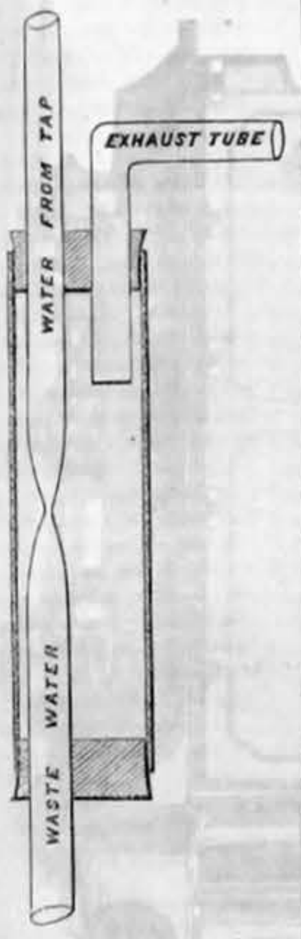
I must remark, however, that further discussion on the relations of P, T, and V of air will not help to arrive at an explanation of the difference between the actual consumption of steam by engines and their calculated requirements. It has only been alluded to as an illustration of what may take place in the cylinder of a steam engine, though in a less degree than with air expanding through similar ranges.

W. Worby Beaumont.

Westminster, Oct. 7th.

A NEW FORM OF AIR PUMP.

Sir,—Reading Mr. Brownlee's description of his experiments with water flowing through a nozzle with a diverging outlet, reported in The Engineer of 9th June and 16th June last, a useful application of the principle involved has occurred to me in obtaining a vacuum up to 29·6in. of mercury for assisting filtration, for pneumatic experiments, and other kindred purposes in the laboratory or lecture room. In Mr. Brownlee's experiments he used a metal tube contracted near the middle of its length, at which point a small tube communicating with a vacuum gauge entered it, and water at various pressures was forced through the contracted tube. With the results detailed in this paper, one of which was that when water of a pressure due to a head of 6·5ft. flowed through it, a vacuum of 29·6in. of mercury was shown to exist at the point of entry of the vacuum tube. The requisite head of water is therefore always attainable from the tank supplying any laboratory, and the air pump is easily constructed from glass tubing in the following manner:—A piece of glass quill tubing about 8in. long is drawn out until its internal diameter is about $\frac{1}{16}$in., and cut through at its narrowest part. A wide tube about 4in. long is taken and corks fitted to each end, and the two nozzles formed on the quill tubing passed through the corks and brought close together opposite to each other in the larger tube; a second piece of quill tubing is passed through one of the corks to bring the air from the apparatus to be exhausted. One tube is then connected with a water tap, when the water rushes through the first nozzle into the second, which is so adjusted as to prevent any splashing; the corks are then sealed over and made air-tight. This application may not be new, but I am at present only aware of air being pumped by water on the principle of the Sprengel pump, in which the column of water below the point of entry of the air that produces the vacuum, and not the fast moving water in the diverging nozzle.



J. M. Seabroke.

Rugby, October 2nd.

THE THUNDERER.

Sir,—Now that the jury have given their verdict on the explosion of the boiler on board the Thunderer, I hope you will give me space to make a few remarks on the adjourned inquest commenced on August 21st. Since I arrived here I have read and studied the evidence, and been amused if not instructed. First Mr. Weeks had in his log "fires lighted 10.15 a.m., steam up to 15 lb. 10.50 a.m."—sharp work—then at 11 a.m. Mr. Harding opened the 6in. stop valve on one of the boilers to work the capstan engine, for the fire was just lighted in the auxiliary boiler; the anchor was up about twelve o'clock, and Mr. Weeks, nor any one else, tells us when the steam was up in the auxiliary boiler, but orders were given before the ship went on the measured mile that the auxiliary valve on the main boiler was to be shut to keep the whole of the steam from the main boilers for the main engines; the auxiliary engines were to be worked off the auxiliary boiler. I believe the person that got this order shut the main stop valve on the boiler that exploded, instead of the 6in. stop valve on the opposite boiler. Secondly, Wells tells us the steam gauge did not act at all, never moved from the time the fires were lighted; did not indicate anything when the others showed 5 lb. I have seen no evidence that it went round, but that it never started or moved at all until the glass was broken. Again, at 1.4 p.m. he tells us the engines were making forty revolutions per minute; the smoke box and fire doors shut, and all the stokers doing their duty, *i.e.*, forcing their fires with best Welsh coal; if so the stop valve must have been shut after one o'clock, or the boiler would have burst before 1.13 p.m. Further, Wells tell us there was no unnecessary stoker on watch. Ocean steamers about the same horse-power and number of furnaces as the Thunderer, in the engine department muster from fifty to fifty-five, engineers included. Now a full crew for the Thunderer should not exceed sixty for the three watches, *i.e.*, eight firemen to each watch, and six coal trimmers, two oilers and three engineers, one for the stokeholes, and one for each pair of engines, total $19 \times 3 = 57 + 1$ store keeper, one deck engineer or brakeman, and the chief engineer makes sixty men, and more men are so many unnecessarily exposed in case of accident. If the Thunderer's engines and boiler were in an ocean steamer running 360 miles a day, burning over 100 tons of Welsh coal per diem, more men would not add to the safety or speed of the ship. Next comes Mr. Bramwell's report. Now why should he lecture to the sixteen tradesmen of Gosport about how the boiler and engines were made, when the scientific jury had all agreed that the construction of the engines and boiler had nothing to do with the matter, except the safety valves were set fast, which caused all the mischief? Why not tell them that at once instead of cramming them with such information as, "In its—the boiler—hinder end is placed what is called the combustion, &c." "The fires being made upon the fire-bars!" What has that to do with the safety valves sticking? He also tells them screws or "screwed stays are round." Then remembering he is speaking to some men who are tailors and drapers, he tells them the weights were threaded on the valve spindles, &c.; and summing up says, the boiler burst "because there was a large excess of pressure in the boiler immediately preceding the explosion." Why not make it simple, and say the boiler burst because there was too much pressure inside at the time? He tells them one of the valves did not blow off at 60 lb. pressure although twice tried, but when the cap was taken off and the end of the valve spindle shaken the valve rose freely. Now common sense ought to have whispered, make all your safety valves so that the spindles can be shaken when getting up steam, and the valves lifted and turned around in their seats. You are no doubt aware that had the Thunderer been a merchant ship the Board of Trade would not have passed the boilers to carry more than 20 lb. pressure. He tells them that there was no risk if the safety valves had been free. I don't say that there would be an explosion, but there would be a danger of straining the boiler, which straining, if often repeated, might eventually cause a rupture.

A celebrated English boiler engineer, on a visit to America, took a passage on board a river steamer that had a cylindrical high-pressure boiler carrying 80 lb. steam; he looked at the steam gauge, the diameter of the boiler, thickness of the plates, &c., and found that our Board of Trade would not pass the boiler when new for more than 60 lb. Fearing an explosion, he walked forward to the stem of the ship; looking up at one of the beams overhead he saw cut deep in the wood, "In God we trust." This would be appropriate in the stoke-holds of our war ships.

Further, Mr. Bramwell goes on: "But this is the practice—easing the safety valves when the ship is stopped suddenly—all boiler safety valves should be designed so that with everything closed but the safety valves the maximum amount of steam may be generated without danger." If they should be made so, why are they not? Or will the small valve remedy the evils? He could not tell when the stop valve was closed, but he might have ascertained within a few minutes according to the evidence. I am surprised that it was a novelty to all who witnessed the experiments that safety valves should stick, when no sea-going engineer of any experience trusts to the safety valves, but eases them every time he slows or stops the engines if the pressure rises to the point they are loaded to. Why have so many engineers in the merchant service experimented and improved safety valves? Because they had proof that the old style was defective. It was stated that the safety valves had not been out of their place for three years. Why so, when Circular No. 39 says, "prior to all trials, &c., each safety valve is to be taken out by the chief engineer of the dockyard, &c." I have tried to find out if there is such a thing as a boiler surveyor in our navy. If the chief engineer of the dockyard is not the man for the new work, and the engineer afloat for the old, who is responsible? Next comes Mr. Phillips and his contraction theory. Now it is of no importance whether the valves expanded or the seats contracted; for either complaint there is but one remedy, *i.e.*, make the valve smaller. I have seen new valves jam when heated, not because the seats crept in, but by the difference of expansion, the seating becoming slightly oval while heated. I will not dispute either theory, as we never measure less than $\frac{1}{64}$ in marine engineering practice. I am afraid I have reached the limit of a letter; if you will allow me space another time I will give you an account of a "common visitor's" inspection of the Thunderer's boiler, also a supplement to the six recommendations of the jury. I see you advocate making experiments on screwed stayed surfaces at the expense of the Government. The American Government made extensive experiments on this and boiler engineering in general at Sandy Hook and I believe elsewhere. Well I examined a new set of boilers last month made for one of their war ships from drawings sent from Washington four and a-half months ago; they are four 4-furnaced boilers like the Thunderer's, but with dry bottoms, and no screwed stays used, rivet bolts instead, with a ferule between the plates. Thus they have by experience and experiments found this style safer and better.

W. G.

Liverpool, Oct. 10th.

LEAD MINING.

Sir,—In the midst of the frequent variations in price to which other minerals are subject, lead alone continues in steady demand, and the price of it, though subject to some slight fluctuations, is always remunerative; therefore lead mining ought, if properly conducted, to present a most favourable field for the investment of capital.

The principal lead-bearing districts of England are Wales, Cornwall, and the North of England, and the Isle of Man, the two former being mostly in the killas or clay-slate formation, and the latter in limestone. Of these Wales probably is the oldest, as there are very strong evidences of minerals being sought for even before the Roman era. The latter have left undoubted traces of their mining enterprise in the counties of Carnarvon, Flint, Montgomery, and Cardigan.

In less remote times we have trustworthy records of immense fortunes amassed by the prosecution of mining in these counties, even when all the requisite appliances were of the crudest description, and when it was impossible to go to any great depth, because of the water.

In the year 1563 letters patent were granted to Daniel Haughselter and Thomas Thurland, granting them all "mines royal" in Wales, and parts of England. In 1567 a corporation was formed under the auspices of lords Leicester, Pembroke, and Mountjoy, and called "The Society for Working the Mines Royal." This company opened up many mines, but finally leased them to Sir Hugh Myddleton, who, by judicious management, soon reaped enormous profit; from one mine alone, called "Cwmsymlog," he obtained a clear yearly profit of £25,000 for many years. Subsequently an Act was passed destroying the monopoly by vesting all minerals in the proprietors of the soil.

In later years the Van mine has gained a well-earned celebrity, yielding from £8000 to £9000 per month in mineral, and a net annual profit of from £40,000 to £50,000, and yet showing no sign of failing. The success of this mine has led to the establishment of many others in the vicinity, but so far none have been so successful. Many never had any chance from the first.

In hilly countries like Wales lodes can easily be found cropping out at surface, and prospective mining is rendered easy and inexpensive by driving adit levels, either to cross cut the lode or on the course of it; but, as a rule, it is not until the lodes have been worked below the settled ground or valleys that a really permanently productive mine can be expected. At the same time, when a good course of ore has once been properly laid open the money comes back very fast.

It is to be regretted that many of the persons engaged in mining matters, either as agents or brokers, are not only reckless but untrustworthy, and ready to foist any scheme on the public. One of the sources of disappointment arises from the system of getting hold of old and worked-out mines, or mines which were failures. These are re-christened, astonishing reports are published, and extraordinary courses of ore are stated to have been left standing in the — fathom level. At the present moment there are mines being *worked* in Wales which nothing but a miracle could make productive, which are forced on the public by advertisements and circulars, and which under different names have been during the last ten years or so floated, liquidated, and re-named half a dozen times, and are as hopefully as ever reported week after week in the mining papers.

There are again a class of men who make a living by buying up the machinery of a "scat ball"—*i.e.*, ruined mine—for a mere song, and, having several mining captains in their pay (or worse, in their debt), the most flourishing of reports can be manufactured at a moment's notice, frequently without seeing the mine at all. It were better for the public to venture their money in an entirely new place than have anything to do with such concerns. Another very common bait is to flourish the name of some really successful mine which is more or less in the vicinity. Now, nothing is so capricious as the metalliferous deposits, and Nature seems very chary of putting more than one egg in a basket, and it is very rare that two great mines are found (in Wales, at least) adjoining each other, and this is where the investing public are led astray and risk their money in mining ventures whose only claim is that they are situate east, west, north, or south of the "Great So and So Mine." At the same time, it is not to be denied that mineral lodes *do* continue their course, and can be traced for miles, but they are not continuously productive—in fact, productiveness is the exception, and most frequently due to some interruptions in the lode, such as other lodes or joints crossing, or change in the stratum of the ground; and practical miners will prefer a mine situated on a *parallel* lode to a great mine, to mines on the course of the same lode. At the present price of lead, which is rather under an average, and with a fairly productive mine and good machinery, half of the total produce ought to be clear profit, and it is few industries or speculations can promise a return like this. At the same time, taking into consideration the great uncertainty of mining, no mine ought to be valued at more than ten years' purchase of the net profits plus the value of the machinery, but in many cases ten years' purchase of the *probable* profits if successful is asked and obtained. Lead mining, if judiciously and honestly conducted, is undoubtedly the most secure and most remunerative of all mining adventures. Mining must always be a speculation, but, taking into consideration the small amount of capital required

to develope a good mine, the steady demand for the mineral, when found, at a remunerative price, and that there is always the chance of a great success, by which the original capital will be returned over and over again in a few years, whilst the chances of total loss can be reduced to a minimum, lead mining may be considered a fair and promising field for the investment of capital, and one which, now that so many other sources have failed, is likely ere long to engage the attention of the public. S. H.

Oct. 4th.

STICKING OF SAFETY VALVES.

Sir,—A number of theories have been started to account for the sticking of dead weight safety valves to their seats, all of which are considered to be more or less unsatisfactory. I should therefore be glad if you will permit me the use of your columns to draw attention to one other theory, particularly as it appears to me to have been up to the present time entirely overlooked.

In investigating this subject, inquiry has been mainly, if not entirely, directed to a consideration of the condition and action of dead weight safety valves whilst subject to the variations of heat and pressure existing in boilers when in full work. Such inquiry has doubtless brought out more distinctly a number of weak points, and suggested several improvements, but it has not shown conclusively why such valves stick, or what should be done in future to prevent them sticking. I am, however, of opinion that the true solution of the problem will be found by an investigation of the condition and action of such valves when the boilers are not in full use, or when they are out of use altogether.

As an illustration of my meaning I will take the valves of the exploded boiler of the Thunderer, which were of the disc class, guided by feathers on their under sides and loaded with dead weights of some seven hundred pounds each. Now it is perfectly clear that when a boiler is cold and there is no pressure of steam within it to act on the under sides of the valves, the whole of these weights must be resisted entirely by the seatings of such valves, and it requires but a glance at them to show most clearly how little adapted their narrow and delicate surfaces are to resist such immense weights without receiving injury. The grinding and pounding effect of such masses upon these seatings, when a vessel is under sail only in a heavy sea, or rolling about in harbour with fires banked up or out altogether, must be something very considerable, as it must also be even in the case of a vessel under steam when plunging about in a heavy storm. Need it be wondered then that these delicate valve seatings are found to "creep," "distort," "grip the feathers of the valves," and so on. It seems to me quite reasonable that the soft metal of which they are composed should become compressed and burnished till it moves inwards, the direction in which it can move most easily, so as in time to diminish sensibly the diameter of the opening, and make it possible for the valve within it to stick.

That such sticking is not of constant occurrence is due mainly to the large amount of freedom generally given to the feather guides, and so long as the valves are not interfered with, to the fact that the same forces which operate to press the inner surfaces of the seatings in upon the feathers so as to grip them, at the same time drive the feathers against such inner surfaces with sufficient force to bed them in them, and so destroy the grip that would otherwise be set up. When sticking does, however, occur, it arises probably from one of two causes—either the sideway motion of the valve has not been sufficiently powerful to counteract the creeping inward motion of the seating, and so destroy the grip, or the valve has freed itself from such grip, but has been in some way or other turned round in its seating so as to bring the feathers into some new position where they have not previously freed or loosened themselves, and where they must necessarily be gripped.

How well this theory applies to the case of the valves of the Thunderer is at once seen, when it is considered that for some three years her boilers had been out of use, and that during that long period her too tightly fitted safety valves, with their loads of seven hundred pounds each, swaying backwards and forwards with every motion of the vessel, had been slowly but surely burnishing or grinding against the delicate edges of their seatings, till at last they either seized fast together, or a grip came upon the feathers from which they could not free themselves, and sticking became a certainty. W. Payton.

Brook Green, October 10th.

PRELIMINARY EXAMINATION OF PATENTS.

Sir,—The objection to preliminary examination that I now intend to notice is one of paramount importance; indeed, I think it is enough in itself to condemn the system contained in the Lord Chancellor's late bills. I refer to the delay that would inevitably be caused to valuable patents for the sake of inquiring into those applications for patents which would eventually be voluntarily abandoned. In other words, the consideration of the valuable would be postponed to that of the unnecessary. In illustration of this inherent objection I will refer to the figures contained in the Report of the Commissioners of Patents for Invention for last year presented to Parliament. The number of applications for letters patent was 4561, and the number of patents eventually completed and in force was only 3049, thereby showing that 1512 were either stopped by the law officers or abandoned. But it is well known that out of these only an insignificant number are stopped, so that it may be taken that in round numbers about 1500 were abandoned, which is nearly in the proportion of one to three.

Now what would these figures signify on the supposition of the existence of such a preliminary examination as was proposed? They would signify that the progress of many valuable patents through the office would be hindered by the inquiry by the examiners into 1500 applications, which, if left alone, would be voluntarily abandoned. Such an amount of unnecessary inquiry would prove a serious burden on the shoulders of two examiners and four assistant examiners, as proposed to be "appointed by the Lord Chancellor," and would consequently involve serious delay in the work of the office. These 1500 applications would have to be inquired into under four heads—(1) subject, matter; (2) sufficiency of specification; (3) novelty of invention, and (4) frivolity. And it must not be supposed that because these 1500 applications were eventually abandoned, they were all, or a large proportion of them, obviously inferior to those which were completed, or that they would have been necessarily rejected after examination.

Such considerations show us, that even assuming an adequate staff of competent examiners, much unnecessary delay in the whole work of the office must result, and that many valuable patents must be greatly prejudiced by the delay. It is to be remembered, however, that all the security for the competency of the examiners was to consist in their appointment by the Lord Chancellor, and that the extent and due remuneration of the staff was to be limited by "the consent of the Treasury." Appointments by Lord Chancellors have generally been understood to mean appointments of barristers of a conventional length of standing, not otherwise over much employed; and the Treasury have hitherto shown but little disposition to provide for the adequate working of the existing law. Taking into account these well-known facts, it is evident that under such a system of preliminary examination as that proposed, conducted by such an agency as would be likely to be employed for the purpose, much vexations delay to valuable patents must ensue. Neither would there be any security as to the legitimacy of the distinctions between those applications that were accepted and those that were rejected.

Patentees of experience may be appealed to in evidence of the annoyance felt by them when the progress of a valuable patent has been delayed by the absorption of the time of a law officer in official duties unconnected with patents. Our recent experiences also of the practice under "The Trade Marks Registration Act, 1875," is very suggestive of the annoyances that would result from official delays in the Patent-office, where they would be of so much greater consequence.

I might enlarge more fuliy on the inherent difficulties and objectionable features involved in such a preliminary examination as that adverted to, but I trust that sufficient has been said to show the weightiness of the objection, and to suggest to patentees the great interest they have in maintaining the existing law, in preference to that which has been proposed in substitution for it, in this matter of preliminary examination. William Spence,

8, Quality-court, Chancery-lane, Asso. Inst. C.E.

October 10th.

ON A NEW VOLTAIC BATTERY BY MESSRS. FITZ-GERALD AND MOLLOY.*

By Mr. C. H. W. Biggs.

Having used the battery about to be described in a variety of ways, and always finding it effective and economical, I thought a short account might prove interesting. The battery has been made in various forms, and in one of its shapes especially it differs considerably from those in ordinary use. As will be seen, depolarisation takes place by means of a secondary current, and as this current varies directly as the polarisation, and does not interfere with the primary or working current, we get a good constant battery. One form consists of a cylindrical glazed earthenware jar, made of various sizes, the largest being 12in. to 14in. deep, and 6in. or 8in. diameter. Eight or ten carbon plates ¾in. or 1in. wide are fastened by an alloy of lead and antimony to a perforated iron ring fitting the top of the jar, and these form the positive pole of the battery. A porous earthenware diaphragm is placed in the centre of the large jar and contains a piece of zinc which forms the negative pole. The internal resistance of this cell is only about ½ or ¾ of an ohm, whilst the electromotive force is somewhat over 2 volts. The form, however, adapted for general purposes is rectangular in shape. The cell is divided into two liquid-tight compartments by a plate of perforated carbon. The perforations are ⅜in. or ½in. in diameter, into which are tightly glued plugs of porous earthenware. The number of perforations vary with the size of the cell, but should be as numerous as possible. The carbon forms the positive pole of the cell. The negative pole is a plate of amalgamated zinc, placed in one of the divisions of the cell, about two-thirds of the height, and a little narrower than the cell. It is held in its place by means of a screw clamp, which also enables connections to be made. A binding screw is fastened to the carbon plate, and the cell is complete. The battery is charged by filling up the zinc compartments with dilute H_2SO_4 (1 to 10) and the other compartment with a good oxidising agent. The best oxidant for this purpose is calcic dihydro chromate ($H_2\ Ca\ 2\ Cr\ O_4$) with sufficient H_2SO_4 to combine with the oxide of calcium and with the sesquioxide of chromium produced when the calcic salt is deoxidised, forming sulphate of chromium. It is very easily prepared by mixing in the proportions 5¼ oz. of chromate of lime with 4½ fluid oz. of concentrated H_2SO_4. It is found best to mix the acid and the calcic chromate in the cell itself, thus:—Partially fill the cell with water, add the calcic chromate, then the H_2SO_4 gradually, in order to avoid the ill effects which otherwise would be produced by the too sudden development of a large quantity of heat. The proportions given are to be used for every 2½ oz. or 3 oz. of H_2SO_4 used in the zinc compartment. In telegraph offices, to obviate the use of acid the oxidising fluid should be obtained ready mixed. The quantities to be used may be obtained from the following equation: $H_2\ Ca\ 2\ Cr\ O_4 + 4\ H_2SO_4 = Ca\ SO_4 + Cr\ 3\ SO_4 + 5\ H_2O + 3\ O$. The three atoms of oxygen oxidise three molecules of hydrogen produced by the reaction of Zn and H_2SO_4. Thus the battery equation is:—$3\ Zn + H_2\ Ca\ 2\ Cr\ O_4 + 7\ H_2SO_4 = 3\ Zn\ SO_4 + Ca\ SO_4 + Cr_2\ 3\ SO_4 + 8\ H_2O$. The great advantage of the use of calcic dihydro chromate, besides its cheapness when produced in large quantities, is the non-crystallisable nature of the sulphates formed by the action of the battery. By the use of chromate of lime as mentioned, there is absolutely no effect from the generation of gas, deleterious or otherwise, so that the use of this oxidant is preferable to that of nitric acid (HNO_3). An intense current is generated by this form of battery. There is no porous diaphragm to increase internal resistance—the plugs not being traversed by the primary current—and the poles are very near to each other. The depolarising or secondary current may thus be explained, taking each compartment in turn:—First, in that containing the oxidant, any hydrogen given off by the carbon plate is at once oxidised and rendered harmless; carbon alone is exposed. Secondly, in the zinc compartment, when the cell is working hydrogen is deposited on the surface of the carbon plate. This causes a difference of potential to be established between the two sides of the carbon plate, and a current commences, the circuit being completed through the porous plugs and through the plate itself. By this current the hydrogen is oxidised as fast as it appears on the surface of the carbon plate, which is thus wholly kept free from polarisation. Here, then, we obtain the maximum electromotive force of carbon and zinc, which, so far as I am acquainted, is obtained in no other cell except it be the chromic acid cell, and further there is no consumption of zinc when the cell is not working. Absolute perfection, however, is unattainable, and although under ordinary conditions the current is constant, as will be found if set to work with an external resistance, if, however, it is short circuited, there is a gradual but slight diminution of current at first, after which it remains constant till the battery is exhausted. By increasing the number and diminishing the thickness of the porous plugs, and so decreasing the resistance of the secondary circuit to a minimum, the difference can be reduced to any required extent. One of the most interesting features of this battery is perhaps the value of the residue after the exhaustion of working powers. The soluble residual matter should consist, as we have seen, of sulphate of zinc and sulphate of chromium, thus: $3Zn\ So_4 + Cr_2\ 3SO_4$ and a quantity of water. The separation of these sulphates has not yet been effected. However, by treatment in a variety of ways a series of pigments can be obtained which ought to be of great value in the arts. By adding common salt to the residue we get on boiling chlorides of zinc and chromium and sulphate of soda; on cooling the latter crystallises out. If to the remainder be added four equivalents of Pb O for each one of Na Cl — salt — we get oxides of chromium and zinc, and oxychoride of lead; which gives pigment, No. 1, shown. If carbonate of baryta is added to the crude residue, as shown by equation:—$3Zn\ SO_4 + Cr_2\ 3SO_4 + 6Ba\ CO_3 = 6Ba\ SO_4 + 3ZnO + Cr_2O_3 + 6CO_2$, a very pale green is obtained, chalk may be cautiously added instead of baryta, with a somewhat similar result. It seems that a good green may be obtained by this means without the use of arsenic, and this is on all sides admitted to be a desideratum. As a large number of experiments extending over a long period have been made; and as the investigation is not yet finished, I will reserve detailed results for another opportunity.

* British Association.

Paper Collars.—Among other curious machines now exhibited in the "Great Hall of Machines" at Philadelphia is one for the manufacture of paper collars, an enormous business in the United States, producing no fewer than 200,000,000 collars a year. From a roll of thick calendered paper faced with cloth the machine cuts the collars in a pair of cutting-dies, after stamping the stitch-pattern and number upon them. Few, if any, collars made entirely of paper are now manufactured, the cotton-faced kind having driven them from the market. It is estimated that the saving in washing from the use of these collars amounts to 6,000,000 dols. a year. The company which exhibit these machines shows in a glass case a collection of all the styles of collars in use for twenty-two years since the invention was made. A remarkable relic of patriotic fervour is the "Fort Sumter collar," with the stars and stripes printed in colours on each side. This "sweet thing in collars" had, it is stated, an enormous sale in 1861.—*Pall Mall Gazette.*

Health and Sewage of Towns.—A meeting of the Executive Committee of the Society of Arts in connection with this subject, has been summoned for 12 o'clock on Tuesday, the 24th inst.; and an invitation has been addressed to the surveyors and medical officers of health of the vestries and district boards of works of the metropolis, asking them to attend, to meet the committee, and confer with them on the house drainage of the metropolis.

Central Asian Cotton.—A correspondent sends us the following abstract of a report by M. Brodofsky, which appeared in the *Golos* of the 3rd ult.:—"Steps are being taken in Russia for the improvement of the cotton received from Central Asia. Of the 50,000 cwt. yearly worked up (in 1871) by Russian manufacturers, only 10,000 cwt. are received from Central Asia and Persia, the rest coming through Liverpool from America (23,300 cwt.), and from India (16,700 cwt.) Central Asia produces now more than 50,000 cwt., and this production could easily be doubled in a short time; but the Asiatic cotton is little used, as it is imperfectly cleaned, and has short fibres. Cleaned in Russia there is a loss of 25 per cent. of weight, and (taking into account the high cost of the transport) of about 1½ rouble on the price of a pood (38 lb). The imperfect cleaning of the cotton is due, of course, to the primitiveness of the methods used in Asia. As to the shortness of the fibres, M. Brodofsky, who was sent to America with the special purpose of studying the subject, supposes that it is not due exclusively, as asserted until now, to climatic conditions, but mainly to the circumstance that the cotton tree cultivated in Asia (*Gossypium herbaceum, G. indicum*) is a botanical species different from those cultivated in America (*G. Barbadense*, which gives the best upland's kinds of cotton, as Mobile, New Orleans, &c., and *G. arboreum*, which gives the Sea Island kind). As to the last species, which produces the most highly-prized cotton, experiments of its culture in Turkistan have already proved unsuccessful, the thread received being long and silky, but too feeble. It appears, however, highly probable, from the comparison of the climates of the central parts of Texas and of Turkistan, that the *G. Barbadense* can be profitably cultivated in Central Asia, if certain measures are taken to ameliorate the culture. The Society of Friends of Natural Science in Moscow had, therefore, elaborated a plan of an exemplary form, for the culture, united with a station for the cleaning of the Bokhara cotton by American methods, and this was much patronised by General Kaufmann. But work having been postponed owing to a want of funds, a private society has been founded, with a capital of 300,000 roubles, for the encouragement of the cotton trade in Turkistan on a large scale. The society has already received a plot of land of 103,200 acres, and has purchased 6880 acres of artificially-watered land for its farm. The cleaning engines, which have already proven during preliminary essays to be the most useful for the Asiatic cotton, will be received from America during this autumn, together with seeds of the *G. Barbadense.*—*Times.*

The New York and Brooklyn Bridge.—The first permanent wire of the Brooklyn Bridge, over the East River, connecting New York and Brooklyn, was thrown across on the 22nd September. The travellers are wire ropes of three-fourths of an inch, while the carrier, thrown across to-day, is a cable of one and three-fourths in diameter and weighs 21,000 lb. Nearly seven years ago—that is, in October, 1869—work was begun on the foundations, piers, anchorages, and approaches of this great work; and that being finished, the superstructure or bridge proper is commenced. As the connection of the one million City of New York with the 450,000 City of Brooklyn is a matter of some importance to the former and of very great importance to the latter, let us take a glance at what the proposed bridge is to be, what it is to cost, and how it came to be built. A granite tower rises on each bank of the river, and behind each—farther up town on both sides—is an anchorage, from which an approach levels the track down to the city grades. The following figures are feet measurements of the bridge:—

Length of river span	1595
Length of New York land span	1870
Length of Brooklyn land span	935
Length of New York approach	1562
Length of Brooklyn approach	971
Total length	6933

The towers upon the two banks measure, in feet also, as follow:—

Below high water	78
From high water to roadway	135
Above roadway	149
Total height of towers	362

The width of the roadway with its five tracks is made up as follows:—

Two carriage roads, 18 each	36
Two car tracks, 13 each	26
Promenade for foot passengers	15
Divisions	8
Total width of roadway	85

The main supporters of this immense work are four wire cables of steel, something over 3600ft. in length and some 15in. in diameter. These are to be stretched from anchorage to anchorage. They will be wrought in position. Each is to consist of some 6000 separate wires, two of which will be laid at a time. The two cables, of which the first was laid to-day, are to be made into an endless chain, which will be driven by an engine on the Brooklyn side. The wires of the grand cables must be clasped together, and for this purpose a temporary bridge must be built all the way across. This will be the next work now. Two other 1.75in. cables will be thrown across on the upper side; and thus the other two grand cables will go on at nearly the same time with the first two—all four at the same time, that is to say. The wire to be used in these grand cables is what is known in the trade as No. 7 galvanised steel wire, about ⅛in. in diameter. Each grand cable is to consist of nineteen strands, and when these are clamped into a round form the whole will be wound spirally with No. 10 wire so closely pressed as to be water-tight, the whole being saturated with paint during the process of construction. It is expected that two months will be sufficient time to complete the temporary cables, and then will begin the work on the grand cables. The time of this preparatory work depends very much upon the weather, as little can be done during high winds and nothing during fogs. The expense of the work thus far has been 6,758,611.12 dols. in items as follows:—

	Dols.
Lands, buildings, &c.	1,504,438.27
Materials	2,514,791.94
To contractors	1,154,909.32
Engineers' salaries	253,118.05
Miscellaneous	1,331,353.54

The item miscellanies includes some dextrous stealings during the early stages of the movement, it is alleged without restraint. The receipts reported recently by the trustees are the following:—

	Dols.
From the City of Brooklyn	4,465,000.00
From the City of New York	2,100,000.00
For rents, interest, and valuables sold	204,193.24
Total receipts	6,769,193.24

From these figures it appears that the trustees have in hand now about 10,000 dols. Estimates that have been given to the public vary as to the amount yet necessary to complete the bridge; but it appears that, deducting the saving that will come of utilising the lands purchased, the future expense of the trustees all told will not exceed 4,500,000 dols., which makes the round cost, from first to last, about eleven and a-quarter millions, and that will not be much over twice as much as the original estimate, which was 5,000,000 dols. The saving that will result from utilising the lands purchased come of the part of the lands which may be used for other purposes, of the material now on most of the lands, and of portions upon which the buildings or parts of them may remain in use as they are.—*Standard.*

MORTISING AND TENONING MACHINE.

MR. RICHARD CARTER, ENGINEER, HOLME TOP WORKS, BRADFORD.

(*For description see page* 261.)

FIG. 1.

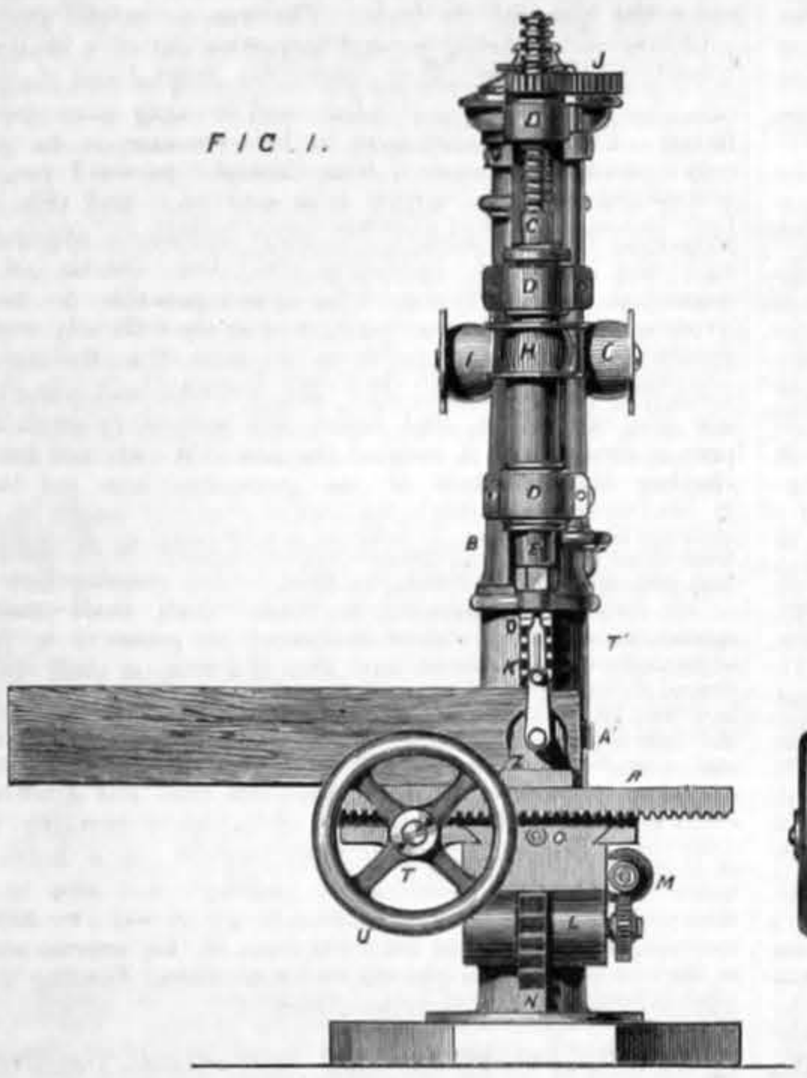


FIG. 2.

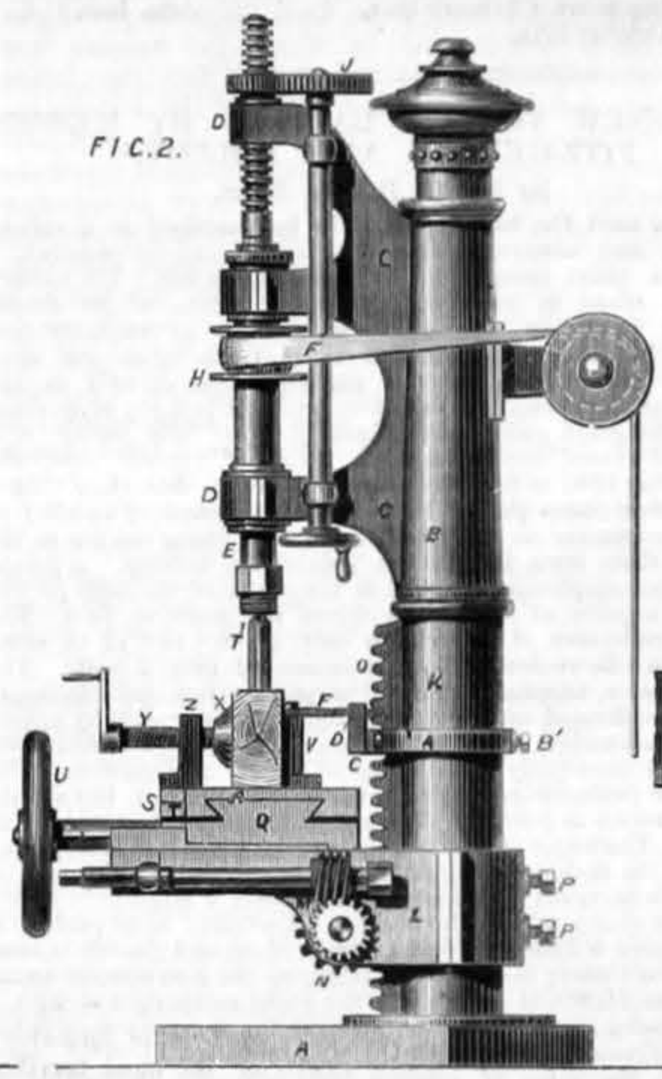


FIG. 3.

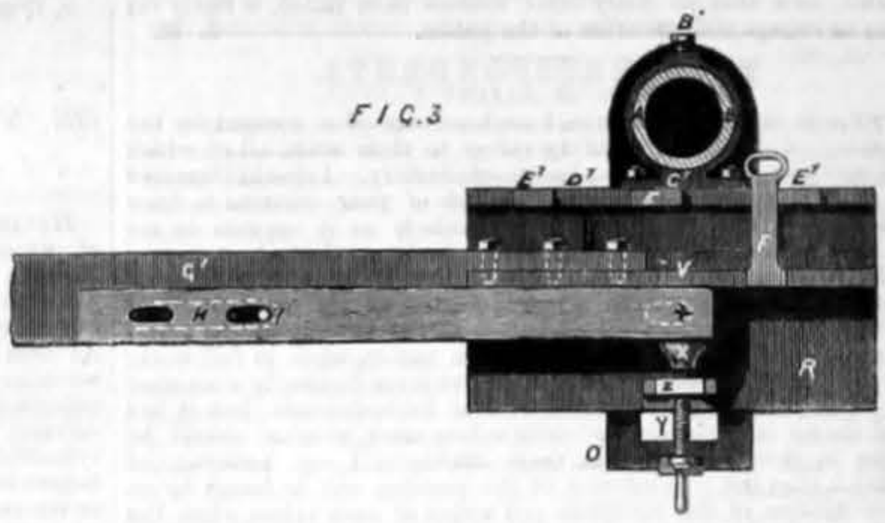


FIG. 4.

FIG. 5.

FIG. 6.

FIG. 7.

FIG. 8.

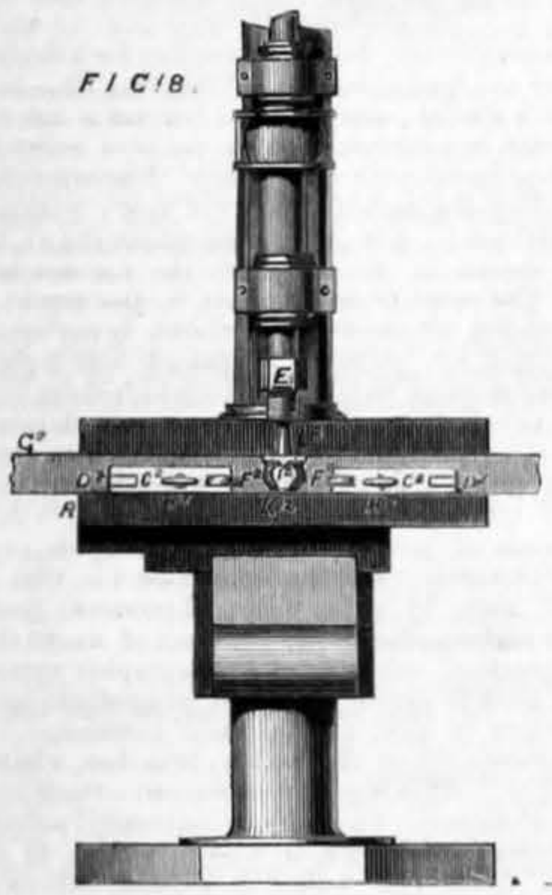


FIG. 9.

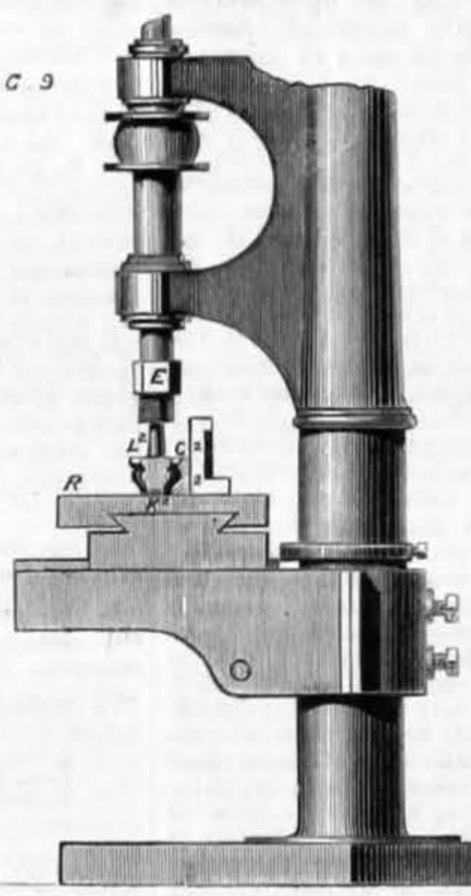


FIG. 10.

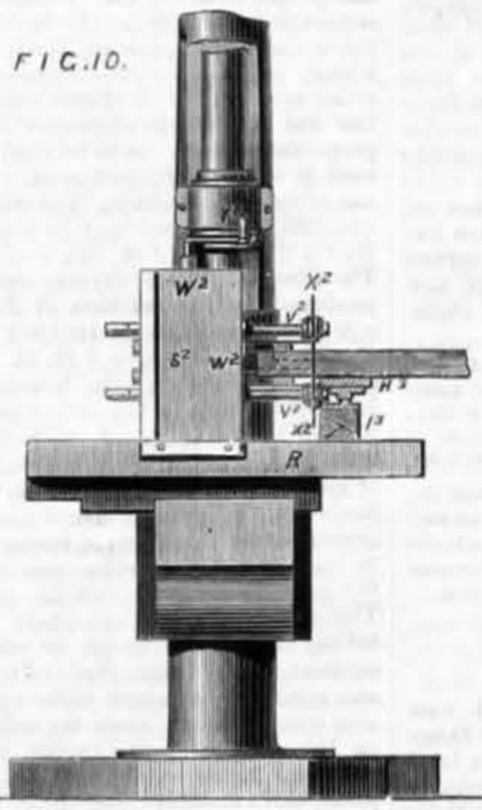
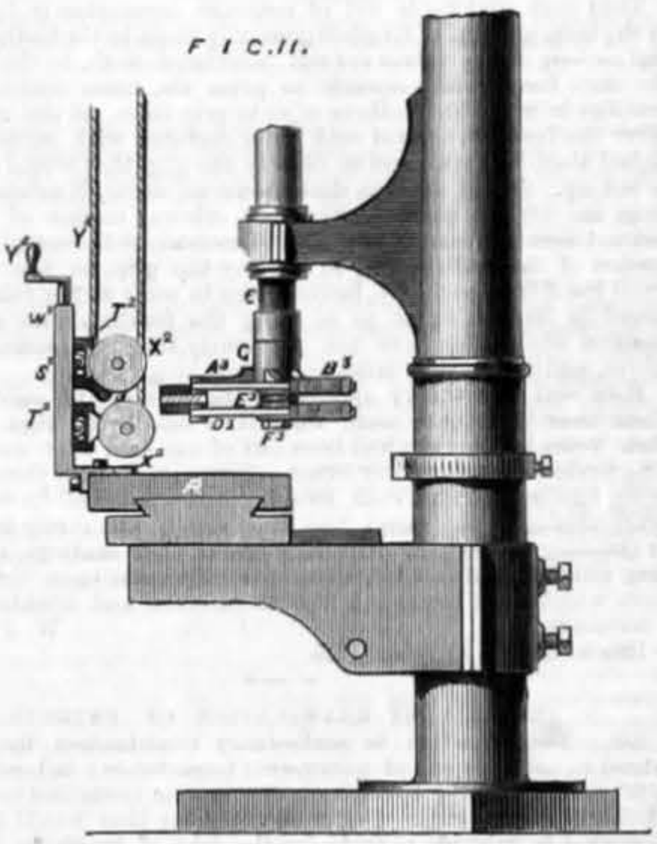


FIG. 11.



HIND'S COUNTER GEAR FOR LATHES AND OTHER MACHINES.

(*For description see page* 261.)

FIG. 1

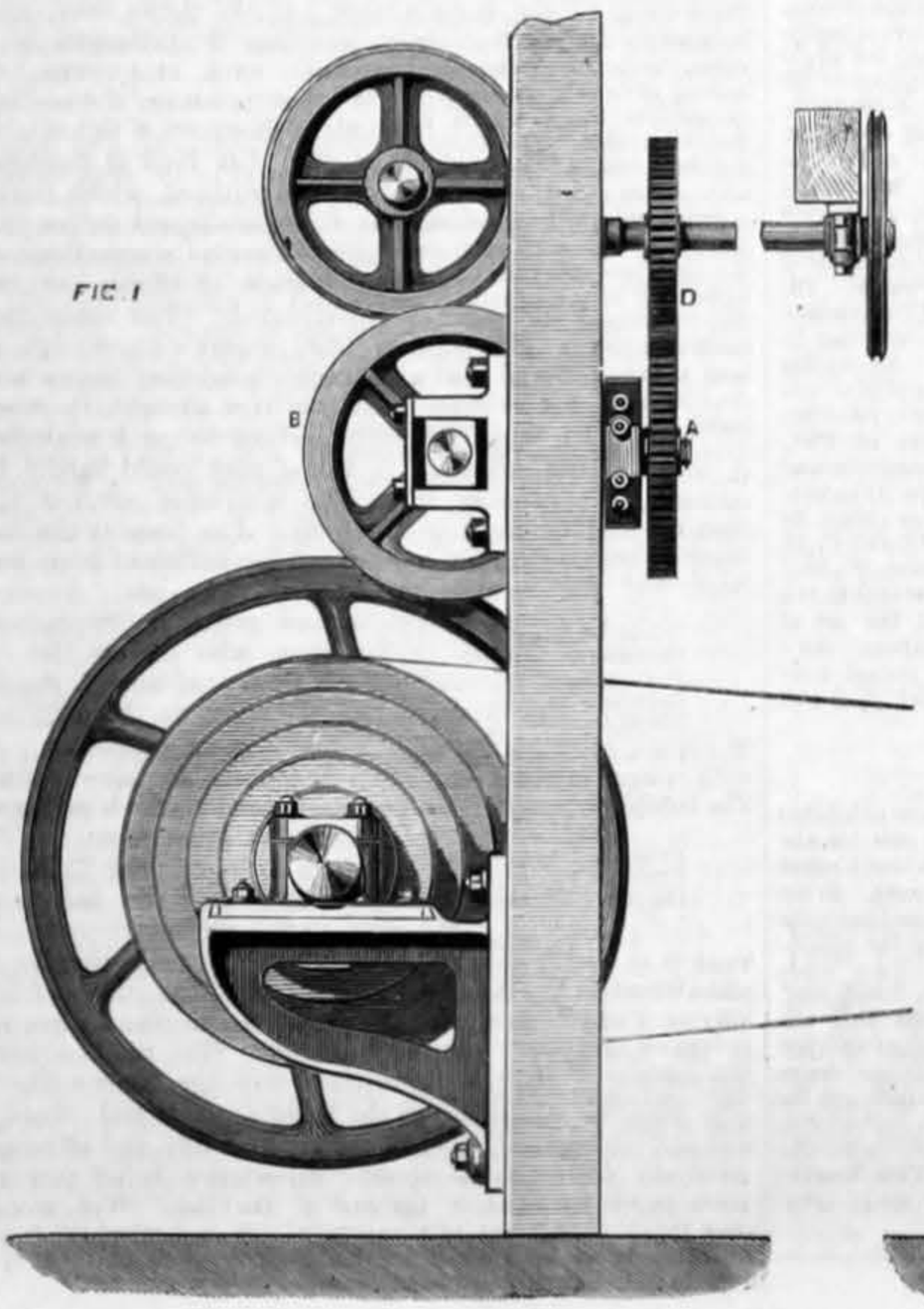
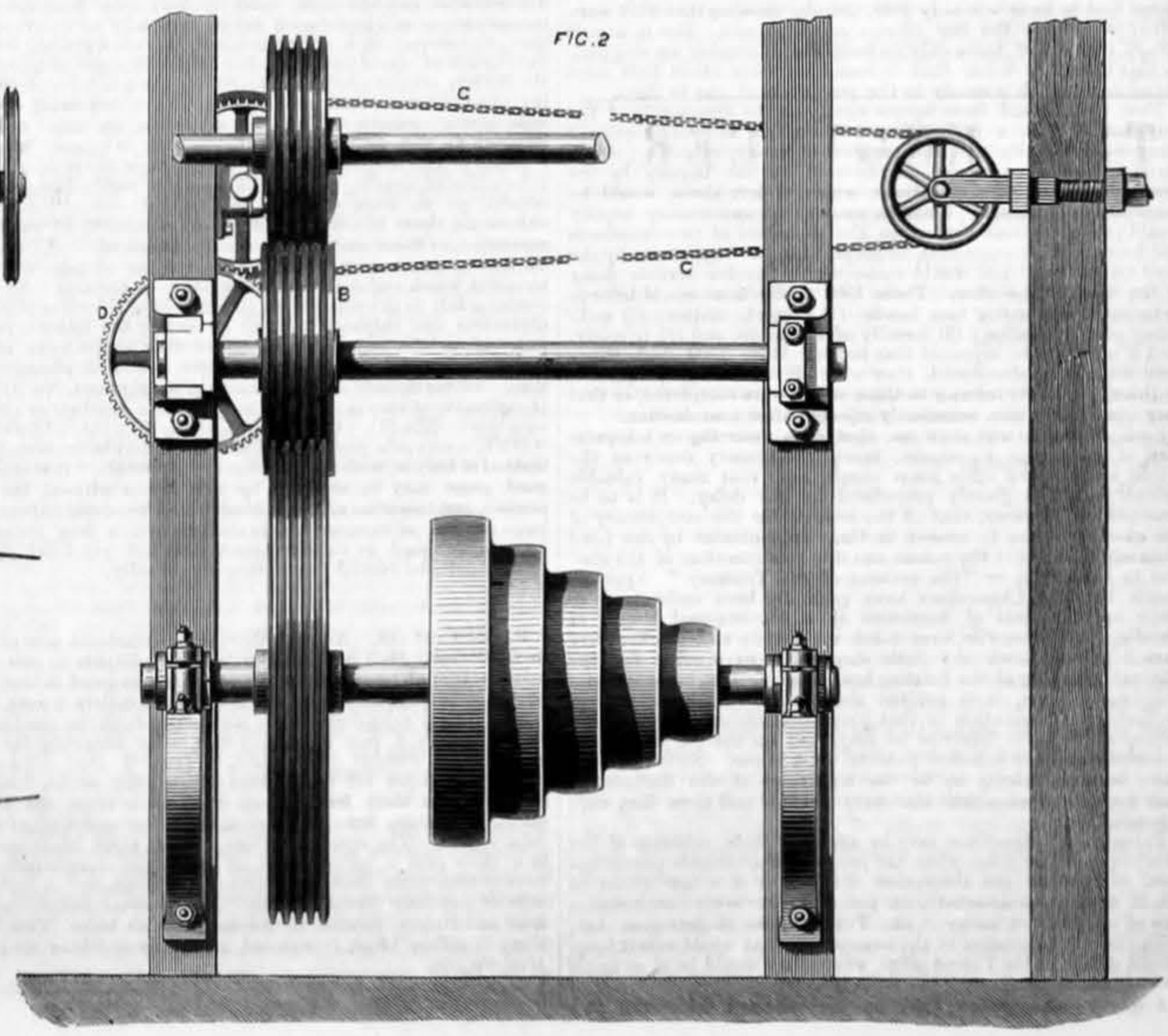


FIG. 2



FOREIGN AGENTS FOR THE SALE OF THE ENGINEER.

PARIS.—Madame BOYVEAU, *Rue de la Banque*
BERLIN.—ASHER and Co., 5, *Unter den Linden.*
VIENNA.—Messrs. GEROLD and Co., *Booksellers.*
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C. H.—*Barlow on the "Strength of Materials." The shearing force is measured by the area cut through and the tensile strength of the material. Thus, to shear through one square inch of fair iron will require a strain of about 20 tons, but this does not apply to shearing machines working with sharp edges.*

C. W. R. (Tanybwlch).—*In setting Cornish or double-flue boilers, the flame should be led from the flue first under the boiler bottom, and then either right round the boiler, or else split, the products of combustion parting at the front end of the boiler and running back along each side. When a boiler is thus set the circulation is improved, because water below the boiling point cannot lie on the bottom, the temperature of the gases being too high to permit this when they first leave the flue. When boilers are so set that the flame first passes round and then last of all under the bottom, cold water may be found below the flues long after steam is up to a pressure of 40 lb. or so. When this occurs it is obvious that the boiler is much strained in the cross seams by unequal expansion. The great object to keep in view is to heat the boiler plates as equally as possible all over.*

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DEATHS.

On the 5th inst., at his residence, 170, Lewisham High-road, New Cross, THOMAS PALMER BAKER, C.B., Inspector of Machinery, R.N., and late of H.M. Dockyard, Chatham, aged 68.

On the 4th inst., at his residence, Lisnamallard, Omagh, Ireland, Mr. MANSERGH GEORGE BUCHANAN, C.E., aged 44 years, deeply regretted.

THE ENGINEER.

FRIDAY, OCTOBER 13, 1876.

LOCOMOTIVE TORPEDOES.

ONE of the most remarkable phases of modern warfare is the employment of mechanical powers to transport explosives to the precise locality where they can prove most mischievous to an enemy. In the days of Nelson ships fought with carronades, stumpy guns of considerable calibre, which pounded the wooden walls of a ship to atoms by a hundred blows. The duty performed by the Victory's artillery was identical with that performed by a Roman battering ram. In the field, again, Napoleon relied on the round shot, which, as we are graphically told by the historians of the time, mowed lanes through the columns of an advancing foe. Grape was used at sea, or on land, only at close quarters. It was practically useless in naval warfare, save in resisting boat attacks, or covering the landing of troops, while its short range and unequal dispersion greatly limited the scope of its powers when it was used in land battles. To the American general Paixhans is, we believe, due the credit of first employing shells in naval warfare. In saying this we do not forget the labours of Cohorn, and we are not oblivious of the circumstance that "bomb ketches," as they were termed, existed and were used from a comparatively early period. But to General Paixhans belongs the credit of using guns which threw shells directly into a vessel without going through the ceremony of first letting them rise high in the air, and then fall, if chance so directed, on the deck or down the hatchway of a ship. The process of development has gone on steadily for very many years, and modern naval artillery relies principally on the effect of shell fire for its efficiency. The 80-ton gun, for example, would be comparatively a very useless weapon if it could project against our enemies' ships only solid shot. A mass of iron weighing 1700 lb. tearing through a ship's side above the water line, and clear of engines and boilers, would do but little injury, save of a purely local character; and a great many successful rounds would have to be fired from the great gun before even a wooden ship to which the weapon was opposed need succumb. But in point of fact the chilled shell proper contributes only indirectly to the destruction which a heavy gun can accomplish. The object and purpose of modern naval artillery is to transport from the decks of one of our own ships to the decks of an enemy a heavy charge of powder, which is ignited at the moment of its arrival. If the shell explodes outside the ship, although in contact with her, half its efficiency is gone. A shell, after all, is but a transport wagon carrying a charge of powder; and that shell and that gun are the best which place the transmitted charge of powder just where it can be exploded with the most effect. It will be seen, therefore, that we have here a total change in the purpose of artillery; and it follows that if the explosive could as well be put on board an enemy's ship by any other means as by the use of a gun, then guns would be comparatively useless. The shell is *the* great engine of modern warfare. In olden times the gun took the place. The modern gun is, however, merely an energy transmitter, and in so far it occupies a secondary position.

A little reflection suffices to show that we are not confined to guns as the only means of transporting explosive charges to an enemy's decks. Various other plans have been suggested. The late Lord Dundonald proposed during the Crimean war that about a gallon of chloride of nitrogen should be carried up over Sebastopol in a balloon and then suffered to fall into that town. The resulting explosion would, no doubt, have cleared Sebastopol, its fortifications, and its fleet, off the face of the earth. The scheme was wild to the last degree. The explosion of a single drop of chloride of nitrogen has been known to completely ruin a large laboratory; and it is tolerably certain that more than a few drops of the most terrific compound that has ever existed have never been made. The use of balloons for dropping shells into an enemy's camp has often been proposed, however, and not many years since a somewhat eminent authority suggested the use of an improved form of the old Roman catapult for flinging grenades and small shells into an enemy's trenches. Powder wagons provided with a slow burning fuse have been purposely suffered to fall into the hands of an enemy, who, removing the wagon to his own lines in triumph, has subsequently suffered severely for his rashness. Such a practice would hardly, we may say for the credit of humanity, be recognised as legitimate in modern warfare, although there is reason to believe that infernal machines assuming the form of blocks of coal have not only been suggested, but actually manufactured. The diabolical scheme of Thomas, which must be fresh in the memory of our readers, supplies another method of placing explosives on board a ship or in some other locality where they are intended to effect destruction. All such schemes, however, have hitherto possessed but a fifth-rate importance as compared with the gun, which above and beyond all other agencies puts in the hands of the sailor or the soldier the means of lodging his shell just where he pleases. There is reason to believe, however, that the gun will not retain this absolute and overwhelming supremacy; and indications are not wanting that in the immediate future means will be provided of effecting all that the heaviest gun could accomplish in this way and a little more. We allude, of course, to the locomotive torpedo—a weapon with probably a great future before it.

So long as the torpedo was an anchored submerged buoy its utility was limited. The ship which it was intended to destroy had to go to it, and so long as it was left alone it would do no one any harm. The Harvey torpedo and the steam torpedo boat both enormously increased the power of the weapon; they each conferred on us the power of transmission; it became possible to take Mahomet to the mountain, as the mountain would not go to Mahomet. But it is obvious that very grave objections exist to both systems of attack. The torpedo launch can only be manned by volunteers who go on a forlorn hope. Not only can they expect no mercy from foes whom they must, in the nature of things, attack insidiously, but they run the risk at the best of times, when they are most successful, of sharing destruction with their enemies. The vessel towing a Harvey torpedo is again in much the same plight, and it is probably true that if several ships were operating together, the use of a Harvey torpedo by one ship might severely hamper the movements of her consorts, who would be compelled to give her a tolerably wide berth. The so-called fish torpedo promises to fulfil every condition that an engine of the kind can be called upon to perform. It is truly a locomotive torpedo, and is the most recent embodiment of the system of carrying on board—or into immediate proximity with—a foe at a distance the explosive charge which is to work her destruction. We say this with a perfect cognisance of the imperfections of the Whitehead torpedo. But we are, at the same time, in possession of facts which tend to show that it is susceptible of very important and valuable improvements. A great deal of money has been expended by the British Government on the invention since it came into their hands; and although a very commendable spirit of reticence restrains the official pen, enough is known to enable us to say that the range of the weapon has been so enormously augmented that it probably equals that of a very heavy gun, instead of being limited to a mile or so, while the difficulties which have been encountered in guiding it appear to be one by one disappearing in the hands of the intelligent officers who have charge of the invention. The Whitehead, or, more strictly speaking, the Woolwich torpedo, is now really a submarine boat, some 25ft. long, capable of running a distance as great as from Portsmouth to the Isle of Wight, the direction of its motion in still water being practically a right line. It is evident, therefore, that for harbour attack it can probably be used with tremendous effect under certain circumstances. Thus an ironclad, by taking up a position at the mouth of a large harbour, and at such a distance that she would be practically safe from the guns of land forts, might, by sending in fish torpedoes, completely destroy a fleet taking refuge under the guns of the forts. The weapon might also be employed for clearing ground torpedoes out of a channel. In such a case it would assume a far simpler and cheaper form than that given to it when used to carry an explosive charge. The great difficulty to be overcome is to give it the power of always moving straight forward exactly in the direction in which it should go; and this has been partly accomplished by very ingenious apparatus depending for its operation on the inertia of a suspended mass. It would be quite possible to use a gyroscope for the required purpose, but the difficulty would remain that if the deviating force be greater than the inertia provided can overcome, then the torpedo will assume a new line of motion, and resist any secondary deviating force as strongly as it resisted the first. We are not aware whether the principle of the gyroscope has yet been adopted in steering fish torpodoes; if not it ought to be tried, as it promises well. It does not seem to us, indeed, that any impassible obstacle exists to the construction of a fish torpedo or submerged boat, which shall possess automatic steering power sufficient to preserve a line sufficiently straight to ensure that the weapon shall strike so large a mark as a man-of-war at moderate range. All that can be said certainly on such a subject, however, is that the locomotive torpedo becomes day by day more manageable; and it is not impossible that naval officers will soon be placed in possession of tables of deviation for their guidance when using the torpedo in a current. These tables would show, for example, if a ship to be attacked lay north of another at a range of say two miles, how many points to the west the head of the torpedo must be laid to provide for the effects of a current flowing at a given velocity in an easterly direction.

THE SCIENCE DEPARTMENT AND THE SPECIAL COMMITTEE ON TELEGRAPHY.

A BLUE-BOOK is extremely delightful reading for a student of human nature and human failings. When that Blue-book is the report of a special committee the interest is intensified. Men, however, accustomed to the paths of everyday life, look on these books with abhorrence. Manufacturers profitably wielding the united labours of many workmen cannot be oblivious to, nor help feeling annoyed at, the incompetence shown in so many of the Government departments. The revelations contained in the report on the telegraph system are, as we have shown in our article of September 22nd, too grave to be passed over lightly. Here incompetence seems to be a rule to which there is no exception. Every division, every subdivision is shown to be wanting. In one branch we find men with high salaries and no duties, then others with low salaries doing work not their own; here a town wherein little is done costing thousands of pounds more than a town overwhelmed with business. But the worst aspect is, that no one seems to learn by experience. Ignorance reigns supreme. The highest officials are ignorant of aught that concerns the practical working of a telegraphic system, and these men have to decide upon the suggestions made by their superiors in pay, position, and knowledge. If such is the management of the higher branches, what is that of the lower? This is readily answered—there is no management whatever. One would naturally suppose that every telegraph manipulator would be able to say what was the fault, and where it existed, whenever derangement of his circuit occurred. But such is not the case. The Government certainly established schools in which to train the men employed, yet their only object is to turn out manipulators with the greatest speed. The instruction given in these schools is of a merely empirical character. No scientific knowledge even of the most elementary nature is imparted; and the clerks may, and ordinarily do, leave without knowing the principles of a galvanic battery, the nature of a circuit, or possessed of the most ordinary notions of what produces the motion of their needles. Such methods of instruction as are now pursued are not calculated to give that kind of teaching and elementary scientific training, without which clerks cannot efficiently perform the more intelligent duties proposed to be assigned to them. Various suggestions, of course, are made to remedy this state of affairs, but one and all seem to us alike objectionable. The committee knowing the benefits arising from superior knowledge, as seen in the case of India, advocate travelling instructors to go from office to office to impart that elementary scientific instruction which has hitherto been so much neglected in the training schools. A worse plan could hardly be devised, for probably when the instructor arrived the clerks would be busy or off duty. The time at the disposal of the instructor would not be sufficient to do any good, and the instruments would be in use. Another plan is to give bonuses, prizes, and gratuities, to promote from lower to higher grades those who possess the required technical knowledge. Certainly promotion should take place in this manner, but we object to the principle of giving prizes. The prize is future advancement.

It is singular that the committee seem to have known absolutely nothing of another department which professes to give exactly what the Government school denies. We hope this Blue-book will lead men to look more into the working of this second department, which we believe to be wholly unsound. We refer to the Science Department located at South Kensington. As we desire especially to call attention in this article to the practical utility of the Science Department, we may be allowed to glance casually at the history of science teaching. Not till the commencement of the present century was any effort made to give scientific education to the masses. Political economy was not understood, nay, is not understood; and although we make feeble jokes about "knowledge being power," we wait for better days instead of working. Were it not that there exists a small minority of energetic workers,

we should have to wait a long time for "better days." The inauguration of mechanics' institutions was the first step up the ladder. In the year 1800 Dr. Birkbeck commenced his classes at Glasgow. Success attended his efforts, but twenty years elapsed before the idea was followed up. A few gentlemen at Edinburgh, in 1821, who felt disposed to encourage the experiment, circulated a prospectus among the mechanics, announcing courses of lectures on mechanics and chemistry, and the opening of a library of books on these subjects. Dr. Forbes and Mr. Galbraith delivered these lectures, which were so much appreciated that classes on architecture, farriery, also architectural and mechanical drawing, were held during the summer recess. In 1822, mainly through the advocacy of the *Mechanics' Magazine*, mechanics' institutes were formed in the metropolis and elsewhere. We owe, then, to Glasgow the credit of having made the first step. It is characteristic of Scotsmen to be ready to receive new truth whensoever it comes. The philosophy of Newton was taught in Scottish universities long before it was substituted for the Cartesian hypothesis at Cambridge. When, however, the light began to dawn in the South, the mass of thinking men was permeated as by an electric shock, and educational establishments arose on every hand. It was soon seen that mechanics' institutes and scientific lectures were worse than useless unless those who joined the one or heard the other could read and write. Then arose the wail for elementary education. Church and chapel bestirred themselves, and the awakening of England commenced. We are not quite wide awake even yet, but steadily approaching that enviable condition. Then came a lull in the formation of institutes and the giving of lectures, which lasted till the year 1851. The first great Exhibition created a revolution in the world's history; it gave an enormous impetus to primary education; it drew attention anew to scientific training. From 1800 to 1851 progress had been slow. The labours of Watt, Harrison, Hargreaves, Arkwright, Wyatt, Cartwright, Stevenson, Smeaton, &c., had cleft inertia and prejudice asunder. The present generation cannot understand the fight these men had to wage, but prejudice gave way with the increase of knowledge, and knowledge increased by more general education. The results achieved are best seen in the increase of population in the districts most benefited by their labours. In 1801 the population of Lancashire was about 672,000, in 1851 it was 2,031,000; in 1801 the population of Yorkshire was about 818,000, in 1851 it was 1,886,000; in 1801 the population of Lanarkshire was about 147,000, in 1851 it was 530,000, an increase varying from 109 to 258 per cent. in fifty years. The Exhibition of 1851 impressed two great truths upon the minds of men. There was beauty, here was solidity; and the cry arose, Why not combine the two? To obtain the beautiful it is necessary to live in and among the beautiful; our artisans lived in and among the solid. Nature to them was a sealed book. We decided to cultivate art, and then science. The Science Department has now issued some twenty-three reports of its work. It has gorgeous palaces at South Kensington, but with these we will not deal. Schools have been established throughout the country in connection with it, and every May it holds examinations. Now, the Science Department was established specially to supply that scientific information required to aid practical men in their work. We dare not in this article attempt to compare results with money spent, but will restrict ourselves to a milder form of criticism. The department examines in some twenty-three or twenty-four different subjects; one of these is "Magnetism and Electricity." Suppose on an average 1000 students attended the classes held every year, we ought to have at least some 5000 or 6000 men scientifically trained in this subject. When, however, we state that during the past few years the number who present themselves for examination is over 10,000 annually, it will at once be acknowledged that there ought to be no lack of scientific electricians. We do not pretend to have looked over all the examination papers, but will it be believed that taking six or seven years at random, not one question of a practical nature as applied to telegraphy has been asked? We find plenty about the direction in which iron filings place themselves under magnetic influence, but not a word about a telegraphic circuit. We doubt if the word "fault" ever occurs in the examination papers, nor can we find "relay." There is no question as to battery powers required under given conditions, insulation, earth, patial earth, condensers, or any of those important branches necessary in practical telegraphy. The syllabus of the department is in a similar plight. The teaching, of course, is given with a view to pass the examination—to pass as many pupils as possible, and thus enable the master to make a large claim. We have no hesitation in saying after a long experience that, putting aside the boys, there are not half a dozen science teachers in the kingdom who can describe an ordinary deep sea cable—the phenomena of its working and the instruments used. And this is the state of things after more than twenty years of existence. The country in its ignorance grants enormous sums every year to be squandered in useless works, yet we doubt if any grant made by Parliament is put to such a bad use as that to South Kensington. It is high time reform was made when we find a special committee speaking of the utter lack of any useful scientific training of thousands of Government employés when for over twenty years the Science Department has pretended to supply the need. It is extremely difficult to trace the influence of the department in many of its subjects, but here we have little or no difficulty, and the result of its labours as applied to practical operations is absolutely nothing. Yet under proper management this department could and would exert a great beneficial influence. The science teachers are ready and willing to do their share of the work. They would to the best of their abilities study the requirements of "practical telegraphy," and attempt to impart the results obtained to the pupils. We would suggest, then, that the Science Department should at once adopt a new syllabus for this examination. The classes are only just commencing, and some progress might be made during the forthcoming winter. The Government could easily influence the telegraph employés to attend these classes as far as their time permitted. The chance of promotion would prove a sufficient inducement in the majority of cases. Thus, with the machinery in existence and at hand, the Government, without any increased expense, has the power, if it possesses the will, to enable its employés to get the scientific training they require, and to ensure a continual supply of the trained material. Our readers must not think that we desire to hinder the work of the Science Department, but we would so reform it that its work should be useful, and not useless. It will be impossible to turn all the men now employed into scientific workers, but it is possible to fill up vacancies with none but competent men. It is well known that such men exist in considerable numbers, who have studied at Glasgow, Edinburgh, and King's College. Such men require a higher salary than the incompetents at present employed, but the saving arising from a reorganisation of the Telegraph Department would more than supply the necessary funds."

RAMSBOTTOM'S WATER-TROUGHS.

Mr. Ramsbottom, of Crewe, when he patented in June, 1860, his extremely ingenious system of filling tenders with water while a train was running at speed, granted an exclusive licence to the London and North-Western Railway Company, and as a consequence other companies were precluded from using a device the practical value of which was not fully recognised for some time. By the aid of Mr. Ramsbottom's invention the London and North-Western Railway Company were enabled to run trains far greater distances without a stop than had ever before been contemplated; and to this circumstance was due in great measure the acceleration of the mails between this country and Ireland. The use of the water-trough was, however, by no means confined to the Irish mail, and express trains were run without a stop between London and Rugby, and thence to Stafford, Chester, and the North. The advantage thus possessed by the London and North-Western Company was very considerable. The benefits conferred by long continuous runs on the travelling public were fully appreciated, and rival companies were compelled to follow suit. But to do this it became essential to carry enormous quantities of water. Tenders grew rapidly in weight and dimensions; and from the modest 15 or 20 tons loaded which they formerly weighed, the dead or unpaying load transported soon equalled or even exceeded three-fourths of that of a powerful locomotive. Thus we have now running in England large numbers of tenders weighing something like 28 tons, and holding as much as 2500 gallons of water, weighing alone over 11 tons. If to this we add four tons of coal, it will be seen that we have left but 13 tons for the net weight of the tender, which is certainly not too much, considering the strains to which its structure is subjected. A reasonably heavy passenger train, complete with engine, tender, and brake vans, will weigh about 150 tons, of which the engine and tender will represent 60 tons. The weight of the paying load—using the term somewhat loosely—will thus be but 90 tons. If one-half the weight of the tender could be suppressed the advantage gained would be almost equivalent to reducing the load by two passenger coaches. It is true that these coaches would weigh together in excess of 14 tons, but tenders run more heavily than passenger coaches, because the wheels, having additional weight to carry, cause greater deflection in the rails, and the journals are larger in proportion to the diameter of the wheels. A saving of two coaches per train in express work would represent a large reduction in the use of fuel, especially in bad weather, and the resulting economy might be very well worth having even if it cost a good deal of money in the first instance.

Now, it is clear that if the Ramsbottom water-trough system be applied extensively enough, tenders can easily be used which shall not weigh more than 14 tons loaded. Taking 4 tons for coal—which is a large allowance—we have 10 tons left for the tender proper and for water. A 10 ton goods wagon weighs a little less than 5 tons. It is not too much, therefore, to suppose that 4 tons of coal and 4 tons of water can be carried by a vehicle weighing empty but 6 tons. The proportion of tare would in such a vehicle be much greater, it will be seen, than it is in a 10 ton wagon. But if we assume that but 3 tons of coal are carried, which is quite enough for all practical purposes, representing as it does a run of at least 200 miles, then our weights will stand thus: Coal, 3 tons; water, 4 tons; tender, 7 tons—total, 14 tons. Assuming that 400 lb. of water are used per train mile—which is an excessive allowance—then 4 tons of water would suffice for a run of a little over twenty miles; and it may be assumed that first-rate express service could be worked with tenders carrying but 900 gallons of water, provided Ramsbottom troughs were laid down at intervals of twenty miles apart. Whether the interest on the cost of such a system of troughs would or would not represent a much smaller sum than that saved by running trains with light tenders is a question which will require to be solved specially for every particular case. It will depend on the nature of the traffic and the ease with which half-mile levels can be obtained near a source of suitable water. We venture to think that in a very large number of instances the game will be found worth the candle; in other words, it will pay to put down the troughs. The reduction in the first cost of tenders would, of course, help to pay for them; but, in any case, a very simple calculation, which can be worked out by any engineer with all the data before him, will suffice to settle the point.

There is, however, another advantage connected with the Ramsbottom system which must not be overlooked. At the present moment there is a very keen competition between certain companies for Scotch passengers, and to attract them the service between London and Glasgow and Edinburgh has been much accelerated. It is well known that the passengers by such trains going North who do not cross the border are very few indeed, and if it were possible to run trains which would only stop, say, at York and Newcastle on the road to Edinburgh, it would be possible to reduce the time of transit to something not much exceeding eight hours. The run to York—in round numbers 195 miles—now occupies four hours fifteen minutes, the fifteen minutes being absorbed in stoppages. It would be quite practicable to build engines which would run for 200 miles without a stop with great ease and certainty. A few modifications would be required, but only in matters of detail connected with the construction of the grates and tubes, and the arrangements for lubricating. It is fair to assume, we think, that a train reaching Edinburgh or Glasgow in eight and a-half hours, and not at any time exceeding a speed of sixty miles an hour—the average velocity being something over fifty miles—would enjoy very great popularity, but such a result can only be accomplished with the aid of Mr. Ramsbottom's invention.

There is yet another argument in favour of long runs, which is, that they are found to be economical, at least that is the experience of our friends at the other side of the Atlantic. For some years past the American railway companies have adopted the Ramsbottom trough extensively, and now runs of 130 and 140 miles without a stop are made in regular daily work on certain main lines radiating from New York. We have in this country nothing of the kind. The longest continuous run ever attempted in conducting ordinary traffic was that from London to Leicester, on the Midland, but it was abandoned, we believe, because, notwithstanding the enormous quantity of water carried by the tenders, a stop had frequently to be made in bad weather to take in more. The Irish mail still makes the longest runs accomplished in England—that is to say, it gets over the distance between Euston and Holyhead with fewer stoppages than any other train going over the same distance. Until recently it was of small use to speculate on the value of the Ramsbottom system, because of the peculiar relations in which the London and North-Western Company stood with regard to it. But the patent expired two years ago, and any one can use the system. It remains to be seen whether other companies in Great Britain will have the courage to avail themselves of the advantages which it indisputably confers.

TRADES UNION DESPOTISM.

Last week we made some allusion to the strike of glass bottle makers at Kilnhurst, Yorkshire, in which case the trades union officials had ordered the men to cease work when they had made a specified lot, technically known as "the number," instead of working out the whole of the metal contained in the melting pots. At the first hearing of the case the trades union officials admitted they had taken this course in order to cause the employers—Messrs. Blunn Bros.—to suffer loss, in revenge for some assistance the firm were supposed to be giving to another house elsewhere. The case again came before the Rotherham bench on Monday, and it is with a sense of considerable gratification that we place on record their decision. The magistrates heard the case very patiently and at full length, and finally decided in favour of the employers. The chairman, in giving this intimation, said they had come to this decision principally because they did not think it reasonable that five or six hours—in which "the number" can be made—should constitute a day's work. The evidence had been rather conflicting on some points, and the magistrates had to bring common sense to clear it up; and they saw it was not right or reasonable that the masters should acquiesce in a custom by which the men could cause them loss, and which was, in addition, opposed to the interests of the men themselves. By the decision the men have to pay nominal damages for leaving their work in an unfinished state. It would be well for the interests of the manufacturing community at large if all employers would, under similar circumstances, take measures to vindicate their own interests.

AIR SPACE ARMOUR-PLATING.

Some years have elapsed, and the power of the gun has enormously increased, since we suggested in this journal that armour-plating should be disposed in two distinct walls with an air space between. We can perfectly well remember that the proposition was at the time pronounced absurd by men who found sufficient cause to condemn the proposition in the fact that it had not originated with themselves. We have nevertheless persistently advocated the system, and urged upon the Government the expediency of trying whether our views were sound or not. We are happy to say at last that on Wednesday the accuracy of our theories was fairly tested with the 38-ton gun, and with results apparently so conclusively in favour of our views that a total change in the system of armour-plating ships cannot well be postponed. The Heavy Gun Committee determined to test the powers of the 38-ton gun. A target was provided for the purpose at Shoebury, consisting of three rolled iron plates each 6½in. thick, between which were placed two layers of teak 5in. each in thickness, the whole supported by piles of 14in. by 15in., bolted together with 3in. bolts. Some 5ft. in rear was an old 10in. target, which has been riddled with shot. A single round was fired at this target at a range of 70 yards, with a charge of 130 lb. of powder, and a Palliser shell weighing about 800 lb. On examination it was found that the Palliser chilled shell had cut completely through the target, and had broken up within a couple of yards of the further side. The gas check, which was one of Lieutenant Goold Adams', lodged in the hole, and the friction was so great that it set fire to the teak backing. Portions of the base of the shell also remained, but the greater part of it was found within 20 yards of its striking object. The target itself, although well shored up, was driven back seven inches, and the piles in rear were cut through. The 10in. target which was behind was scored all over with fragments of the shell, and pieces of the target itself were hurled fully 200 yards away from its base. The striking velocity was estimated at 1420ft. The wound made by the shell was exactly 12½in. by 13in., and the depth to which the gas check sank in it was 22in. The committee expressed themselves exceedingly pleased with the strength of the target. On the farther side a space of about 5ft. in diameter was completely shivered away by the shot. From this it will be seen that the 38-ton gun sent shell through no less than 19½in. of iron and 10in. of teak, when these plates were disposed in the ordinary way. But before the round we have just described was fired, a preliminary shot was discharged at an old 10in. target, behind which, at a distance of 6ft., stood a 4in. plate with a 13in. teak backing; an 800 lb. shot was fired against these with 130 lb. of powder. The result was that the shot smashed through the first plate with the greatest ease, but *it broke upon striking the 4in.* target, which it entirely failed to penetrate. We have then the fact proved that 19½in. of iron,

the plates being close together, cannot resist the 38-ton gun at 70 yards, while 14in. of iron, or plating one-third less in thickness, may be made to afford complete protection. The importance of this experiment requires no further comment at our hands. It is proper to state that so far as we are aware the first proposal to use air space armour was made by a young officer, whose name has not reached us, at the United Service Institution. Our suggestions put forward, not long afterwards, were made in ignorance of the circumstance that very similar views had already been broached. The question of priority of claim is one, however, of no importance to us; we willingly concede all that can be asked of us in this direction, but it is a matter of considerable importance to us to find that the system we have so long advocated now promises to be a complete success.

FOREIGN TARIFFS.

Subjects hardly less significant to British traders than those relating to the treatment by Turkey of her Christian subjects require to be pressed upon the attention of the British Government. The person who has recently suggested that because the United States Government impose duties on imported British steel which make it to the advantage of a Sheffield steel firm to manufacture in America, the British Government should take steps with a view to bring about a heavy duty upon United States goods imported into Canada, was very partially educated in political economy. Few people in this country will regret that the reply to his communication from Lord Carnarvon should have been that the proposal was one "which her Majesty's Government could not entertain." Of a very different kind, however, is the communication which the Chamber of Commerce of Glasgow have resolved to send to the Foreign-office. That body has determined to memorialise the Earl of Derby to the effect that in the event of his lordship being unable to induce the French Government to adopt Free Trade with Great Britain, then that he will press them in renewing the Treaty of Commerce to adopt a more liberal fiscal policy. Since France has so largely benefited by the commercial measures which we have ourselves adopted, it would be only reasonable to look, on the principle of reciprocity, for such a result as is here desired; but we fear that we must not anticipate changes favourable to ourselves on grounds which shall not seem immediately favourable to the French manufacturers immediately concerned. Much less enlightened views are held by too many people now in authority in France than those held by Napoleon III., to whom the last Treaty of Commerce with France is almost wholly owing. We have a better opinion of the German Government. Still it must not be forgotten how severe is the pressure which is being put upon them to uphold subsisting duties. There is now but little doubt that of the thirty-six German Chambers of Commerce who in their reports to the Ministry of Commerce have dealt with the iron question, twenty-five have declared themselves decidedly in favour of the maintenance of the duty on imports, and only eleven for its abolition. The present duty on British finished iron imported into Germany is 20s. per ton. If the majority of the German chambers can have their way the duty will not be reduced in the forthcoming new tariff, notwithstanding that the undertaking of the Germans two or three years ago was that this year that duty should be entirely removed. Nor would our competitors in the German iron trade confine themselves to keeping us out of the finished iron market. The understanding of which we speak was come to when the duty on pig iron entering Germany was swept away. The effect of the removal was to greatly advantage the pig makers of Cleveland in particular. That advantage is now seriously imperilled; for the application of the German ironmasters is that a duty of 5s. a ton shall be imposed upon pig iron. No efforts should be spared by English ironmasters to press upon our Foreign-office the great importance of these questions to all our iron-producing centres.

MORTISING AND TENONING MACHINE.

In the engraving, page 258, we illustrate a combined mortising and tenoning machine, which appears to include several excellent features. It performs a multiplicity of operations, mortising, tenoning, housing staircase strings, sticking moulding suitable for doors, small architraves, and other work. The mortising, &c., is performed without the work being previously set out by a skilled man. It can be used for dowelling purposes, chairs, &c., for cabinet makers, and it will cut with ease ornamental open work of any pattern, however irregular, for the eaves of houses. The machine consists of a stout iron pillar, bolted to an iron base. Projecting from the pillar are three iron arms which support the cutting machinery, and at the back is an iron bracket, bolted to the pillar, to carry the wheels for pulleys. In front of the machine is an iron table and framework bolted on to the base. The table travels, and can be raised or depressed according to the thickness of the material operated on, a projecting lever locking the table when the chisels and cutters are in motion. In a minute a door can be mortised ready for a lock, an operation which at a building would take a workman an hour. The chisel for moulding and rebating circular-headed sashes cuts both ways, according to the grain of the wood, springs keeping the moulding in proper position. In tenoning, two small circular saws driven by an endless cord cut the shoulders clean. There is no snipping, and the joints fit to a nicety. The saws can be raised and lowered by means of a lever and screw for the required size of a tenon, and they move sideways for long and short shoulders, and for solid, moulded, or beaded framing.

Figs. 1 and 2 are respectively side and front elevations of the machine ready for mortising; Figs. 3 and 4 show the arrangement for mortising; 5, 6, and 7 show chisels; Figs. 8 and 9 show one side and front elevation of the machine as a moulder, with chisel in position; Fig. 10 is a side view as a tenoning machine; and Fig. 11 is a front elevation of the same. On a foundation plate A is fitted a pillar B, having brackets C formed or fitted on it; these brackets carry the bearers D of the revolving spindle E, to which motion is imparted by means of the belt F passing over the pulleys G, H, and I; the spindle E is regulated and raised or lowered by the spur gear J, which actuates a nut on a screw formed on the spindle, in which is fitted the mortising bit. The bottom part K of the pillar B is turned true, and on it is fitted a bracket L, so arranged that it can be swung round the pillar, so that the one arrangement will serve for mortising door locks. The bracket L can be raised or lowered by means of the worm gear M, which actuates the pinion N, gearing into the rack O, allowing the different heights for mortising to be obtained. The bracket L can be swung round the pillar B, and t can be fixed in any required position by the screws P; on the bracket L are fitted ordinary longitudinal and transverse slides Q, and on the top slide is fitted a table R make to slide thereon. Underneath and on the side of the table R is fitted a rack S actuated by a pinion T, and worked by the hand wheel U; this wheel is made so that it may be removed when the table is once fixed to the required position and not required for mortising. The table R is fitted with a movable fence V working in slides W. The wood to be fixed for mortising is held against the fence V, and held by the cramping piece X, actuated by the screw Y working through the bearer Z; this bearer is fitted with screws, and can be removed when not required.

On the part K of the pillar B is fitted a ring A^1, made so that it can be raised or lowered, and fitted with a screw B^1 for fixing it to any required position; the ring A^1 is formed with a projecting piece C^1, to which is bolted a guide D^1 made with openings E^1, in which works a guide lever F^1 fitted on the fence V. The lever F^1 travels with the table R, and on and in the opening E^1, which is made equal in travel to the length of the mortise hole to be cut. On the table R, and bolted to the fence V, is a wooden guide frame G^1, on which is placed the wood to be operated on, and on the under side of the frame G^1 are fitted springs H^1 having studs I^1 which pass through openings made in the bottom of the frame G^1, and enter the mortise holes which have first been cut, acting as guides for cutting the other mortise holes, and doing away with the present system of setting out all the holes to be mortised, and in addition making each piece of wood mortised mathematically true.

On the side of the table R is fitted a bracket J^1, in which works the end of a screw K^1, which works through a swivel lug L^1 fitted underneath an independent table M^1; this table is fitted on the top of the table R. Underneath the independent table M^1 is fitted a stud N^1, which works in a curved guide O^1 formed in the table R; on the top of the independent table M^1 is fitted a guide plate or fence P^1 for guiding the wood operated on. The table M^1 is used for the purpose of cutting away the wood of the treads Q^1 and rises R^1 of staircase strings. When the independent table M^1 is parallel with the table R, the treads Q^1 are cut straight on one side by means of the bit Z^1, but by turning the handle S^1, which actuates the screw K^1, the independent table M^1 is made to work sideways, giving the required angle to cut away the wood of the treads Q^1 and rises R^1, cutting the wood at an angle giving the required width at the end, as shown in the drawing, for the purpose of wedging the treads and rises up to the proper joint.

The mortise bits are made of steel, and formed with three, four, or more distinct cutters of a spiral curved shape, cut round and lengthways of the boring bit, and sharpened on the edges. When boring—for first passing through the article to be mortised—all the cutters are acting, but only one or two cutters is or are on the cut when the bit or wood is made to travel sideways or horizontally, that is to say "slotting," the other cutters being formed equally in a circle steady the bit, preventing it working sideways, and producing an evenly cut mortise hole, doing away with the evils in bits heretofore in use, made with two cutters and two small wings, which left the bit loose in the hole until the cutters came in contact with the wood, causing the bit to work sideways, and producing an unevenly cut hole.

The mortising machine is shown fitted with moulding bit and apparatus for keeping the wood in position during the operation of cutting the mouldings. On the table R are fitted plates C^2 having jaws D^2, in which work spring levers E^2 having friction pulleys F^2 fitted in the ends; these friction pulleys are kept pressed against the wood G^2, which is operated on by the screws H^2, giving the required pressure, and preventing the wood working sideways during the operation of cutting the mouldings. In the spindle E is fitted a moulding bit or tool I^2, this tool is made with five cutters J^2 of a curved shape. The bit or moulding tool can be made of any pattern to suit the required mouldings; on the bottom part of the bit is formed a stud K^2, which fits in a hole formed in the top table R, and the top L is made taper to fit the spindle E.

Figs. 10 and 11 represent the mortising machine fitted with apparatus for cutting shoulders and tenons. On the table R is bolted a frame S^2 having slides T^2, in which are fitted the bearers U^2 of the saw spindles V^2; these slides or bearers are raised or lowered to suit the thickness of the wood to be cut, and are actuated by screws W^2, worked by the handle Y^2, which is made to fit the heads of the screws W^2. On the ends of the spindles V^2 are fitted small circular saws X^2, which are actuated by a rope or belting Y^3 working over pulleys Z^2; the circular saws X^2 cut the shoulders of the tenons, and prevent broken shoulders, and consequently bad workmanship. On the end of the spindle E of the mortising machine is cut a screw, on which is screwed a disc A^3 having three cutters or sections of a saw B^3 fitted on it. The spaces C^3 are for the purpose of clearing the cutters from the chips or sawdust. A similar disc D^3 is fitted underneath the disc A^3, having similar cutters; the top disc cuts the top of the tenon, and the bottom one the under side of the tenon. Between the disc is fitted a wooden washer E^3, and this washer varies in thickness according to the thickness of the tenons to be cut. A set screw F^3 is passed through the bottom disc and washer, and screwed in the boss G^3 of the top disc. The wood operated on is made to slide on a top sliding frame H^3 working on bottom frames I^3; stops and a brake are employed to keep the wood firmly fixed on the sliding frame H^3, and to regulate the length of the tenons being cut; the sliding frame H^3 brings the wood first through the circular saws W^2, cutting the shoulders, and afterwards through the discs cutting the tenons.

For planing wood a long wooden or iron table is fitted on the table R, and the spindle of a planing tool is screwed on; the table for planing is actuated by gear fitted on the table R and bracket L.

COUNTER GEAR FOR LATHES.

The engraving at page 258 shows a new driving gear for lathes, &c., now being introduced by Messrs. Hind, of Nottingham. The drawings practically explain themselves. Friction wheels are used. That marked B can be wedged out between or withdrawn from the other two by a screw on the axis of A. This latter wheel can be moved by the endless chain C C.

When we read—says the *Railway Age*—that the last link of the Southern Pacific Railroad was closed up with a golden spike costing 180 dols., driven by a silver hammer worth 60 dols., both of which valuable instruments "were presented by our well-known and enterprising jeweller," Mr. So-and-So, the question will arise, did the enterprising jeweller take back his costly spike and hammer and so get all his advertising for nothing? If not, who did pull that spike and pocket that hammer? Shall we ever know?

South Kensington Museum.—Visitors during the week ending Oct. 7th:—On Monday, Tuesday, and Saturday, free, from 10 a.m. to 10 p.m., Museum, 13,948; mercantile marine, building materials, and other collections, 6392. On Wednesday, Thursday, and Friday, admission 6d., from 10 a.m. to 5 p.m., Museum, 2240; mercantile marine, building materials, and other collections, 691. Total, 23,271. Average of corresponding week in former years, 17,653. Total from the opening of the Musem, 15,744,335.

THE CENTENNIAL EXHIBITION.

(From our own Correspondent.)

If the attention is directed to the workmanship at the Centennial there will be found much to instruct, much to surprise, and something to regret. The foreign exhibits are so limited that there is really insufficient wherefrom to form a comparison. The Belgian engine is, taken altogether, an excellent specimen of workmanship, and one experiences a feeling of regret that a set screw on one connecting rod should at the crosshead end stand out at least an inch farther than does the one on the opposite side of the engine. The fly-wheel is bored out about ¼in. larger than the size of the crank shaft, and the wheel is trued by the fit of the four large keys. The edges, top and bottom of the connecting-rod jibs are left sharp, and not chamfered off at all—a defect which exists on nearly one-half the jibs in the whole Exhibition—and the consequence is that if a burr becomes raised on the corner, as it is very apt to do, the engine may have to be moved so that one can get at the burr to file it off. This is apparently a small matter, but it is not so in practice, because one is not apt to find the burr until its cutting in the key-way gives notice of its existence; then a file is not always at hand, nor are filings the most desirable things to have round about a key-way, and a journal and bearings. The scraping on the crosshead and slides of the Belgian engine is fairly executed, which is more than can be justly said for the greater part of the scraping in the exhibition. The crosshead is of that ugly octagonal shape that offends the mechanical eye on so many of the engine exhibits.

On the English engine and sugar mill we find substantial, if not highly-finished work. The connecting-rod keys have, in addition to the set screws, split pins at the small end. All bolts upon the working parts are provided with nuts and check-nuts, as also are those bolting the segments of the fly-wheels together, and bolting the arms to the hub or boss. The brasses are, as also are those of the Belgian engine, fitted to come together—brass and brass. On the big Corliss engine the bolts bolting the fly-wheel sections, and those bolting the arms to the boss, have neither check-nuts nor pins. It is only when turning to the locomotive exhibits that one realises how much may be overlooked or slighted, and yet escape criticism. Here is a four-wheeled coupled engine, No. 2436, made by a large and well-known firm of locomotive builders, with the crosshead on the left-hand side keyed on all out of true. It is, in fact, a disgraceful piece of workmanship, for beneath the guide-block and the bottom guide-bar at one corner, and between the block and top bar at the diagonally opposite corner, we can put in I don't know how many thicknesses of writing paper; the other corners of the guide-block are a fit to the bars, hence how much the piston-rod will be sprung when the engine is running I hardly dare to think of, much less to guess at. The bolts securing the straps to the connecting and coupling-rod ends have neither cotters, check-nuts, or pins to secure them—a remark which applies equally to the eccentric straps. The bolt connecting the lifting link to the quadrant is provided with a cotter, which is, however, left unsplit. The link motion and the connecting-rods of this engine are well-fitted—a fact, indeed, which applies to nearly all the locomotive connecting and coupling-rods, for better samples of fitting need not be desired.

Before going any further on the subject of the securing of bolts, it will be as well to state that it is in each case strenuously asserted and insisted upon that safety is, in each and every individual case, positively assured. To the assertion that single nuts are apt to slacken back, the reply is, that they don't slacken. In Europe the eccentric straps and connecting-rod bolts are secured by nuts and check-nuts, and by split pins or split cotters in addition, and where taper pins are used they are forged split, and opened out after being put finally in their places; but in the engines exhibited, the taper pins—where there are any—are solid, and depend upon the driving fit only to retain them in their places. European mechanics strongly object to this, while nobody claims any advantage from the dispensing with these extra securities which render it necessary for Mr. M. N. Forney, in that valuable little book, "Forney's Catechism of the Locomotive," to say as follows:—"Question 460: In inspecting the cylinders, pistons, guides, and connecting-rods, to what points should the attention be directed? Answer: . . . Especial attention should be given to seeing that all the bolts and nuts on the connecting-rods are tight.—Question 466: What part of the valve gear should receive attention when the engine is inspected? Answer: All the bolts, nuts, and keys should be carefully examined, to see that they are properly fastened. The bolts and nuts in the eccentric straps are especially liable to come loose, &c. &c.—Question 468: To what points of the running gear should attention be directed during inspection? Answer: . . . The bolts and nuts about both the engine and the tender trucks should be watched, to see that none are lost or work loose. . . .—Question 471: What duplicate parts should be carried with the engine? Answer: Keys, bolts, and nuts for connecting-rods. . . ." Mr. Forney's catechism is thoroughly practical, and there is no doubt that each of the above instructions is well directed and positively essential. To proceed, however, a locomotive, numbered 3860, and exhibited by another large firm, has bolts and nuts and pins to the eccentric-rod eyes, but bolts and nuts without pins are employed to hold the link halves together, the links being made in two pieces, bolted together at the ends with a distance block between them. The connecting-rod bolts have check-nuts but no pins, while the eccentric-rod eyes have nuts and taper pins.

The Philadelphia and Reading Railroad exhibit a locomotive that, so far as workmanship is concerned, is a positive eyesore. It is a consolation to know it was built by apprentices, and it would be a still greater consolation to know it had been built in the dark. The pump is operated by an outside crank attached to the end of the crank pin. The crank was bored too large for its seat, and the key has sprung it on the keyway side away from the seat so that a piece of paper can be passed between the bore of the crank and the seat. The connecting-rod key on the right-hand side of the engine is so loose in the keyway of the strap that a three cent silver piece has been slipped in between the two. A washer on the end of one of the crank pins, to secure the rods, is fastened with a taper pin, and while the face of the washer is a close fit on one side of its diameter, it is gaping at least $\frac{1}{32}$in. open on the other side. The pin connecting the slide spindle to the rocker arm on the right-hand side of the engine shows under the head a similar state of affairs. The rods are, with the exception of the keys, well fitted, and so is the link motion, the bolts being secured with split cotters, and the casehardening being especially well executed.

A large marine engine-building firm exhibits, near the locomotives, a large marine engine shaft and crank, with the machine work on them all done. The turning work on the shaft is anything but noteworthy, except it be for coarse chatter marks which appear all over it, while the less said about the planing on the back of the crank the better.

It is with a sigh of deep relief that one turns from these two

last exhibits to the handiwork exhibited by the Cornell University students, who show the best exhibited specimens of scraping, or to the lathes exhibited by the Worcester Massachusetts Free Institute, on which both the fitting and the finishing are excellent.

The finishing on the machine tools exhibited by the Putnam Machine Company is equal to the finest silver plating. The finish is, it is true, done with the burnisher, but that is of no consequence, since it is only applied to those parts where finish and not fit is the object sought.

In the Hoe printing press exhibit we have examples of excellent and substantial fitting and finishing, while for a specimen of accuracy of machine work the Poole rolls are a marvel.

The workmanship upon the Sellers machine tools is also noteworthy for excellence of execution both in fit and finish, as might be expected of this firm.

One of the most interesting exhibits in the Machinery Hall is the Thompson or Buckeye engine and governor. The engine is illustrated in the accompanying engraving. It will be seen from the section of the main and cut-off valves that the main valve is substantially a hollow box or chest closed with a lid or cover. In the large long stroke engines its form is that of two such boxes connected by a hollow neck. The steam enters its interior through circular openings in its cover, and thence passes into the cylinder through ports near its ends as they are by its travel brought to coincide with its cylinder ports. The exhaust takes place at the ends of the valve into the ends of the chest, thence through passages into the exhaust pipe. To the openings in the back of the valve are fitted self-packing rings, which serve the purpose of insuring a steam-tight connection between the interior of the valve and the steam chamber in the back of the chest. The area of these openings is made just sufficient to hold the valve to its seat, hence it is as nearly balanced as is practicable or desirable. As the valve chest contains only exhaust steam, the engines may be run with the chest lid removed, and any leakage detected. The cut-off valve works inside the main valve, and alternately closes the ports leading to the cylinder. A fixed eccentric operates the main valve, and an adjustable one operates the cut-off valve through the medium of a compound rocking-arm device and its connections. A small rocking shaft, which forms a part of the device, works in a bearing in the main rocking arm, and moves with it, so that the movement of the cut-off valve, relatively to its seat in the main valve, is both as to time and extent just what its eccentric would produce if the valve worked in a stationary seat, and was attached directly to said eccentric. The stem of the cut-off valve passes through the hollow stem of main valve, and is connected to an upright arm on the cut-off rock shaft, on the end opposite to that to which the eccentric rod is attached. The automatic adjustment of the cut-off eccentric is effected by means of its connection with two weighted levers contained in the circular case seen on the engine shaft. The outward movement of these levers advances the eccentric forward on the engine shaft, and two well tempered cast steel wire coil springs furnish the centripetal force which returns them when the speed slackens. Said springs are provided with set screws for adjusting their tension. Figs. 3 and 4 explain the construction of the governor, and its attachment to the loose eccentric. Fig. 3 shows the position of the weighted levers *a a*, and the eccentric C, when the engine is at rest or when the speed is not sufficient to move them. The spring E is shown drawn out to a certain degree of initial tension, while D shows its appearance without tension, the space between nut *f* and the stud *d* representing the distance it should be drawn to equal E. Fig. 4 shows the weights thrown out as far as they will go, in which position the earliest cut-off takes place. It also shows the position of the levers required for a direction of motion the reverse of Fig. 3, the direction in each case being shown by the arrows. The range of adjustment turns the eccentric one quarter of a turn, so that if the earliest cut was fixed exactly at the beginning of the stroke, the latest would be just at mid-stroke, but as the earliest does not need to be earlier than about one-twentieth, to hold the engine without load, the latest will, when the earliest is so placed, be a very little earlier than three-fourths of the stroke. The proper adjustment in this respect is obtained by turning the governors forwards and backwards on the shaft as required. The action of the governor can be best understood by reference to the accompanying sketch, Fig. 5. Let A represent the engine shaft, and B the weight attached to the lever of the governor, which lever is pivoted to the case at *d*, and having a range of movement outward to *c*. The centrifugal force of a body revolving in a circle is, for a given uniform speed, directly as its distance from a centre round which it revolves. The resistance of a coiled steel wire spring increases directly as it is extended. Supposing the spring to be attached to the lever at *b*, with an amount of tension equal to the distance *a b*, it is evident that if the weight B is moved out to C, the spring will be drawn to *c*, and will exert just as much more force than when at *b*, as will equal the increased centrifugal force of the weight at C. With such an adjustment of tension the regulation would be perfectly isochronous, provided an equilibrium between the two forces could ever be reached, but since it cannot it is necessary to introduce such conditions as will require a slightly greater speed to carry the weight to C than is required to start it from B. This condition is obtained with a little less tension than the distance *a b*, the diminution of the tension being determined by the degree of stability required in the equilibrium. The engine exhibited has a cylinder 16in. diameter, 36in. stroke, driving a pulley 10ft. diameter, 25in. wide, and 300ft. of shafting, for the purpose of exhibiting the engine at work.

Mr. J. W. Thompson, the inventor of this engine, has made a laudable effort to improve the construction of the well-known indicator, and especially with the view of improving the diagrams taken from high-speed engines, which it is well known are frequently of a most unsatisfactory character when the ordinary instrument is employed. Mr. Thompson states that the circumstances which compelled him to make the improvement were similar to those which led Mr. Gooch to adopt the principle of causing the marking-point only to travel to the full extent required by the diagram. Subsequently Mr. Richards added a parallel motion to steady the movements of the pencil, and caused the latter to travel a greater distance than the piston. Mr. Thompson contends that Mr. Richards' improvements did not fully carry out Mr. Gooch's idea, as the mechanism adopted by Mr. Richards involved three times as much disturbing momentum as produced by the single lever of Gooch.

In order to remedy this defect, and overcome the difficulty of obtaining a clear diagram from a high-speed engine, Mr. Thompson reverted to a single lever, and caused the end of it to move in a straight line.

The lever *a*, Fig. 6, is pivoted to a bracket E, which has a fixed pivot, so that its upper end *c* is free to move. A light and short radius bar *b* is attached to a rigid standard F, and also to the lever *a*, at such a point that its effect is to counteract the curvature which the end *a* would have if the end was fixed. The line produced is practically straight for a distance ample for the purpose, though beyond certain limits the lines produced by this and the Richards' indicator begin to curve, and the length of the straight portion is the same in each. The reduction in weight in Thompson's indicator as compared with Richards, ascertained by actual weighing at the pencil, is stated to be fully two-thirds; but it is claimed that the saving of weight is greater than that proportion, as the lever having to carry a pencil alone, does not require the same strength as one that has to carry a link and another lever. The connection is made of the length mathematically required to give correct indications, and is a trifle longer than that of the rod *b*. The joint is thus brought down near the piston, and is a modified form of ball and socket, which allows both the lateral movement required by the parallel motion and the rotative movement involved in swinging the lever to and from the drum. This joint is made compensating, so that lost motion may be easily taken up. On this indicator two joints between the piston and the pencil are dispensed with.

The result of these alterations in the construction of the

FIG. 1

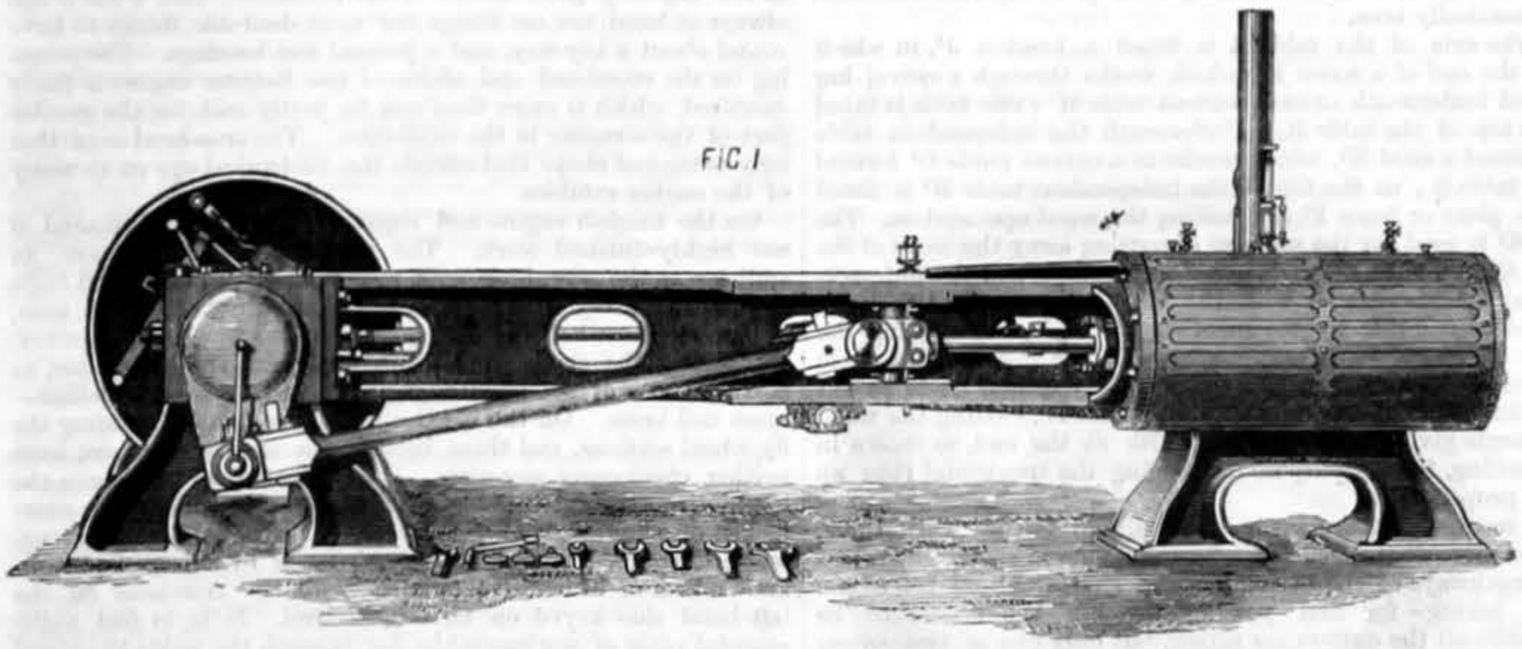
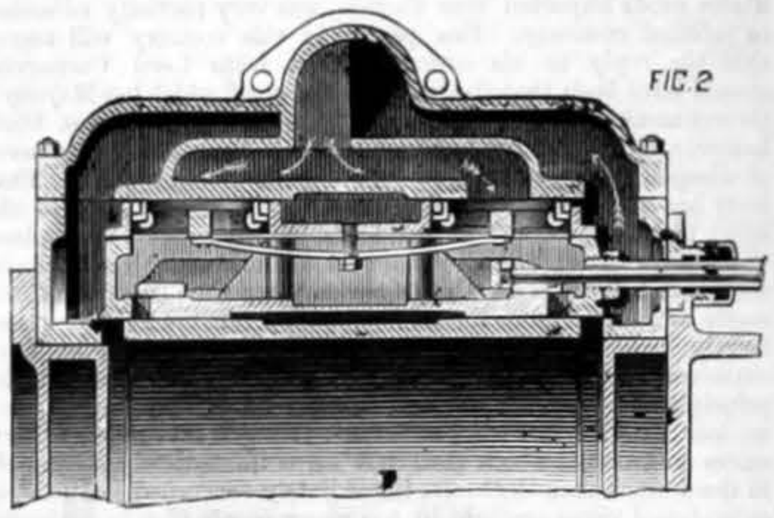
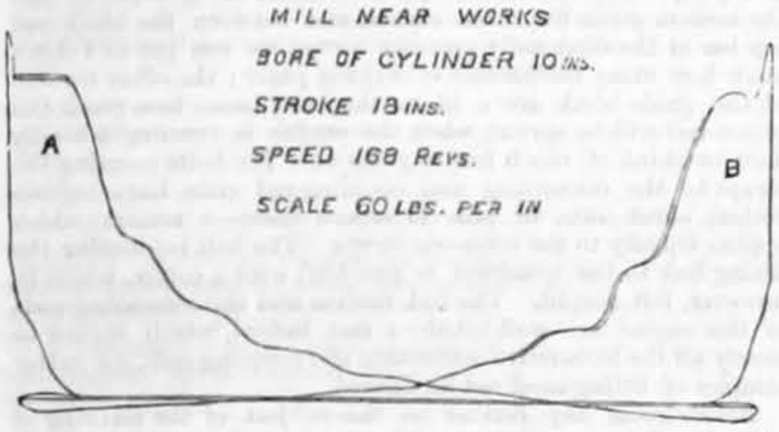
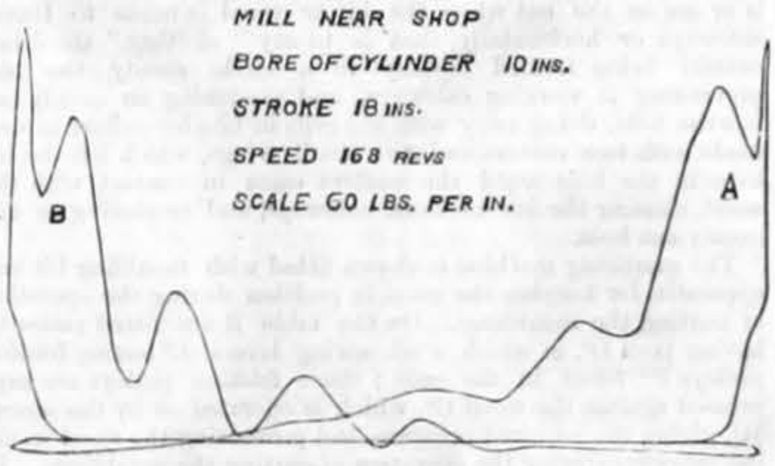
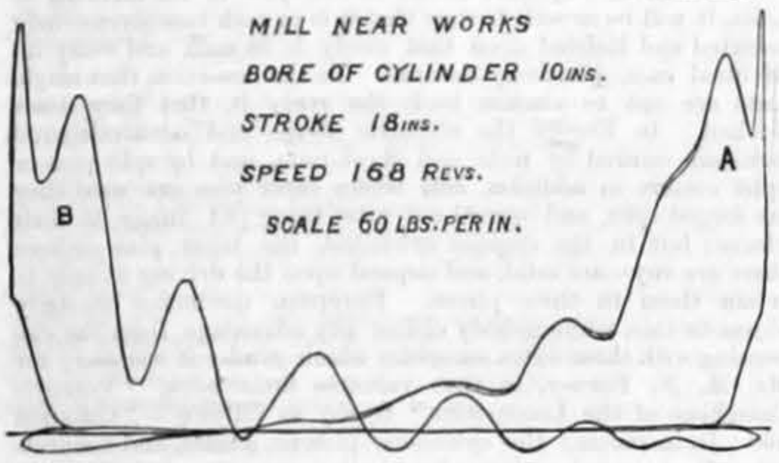


FIG. 2









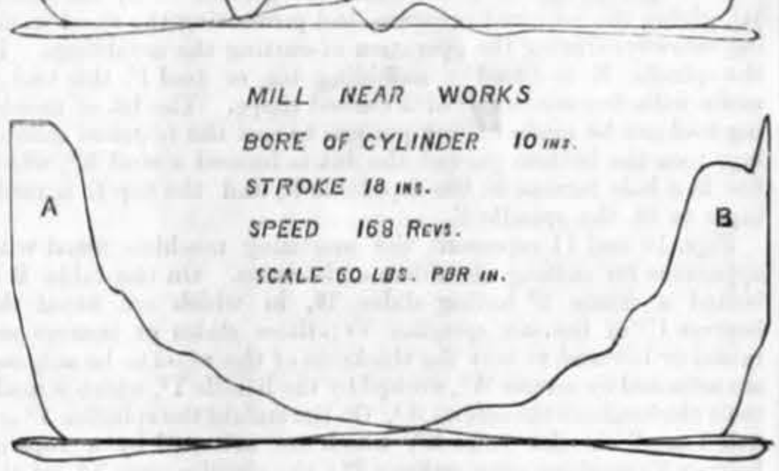


Fig. 6.

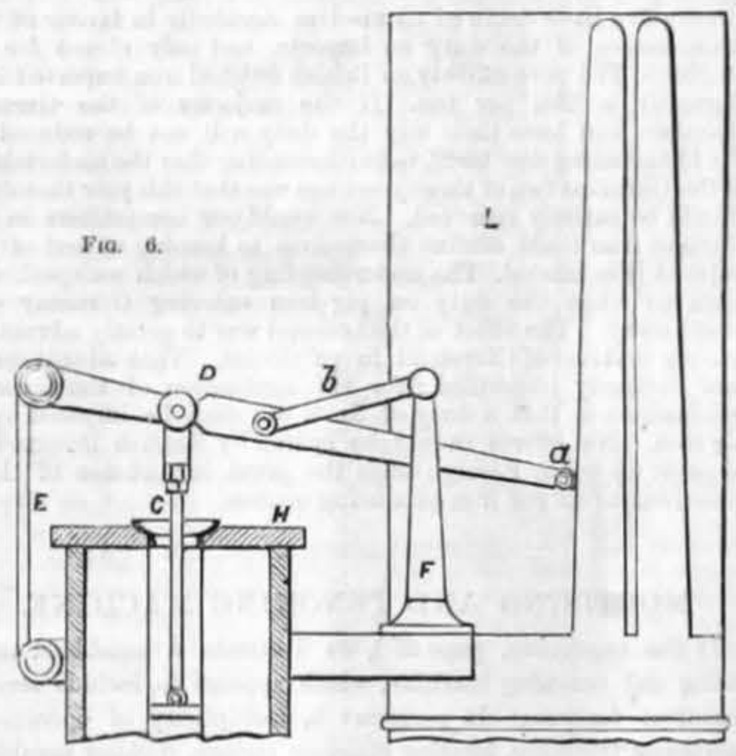


FIG. 3

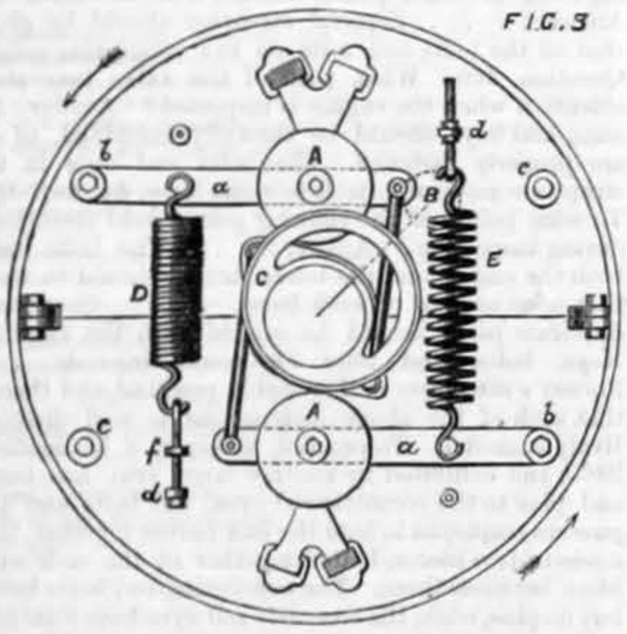


FIG 5

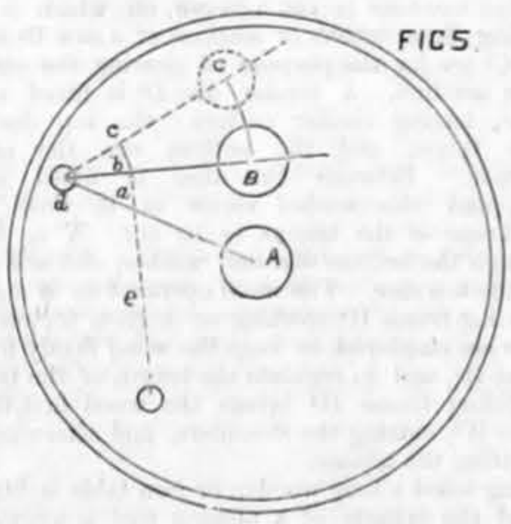
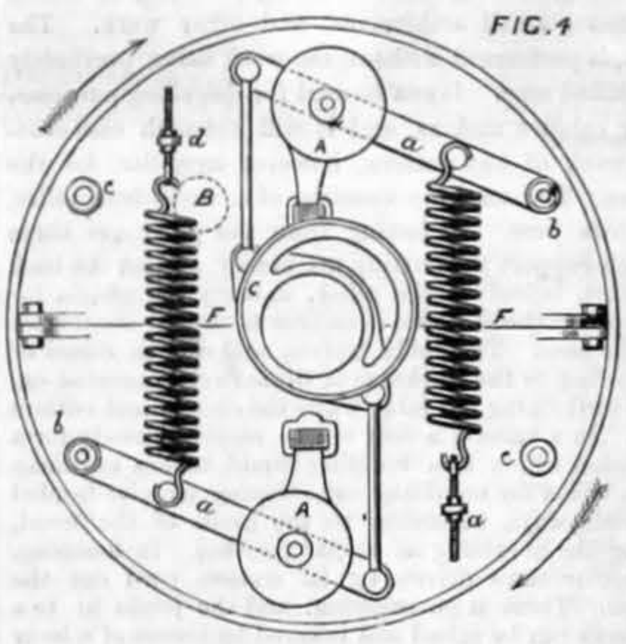


FIG. 4



indicator is shown on the diagrams sent herewith. One was taken with the ordinary indicator, the other with the improved instrument; one instrument was right-handed and the other left-handed, so that the corresponding ends of the cylinder are at opposite ends of the paper. These diagrams were taken under such circumstances as most severely test the instrument used, such as high speed, light load, quick induction and cut off, and a high grade of expansion.

They were both taken from the same engine, and under the same conditions, as far as these could be obtained. The size, speed, and kind of engine are marked on the diagrams. The best diagrams were taken with the new indicator.

Among the novel motors in the Exhibition is the Rider compression engine, by the inventor of the well-known Rider cut-off gear. The Rider compression engine consists essentially of a compression and a power cylinder, with their respective pistons and connections. The lower portion of the compression cylinder is kept cold by a current of water which circulates round its exterior, while the lower portion of the power cylinder is kept hot by the action of the fire below the heater. The heating and also the cooling of the air is instantaneously effected by its alternate presentation to the surface of the heater and cooler in a thin annular sheet. The same air is used continuously, as there is neither influx nor escape, the air being merely shifted from one cylinder to the other. All the movements of the various parts are uniform, being solely derived from regular, circular, and rectilinear motion; and as there are no complicated parts, and none of the irregular intermittent impulses which characterise caloric engines, a high rate of speed and smooth action may, it is claimed, be safely and easily obtained.

FIG. 1

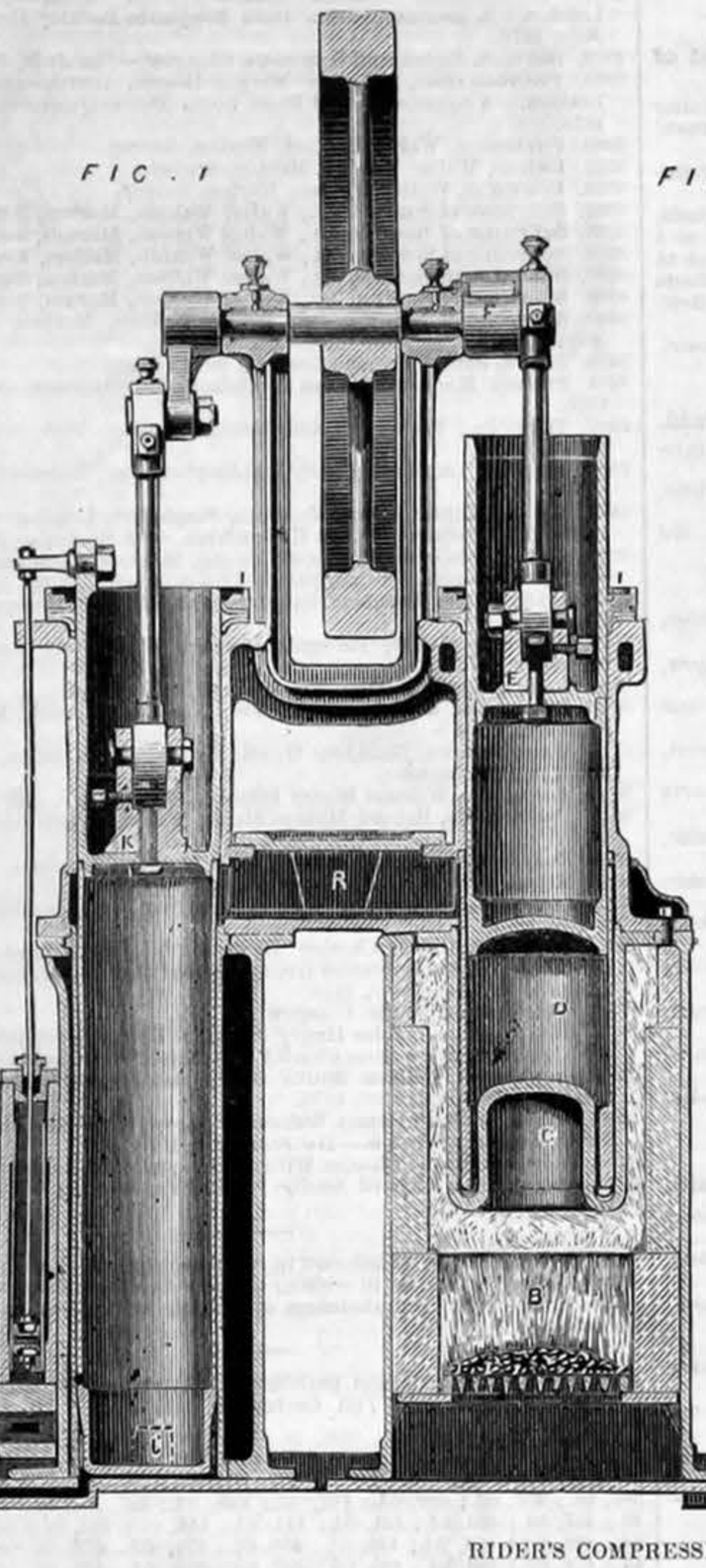


FIG. 2

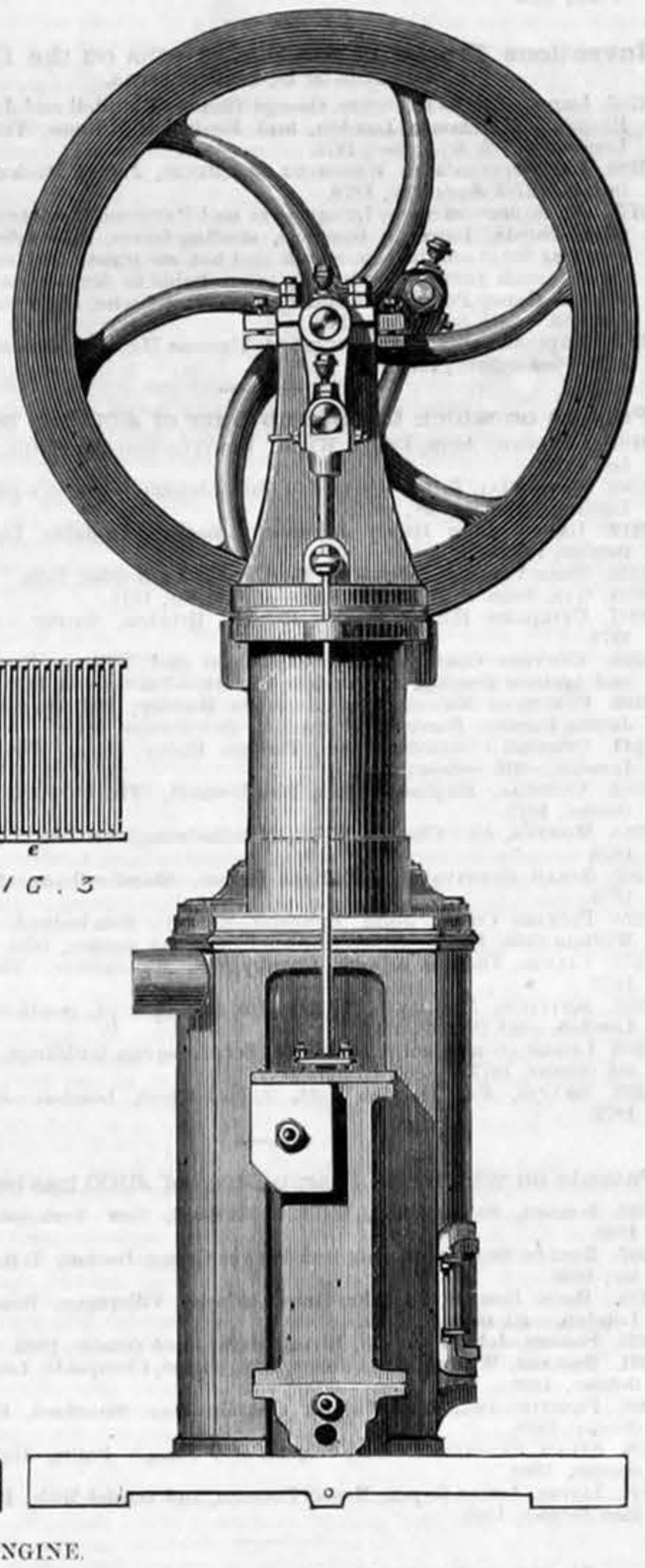


FIG. 3

RIDER'S COMPRESSION ENGINE.

The operation of the engine is briefly as follows:—

The compression piston C first compresses the cold air in the lower part of the compression cylinder into about one-third its normal volume, when, by the advancing, or upward motion of the power piston O, and the completion of the down-stroke of the compression piston C, the air is transferred from the compression cylinder through the regenerator R, and into the heater B, without appreciable change of volume. The result is a great increase of pressure, corresponding to the increase of temperature, and this impels the power piston up to the end of its stroke. The pressure still remaining in the power cylinder and re-acting on the compression piston forces the latter upward till it reaches nearly to the top of its stroke, when, by the cooling of the charge of air, the pressure falls to its minimum, the power piston descends, and the compression again begins. In the meantime, the heated air, in passing through the regenerator, has left the greater portion of its heat in the regenerator plates, to be picked up and utilised on the return of the air toward the heater.

The regenerator, as it is called, is a very important part of the engine, and consists of numerous thin plates of iron between which the air passes, and which alternately absorb the heat from the air and return it.

One of these engines is at work in the boiler-house, No. 4, feeding a boiler.

FALL OF THE NERBUDDA VIADUCT.

The Bombay, Baroda, and Central India Railway runs from Bombay northwards, up the coast to Guzerat and the district of Kattiawar, passing in its course by the important towns of Surat, Broach, Baroda, and Ahmedabad. It has to cross several rivers, the principal of which are the Taptee, at Surat; the Nerbudda, at Broach; the Mahee, near Baroda; and the Saburmuttee, at Ahmedabad. The viaduct over the Saburmuttee was seriously injured by the floods last year. This year the Nerbudda viaduct has suffered, and the damage done to it has been very considerable, amounting to the total destruction of more than one-third of its length. The river where the railway crosses has channelled out for itself a bed of nearly three quarters of a mile in width in the gravel and clay formation. During the dry season the water only covers a portion of the bed where the channel is deepest, but like many other Indian rivers its course is perpetually shifting, and the channel which a few years back hugged the right bank has been gradually silted up, the deepest section now approaching the left bank. In the rains the water covers the whole bed, and when heavy floods occur it rises over the left bank and overspreads a large extent of country. The town of Broach lies on the north, or right bank; it is considerably raised so as to be completely protected from floods. The railway viaduct over the Nerbudda consisted of sixty-seven spans of generally 62½ft. length each, supported upon cast iron columns or piles 2ft. 6in. external diameter, made up of 9ft. lengths. The total length of each averages between 80ft. and 90ft., and they are screwed into the bed of the river to depths varying from 30ft. to 40ft. Each pier consists of five of these piles ranged in a single row transversely to the viaduct, with here and there some extra piles supporting fenders for protection from the trunks of trees which are frequently floated down by the floods. The double line of rails is carried by longitudinal wrought iron lattice girders over the three central piles, and the weight is distributed over the five by cast iron cross girders. There is room left, therefore, on each side of the line for a platform or footway, but these, although at one time contemplated, have not been completed, and foot passengers usually cross the river in boats. The piles are cross trussed down to and below the river bed, and the structure is very rigid. On the night of the 5th ult. the water had risen to the greatest height which had been observed since the erection of the bridge, and was rushing through at a velocity estimated at from eight to ten miles an hour, throwing up a wave against each pier of about 7ft. in height. At about midnight the surface of the water is stated to have been 42ft. above low-water mark, or 5ft. higher than it had been known to rise for many years. It was then about 13ft. below rail level. The left bank of the river was submerged and the adjacent country flooded, a small neighbouring village being entirely destroyed. Shortly after this, two or three of the spans of the bridge near the left bank were carried away, quickly followed by several more, and ultimately twenty-five in all were bodily thrown into the river, leaving only forty-two spans remaining. The whole of the south end of the viaduct was thus destroyed, and although the river has since subsided some 15ft. to 20ft., there is nothing visible of the structure beyond two or three of the girders of the shore span, which are lying on the end of the embankment very much contorted, and a few of the broken stumps of the last two piers nearest the shore. The current on the 13th instant was running too strongly to allow diving operations to be effected, so as to examine the condition of the bed of the river where the viaduct stood. The last standing pier has its cast iron girders cracked and is otherwise shaken, but the rest of the bridge at present appears intact. The longitudinal teak sleepers are broken off with the usual wood fracture, but the up rails—iron—are broken short off over the girder, almost as if shorn; the right-hand down rail is cut in a similar way, but the left-hand down rail hangs over about 3ft. and is contorted. To a casual observer, except for this last fact, there is nothing to show the excessive wrench the structure must have borne. The greater part of the submerged portion of the viaduct is apparently lying not many yards below where it originally stood, as indicated by the eddies in the water, but none of it is as yet visible.

Unfortunately the accident caused the loss of one life, namely, that of Pestonjee Framjee Green, inspector of bridges, who with two others was on duty on the bridge, and near the shore end when it was carried away. All three were thrown into the river, but two escaped. The inspector Pestonjee is still reported missing.

Although traffic was suspended for a day, on the morning of the 8th a steam launch was in readiness, and was actively engaged in carrying traffic and tugging native boats across the river. The launch was brought from Bombay by rail, a distance of 200 miles. A delay of little over an hour is occasioned to the mails in crossing.

Temporary landing stages have been erected, and a more convenient one is in course of construction attached to one of the piers of the standing viaduct, which will enable the larger barges to land goods and passengers readily. It is clear that, great as the difficulties are which the engineers and traffic manager and his staff have to overcome, they have met them with admirable energy and foresight.

When circumstances allow diving operations to be carried out, it will be ascertained whether the piers were undermined or otherwise. Either that or the fracture of some of the piles from side strain caused by a diagonal current are among the most probable causes of failure. The appearance of the fractured rails tends to show that the last span must have fallen almost vertically downward.

The viaduct has been standing for about fifteen years. It suffered damage in 1864, when six spans were carried away and subsequently renewed. In 1868 three spans were carried away and were replaced. The present destruction of twenty-five spans represents a length of about two and a-half furlongs.

The excessive flood this year is attributed mainly to the late but heavy fall of rain up country. Great apprehensions were entertained for the safety of the Taptee viaduct, owing to reports of heavy floods up the river in the neighbourhood of Nagpore. The water is stated to have risen within 4ft. of rail level on that viaduct. The country bears signs of heavy local rain, but the floods have subsided, and both the rivers are now in their normal monsoon condition.

THE PATENT JOURNAL.

Condensed from the Journal of the Commissioners of Patents.

Grants and Dates of Provisional Protection for Six Months.

2329. Improvements in obtaining and applying Motive Power to submarine operations, Edward Jordon Hough, St. Helen's-place, London.—*2nd June*, 1876.

2966. Improvements in machinery for Scouring, Setting, or Glassing Leather or Beaming Hides, Frederic Augustus Lockwood, Bristol, U.S.—*21st July*, 1876.

2999. An improved machine or apparatus for Washing and Peeling Potatoes or other vegetables or roots, Thomas Bradford, High Holborn, London.—*25th July*, 1876.

3091. Improvements in the construction of Steam Boilers, and in apparatus to be used in the manufacture thereof, Bristow Hunt, Serle-street, Lincoln's-inn, London.—A communication from Alvan Dinsmore Brock, Washington, U.S.—*2nd August*, 1876.

3181. Improvements in the manufacture of Articles from Copper, and in apparatus employed therein, Sydney Pitt, Sutton, Surrey.—A communication from Count Stanislas de Plater-Syberg, Paris.—*14th August*, 1876.

3376. Improvements in Gas Regulating and saving apparatus, Peter Sieh and Theodore Schwarz, Hamburg, Germany.

3377. The improvement of Turnstiles, and apparatus connected therewith, George Lowry, Salford, Lancashire.

3399. An improved combination of processes and apparatus for the manufacture of Soda and Potash, and the recovery of the sulphur employed therein, Walter Weldon, Abbey Lodge, Merton, Surrey.—*28th August*, 1876.

3409. Improvements in Automatic Thread Layers combined with Thread Carriers, applicable to the machines employed in manufacturing ribbed, looped, or knitted fabrics, Thomas Coltman, Leicestershire.—*30th August*, 1876.

3436. Improvements in Solitaires or Sleeve and Collar Studs, Frederick Weintraud and Richard James Secundus Joyce, Aldermanbury, London.—*31st August*, 1876.

3477. An improved method of Raising and Lowering Window-blinds and apparatus therefor, Charles Dawbarn, Bury-court, St. Mary Axe, London.—A communication from Louis H. Gano, New York.—*4th September*, 1876.

3519. Improvements in apparatus for Weaving Looped and Piled Fabrics, Bristow Hunt, Serle-street, Lincoln's-inn, London.—A communication from Octave Alexandre Gallet, Paris.—*7th September*, 1876.

3530. A new or improved Grave Tablet for perpetuating the memory of the dead, James Gillman, Leeds.

3538. Improvements in Sewing Machinery, Howard Pratt Garland, Dundee, Scotland.—*8th September*, 1876.

3549. Improvements in Discharging Water from Steamships and other vessels, and in apparatus to be employed for this purpose, Robert Griffiths, Bayswater, London.—*9th September*, 1876.

3558. Improvements in Roller or Wheel Skates, Frederick Young, Dalston-lane, Hackney, London, and Charles Frederick Deacon, Southampton.

3560. Improvements in Reaping and Mowing Machines, Adam Carlisle Bamlett, Thirsk, Yorkshire.

3562. Improvements in apparatus for use in Stopping and Controlling the Motion of Ships' Cables, Alexander Jardine Alderman, Copenhagen-street, Cloudesley-road, Islington, London.—*11th September*, 1876.

3566. A new or improved apparatus for Stopping Pumping Engines, John Robertson, Lanemark, New Cumnock, Ayrshire.

3572. Improvements in School Furniture, William Coor Parker and James Stabler, Darlington, Durham.

3574. Improvements in Cooling Woven or Felted Fabrics after the process of steaming or blowing or boiling in water, Henry Lister, Ashbrow Mills, Huddersfield, Yorkshire.

3576. Improvements in Purifying and Disinfecting Sewage and other foul waters, and in the preparation of disinfectants, William White, London-road, Newcastle-under-Lyne.

3578. Improvements in Harvesting Machines, Bernhard Samuelson and William George Manwaring, Banbury, Oxfordshire.

3580. Improvements in the method of Winding Hosiery Yarn, and in apparatus employed therefor, Howgate Greaves Warburton, Leicestershire.—*12th September*, 1876.

3582. Certain improvements in machines for Printing or Embossing Spools Peter Joel Livsey, Manchester.—A communication from Ira Dimock, Hartford, U.S.

3586. Improvements in apparatus connected with Cleansing the Bottoms of Ships and other submerged structures, Henry James Cole, Wandsworth-road, Surrey.

3587. Improvements in Signalling Apparatus, Philip Haughton Whittaker, Parr-street, Liverpool.

3588. Improvements in Rim, Mortise, and other Latch Locks, Edgar Hum, Stoke Newington, London.

3592. Certain improvements in the construction of instruments for Shearing Sheep or other Animals, William Clark, Oxford-street, London.—*13th September*, 1876.

3596. Certain improvements in machinery for Finishing the Ends of Rolls for Metal Rolling, Frederick Richard Wheeldon, Wolverhampton.

3598. Improvements in Globe Holders suitable for gas and other lamps, Henry Horton, Finsbury-street, London.

3600. Improvements in Frames employed in stretching and finishing of skirts, Thomas Bernard Ward, Holt Town, Manchester.

3602. Improvements in the construction of Decanters, Water Bottles, Tumblers, and other vessels or articles made of glass, china, stoneware, or other brittle or hard materials, James Vernon, Newton Stewart, Wigton.

3604. An improved Printing, Paper-cutting, and Tag-making Machine, William Robert Lake, Southampton-buildings, London.—A communication from William Heckert, Providence, U.S.

3608. An improved Fountain Penholder, William Alexander Brice, Chancery-lane, London.—*14th September*, 1876.

3610. Improvements in Tanged Spades and Shovels, Francis Adkins, Oldbury, Birmingham.

3614. Improvements in the construction of Crank-arms used in looms for weaving, Denis Bury, Oswaldtwistle, Lancashire.

3615. Improvements in Wood Screws, and in machinery for making the same, and in means, methods, and processes connected therewith, Thaddeus Hyatt, Gloucester-gardens, Hyde Park, London, and Thomas Rickett, Devonshire-place, Pershore-road, Birmingham.

3616 Improvements in Studs or Clasps, William Henry Douglas, Stourbridge, Worcestershire.

3618. Improvements in Screw Propellers for propelling vessels through the water, Robert Henry Armit, Victoria-chambers, Westminster.

3620. Improvements in Engines worked by the combustion and expansive force of an inflammable fluid mixture, Matthew Piers Watt Boulton, Tew Park, Oxfordshire.—*15th September*, 1876.

3622. Improvements in means or apparatus for Folding Wrappers or

Covers around Cakes of Blacking or other material, William Cowper Pellatt, Holborn, London.
3626. Improvements in Packing Rings and in the method of and apparatus for manufacturing the same, Frank Wirth, Frankfort-on-the-Maine, Germany.—A communication from Theodor Remus, Lodz, Russia
3628. Improvements in Kilns, John Garlick, Birmingham.
3632. A new or improved Fishing Gear Winch, or arrangement of mechanism for heaving in herring or other fishing nets, trawl ropes, and deep-sea fishing or other lines, Charles Robertson Mitchell, Aberdeen, N.B.
3633. Improvements in Centrifugal Machines, Edward Alfred Cowper, Great George-street, Westminster.
3634. Improvements in apparatus for Grinding Wire Cards, William Walton, Denton, Lancashire.
3636. An improvement or improvements in Lamps for burning kerosine or other light or volatile oils, William Lowe, Handsworth, Staffordshire.—A communication from William Henry Dalton, Emeral Hill, Melbourne, Victoria.
3638. Improvements in Locks or Fastenings for Boxes, the same being specially applicable in improved boxes for cigar lighters and matches, Carl Hermann Wetzel, Aldermanbury, London.—16*th September*, 1876.
3640. Improvements in apparatus for Disinfecting Clothing and other similar articles, Charles Edward Heron Rogers, East Retford, Nottinghamshire.
3644. An improved Photographic Tinting Apparatus, George Nesbitt, Bournemouth, Hampshire.
3646. Improvements in Steam Boilers, Charles Denton Abel, Southampton-buildings, London.—A communication from Lebrecht Steinmüller and Carl Steinmüller, Gummersbach, Germany.
3648. Improvements in Windows for Carriages and in fastenings for the same, Henry Brittain, Birmingham.
3650. A machine for manufacturing the improved apparatus to Produce Sound, as a substitute for a castinet, Henry John Distin, Tavistock-street, Bedford-square, London.—18*th September*, 1876.
3653. Improvements in Self-acting Mules used for spinning cotton, flax, wool, and other fibrous materials, John Farran and James Walsh, Over Darwen, Lancashire.
3654. Improvements in the construction of Carriers, Pedestals, Pulleys, and Couplings for Shafting, and Mechanism for Counter-shafting, and in Lathes or Machinery for Making Shafts, William Ford Smith and Arthur Coventry, Salford, Lancashire.
3655. A new or improved Gas Governor, William Foulis, Glasgow.
3656. Improvements in Ball-cock Hydrants, Samuel Benjamin Wilkins, Edinburgh.
3658. Improved self-detaching apparatus for Disengaging Ships' Boats and other purposes, William Alexander Brice, Chancery-lane, London.
3659. Improvements in Looms for pleating and diapering all kinds of cloth and tissues, William Morgan-Brown, Southampton-buildings, London.—A communication from Hyacinthe Marie Fouillet, Chaussée d'Antin, Paris.
3660. Improved means and apparatus for Regulating Reciprocating Motion in Motor Engines and other machinery, Gustav Ernst Adolph Hoermann, Great Tower-street, London.
3661. Improvements in Steam Boilers, John Henry Johnson, Lincoln's-inn-fields, London.—A communication from Charles Ten Brink, Paris.
3662. Improvements in apparatus for Marking Lawn Tennis Courts and other surfaces, Thomas Frederick Hunt, Banbury, Oxfordshire.
3663. Improvements in machinery or apparatus for Cutting, Turning, or Shaping Wood, George Broy, Keighley, Yorkshire.
3665. Improvements in apparatus and means for the Transmission of Pressure to Hydraulic Machine Tools, to facilitate their application to the work on which they are to be applied, Ralph Hart Tweddel, James Platt, and John Fielding, Gloucester.
3666. An improved Sash Fastener for Windows, which is also applicable for securing casements, cupboards, or doors, or for other similar purposes, Samuel Hill, Southwark, London.
3667. Improvements in the manufacture of Skelps and Tubes, Charles Frederick Grimmett, Edgbaston, Warwickshire.
3668. Improvements relating to the combination of Articles of Confectionery, and the like, with musical instruments, William Robert Lake, Southampton-buildings, London.—A communication from Johann Kluge and Johann Burmueller, Prague, Bohemia.
3669. An improved Seat, Charles Henry Everett, Douglas-place, Queen's-road, Bayswater, London.
3670. An improvement or improvements in Thermo-electric Generators and in Electro-motors, Camille Alphonse Faure, Faversham, Kent.—19*th September*, 1876.
3674. Improvements in the Purification of Gas, Robert Harris, Bow, London.
3675. An improved apparatus for Raising, by means of compressed air, Submerged Ships or other vessels, Ernest Cuyer, Honfleur (Calvados), France.
3676. A new mode of and apparatus for Breathing Warm Air, Noble Seward, Templeogue, Dublin.
3677. Improvements in Foo Signalling on railways or tramways, and in apparatus therefor, John Keighley, Ormskirk, Lancashire.
3678. Improvements in Engines for propelling steam launches and yachts, and for other purposes, Eustace Ernest Wigzell and Claude Halsey, Mark-lane, London.
3679. Improvements in treating Paraffine, William Bryer Nation, Charles-street, Old Kent-road, Surrey, and Walter Symington, Old Kent-road, London.
3682. Improvements in the Furnaces and Flues of Steam Boilers, Samuel Hancock and William Soar, Nottinghamshire.
3683. Improvements in the action of Upright Pianofortes, Henry Brooks, Regent's Park, London.
3684. Improved means or apparatus to be employed in Connecting and Disconnecting Railway or Tramway Rolling Stock, Frederic Barnes, Sulham, Reading, Berkshire.
3685. Improvements in Fans for protecting food from insects, and for similar purposes, William Robert Lake, Southampton-buildings, London.—A communication from Samuel William Lambeth and William Raymond Lafourcade, Philadelphia, U.S.
3686. Improvements in the manufacture of Artificial Marble or Stone, Louis Abraham Brode, Glasgow.
3688. Improvements in the mode or method of arranging and disposing the connections of Electro-magnetic Signalling Instruments, William Smith and Richard Robert Harper, Salisbury-street, Strand, London.
3689. An improvement or improvements in Breech-loading Small Arms, John Field Swinburn, Birmingham.
3690. Improvements in Steam Boilers, Hunter Henry Murdoch, Staple-inn, London.—A communication from Emile Bède, Verviers, Belgium.
3691. Improvements in Railway Sleepers, William Edward Newton, Chancery-lane, London.—A communication from Jules Leonard Lenoir, Paris.—20*th September*, 1876.
3692. Improvements applicable to Gas Furnaces, and in the utilisation of gas furnaces, Samuel Godfrey and Richard Howson, Middlesbrough-on-Tees.
3693. Improvements in the manufacture of Sugar, and in the means employed therefor, William Renny Watson, Glasgow.—A communication from David McColley Weston, Boston, U.S.
3694. Improvements in apparatus for Grinding Wire Cards, William Walton, Denton, Lancashire.
3695. Improvements in the method of and apparatus for Securing Glass in metallic window frames, Robert Hird, Shipley, and Alfred, Calvert, Leeds, Yorkshire.
3697. Improvements in machinery for Knitting Healds, James Haydock and Thomas Blackburn, Blackburn, Lancashire.
3698. Improvements in Looms, David Sowden and Reuben Calvert Stephenson, Bradford.
3699. Improvements in means or apparatus for effecting the Twisting of Flax, Tow, Woollen, Silk, Cotton, or other yarns, William Bywater, Holbeck, Leeds.
3700. Improvements in Bicycles and Bicycle Stands, Thomas Browett, Manchester, and William Harrison, Portland-street, Manchester.
3701. Improvements in apparatus for Working and Locking the Points and Signals of Railways, John Brierley and Walter Wright Brierley, Kilburn, London.—A communication from Frederick Wade Brierley, Philadelphia, U.S.
3702. Improvements in Sewing Machines and in attachments for the same, Alfred Vincent Newton, Chancery-lane, London.—A communication from Robert Whitehill, New York.
3705. Improvements in the means or apparatus employed in the manufacture of Wrought Iron or Steel Discs or Wheels, James Abercromble Curling, Leeds.
3706. Improvements in apparatus for the treatment of Iron and Steel, John Henry Johnson, Lincoln's-inn-fields, London.—A communication from Charles Dion, Chambly Basin, and James Baylis, Montreal, Quebec, Canada.
3707. Improvements applicable to Driving Small Machines, Joseph Brunt, Derbyshire.—21*st September*, 1876.
3710. Improvements in Telegraphic Instruments, St. John Vincent Day, Glasgow.—A communication from Georges Dubern, Allipore, India.
3711. Improvements in the method of and apparatus for Warming Railway Carriages with exhaust or waste steam from the engine, Alfred Mason Bradford.
3712. Improvements in machinery for Carding Cotton and other fibrous substances, William Dobson, Plymouth, and Thomas Henry Rushton and Benjamin Alfred Dobson, Bolton.
3713. Improvements in the method of and apparatus for Refrigerating and for Heating Liquids, William Lawrence, St. Mary Axe, London.
3714. Improvements in processes for the production of Iron and Steel, and in the construction of furnaces for that purpose, Charles William Siemens, Queen Anne's-gate, Westminster.
3715. Improvements in machinery or apparatus for making Composition Ornaments, and for applying the same to mouldings, Richard Scully, Banner-street, St. Luke's, London.
3716. Improvements in the construction of Looms for weaving, William Lancaster, James Henry Pilkington, and William Peel, Accrington, Lancashire.
3717. An improved arrangement of a regenerative Siemens' Furnace, Ludwig Haarmann, Hanover, Prussia.
3718. Improvements in Inhaling Apparatus, applicable also for diffusing perfumed and other vapours, Charles Ambrose McEvoy, Piccadilly, London.
3719. Improvements in Steam Power Furnaces for the manufacture of sulphate of soda and potash, and the calcination of alkalies and other materials, George Dryden Mease, South Shields, Northumberland.—22*nd September*, 1876.
3720. Improvements in the manufacture of Edging in twist lace machines, Robert Scott, Cromwell-street, Nottinghamshire.
3722. Improvements in Colliery Tubs, Henry Johnson, jun., Dudley, Worcestershire.
3724. Improvements in apparatus for Mashing and Grinding Materials for distilleries, and for similar purposes, Frank Wirth, Frankfort-on-the-Maine, Germany.—A communication from Gustav Ellenberger, Darmstadt, Germany.
3726. A new or improved Composition or Varnish, Charles Joseph de Meyer, Alphonse Ruidant, and Pierre Joseph Mulders, Brussels.—23*rd September*, 1876.
3730. Improvements in Safety Alarm Apparatus for steam boilers and other structures where gaseous matters are liable to accumulate to an abnormal pressure, William John Coe, Liverpool.
3732. Improvements in Rollers for expressing liquid from textile materials, yarns, and fabrics, James Shaw, Galashiels, Selkirk.
3736. Improvements in Abdominal Supports, Abram Charles Herts, Bloomsbury, London.—A communication from John Herts, New York, U.S.

Inventions Protected for Six Months on the Deposit of Complete Specifications.

3763. Improvements in Pumps, George Thomas Blundell and James Walter Blundell, Limehouse, London, and Frederick Holmes, Victoria Park, London.—27*th September*, 1876.
3766. Improvements in Weighing Machines, James Mackenzie, Edinburgh.—27*th September*, 1876.
3773. An improvement in Lubricants and Packings for steam engines, steam chests, journals, bearings, stuffing-boxes, also safes, and as a covering for steam boilers, steam and hot air pipes, and roofs, and in general such parts of machinery as are liable to friction or the effects of heat, Henry Potts Scott and Benton Hart Zerbe, Burdett-road, Bow, London.—28*th September*, 1876.
3828. Improvements in Lubricators, Thomas Haynes, Kansas, Missouri, U.S.—3*rd October*, 1876.

Patents on which the Stamp Duty of £50 has been Paid.

3194. Carbonic Acid, Frank Wirth, Frankfort-on-the-Maine.—2*nd October*, 1873.
3208. Artificial Fuel, Richard William Johnson, Queen's-gate-gardens, London.—3*rd October*, 1873.
3212. Lamps, John Henry Johnson, Lincoln's-inn-fields, London.—3*rd October*, 1873.
3216. Beer Vessels, John Rice, Southsea.—4*th October*, 1873.
3225. Gas, John West, Maidstone.—4*th October*, 1873.
3227. Utilising Heat, Charles Ritchie, Brixton, Surrey.—4*th October*, 1873.
3248. Cutting Coal, William Stevenson and William Ree, Glasgow, and Andrew Dunlop, Stonehouse, Lanark.—7*th October*, 1873.
3498. Punching Metals, &c., Lawrance Beesley, William Beesley, and James Beesley, Barrow-in-Furness.—28*th October*, 1873.
3241. Opening Casements, &c., Thomas Elsley, Great Portland-street, London.—6*th October*, 1873.
3252. Cupolas, Eugène Voisin, South-street, Finsbury, London.—7*th October*, 1873.
3255. Mortar, &c., Charles Wood, Middlesbrough-on-Tees.—7*th October*, 1873.
3262. Steam Cultivating, William Fisken, Stamfordham.—8*th October*, 1873.
3276. Picking Coals, John Ephraim Walker, Sunderland, and John William Cole, Byker, Newcastle-on-Tyne.—9*th October*, 1873.
3435. Valves, Thomas Adams, Granby-row, Manchester.—22*nd October*, 1873.
3257. Knitting Machines, Henry Josiah Griswold, Southwark-street, London.—8*th October*, 1873.
3258. Lubricators, George Haseltine, Southampton-buildings, London.—8*th October*, 1873.
3265. Shafts, &c., Thomas Nott, Oxford-street, London.—8*th October*, 1873.

Patents on which the Stamp Duty of £100 has been Paid.

2882. Screws, Spikes, &c., William Horsfall, New York.—5*th October*, 1869.
2917. Roller Skates, Washington Parker Gregg, Boston, U.S.—7*th October*, 1869.
2878. Rock Boring, &c., Ferdinand Floran Villepigue, Brewer's-lane, London.—4*th October*, 1869.
2929. Forges, John Frearson, Birmingham.—8*th October*, 1869.
2931. Boilers, William John Jones, King-street, Cheapside, London.—8*th October*, 1869.
2946. Printing Ink, &c., William Chaplin May, Stratford, Essex.—9*th October*, 1869.
2898. Steam Engines, Eustace Wigzell and Joseph Pollit, Halifax.—6*th October*, 1869.
3024. Looms, James Raper, Mason Pearson, and Daniel Mills, Bradford.—16*th October*, 1869.

Notices of Intention to Proceed with Patents.

2199. Hats, Thomas Lees, Stockport.—25*th May*, 1876.
2215. Bottling Wines, &c., Charles Thomas Marzetti, Minories, London.—26*th May*, 1876.
2227. Clinometers, Alan Charles Bagot, Churchdale, Stafford.—27*th May*, 1876.
2246. Hats, Hermann Stern, Berlin.
2252. Carding Engines, Joseph Dean, Rochdale.
2259. Checks, &c., James Boorman Johnston, New York, U.S.—29*th May*, 1876.
2262. Looms, William Morgan-Brown, Southampton-buildings, London.——A communication from George Crompton.
2263. Marking Billiards, &c., James Ashcroft and Walker Moseley, Liverpool.
2267. Compasses, Francis Barker, Clerkenwell, London.
2271. Filing Metal, &c., William Sauday, Radcliffe-on-Trent.
2273. Drills, William Hensman, Woburn, and John Hensman, Ampthill, Bedford.
2274. Desks, Frederic Thomas Burrows and Joseph Dufais Colton, Portman-square, London.—30*th May*, 1876.
2291. Earthenware, John Wood, Manchester.
2301. Wood Paving, Charles Henry Green, Southampton-buildings, London.—A communication from Barzilla Foster Pond.
2302. Steam Boilers, Frederick Hayward, Gracechurch-street, London.—31*st May*, 1876.
2306. Furnaces, Fred Barber, Sheffield.—A communication from Emil Vossnach.
2311. Ventilators, John Banks, Cork.
2314. Valves, George Frederick Deacon, Liverpool.
2315. Scouring Grain, John Matthew Audus and Nathaniel Bates, Sowerby Bridge, York.
2319. Lowering Boats, Lieut. Alan Howard, R.N., Portsmouth.—1*st June*, 1876.
2323. Buildings, John Sidebotham, Blackpool.
2325. Elevators, John Hancox, Hungerford.
2329. Motive Power, Edward Jordan Hough, St. Helen's-place, London.—2*nd June*, 1876.
2335. Cartridge Case, George Lincoln Jeffries, Birmingham.—3*rd June*, 1876.
2347. Furnaces, Désiré Liévin Dernoncourt, St. Denis, France.
2351. Brushes, William Edward Teale, Worsley, Lancashire.—5*th June*, 1876.
2359. Treating Plants, Octavius Francis Feall, James William Roy, and Peter Dorward, St. Mary Axe, London.
2373. Kilns, John Thomlinson, Carlisle, and John Salkeld, Junction-road, London.—6*th June*, 1876.
2381. Planing Metals, Charles Clement Walker, Lilleshall, Salop.—7*th June*, 1876.
2391. Steam Engines, James Cadoux Hudson, Brixton.
2392. Testing Flour, &c., Peter Jensen, Chancery-lane, London.—A communication from Emerich Pekar.—8*th June*, 1876.
2410. Cartridges, William Morgan-Brown, Southampton-buildings, London.—A communication from Benjamin Berkley Hotchkiss.—10*th June*, 1876.
2418. Hauling Gear, George Weston, Sheffield.
2419. Paper, William Edward Newton, Chancery-lane, London.—A communication from Richard March Hoe.
2426. Pasting Labels, William Morgan-Brown, Southampton-buildings, London.—A communication from Fisk Russell.
2429. Ploughs, William Henry Sleep, Crofthole, Cornwall.—12*th June*, 1876.
2443. Braces, Henry John Broughton Kendall, Great Winchester-street, London.—13*th June*, 1876.
2520. Tin Plates, Francis Prange, Liverpool.—A communication from Lewis Mannstaedt.—17*th June*, 1876.
2534. Dye, Alexander Melville Clark, Chancery-lane, London.—A communication from Charles Rave.
2538. Propellers, Charles Neer, Brooklyn, U.S.—19*th June*, 1876.
2546. Pipe Plugs, James Robert Cotton, Bishopsgate-street-within, London.—20*th June*, 1876.
2591. Gas, Thomas Boverton Redwood, Fairlawn, North Finchley, Middlesex.
2594. Governors, Henry Edward Newton, Chancery-lane, London.—A communication from George Steele.—23*rd June*, 1876.
2689. Skins, &c., Alexander Melville Clark, Chancery-lane, London.—A communication from Paul Pansard.—29*th June*, 1876.
2700. Sewing Machines, Lyman Luther Barber, Boston, U.S.
2702. Bolts, Alexander Melville Clark, Chancery-lane, London.—A communication from Bouchacourt et Compagnie and Armand Delille.—30*th June*, 1876.
2735. Lowering Boats, William Robert Lake, Southampton-buildings, London.—A communication from Thomas Thomson.—4*th July*, 1876.
2860. Engines, Robert Douglas and Lewis Grant, Kirkcaldy.—13*th July*, 1876.
2883. Envelopes, William Morgan-Brown, Southampton-buildings, London.—A communication from Marc Spaulding Chapman.—14*th July*, 1876.
2933. Gas, James Steel, Glasgow.—18*th July*, 1876.
2947. Cloth, &c., Christopher Webb Smith, Barnwood, Gloucester.—19*th July*, 1876.
2952. Projectiles, William Morgan-Brown, Southampton-buildings, London.—A communication from Benjamin Berkley Hotchkiss.—20*th July*, 1876.
2972. Bottles, Sigismund Schuman, Glasgow.—21*st July*, 1876.
2973. Photography, William Morgan-Brown, Southampton-buildings, London.—A communication from Louis Ducos Duhauron.—22*nd July*, 1876.
3380. Potassium, Walter Weldon, Merton, Surrey.
3382. Bricks, Walter Weldon, Merton, Surrey.
3383. Furnaces, Walter Weldon, Merton, Surrey.
3384. Sulphide of Sodium, &c., Walter Weldon, Merton, Surrey.
3385. Sulphide of Sodium, &c., Walter Weldon, Merton, Surrey.
3386. Sulphide of Sodium, &c., Walter Weldon, Merton, Surrey.
3387. Sulphide of Sodium, &c., Walter Weldon, Merton, Surrey.
3388. Sulphide of Sodium, &c., Walter Weldon, Merton, Surrey.
3389. Sulphide of Sodium, &c., Walter Weldon, Merton, Surrey.—28*th August*, 1876.
3479. Brine, James Thomas Lockett, Northwich.
3484. Sewing Machines, John Mountain, Birmingham.—4*th September*, 1876.
3507. Tiles, &c., Francis Chamberlain, Barnsley, York.—6*th September*, 1876.
2521. Rousing Liquors, Henry Boddington, jun., Manchester.—7*th September*, 1876.
3539. Sugar, Hunter Henry Murdoch, Staple-inn, London.—A communication from Robert Stothert Kirkpatrick.—8*th September*, 1876.
3558. Roller Skates, Frederick Young, Hackney, London, and Charles Frederick Deacon, Southampton.—11*th September*, 1876.
3578. Harvesters, Bernhard Samuelson and William George Manwaring, Banbury.
3580. Winding Yarns, Howgate Greaves Warburton, Leicester.—12*th September*, 1876.
3598. Lamps, Henry Horton, Finsbury-street, London.
3602. Decanters, &c., James Vernon, Newton Stewart, Wigton.—14*th September*, 1876.
3715. Wood Screws, Thaddeus Hyatt, Hyde Park, London, and Thomas Rickett, Birmingham.
3616. Stops, &c., William Henry Douglas, Stourbridge.
3618. Propellers, Robert Henry Armit, Westminster.—15*th September*, 1876.
3622. Blacking, William Cowper Pellatt, Holborn, London.
3628. Kilns, John Garlick, Birmingham.
2638. Locks, Carl Hermann Wetzel, Aldermanbury, London.—16*th September*, 1876.
3646. Steam Boilers, Charles Denton Abel, Southampton-buildings, London.—A communication from Lebrecht Steinmüller and Carl Steinmüller.—18*th September*, 1876.
3655. Gas, William Foulis, Glasgow.
3661. Steam Boilers, John Henry Johnson, Lincoln's-inn-fields, London.—A communication from Charley Ten Brink.—19*th September*, 1876.
3688. Signalling, William Smith and Richard Robert Harper, Strand, London.—20*th September*, 1876.
3693. Sugar, William Renny Watson, Glasgow.—A communication from David McColley Weston.—21*st September*, 1876.
3714. Iron and Steel, Charles William Siemens, Westminster.
3715. Ornaments, Richard Scully, St. Luke's, London.—22*nd September*, 1876.

All persons having an interest in opposing any one of such applications should leave particulars in writing of their objections to such applications at the office of the Commissioners of Patents within twenty-one days of its date.

List of Specifications published during the week ending 7th October, 1876.

3865, 2s. 10d.; 4039, 1s.; 4206, 2s.; 4285, 8d.; 4288, 8d.; 4348, 4d.; 4353, 10d.; 4420, 4d.; 4460, 8d.; 4481, 8d.; 4498, 10d.; 4501, 8d.; 4521, 10d.; 4527, 2s. 10d.; 4540, 4d.; 315, 6d.; 319, 6d.; 372, 6d.; 381, 6d.; 383, 6d.; 385, 6d.; 387, 6d.; 407, 6d.; 409, 6d.; 412, 4d.; 420, 6d.; 427, 1s. 4d.; 433, 6d.; 436, 4d.; 437, 8d.; 439, 4d.; 441, 6d.; 442, 4d.; 444, 6d.; 452, 6d.; 459, 6d.; 462, 6d.; 463, 6d.; 464, 2d.; 468, 6d.; 470, 6d.; 471, 6d.; 473, 6d.; 475, 4d.; 476, 4d.; 478, 6d.; 480, 6d.; 485, 6d.; 487, 6d.; 488, 4d.; 490, 4d.; 491, 4d.; 493, 6d.; 497, 6d.; 498, 6d.; 499, 6d.; 527, 6d.; 534, 6d.; 535, 6d.; 536, 4d.; 548, 6d.; 552, 4d.; 555, 6d.; 560, 6d.; 572, 6d.; 576, 6d.; 577, 6d.; 581, 6d.; 582, 6d.; 583, 6d.; 590, 6d.; 592, 6d.; 595, 6d.; 599, 6d.; 619, 2d.; 623, 2d.; 635, 2d.; 639, 2d.; 652, 2d.; 658, 2d.; 659, 2d.; 660, 2d.; 663, 2d.; 665, 4d.; 675, 2d.; 675, 2d.; 677, 2d.; 689, 2d.; 686, 2d.; 689, 2d.; 690, 2d.; 691, 2d.; 692, 2d.; 694, 2d.; 697, 4d.; 698, 2d.; 701, 2d.; 702, 2d.; 703, 2d.; 705, 2d.; 706, 2d.; 711, 2d.; 713, 2d.; 715, 2d.; 716, 2d.; 717, 4d.; 722, 2d.; 727, 2d.; 729, 2d.; 731, 2d.; 733, 2d.; 735, 2d.; 737, 2d.; 738, 2d.; 740, 2d.; 741, 2d.; 744, 2d.; 746, 2d.; 754, 2d.; 756, 4d.; 758, 2d.; 763, 4d.; 764, 4d.; 766, 2d.; 767, 2d.; 770, 2d.; 772, 6d.; 776, 4d.; 781, 2d.; 786, 2d.; 790, 2d.; 805, 2d.; 808, 2d.; 813, 6d.; 814, 2d.; 815, 2d.; 816, 2d.; 823, 2d.; 831, 2d.; 833, 2d.; 838, 2d.; 846, 2d.; 847, 2d.; 848, 2d.; 851, 2d.; 852, 2d.; 857, 2d.; 860, 2d.; 863, 6d.; 869, 4d.; 870, 2d.; 871, 2d.; 872, 2d.; 873, 2d.; 874, 2d.; 875, 2d.; 876, 2d.; 878, 4d.; 886, 2d.; 892, 4d.; 893, 4d.; 897, 4d.; 901, 4d.; 906, 2d.; 909, 2d.; 914, 2d.; 915, 2d.; 920, 8d.; 943, 6d.; 960, 2d.; 983, 6d.; 1000, 6d.; 1033, 6d.; 1036, 2d.; 1050, 6d.; 1070, 2d.; 1126, 6d.; 1203, 4d.; 1215, 6d.; 1238, 6d.; 1274, 8d.; 1312, 6d.; 1362, 4d; 1420, 2d.; 1466, 6d.; 1489, 8d.; 1497, 6d.; 1517, 6d.; 1537, 4d.; 1640, 4d.; 1641, 6d.; 1764, 6d.; 1895, 6d.; 1976, 2d.; 2025, 4d.; 2909, 6d.

*** Specifications will be forwarded by post from the Patent-office on receipt of the amount of price and postage. Sums exceeding 1s. must be remitted by Post-office Order, made payable at the Post-office, 5, High Holborn, to Mr. H. Reader Lack, her Majesty's Patent-office, Southampton-buildings, Chancery-lane, London.

ABSTRACTS OF SPECIFICATIONS.

790. Screw Propellers, *H. S. Eyre.—Dated 25th February*, 1876.

This invention relates to screw propellers in which the blades are adjustable by racks. The racks are connected together by a frame or plate, a central opening through which is of circular form. The inner periphery of this plate takes into a circular groove, formed in and around the periphery of a compound ring. At the inner periphery of this ring are recesses to receive the ends of trunnion-shaped projections of a nut which fits on a screwed shaft, capable of being rotated from the deck or other part of the vessel, but arranged to be incapable of longitudinal or end movement. The racks, with their connecting frame, compound ring, and nut, are arranged within the hollow boss of the propeller, and the screwed shaft passes into the boss through a stuffing box, one part of which projects into the hollow boss in the form of a tube, having formed in it longitudinal slots, through which the projections of the nut pass. One method of locking the blades in either of their two extreme positions, is as follows: Only a portion of the periphery of each blade root is formed with teeth, the outer extremities of these teeth are of the same radius from the axis of the blade root as is the plain circular part of the root. On this plain circular part are formed, at each side of the series of teeth, flat portions, so arranged that when the racks have been moved right home in either the forward or backward direction, one of the flat parts of the boss will bear against a corresponding part of the neighbouring rack; thus the root will be, as it were, jammed up, and the blade will be held

in the position to which it has been moved. According to another method, each blade root is made with a circular flange, formed on a part of its circumference with ratchet teeth to receive a pawl having its axis in the body of the boss; the pawl is pressed towards the flange of the blade root by a spring and is moved out of gear by the movement of the free end of a small lever, having its fulcrum on the boss and provided with a projection which acts upon a cam-shaped part of the pawl, the free end of the lever being moved as required by pins or projections on the flange. It will be evident that the improvements may be carried out in various forms, without departing from their distinctive character.

791. Stoppers, *E. Breffit and T. Neville.—Dated 25th February*, 1876.

This invention relates to stoppers for bottles known as patent stoppered bottles, in each of which there is a flexible lining of cork or other material resting on a bearing shoulder, and into which is inserted the stem or plug of the stopper, the head forming a cover; and the improvements consist in forming two grooves or sluices opposite each other in the stem or plug of the stopper, one groove for the admission of air, and the other to be used as an outlet for the contents of the bottle, and the inventors also make the head of a beak shape with swells or curves on the under-side, which, when pressed down on to the cork or other lining, excludes the air and prevents leakage.

792. Needle Machines, *E. T. Hughes.—Dated 25th February*, 1876.

This invention relates to the construction of a machine for the manufacture of that class of sewing machine needles in which the body of the needle is reduced from the shank, the object of the invention being to present the needles to, and rotate them in their passage over, the longitudinal surface of a grinding cylinder; and the invention consists principally in a feeding device composed of notched detachable plates, combined with mechanism to impart a progressive movement thereto.

793. Drilling and Breaking Down Coal, *J. G. Jones.—Dated 25th February*, 1876.

This invention relates, First, to improvements in apparatus for boring or drilling holes in coal, stone, or other minerals, preparatory to breaking the same down by blasting, or by mechanical means, as is well understood. Heretofore the drills or tools employed for boring or drilling holes in coal, stone, or other minerals, have been fed forward by means of a screw, working through a fixed or a slip nut, or between worm wheels on each side of the screw, having brake power applied to them in order to offer a force equivalent to the varying resistance of the mineral to be perforated. Where two or more of such worm wheels are employed on opposite sides of the screw, it is impossible to bore or drill a hole close up to the roof, bottom, or sides of the surface of the coal, stone, or other mineral, as the drill cannot be placed nearer to the sides, top, or bottom, to drill a parallel hole with the sides of the working than the diameter of one of the worm wheels will allow, and the object of this part of these improvements is so to arrange apparatus of this character that only one of such worm wheels are required, and thereby simplifying the apparatus and rendering it suitable for boring or drilling holes in any position or direction required. Another part of these improvements relates to improved methods of actuating the screw which carries the drill, or tool for drilling or boring holes in coal, stone, or other minerals. The methods for causing the tool or drill to cut or operate at each movement of the actuating lever may be applied, according to another part of these improvements, to the ordinary ratchet brace, so as to facilitate the drilling of holes in metal or other substances. In the specifications of letters patent granted to the said James Grafton Jones, and dated respectively the 18th June, 1867, No. 1783, and the 4th October, 1869, No. 2878, arrangements of wedge apparatus were described for the purpose of inserting into holes, drilled into coal, stone, or other minerals, in order to break down the same. In the said specifications, mechanical means were described for forcing the wedge employed into and between segments in order to expand the same, and the object of this part of these improvements is to dispense with the means employed for forcing or driving in the wedge, and thus greatly simplifying the apparatus and reduce its cost. For this purpose the segments and wedge only are employed, and when the segments are introduced into the hole previously bored or made, the wedge is driven between them by means of a sledge hammer or ram by manual power.

794. Rock Boring, Tunnelling, and Shaft Sinking, *H. N. Penrice.—Dated 25th February*, 1876.

This provisional specification describes producing tunnels or shafts by means of a machine cutting an annular groove in the face of the rock. The bore is then enlarged at the top and sides to allow the body of the machine to pass, and to allow the core and *débris* to be carried back over the machine. The lower part of the bore is left intact, that the machine may slide truly upon it to and from the working face. The machine has chisel-like cutters, set circumferentially upon the head of a ram they act percussively. Two or more cylinders are set one behind the other to actuate the ram, thus sufficient power is obtained within the space available.

795. Bricks, *C. Wood.—Dated 25th February*, 1876.

This provisional specification describes arranging a number of sand cores or mould in a block, and running furnace slag in amongst them. The block is left unbroken until it has cooled.

796. Pumps, *E. G. Brewer.—Dated 25th February*, 1876.

The application to, and construction of, pumps with two or double screws; the lower revolves and the upper may be fixed. The screws are preferably of different pitch; the upper is conical and in tube of corresponding shape.

797. Refining Ozokerit, *C. M. Pielsticker.—Dated 25th February*, 1876.

This invention relates to a process of refining crude ozokerit without distillation, and without pressure, also to a saponification process for precipitating the carbonaceous particles and impurities, and removal of colouring matter in the refining of crude ozokerit.

798. Thrashing Machines, *C. Pieper.—Dated 25th February*, 1876.

The object of this invention is to decrease the power required for driving thrashing machines, and for this purpose the inventor constructs the drum as well as the cage of the same of a conical shape.

799. Regulating the Flow of Fluids, *J. Howard.—Dated 26th February*, 1876

To the main water supply tap the inventor attaches an apparatus constructed substantially as follows:—A cylinder of brass or other material having one end clothed by a cover, through which he makes an outlet, to which a tap can be attached, is fitted with two metal discs, both of them having a seating turned at one end or a leather washer attached, one of them having a cup leather secured to the reverse end. This disc, which he prefers to be solid, has a hole drilled through it, which he partially closes with a regulating screw. He fixes the cylinder containing the discs above the water way of a cottage or other valve having a seating; when water is allowed to enter the pipe leading to the seating it forces the two discs into the cylinder, and the water passes through the water way, the upper disc being held firmly against the top of the cylinder closes the outlet in the cover, and the water forcing through the hole in the other disc pushes it down upon the seating of the water-way pipe, closing it. When the main supply tap is closed the upper disc frees itself from the outlet and returns to its original position. He sometimes places the cylinder below the valve, in which case he only uses the disc fitted with a cup leather and closes the way through it, admitting the water to raise it by a tube attached to the water-way pipe.

800. Self-Securing Skate, *J. M. Lamb.—Dated 26th February*, 1876.

In having the sole plate made in one piece containing the toe clips, and being so constructed as to fit on a specially prepared runner as to need no screws, rivets, or bolts, and in having a lever fastened on side of runner which propels the sole plate forward and backward, the toe clips moving with the sole plate in which they are adjustable. The heel plate being made separately and adjustable with a clamping nut and bolt, so as to fit any size boot or shoe.

801. Purifying Middlings, *C. Redwood.—Dated 26th February*, 1876.

This invention relates to apparatus used for purifying coarse kind of flour called middlings by removing or separating dust, bran, and other extraneous matter therefrom. The inventor dispenses entirely with the silks or sieves hitherto employed in such machines, and he effects the purification or separation by a series of air currents in combination with an inclined shaking lattice platform made of laths; the flour being caused to pass evenly over the inclined lattice platform, whilst the air currents coming through the interstices pass through the flour or middlings and carry away the dust and bran.

802. Producing a Continuous Current of Electricity, *W. J. Kilner.—Dated 26th February*, 1876.

The invention consists of a circle of soft iron, having coils of wire round it, and these coils are terminated by metal knobs or brushes. There are one or more rotating magnets, either within or without, or partly within and without, to produce a current of electricity. The electricity is collected by means of circular moving collectors. The tension of the current is altered by having each of the aforesaid coils of wire composed of several wires and using them in different combinations.

803. Roller Skate, *H. Low.—Dated 26th February*, 1876.

A skate is only useful by which a curve can be described by it, and according to this invention, a roller skate is arranged with rollers, of which the middle roller, or one or more rollers in the middle, is or are deeper than the others. The running surface of the rollers are either globular or partly globular, and by the pressure of the body on the middle or one of the middle rollers, which is or are deeper than the others, the skater is enabled, during the time that the pressure of the body is on the middle or deeper roller, to turn the feet in any direction, and by this means produce any desired curve. The skate itself consists of a footboard of either wood, metal, or any other suitable substance, to which are fastened three or more rollers on parallel axles one behind the other, which axles can be either firm or loose, but the middle roller or rollers must be deeper than those at the extremities, so that the middle roller or rollers, which is deeper, touches the ground alone, when put on a flat or plane surface, which surface cannot be touched with all the rollers at the same time, and this is brought about by making the middle roller or rollers larger than the others, or raising sufficiently the middle axle or axles, in which latter case the middle roller can be made of any size.

804. Reducing the Condensation of Steam, *H. G. Hautermann.—Dated 26th February*, 1876.

According to this provisional specification, non-conducting materials and air spaces are applied in a variety of ways for the purposes mentioned in the title.

805. Steam Boilers, *J. Wilson.—Dated 26th February*, 1876.

This invention mainly consists in the adoption of three circular fireboxes fitted with fire-bars in the usual way, terminating by the bridge; the flues conveying the products from the furnaces, however, should be oval, as by the flues being of that form the cross tubes for giving more heating surface are fitted with greater ease than heretofore, and almost any number of tubes can be fitted. Other incidental arrangements are described.

806. Knitting Machinery, *S. Frith.—Dated 26th February*, 1876.

The invention consists in employing a single presser working behind the sinkers in rib frames to act upon both sets of needles; or two pressers so placed may be employed. Also in placing a shifting apparatus at the back of the sinkers to shift the loops of the frame course, and a shifting apparatus in front of the machine needles to shift the loops of the machine course.

807. Towing Steamer, *F. J. Meyer and M. Wernegh.—Dated 26th February*, 1876.

Cable passes over two coupled drums along centre of vessel; there is a movable truck with peculiar guide pulleys at each end of vessel.

808. Signalling on Railways, *J. Robinson.—Dated 26th February*, 1876.

A semaphore on each side of each carriage is actuated by passenger, and simultaneously with the lifting thereof, a bell rings in van, and a lamp at side of carriage is ignited, applicable to goods and passenger trains. Similar contrivances may be fitted to signal boxes.

810. Middlings' Separators, *J. Walworth. — Dated 26th February*, 1876.

This invention relates to separating and purifying middlings flour or fine sharps, also in separating wheat, rice, or other grain. Two rollers having an endless apron are fitted across the apparatus and made to revolve by gear; above the apron is fitted a hopper with open top and bottom, and an opening is left between the bottom of the hopper and apron for the middlings or fine sharps to pass on to the travelling apron, which carries a thin feed all the width of the apron, and arriving at the end falls on to a slanted board, and thence into an upright exhaust chamber and into three, four, five, or more upright exhaust chambers, through which a strong current of air is drawn, a fan or blower lifting the light branny particles and fine middlings into a chamber having an opening at the bottom, delivering the middlings on to a silk oscillating sieve; the brown particles pass off on the top of the sieve, and the fine white particles through the sieve into a chamber. The heavier particles or coarse middlings fall at the bottom of the exhaust chamber on to a coarse silk oscillating sieve, separating the unground flour from the coloured portion. For separating wheat, rice, or other grain, a similar apparatus is employed, but without sieves.

811. Artificial Fuel, *J. H. Johnson.—Dated 26th February*, 1876.

This invention, relating to apparatus for the manufacture of artificial fuel, has reference more particularly to the machinery for forming the blocks, also to the arrangement of the kneader or pug mill which, according to this invention, is placed in the centre of the machine and between two compressing apparatuses which form the block, the machine being double-acting and forming two blocks at a time. Two conduits, by preference of sheet iron, closed by a door at their upper part, serve to bring the mixture from the kneader or pug mill into the moulds.

812. Burning Lime, *H. J. Walduck.—Dated 26th February*, 1876.

This invention consists in burning lime by the ignition of inflammable gas. In performing this invention the inventor erects a gas retort or other apparatus for generating inflammable gas from coal or other material, and he conveys the gas from the retort or other apparatus to the lower end of a vertical or diagonal kiln or oven, in which the lime is placed. He employs an oven with an inclined floor to admit of the limestone being fed from the higher side and drawn when burnt through an aperture at the lower side.

813. Ice, *T. M. Nishigawa.—Dated 26th February*, 1876.

This invention relates to improvements in the manufacture of ice, and is applicable to the formation of skating rinks; it also relates to machinery or apparatus to be used in this manufacture, and for cooling or refrigerating liquids, and other similar purposes.

814. Roller Skates, *R. Hambling and G. Bowles.—Dated 26th February*, 1876.

The feature of novelty of this invention consists essentially in forming the soles of roller skates, divided crosswise and jointed or pivoted at such divided parts to enable one part of the sole to be capable of moving horizontally sideways, by which the rollers—which may be of the ordinary kind, two in front and two behind—are enabled to move in a curved direction when required, without canting or rocking the sole to effect that object, as is now practised in the construction of some roller skates, to enable them to move in a curved direction.

815. Artificial Ice Rink, *H. Low.—Dated 28th February*, 1876.

A rink or surface of real ice requires a low temperature, which is not only expensive to lay down and to maintain, but very injurious to health in warm weather. Now, according to one part of this invention, this improved rink or skating surface does not depend upon any particular temperature, but can be used in any climate and at any degree of cold or heat. This improved rink or skating surface is made of common or rock salt, which is applied either by melting the same and pouring it into the ground intended for the rink, or by paving the ground or surface with blocks of salt, or by macadamising the rink with broken salt. Any other suitable salt, such as sulphates, alum, or gypsum, may be substituted for common or rock salt in accordance with this invention.

816. Fettling Puddling Furnaces, *T. H. Hickman.—Dated 28th February*, 1876.

The mixture consists of the following ingredients, namely, antimony, sal-ammoniac, nitrate of potash (saltpetre), and ferrocyanide of potash, prussiate of potash. When used in fettling puddling furnaces salt is added to it, and the whole is thrown into the furnace and stirred with the fluid cinder after the heat is withdrawn. The cinder must be flashed first and the damper kept down during the stirring. The cinder when tapped and cooled may be used for fettling without being calcined. The quality and yield of the wrought iron are thus improved, but the quality may be further improved by adding a small quantity of the mixture to the molten metal in the furnace. The quality of cast iron is improved by adding the mixture when the iron is in a molten state.

817. Bricks, *C. H. Green.—Dated 28th February*, 1876.

The invention relates to a machine in which the pug-mill is mounted horizontally, and the mould wheel is upon a horizontal shaft above the pug-mill shaft, with the moulds arranged so as to pass properly across the delivery end of the pug-mill in the lower part of their circuit.

818. Application of Electricity for Disinfective and Curative Purposes, *J. E. Molesworth.—Dated 28th February*, 1876.

Plates are fitted to a chair and put in connection by insulated wires with a battery under the chair. The plates may be loose and depressed to make contact, or screws may be fitted for that purpose.

819. Plaiting Textile Fabrics, *W. Tucker.—Dated 28th February*, 1876.

This invention consists in a machine with rollers heated by gas or other means, and two rocking and reciprocating parallel knives, plaiting and carrying, or feeding the plaits into the rollers for pressing and delivering.

820. Linen Towelling, *C. J. Webb and R. T. Webb.—Dated 28th February*, 1876.

This provisional specification describes a novel mode of weaving towelling by grouping three or more threads together in such manner that they shall present a neat appearance; the towelling shall be woven with unexampled rapidity, and it shall be very retentive of moisture. Also an arrangement of loom for quickly weaving the same, also a mode of finishing towelling.

821. Mending, Joining, or Fishing Broken Shafts, *S. Bellotti and G. de Chock.—Dated 28th February*, 1876.

This invention relates to apparatus for mending or joining broken shafts, axles, springs, masts, oars, ladders, and every kind of rod which may be broken. It is composed of two, three or a greater number of rings or collars opening on a hinge and closed by a screw or catch. These rings are connected by longitudinal bar splints or fishes, some of which form part of or are cast with one of the two jointed parts of the collar, so as to form one whole, the others, similarly arranged to the first, being attached to the other jointed part of the collar, by screws placed in these latter, the tightening or loosening of these screws decreasing or enlarging the circle of prehension of the apparatus according to the thickness of the pieces to be joined. The pressure of the splints is also given by these screws, which are pointed so that the pieces to be joined are not only held together by pressure but also by penetration, whereby any longitudinal slipping of these pieces after being seized by the apparatus is avoided; pins or projections may be carried by the splints for the same purpose, and the longitudinal bars or splints may be jointed lengthwise to accommodate themselves to curved shafts or other curved pieces.

822. Warming and Ventilating, *W. Weems.—Dated 28th February*, 1876.

The aggregation of heated surfaces within a limited compass. Combination of steam and hot water for heating buildings, heating apparatus combined with air and water discharger. Self-acting governor for controlling the temperature.

823. Belting Bands, *R. Lowndes and E. Wilkinson.—Dated 28th February*, 1876.

The features of novelty in this invention consist in applying one, two, or more strips of metal—preferably of finely tempered steel—to the back of belts, bands, or flat ropes, as described, whereby they are rendered stronger, lighter, and more durable than heretofore.

824. Lubricant, *G. Newton.—Dated 28th February*, 1876.

This invention mainly consists in an improved lubricant, composed in stated proportions of tar oil, rosin oil, or other suitable oils, tallow or other grease, caustic or other soda, pitches and limes, in suitable proportions, as found applicable for various kinds of machinery or rolling stock.

825. Cleaning Knives, *C. T. Guthrie.—Dated 28th February*, 1876.

This invention has for its object the self-adjustment of the cleaning surfaces to the sectional form of the blades and the cleaning of both sides simultaneously. The cleaning surfaces are formed of superposed facings of leather bedded against layers of india-rubber; the bottom one is arranged so as only to allow of its removal for renewal, and the top one is placed in suitable guides, and directly above it and in this top one is made a recess (provided with a cover) to contain cleaning or polishing powder, and in the bottom of such recess are made small holes so that the powder may escape to between the cleaning surfaces, which are kept in close contact by elastic pads attached to a hinged cross bar secured by a spring catch. This apparatus may all be arranged and combined upon a small foot or bedplate, which may be secured by screws or otherwise to a table or support. The above-described arrangement may be amplified to any extent required.

826. Driving Belts, *T. Aitken.—Dated 28th February*, 1876.

In the construction and manufacture of driving belts according to this invention, the inventor employs a strong and woven fabric composed of many warps—by preference of cotton—and treats, tempers, and consolidates the same when woven by means of boiled oil and squeezing rollers. He uses four, five, or more warps, according to the strength and thickness of belt required; the several warps are operated by ordinary heald mechanism, so that different "sheds" are presented for the passage of the shuttle and weft thread, whereby both warp and weft are thoroughly interlaced and woven, and a strong and closely woven material with perfect selvages is produced.

827. Expansion Gear, *M. A. Starke.—Dated 28th February*, 1876.

This invention is applicable to all classes of machines, the principal parts of the gear being, First, a valve chest with expansion valve and disposition; Secondly, gear with pawls and regulation arrangement. The box of the new expansion valve is bolted to the flange of the old valve chest instead of the throttle valve, in such a way that the valve stands vertically. The lifting of it is effected by the expansion gear at each stroke, and so that it remains unaltered in an open position during the period of full pressure, the shutting of the valve depending on the governor.

828. Splitting and Dividing Wood, *J. Rowley.—Dated 28th February*, 1876.

This invention relates to improvements in machinery or apparatus for cutting, splitting, rending, and dividing wood, by means of reciprocating cutters, and in apparatus for making up the same into bundles suitable for being used for lighting fires, for laths, or other purposes.

829. Earthenware Pipes, *J. W. Dennison.—Dated 28th February*, 1876.

This invention relates to improvements in pottery or earthenware pipes, whereby certain shaped pipes of stoneware or similar material can be made in conjunction with certain shaped brackets or clips of terra-cotta or similar material, practically available for conveying rain water from roofs of buildings, and for other similar purposes.

830. Kilns, *T. Whitwell.—Dated 28th February*, 1876.

In making bricks, long kilns or chambers are employed, the bricks are loaded upon wagons and are caused to enter the cool end of kiln or chamber, and to advance forward to the hot end of the same at a suitable speed.

831. Gas Lighting Apparatus, *J. A. McEvoy.—Dated 28th February*, 1876.

This provisional specification describes combining an electrical contact maker with the handle of a gas tap, in order that each time gas is turned on to a burner it may be simultaneously lighted by electricity.

832. Regulating the Flow of Fluids, *H. Jenkin.—Dated 28th February*, 1876.

This provisional specification describes, First, an apparatus for causing a constant flow, which consists of two vessels separated by a partition through which passes a plunger which is attached to an equilibrium valve admitting fluid into the first chamber. The fluid passes through an aperture in the partition from the first to the second chamber. The difference of pressures in the two chambers is kept constant by the motion of the plunger which opens or closes the valve. Secondly, an apparatus for causing a constant flow which is similar to the above, but has instead of the plunger a compressible float in the second chamber which is attached to the stem of the valve, and which by its change of displacement, and consequent rise and fall, keep the pressure in the second chamber constant.

833. Roller Skates, *W. E. C. Stanhope.—Dated 28th February*, 1876.

Two wheels are placed centrally and longitudinally of the foot-stand, and are mounted in bearings in swinging frames which are pivoted to, and horizontally on vertical pivots.

834. Feeding Fuel into Furnaces, *W. C. Ford.—Dated 28th February*, 1876.

This invention is for supplying small pieces of coal from a hopper upon a deflector plate, from which the fuel is scattered over the fire in the furnace by the force of a jet of steam or air, or both combined. The deflector plate is preferably movable, so as to be pushed slightly into the furnace through the opening in the plate or wall, and slides are provided to regulate the flow of fuel from the hopper, and to close the opening into the furnace.

836. Improved Electro-Magnets, *P. Jablochkoff.—Dated 29th February*, 1876.

This invention relates to an improved construction of electro-magnets, wherein the conducting coils are brought into direct metallic contact with the soft iron core. For this purpose he employs for the conducting coil, by preference, a thin metallic band coiled up the core in such a manner as to have one of its edges in direct metallic contact with the core, while the flat surfaces of the successive coils are separated from each other by an interposed band of non-conducting material, such as paper.

837. Screwing Machines, *W. Kendall.—Dated 29th February*, 1876.

This invention relates to screwing machines, in which the dies are withdrawn by the action of a sliding cam ring. The said cam ring is formed with an incline or cam, and an anti-friction bowl is mounted so that it can be moved by the action of a spring into position for the said cam to act upon it. The said spring is released by the carriage when the screwing is completed, and the dies are then withdrawn from action.

838. Tanning Hides, *L. H. Tramier.—Dated 29th February*, 1876.

The inventor injects carbonic acid gas, or the gases resulting from combustion, into the tanning liquid, and sometimes uses a weak acid liquor. The skins and the liquid are kept in motion and in a state of agitation.

839. Public and other Clocks, *J. G. H. Hoch.—Dated 29th February*, 1876.

The movement or works are enclosed in the hands of the clock or within the dial when necessary. The dial to be illuminated within its chamber.

840. Fog Signals, *W. Worthington.—Dated 29th February*, 1876.

Many railway accidents occur from want of properly placing fog signals, and at given times in dangerous places. This invention has for its purpose an apparatus which will entirely overcome these difficulties, as it may be charged with a number of signals under the command of a signalman at any reasonable distance, or may be acted upon by a passing railway vehicle or the action of any other signal apparatus.

841. Sample Envelopes or Bags, *E. A. Makin, C. W. L. Makin, and B. Marcroft.—Dated 29th February*, 1876.

This consists in forming envelopes or bags for samples and letters with two pockets. The paper, cloth, or material is first cut to the required form, then the edges are gummed and folded over, afterwards the material is doubled until the two pockets are formed each one with a closing flap.

842. Meters, *P. Jensen.—Dated 29th February*, 1876.

The meter is made with a revolving wheel within a case, and at the end of a pipe that supplies the water into the case curved or inclined wings extend from the periphery of the meter wheel down around the inlet pipe, and the water issuing between the inlet wheel and pipe rotates the wheel. The portions of the wings that are in quiescent water form resistances, and as the meter wheel rises to accommodate the increased volume of water, the resistances become less, and consequently the speed increases. A deflector directs the water out horizontally.

843. Telegraphy, *P. Jensen.—Dated 29th February*, 1876.

Relates to La Cour's telegraph system patented 2nd September, 1874, No. 2999. Tuning fork of transmitter vibrating constantly. Isochronously vibrating currents by induction. Using a very small tuning fork on the receiver.

844. Pressing, *L. Smethurst, S. Shaw, and T. Shaw.—Dated 29th February*, 1876.

This consists, First, in covering the hollow pressing plates with woven or felted fabric or other suitably prepared soft or elastic material, in sheets or as a padding or wadding between the paper boards and e

plates. Secondly, in so constructing and arranging such machines as to be self-acting in charging the hollow plates with heating medium or cold.

845. Horseshoes, *M. Smith.—Dated 29th February*, 1876.

This relates to improved interchangeable applicances for roughing or sharpening the shoes of horses during frosts, and appliances for ordinary wear without removing the shoes from the feet. In connection with the front "cogan" the inventor employs a plate branching at right angles therefrom, one end of the plate being turned up to form a hook, which embraces the inner edge of the shoe; and the other end of said plate terminates in a tongue or lock-piece which passes through an eye formed in a projecting part of the shoe; in another method the plate ends are of hook form to clip the inner and outer edges of the toe of shoe. The plate is secured by a screw in conjunction with the "cogan" pin, and the "cogans" are made rounder or elliptical to avoid the wedge form.

846. Wooden Structures, *H. Westman.—Dated 29th February*, 1876.

The novelty of this invention consists in shaping waste pieces of wood, such as short ends or the like, into geometrically shaped blocks, and subsequently utilising them for building purposes.

847. Regulating Valves, *A. Elliott and C. Burnett.—Dated 29th February*, 1876.

The inventors use an eccentric or crank in combination with an ordinary mushroom or other suitable valve, so arranged that the valve may be opened or closed by the crank or eccentric, which may be actuated by a hand wheel or lever fixed on a spindle which passes through a stuffing-box, and to which the eccentric or crank is attached.

848. Tap for Water, *C. Banks.—Dated 29th February*, 1876.

The inventor provides a suitable piece of tubing, which is so constructed or jointed as to form an elbow, and at that end of the said elbow joint which is attached to the supply pipe it is enlarged sufficiently to allow of a valve seating to be performed. Against this valve seating comes the stop valve, which is constructed of any suitable material, and the flow of liquid constantly pressing this valve upon its seating, the normal tendency of the tap will be to be closed, and, as will be readily understood, the greater the pressure of water the more securely will the tap be closed.

849. Lock, *W. E. Gedge.—Dated 29th February*, 1876.

This invention relates to the description of locks known as stock locks or French locks, and consists in manufacturing them entirely without springs, the bolt being driven by a solid piece acting simply by its weight.

850. Roller Skates, *G. Chapman.—Dated 29th February*, 1876.

The invention consists in placing two rollers or wheels on the outside of the skate and one on the inside thereof, the latter being intermediate of the former.

851. Rink Skates, *J. Cole, sen., and J. Cole, jun.—Dated 29th February*, 1876.

Making roller skates with either three or four wheels, one at heel, two near toe part, and one at toe; a cross piece supports the bracket carrying the fore wheel's axles, which is sometimes made to act as spring.

852. Desulphurising, Roasting, and Drying Ores, *S. J. Thomas.—Dated 29th February*, 1876.

The apparatus described in this provisional specification consists of a tower, through which the heat and products of the furnace ascend whilst the ore which is put in at the top descends, falling over a series of traps and discs. The discs are rotated to keep the ore in motion.

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

(From our own Correspondent.)

The Wolverhampton and Birmingham quarterly meetings were held yesterday and to-day—Thursday. The great attendance of last quarter day was exceeded, and there appeared more anxiety about the course of prices. No alterations were made in the prices of finished or pig iron or coal, and this led to negotiations upon last quarter's basis. Owing to the large sales of pigs which had taken place in the previous few weeks, they were not in much request. Makers were, however, firm in all cases. An advance of 2s. 6d. over previous transactions ruled the few purchases which were reported. Nevertheless good hematites might have been obtained at from 70s. to 72s. 6d., but Staffordshire all-mine could not be got at all under £4 5s. From 60s. to 62s. 6d. were the rates for Derbyshire medium qualities, and up to 70s. for the better qualities of Derbyshire and Yorkshire. At £2 15s. common cinder qualities of Staffordshire make were abundant.

At under the rates regulated by £9 12s. 6d. for Earl Dudley's bars and £9 for B.B.H. bars, best marked iron could not be had. Bars of a capital quality were in large supply at £8 10s. Between that price and £6 15s. (which is now the minimum quotation for common Staffordshire bars), various figures prevailed. Various prices were asked for sheets (singles) from £10 down to £9; and at £9 10s. a fair quality was to be had. Great endeavours to get £8 were made by established hoop firms, but they had to meet the competition of men who quoted one or two figures between that and £7 10s. delivered in Birmingham. Keen buyers could not get strips at under £7, and £7 2s. 6d. to £7 5s. were the quotations of makers generally. From £11 down to £10 was asked for good boiler plates; but £9 10s. was the price for girder plates.

Of the two there was more disposition to purchase finished iron than was observable three months ago. The orders upon the market, however, cannot be characterised as either numerous or of great aggregate worth. The inquiries touching best iron were, nevertheless, less insignificant than has lately been usual. In relation to medium and common qualities, indeed, a similar condition of things was observable. However, this does not mean very much, since specifications for quantities at one time demanded from mill and forge proprietors in Staffordshire were very rare.

Coal, for ordinary forge qualities, was very strong at from 7s. 9d. to 9s. 6d., and 11s. for furnace coal mined East of Dudley. That all fears of a further advance before winter is over have passed away, the market was by no means satisfied. Than for three weeks past, there was, however, much less apprehension under this head. The understanding now is that Earl Dudley will not advance his coal unless the Cannock Chase Colliery proprietors should make a further rise upon their recent advance of 1s. per ton.

At the Michaelmas quarterly meeting in Birmingham last year there was a painful anxiety about the action of the colliers, lest they should resort to force to get the rise for which they were then clamouring, and this made makers of iron generally disinclined to book forward. Transactions were reported in all departments, but they were only for small quantities, and prices were strong in every branch. No alteration was made in the crucial prices of pig iron. Mr. Lloyd, the manager of the Lilleshall Company, Shropshire, declared that there would be no alterations in the quotations of his firm; Shropshire cold blast pigs were therefore £6 and hot blast £4 15s. a ton. The chief Staffordshire makers acting in unison with Shropshire, prices of native pigs were mostly unaltered. Staffordshire all-mine were £4 10s. to £4 15s.; pigs containing a small proportion of cinder were £3 5s.; and cinder pigs proper were strong at £2 15s. Finished iron remained as before, the prices ranging for bars from £10 and £10 12s. 6d. down to £7 17s. 6d.

At the corresponding quarterly meeting in Wolverhampton in 1874 prices were maintained on the basis of £12 a ton for marked bars, but on the morrow in Birmingham the price list of marked iron was reduced £1, or to the basis of £11 for bars, with the usual extra 12s. 6d. for Earl Dudley's make. At the same time the Lilleshall Pig Making Company reduced prices 10s. a ton, which left cold blast at £6 10s. and hot blast at £5 5s.

No drop was declared in either pig or finished at the first quarterly meeting this year (in January) in Wolverhampton. Prices all round were declared without quotable change upon the basis of £6 for cold and £4 15s. for hot blast pigs of the Lilleshall Company, and £10 12s. 6d. for Round Oak bars. Pigs were very strong, and the leading brands in other districts were declared to have been sold to the extent of the output for a few months to come. The all-mine pigs of Staffordshire were quoted £4 15s., and the best brands were hard to get at under 2s. 6d. below that figure. The demand for finished iron, whether of the best or of a medium, or, indeed, the cheapest, quality, was not at all active; still makers were firmer in their quotations, by reason of the high price of pigs, than they would otherwise have been. The minimum quotation for bars was £8, and no difficulty at all would have been experienced in placing orders for singles at £11. Messrs. Baldwin's minimum quotation was £13. Coal was less difficult to get than before Christmas, both at Cannock Chase and about Dudley, and throughout the Black Country generally. Prices were based upon the quotation of 13s. for furnace coal.

At the Wolverhampton April Quarterly Meeting a reduction took place. The Lilleshall Company officially dropped their pigs 10s. a ton, making their cold blast £5 10s. and their hot blast £4 5s. What course it was the intention of the Earl of Dudley, Messrs. Ward and Sons, Messrs. Williams, Messrs. Barrows, and the other leading makers of pig and finished iron, to take, was not made known. The Cannock Chase Coal Company had a day or two previously reduced their prices in amounts ranging from 6d. up to 3s. per ton (leaving their best yard coal from 14s. 6d. to 12s. 6d. a ton), and the market took it for granted that there would be a reduction likewise in Dudley and Staffordshire coal, with a drop in marked iron of 20s. a ton. Such a drop was not, however, declared on that day. Still iron of second and third-rate qualities might have been bought at £1 under the quotations of the previous quarterly meeting. At Birmingham on the next day (April 13) all classes of traders were disappointed. No reduction was declared in the standard prices of either coal or manufactured iron. At this time only 58 of the 148 furnaces built in South Staffordshire were in blast.

On Friday, April 21st, however, the principal coalmasters of South Staffordshire and East Worcestershire met at Dudley, and after an hour's discussion it was agreed that Lord Dudley's furnace coal should be reduced from 13s. to 11s. a ton. Subsequently, Messrs. E. P. and W. Baldwin and another conspicuous sheet firm dropped prices £1 a ton, and in Birmingham on April 27th the principal list houses reduced marked bars £1 a ton, making the standard £9, with the usual 12s. 6d. extra for Round Oak. Common unmarked bars were then selling at £7 10s., and, of course, the above-mentioned drop did not apply to them. Plates fell 20s., and Messrs. Barrows, by reducing their qualities 40s. a ton, brought their quotations down to a level with those of the trade generally, in advance of whom Messrs. Barrows had previously been by £1.

At the Midsummer quarterly meeting this year in Birmingham, and also at Wolverhampton, prices alike for raw and finished iron were declared unchanged upon the above quotations. But little else than a disposition to throw feelers was to be noted. The Lilleshall Company announced at the commencement of business that their rates would remain as last quarter, viz., hot blast £4 5s., and cold blast £5 10s. long weight. Staffordshire all-mine pigs were stronger than they had been, consequent upon a reduction in make. Hematites were freely offered at £3 12s. 6d. short weight, at which figure a good sample of part Staffordshire and part Northampton pig was also to be obtained, long weight. Quotations for finished iron were maintained upon the basis of £9 for bars. A fair quality of singles might have been got at slightly under £9 10s., whilst others were tolerably firm at a little less than £10, and "Severn" singles were quoted at £13, and I.B. quality of the same firm, Messrs. Baldwin, £16 per ton. Common bars were to be had at £7 as a minimum; but the more frequent quotations were £7 10s. and £7 5s. Colliery proprietors reported that hardly a third of the coal, which in ordinary times, the pits would be yelding, was brought up. Furnace coal was freely offered at 7s. a ton; a fair quality was to be bought readily at from 7s. 6d. to 8s. 6d., with two tons in upon a boat load.

Throughout Birmingham orders on home account are those which are just now mostly occupying the hands. Those orders, however, while they indicate that there are necessities which have been long unexpressed, and which are now beginning to find vent, are not of anything like sufficient extent to occupy all the hands who have for the past month or two been engaged on foreign orders, but who, now that the navigation season is over, are needing new orders. The current requirements of buyers are small, and in some instances unprofitable. Some amusement has been created in the fire-arm departments by a report that a City firm had received a commission from Birmingham to sell 150,000 Sniders, and that that commission had been executed, and the arms sold to "a foreign-looking individual." The report further says that these 150,000 arms, together with 30,000 more of the same description purchased from Birmingham, have been shipped for Servia. The tale is regarded in Birmingham as apocryphal. In the districts lying around Birmingham the orders received from the European Continent are fairly encouraging considering the condition of affairs there. The Baltic trade is now fast closing. Makers of marine ironwork have had a fair time of it; but their home prospects for the winter are not encouraging. Manufacturers of iron padlocks, traps, and wrought nails, have not sufficient work for their workpeople, many of whom are on short time. Those among the latter who make spikes and large nails have reduced wages 10 per cent., or 6d. per cwt. The dispute in the chain trade continues, and with no prospect of its settlement. One or two employers have acceded to the men's demands, and given them the 10 per cent. rise. This, while it is alleged to have been done simply to secure the execution of pressing orders, is loudly complained of by other makers. It is ascertained that it will cause ships' chandlers, who about now place some orders, to withhold them under the impression that the concession is general, and that to make inquiries now will only strengthen prices. The difference between the brass padlock smiths and their masters was settled on Monday by the latter agreeing to pay the men a rise forthwith of 7½ and the remaining 2½ in January, making the total 10 per cent. which the men struck for six months ago. The advance is to be upon a list issued to the trade some three years since. The customary trade notice has been given to merchants and factors of a proportionate rise in the price of brass pads, as the result of this concession. Brass pads of the better sort will soon be made out of sheet brass stamped as well as out of brass castings. A manufactory for the purpose, to be furnished with specially made stamping machinery, is now in course of erection in the town. Birmingham engineers and machinists complain of the limited amount of foreign business now in hand; nor are the engineering firms in the surrounding districts any better off. The prospects of the winter are bad, but they have been worse.

Worse, however, as to the great jewellery trade of Birmingham they never were; and numerous operative jewellers are seeking employment in trades to which they have before been wholly unused. Their prospects are not bettered by the fact that a United States firm, who make with machinery alberts and other chains plated with gold, have established a wholesale agency in Birmingham. The goods are called "Canadian," but they are really made in the United States, where the links are closed by hydraulic power.

Brass wire has been advanced ¼d. per lb. in Birmingham, where the greater strength of the London metal market in copper is upheld.

NOTES FROM LANCASHIRE.

(From our own Correspondent.)

During the last few days a considerable amount of iron has been sold in this district, and there is a stronger feeling in the market, but the business doing so far as can be judged seems to be very much of a speculative character, and there is not yet any general influx of orders from consumers to indicate any great improvement in actual trade, and the market at the Manchester weekly meeting on Tuesday was again very dull. It seems, however, now more than possible that prices have at length touched their lowest point, and makers are very chary about entering into forward engagements, as they are evidently anticipating a more favourable market before long.

Lancashire makers, although they are not doing much more business, exhibit rather a stiffer tone, and are not at all disposed to entertain deliveries into next year at current rates. Quotations for delivery into the Manchester district remain at 56s. to 57s. per ton for No. 3 foundry, and 55s. per ton for No. 4 forge.

Lincolnshire iron also, notwithstanding the amount of business doing is still very small, is rather stiffer in this district, No. 3 foundry delivered being now quoted at 58s. 6d.; and No. 4 forge at 57s. 6d. per ton.

Middlesbrough iron is not now being pushed in this district to anything like the extent it was a few weeks ago, and makers, many of whom are evidently pretty well sold for the present, are asking an advance upon late rates, No. 3 foundry delivered into the Manchester district, being now quoted at 54s. 9d. to 55s. 9d. per ton; No. 4 foundry, 53s. 9d.; and No. 4 forge, 52s. 9d. per ton.

Cumberland hematites appear to be scarce, and they are rather difficult to obtain in this district. The average quotations here are 78s. 6d. per ton for No. 1 Bessemer, 76s. for No. 2, and 73s. 6d. for No. 3, less 2½ per cent.

In the finished iron trade there is a better feeling; a good many more inquiries are reported, and some of the large forge proprietors have secured orders which will see them over the next couple of months or so. Prices are stiffer, and one or two makers have intimated their intention of advancing their list quotations for bars 2s. 6d. per ton after the quarterly meetings this week. For bars delivered into this district Lancashire and Middlesbrough makers are now asking £6 17s. 6d. to £7 per ton, and Staffordshire ditto £7 per ton and upwards.

In the coal trade the milder weather of the last few days has had a tendency to check any increased demand for house fire classes of coal, but still generally a steady trade is being done, and late prices are well maintained. The advanced prices, however, which were contemplated this month by some of the colliery proprietors in the Wigan district, are difficult to obtain, and with the exception that Pemberton 4ft. cannot be bought at quite such low figures, there is no material change upon last month's rates. The first and second qualities of common coal suitable for house-fire purposes are in rather better demand, but inferior sorts for forge and steam purposes are still a drug. Burgy is not quite so stiff as it was, and slack, which is now much more plentiful in the market, is being pushed in some quarters at slightly lower prices.

In the shipping trade there is no very material change. The slight amount of improvement which was observable a few weeks back has been scarcely maintained, and there is very little doing in the export trade, business being chiefly confined to a few cargoes of best coal and gas coal for coastwise consignments.

THE SHEFFIELD DISTRICT.

(From our own Correspondent.)

In the lighter branches of the principal trades carried on in this town and neighbourhood, there is, if anything, even more satisfaction expressed at the improved state of affairs than was the case when I last wrote, several of the leading cutlery and electro-plate manufacturers being now very well supplied with orders. This is also the case, to a more irregular extent, in the saw, tool, and edge-tool departments, some few of the manufacturers of joiners' and other edge tools being quite busily engaged. Other houses devoted to the same line of business complain of a slackness of work, and report that they have still very great difficulty in getting in their accounts. This, indeed, is the general outcry of the travellers out all over the country. They can now get a few orders, but money is as scarce as ever.

When I revert to the iron trade proper, I am not able to report in so favourable a manner, nor do my observations lead to the belief that any great change is at hand. In pig iron, as I remarked last week, there are a fair number of sales for the use of the local founders and others, but the bulk is not heavy, nor are forward contracts the rule. Prices are steady in this respect, consequent upon the continued firmness of the Scotch pig iron market, and the reports of improving trade which are now being made from almost every ironmaking district throughout the kingdom. In the North Lincolnshire ironstone district, which is a feeder and valuable source of supply to the South and West Yorkshire manufacturers, dulness still reigns, the majority of the furnaces being out of blast. Matters are so bad, in fact, that a strong stream of emigration is going on from that part of the country.

In finished iron the end of the quarter, and the unsettled state of the market arising out of the possibility of an advance in quotations being declared at the Staffordshire quarterly meetings, has further limited the previously small number of transactions in the open market. Some of the works in the district, however, are producing a common bar at a very low price, one or two of the makers having recently disposed of parcels in the Lancashire market—inferentially for shipment—at appreciably under £7 per ton, delivered either in Manchester or Liverpool. Whether the price pays or not is anything but clear, taking into consideration the costs of materials, labour, and other prime charges.

In the armour-plate departments there is only a moderate amount of work in hand. At the Atlas Works, John Brown and Co., Limited, the armour-fort, citadel, and other parts of the Inflexible are in course of being made; the mouldings for the rounded parts of the citadel having been received here this week from Portsmouth.

The trade report of the Leeds Chamber of Commerce for the month of September states that "the depression amongst the makers of iron continues, and there is, perhaps, even less disposition to give orders now than there was a month ago. In the locomotive trade orders are difficult to obtain. The machine makers have with few exceptions experienced a further falling off, and the tool trade continues without improvement. For cut nails a moderate demand prevails."

A few days ago Messrs. John Brown and Co., Limited, Atlas Works, Sheffield, successfully rolled an armour-plate of the hitherto unprecedented thickness of 24in. When the rough ends were cut off the plate was found to be in the most perfectly homogeneous condition, the iron used being of the ordinary fine quality. The thickest plate previous to the rolling of this was one 22in. thick.

The dispute between the railway spring fitters and their employers continues, and without any prospect of an early settlement being arrived at. The men are very firm.

The report of the directors of the Sheffield United Gas Light Company, just issued, shows that the profits for the half-year ending June 30th last were £25,658 15s. 6d., out of which dividends are recommended at the rate of 10 per cent. per annum on the A and B stock, and 7½ per cent. on the C stock and the new ordinary £10 shares. After these payments have been made £3504 10s. will be left to the credit of the reserve fund, which will then amount to £44,329. The maximum charge for gas was reduced on July 1st to 3s. per 1000ft. Mr. John Young, the company's engineer, has resigned, and Mr. William Romans—for several years engineer to the Alliance Gas Company, Dublin—has been appointed in his stead.

Some months ago I mentioned that a Leeds firm had arranged to begin making horse nails by machinery, with Swedish iron specially rolled for them here. The firm alluded to was Messrs. Greenwood and Batley, of Leeds, who have now been working the machine—invented by Mr. Brundage, an American gentleman—for some little time. Each nail is struck forty-five times by a steam hammer, a process which is claimed to impart to it a ductility equal to the hand-made article. The machine turns out about ninety nails per minute.

It appears that some ardent patriot residing in this vicinity has been writing to Earl Carnarvon, the Colonial Minister, on the subject of the successful exclusion of Sheffield steel and other goods from the United States, and suggesting that the colonies should be induced to retaliate by imposing a heavy tax on all American goods sent to them. As might have been pre-supposed, Earl Carnarvon writes in reply that the proposal, "as you will see *on consideration*, is not one which her Majesty's Government can entertain."

The Board of Trade returns for the month of September are again unfavourable, there being a falling off in almost every particular, except in respect of fuel and machinery. In hardwares and cutlery the only increase was to Spain, Brazil, and minor countries. For the nine months of this and former years the fol-

lowing are the comparative figures, relating to hardware and cutlery alone:

To	1874. £.	1875. £.	1876. £.
Russia	83,122	78,369	57,677
Germany	200,239	193,683	175,184
Holland	82,023	79,896	78,728
France	102,812	106,616	104,310
Spain and Canaries	78,762	72,502	92,507
United States	490,166	445,003	277,347
Spanish West India Islands	57,249	99,174	61,577
Brazil	193,408	211,591	196,449
Argentine Republic	107,731	83,222	46,305
British North America	214,559	223,066	131,004
British India	230,424	212,266	205,432
Australia	452,738	508,880	429,316
Other Countries	975,783	881,305	796,910
Total	3,269,016	3,195,564	2,652,746

The Albion Steel and Wire Company, Limited, which came into existence in September, 1872, is now likely to be wound up. The nominal capital is £150,000 in £15 shares. The company lost over £73,000 during the first three years of its existence, and has almost always been before the public in a prominent manner by reason of the shareholders' meetings, and the strenuous efforts made some time ago with the view of putting the concern in a better position. These efforts appear to have failed, as on Friday last the directors issued circulars convening an extraordinary general meeting of the shareholders, at which it was proposed to submit certain resolutions having for their object the winding-up of the concern. This course is explained as having been necessitated by the legal proceedings recently commenced against the company by one of its creditors. On Tuesday another circular was issued by the company's solicitor, stating that, in order to prevent the creditor mentioned from obtaining a preference, a petition has been filed, and that an application will be made to the Vacation Judge on October 24th.

Some classes of house coal continue to "go up," nominally at all events. In one case I hear of an advance of 1s. 6d. per ton, in another of 1s., and in a third of 2s. per ton; but I greatly question whether, in any instance, the rise can safely be enforced, now that the market is so plentifully supplied. Steam and gas coal are unchanged. An order just promulgated by the Hull Dock Company, to the effect that no wagons other than those having "hopper" bottoms shall be used at those docks, has caused some indignation in South and West Yorkshire. At the present time not 10 per cent. of the wagons are so constructed, nor is that form of unloading prescribed at other docks, so that the coalowners are hardly likely to put themselves to serious expense in order to suit the convenience of this particular board. The immediate result will be, I presume, a diversion of shipments to Grimsby, Goole, and Keadby.

THE NORTH OF ENGLAND.

(*From our own Correspondent.*)

A DECIDEDLY better tone has been apparent in the North of England iron trade during the past few days. This is largely due to the better prospects raised by the publication on Friday last of the returns of the North of England iron manufacturers, which showed, as I indicated last week, a reduction in the stock of iron held in makers' hands to the extent of over 12,000 tons, as compared with the immediately preceding month; and although this was to some extent counterbalanced by an increase of over 5000 tons in the stock of iron in the public warrant stores, yet there has been a more substantial fall of stocks than there has been in any previous month of the present year, and the hopes of those engaged in the trade have been correspondingly stimulated.

At the present time there are only 108 furnaces in blast in the North of England, as compared with 112 in blast at this time last year, while fifty-five furnaces are out, as compared with forty-seven at this time last year. It is a curious and apparently anomalous fact that notwithstanding four fewer furnaces have been in blast, the make of pig iron for the past month has been 3078 tons more than in September of last year.

The amount of business done on 'Change on Tuesday was not large, but makers were firm in their quotations, and generally declined to accept less than 46s. 6d. to 47s. per ton for No. 3. The shipments to the Continent are now going forward on rather a large scale, especially for the Baltic ports. There is also a greater disposition to speculate in iron with a view to a probable rise in prices. It is not expected that more blast furnaces will be blown out at present. Now that there is a chance, however seemingly limited, of a permanent rise in prices, there is a disposition on the part of blast furnace owners to reserve themselves for the expected flow of the tide. At the same time, the blast furnaces blown out during the past month will prevent the production for the current month from coming up to that of either of the last two.

There is a large quantity of Cleveland pig iron going into the home markets, especially into Scotland and the Midland counties, where it seems to beat all rival brands in the quality of cheapness. The coastwise shipments of pig iron for the past month exceed by nearly 7000 tons those for the corresponding month of 1875.

The report of the accountant to the North of England Iron Trade Board of Arbitration was published on Saturday, and is to the following effect:—

Gentlemen,—Having collected from the firms and companies belonging to your board the return of their sales of manufactured iron during the three months ending the 31st August, and having verified the same by an examination of the books, I certify the average net selling price per ton for that period to have been £6 19s. 7d. Beneath is a statement of the different classes of iron, and the average net selling price of each:—

SALES DURING THE THREE MONTHS ENDING 31ST AUGUST, 1876.

Description.	Weights invoiced. Tons. cwt. qr lb.	Percentage of total.	Average net price per ton. £ s. d.
Rails	22,133 1 0 11	23·69	6 3 9·68
Plates	39,347 0 1 11	62·11	7 8 6·81
Bars	21,095 17 1 15	24·53	6 19 11·24
Angles	10,855 9 2 10	11·62	6 18 4·22
Total	93,431 8 1 19	100	6 19 6·80

I am, gentlemen, your obedient servant,
EDWIN WATERHOUSE.

13, Gresham-street, E.C., 5th October, 1876.

Inasmuch as the net average selling price of all kinds of finished iron for the immediately preceding quarter was £7 6s., or 6s. 6d. per ton more than for the present quarter, the employers connected with the Board of Arbitration have just given a three months' notice to terminate the existing wages agreement, which is based on 8s. 3d. per ton for puddling. It is interesting to note that this is the lowest price that has been paid for puddling in the North of England since 1870, and if the present rate is still further reduced, it will be brought lower than it has been since 1865.

The Board of Arbitration held a meeting at Darlington on Monday to consider a claim made by the owners of the Moor Ironworks, Stockton, for £600, on account of the failure of the workmen connected with these works, while members of the board, to carry out the terms prescribed for the rolling of light rails by Mr. Rupert Kettle, or to submit the same to the judgment of the board. The owners of the Moor Works in May last received an order for 650 tons of rails, of a special section, and they made, or endeavoured to make, special arrangements with their men for its completion. The men, however, refused to execute the contract on the terms proposed, and their employers subsequently brought the present claim for £600. The workmen's representatives of the board decline to entertain the claim, on the ground that the rules of the board do not contain any provision for dealing in such a case. The board could not agree upon the matter on Monday, and hence the meeting was adjourned for a fortnight. Some of the employers attach a good deal of importance to this claim, inasmuch as it will test the question, not heretofore settled, of whether employers can claim compensation for the default of their workmen as members of the Board of Arbitration.

The finished iron trade generally remains *in statu quo*. There is really no change in the matter of work on hand, but in view of what are regarded as brightening prospects, neither rail makers nor plate makers are disposed to accept the rates that were current a few months ago, and I am well informed that the Consett Iron Company have positively refused orders they would gladly have accepted a month ago, except at an advance of 2s. 6d. per ton. This feeling is generally shared in by other firms in the district.

The ironstone miners of Cleveland, in consequence of the diminished demand for ironstone, have recently been put on short time. The principal mines are now working no more than five days per week, and some others are likely to be reduced to four days. Workmen, also, who were rather scarce during a great part of the summer, are now become rather plentiful.

Little change can be noted in the coal and coke trades. It is, no doubt, true that for household and steam coal there is just now a rather better demand, and prices are firmly maintained, but otherwise the trade is not calling for any remark. Coke is quoted at substantially the rates of last week, and the consumption is falling off, while the inquiry for manufacturing coals is quite as dull as ever, good puddling sorts being quoted at 6s. per ton delivered on Tees-side.

The Board of Trade returns show that during the month of August thirty-six vessels, of an aggregate tonnage of 23,965 tons, were built on the Tyne, Wear, and Tees during the months of July and August.

On Tuesday an application was made at the London Bankruptcy Court, by the Forcett Stone and Lime Company, to oppose the registration of resolutions arrived at at a recent meeting of the creditors of Messrs. Thos. Vaughan and Co., of Middlesbrough, to liquidate by arrangement. Mr. Registrar Spring Rice, after hearing the objections, decided that the resolutions to liquidate by arrangement should be registered, and that the objections must, therefore, fail.

NOTES FROM SCOTLAND.

(*From our own Correspondent.*)

THE condition of the warrant market is not quite so encouraging as it was a week ago. There can be no doubt that the confidence in improving trade, which, from a variety of causes had been inspired, had the effect of creating great anxiety to buy, which has now given place to more caution and greater quietness. Still it is certain that a substantial improvement has taken place. Ardent speculators may be anxious to drive a big trade sooner than the exigencies of the market will permit, and for this reason we may expect that before a steady course of activity sets in there will be two or three false starts made. Among other indications of the growing improvement in trade, it deserves to be noticed that during the last three months the revenue of the Clyde trustees shows an increase of £4328 over that of the corresponding quarter of last year. There are at present 118 blast furnaces in operation, or one more than at this time last year, and the manufacture is being steadily prosecuted, though considerable additions have regularly to be made to stocks. The quantity of pig iron under warrant in Messrs. Connal and Co.'s Glasgow stores is now 92,400 tons, or about 2000 more than at this time last week.

During the week the warrant market has been considerably quieter, with less business doing, and prices have also slightly given way. On Friday forenoon business was done at 57s 6d. fourteen days, and in the afternoon 57s. 3d. cash was accepted. Business opened on Monday at 57s. 3d. three weeks and 57s. 4½d. one month, and transactions afterwards took place at 57s. 1½d. cash. On Tuesday the market was again rather easier, with business in the forenoon at 57s. 1½d. to 56s. 11d. cash and 57s. 1½d. month open, whereas in the afternoon buyers offered 57s. one month, which sellers accepted at prompt cash. The market had an improved tone yesterday and to-day, and business has been done up to 57s. 4½d. cash and 57s. 6d. one month.

Buyers of shipping iron have obtained some slight concessions on account of the altered condition of the warrant market, but makers' prices may be said to have been substantially sustained. G.m.b., Nos. 1 and 3, declined 6d.; Summerlee, No. 1, improved 1s; Carron, ordinary No. 1, advanced 2s. 6d.; and the specially selected brands of the same company also show a rise of 2s. 6d.

The shipments of pig iron from Scotch ports for the week ending the 7th inst. amounted to 11,903 tons, being 1008 less than in the previous week, but showing an increase of 157 tons as compared with those of the corresponding week of 1875. There is, however, a decrease on these exports for the year, so far as it has gone, amounting to 74,030 tons.

The imports of Middlesbrough pigs at Grangemouth for the week were 3940 tons, being 515 less than in the previous week, but 971 tons more than in the corresponding week of last year. There is a total increase on these imports of 55,214 tons since last Christmas.

Makers of manufactured iron have little or nothing to report this week. There is still a great lack of orders in most departments. Last week's exports of iron manufactures from Glasgow embraced £4000 worth of machinery, £5700 castings, £600 tubes, £6000 wrought iron, £3000 malleable iron, and £600 miscellaneous.

The demand for household and shipping, and also for steam coals, has continued very good throughout the week, and prices of these sorts have shown rather an upward tendency. Steam coals have advanced about 3d., and household 6d.; other qualities being unaltered. After a time of so great depression, even the slightest improvement is hailed with satisfaction, as is the case in this instance. The f.o.b. quotations are as follows:—Household coals, 8s. 6d. to 11s. per ton; steam, 9s. 3d. to 10s. 9d.; splint, 8s. to 8s. 9d.; main, 7s. to 7s. 6d.; smithy, 13s. 6d. to 14s. With regard to the trade in the eastern mining counties, little change can be reported. There is still, for the season of the year, a very good shipping demand, but prices continue low.

A few days ago a mass meeting of the miners of the Croy and Kilsyth districts was held in Kilsyth, for the purpose of taking into consideration the present state of the mining trade. Several addresses were delivered, the chief speakers being Mr. Hughes, of Maryhill, and Mr. Gillespie, miners' agent, Falkirk, and they held out the hope that, now that the trade was reviving, the miners might soon be able to demand a rise of wages. A strong effort was made in behalf of union, those present who did not belong to the society being urged to join.

The riveters in the employment of Messrs. Robert Duncan and Company, shipbuilders, Port Glasgow, are now on strike on a question of wages. They work by the piece, and they desire to be paid 8s. 6d. per 100 rivets, while 8s. 3d. is offered by the employers.

Arrangements are now completed for the winter course of lectures under the auspices of the Glasgow Science Lectures Association. The first lecture will be given by Professor Tyndall on "Fermentation," on Thursday evening, the 19th inst., and those to follow will be by Mr. R. A. Proctor, F.R.A.S., on "The Giant Planets;" Sir C. Wyville Thomson, LL.D., F.R.S., on "The Conditions of the Antarctic Regions;" Professor Odling, F.R.S., on "A Glasgow Discovery in the Chemistry of Gases;" Mr. William Pengelly, F.G.S., on "The Antiquity of the Cave Men;" and by Professor Allen Thomson, LL.D., F.R.S., on "The Evolution of the Brain." There is, I hear, a great demand for tickets.

It is worthy of notice that there are at present berthed in the Clyde getting loaded fourteen new sailing vessels of an aggregate tonnage of 13,700, and four new steamers of 5550 aggregate tonnage, which have all been launched within the last two months, and are estimated to have cost upwards of £300,000.

The Vale of Clyde Tramways Company, who obtained powers in last session of Parliament to propel their cars by mechanical power, have been making trials of the engine of Messrs. Merryweather and Son, London; that of Messrs. H. Hughes and Co., Loughborough; and the pneumatic car of Mr. W. D. Scott-Moncrieff, of Glasgow, with the view of making what they may consider the most suitable selection for the purpose of their traffic.

A new dock, giving 1550ft. of quay space, 19ft. depth of water at ordinary spring tides over the sill, and an entrance of 40ft., the work costing nearly £40,000, has been opened at Berwick-on-Tweed.

WALES AND ADJOINING COUNTIES.

(*From our own Correspondent.*)

GREAT complaint exists at Cardiff amongst the shippers with respect to the smallness of the freights obtainable. To give an idea of the rates I append a few of the leading ones levied on the steam coal—to China, from 25s. to 26s.; India, 16s. to 19s. 5d.; Cape of Good Hope, 19s.; Jamaica, 10s.; France, 9f. to 10f.; Gibraltar, 9s.; Beyrout, 14s. 6d. It will be seen that for short trips, such as to the French coast, the return is very small. I am in bounds in stating that most of the French cargoes are under 300 tons, many of them, indeed, but a little over 100. Taking one of the latter dimensions at 10f. per ton, and estimating the loss in bulk as at least 2d. per ton, we have a return of £20 for the trip, a charge that may defray the wages of the captain and crew, but yields no return to the owner.

Yet still in Cardiff this week there is an energetic effort being made to float another steamship company, and the inducements held out are 20 to 30 per cent. after paying insurance.

It is well known that in good times steamers have realised as much as 80 per cent. upon a voyage; but speaking to a gentleman thoroughly conversant with the trade, he gave it as his confident opinion, first, that the speculation was overdone; and secondly, that even when good freights were obtainable, the wear and tear of a vessel was such as to leave in the best of cases but a sorry return for the investment.

One cause of the depression is to be seen in the slackness of the iron trade. When vessels could take out coal and bring back iron ore, then vessels of all classes paid well, and if there is any reasonable prospect of a return to this state of things shipbuilding might safely be encouraged.

Several Welsh capitalists have diverted their attention from iron ore to silver, and I hear of one promising undertaking in Spain which has one of the ablest of our mining engineers at the head.

Iron, steel, and tin are all at a discount, and nowhere is satisfactory business being done.

In reference to iron, the demand seems falling rapidly, even from the small average of the last year. Part of Tredegar works were stopped last week, and have only, as regards a mill or so, been restarted in the last few days. The paying off of some of the "tradesmen," as the best hands are called, has awakened gloomy forebodings in the neighbourhood.

Dowlais is pushing on as briskly as any works on the hills, and has now one of the largest stocks of pig, puddled bar, and steel ingots I have ever seen. The spirited enterprise at these works well merits a good return.

The management at Rhymney is progressing with its arrangements for the make of steel, but it will be some time before they are completed. There is no movement at Cyfarthfa at present.

Some of the Welsh papers have been raising false impressions with respect to the amount of orders for iron rails now held in hand by the Welsh manufacturers. The true character of the trade can be seen at a glance from the September exports. The total quantity from Cardiff during the month was 3644 tons—insufficient to keep even one works in vigorous make. The best course for our ironmasters will be to supplement their works with appliances for steel making, and now that labour is cheap, the sooner done the better.

The tin and tin-plate trade is dull. The men at Briton Ferry have resumed work at the reduction, after a brief strike. A few large orders are held, but the prices are unremunerative.

In the neighbourhood of Llanelly the state of trade, both as regards coal and tin-plate, is deplorable, and strikes of a serious nature are impending. At one colliery the men threaten to leave work this week if a reduction is enforced. Messrs. Neville and Co., who have well earned the character of being the most considerate of employers, and have striven energetically to maintain full work during adverse times, are at present exposed to very serious antagonism on the part of their colliers.

There was a little difficulty with the men in the South Dunraven Colliery, Rhondda Valley, this week, and a charge of refusal to give a month's wages in lieu of a month's notice was heard against the manager before the magistrates, but dismissed. The men are now working again.

The Taff Vale strike continues, and up to the present the tactics of the men have checkmated the masters. I stated last week that a number of men have been had from Newcastle-on-Tyne. These came and took the place of the others, but the strikers managed to "interview" them, and succeeded in representing themselves in so sad a plight that the strangers have returned. Rather excited feelings now prevail, and a police charge of assault heard on Monday is expected to presage a storm.

The coal trade of the week has been a fair average. The export, foreign, has been close upon 80,000 tons from Cardiff alone, and this week would have promised well but for the storms.

New engineering works have been opened at Newport, which promise well. They are under the direction of Messrs. Arthur and Coyne. Considerable interest has been aroused at Newport from the fact of Sir Geo. Elliot taking up his residence in the locality. The port is evidently looking up. Last week the exports of coal were nearly doubled.

None of the papers have noticed the death of Mr. Lionel Brough, Government Inspector of Mines for Bristol and Monmouthshire districts. He was a shrewd, independent, and somewhat rugged gentleman, much liked by the colliers; and, in his official position, holding high rank. It has been my lot to come in friendly contact with him at most of the great colliery explosions of South Wales, and to have frequent opportunities for noting his energy and ability. He is succeeded by the assistant inspector, Mr. Cadman.

PRICES CURRENT OF IRON AND STEEL.

THE following prices are corrected up to last night, but it should be borne in mind that in many cases makers are prepared to quote different terms for special contracts. It is obviously impossible to specify these cases and terms, or to give more than the market quotations and makers' prices. Readers should also refer to our correspondents' letters.

PIG IRON AND PUDDLED BARS.

	£ s. d.
SCOTLAND—	
G.m.b.—No. 1	2 18 6
No. 3	2 16 6
Gartsherrie—No. 1	3 6 6
No. 3	2 18 0
Coltness.—No. 1	3 1 6
No. 3	2 18 6
Summerlee—No. 1	3 3 6
No. 3	2 17 0
Langloan—No. 1	3 6 0
No. 3	2 17 6
Carnbroe—No. 1	3 0 0
No. 3	2 17 0
Monkland—No. 1	2 18 6
No. 3	2 16 6
Chapelhill—No. 1	3 0 0
No. 3	0 0 0
Clyde & Quarter—No. 1	3 0 0
No. 3	2 16 6
The above at Glasgow, deliverable alongside.	
Govan—No. 1	2 18 6
No. 3	2 16 6
At Broomielaw.	
Calder—No. 1	3 6 0
No. 3	2 17 6
At Port Dundas.	
Glengarnock—No. 1	3 4 6
No. 3	2 18 0
Eglinton—No. 1	2 18 6
No. 3	2 16 6
Dalmellington—No. 1	2 18 6
No. 3	2 16 6
At Ardrossan.	
Carron—No. 1	3 2 6
Do., specially selected	3 7 6
At Grangemouth.	
Shotts—No. 1	3 5 6
No. 3	2 18 0
At Leith.	
Kinneil—No. 1	2 18 6
No. 3	2 14 6
At Bo'ness.	
CLEVELAND—Prices at works—	
No. 1	2 10 6
No. 2	2 7 6
No. 3	2 7 0
No. 4, foundry	2 5 0
No. 4, forge	2 3 6
Mottled	2 2 0
White	2 2 0
Thornaby	2 16 0

Messrs. Bolckow, Vaughan, & Co.'s net prices, f.o.b., are, for No. 1, £2 13s.; No. 3, £2 8s. 6d.; No. 4 foundry, £2 8s; No. 4 forge, £2 7s. 6d.

	£ s. d.	£ s. d.
Wales—No. 2, f.o.b., Newport	2 7 6 to	0 0 0
Forge (at works)	2 12 6 to	3 0 0
Common pig (at works)	2 2 6 to	0 0 0
Best native ore (at works)	2 15 0 to	0 0 0
Both, Davenport, delivered in Aberdare.		
Derbyshire—No. 1, at Sheffield	2 14 0 to	2 17 6
No. 3	2 7 6 to	2 10 0
Lancashire, delivered in Manchester.—No. 3	2 16 0 to	2 17 0
" " " " No. 4	2 15 0 to	0 0 0
K. H. Messelmoun	5 10 0 to	0 0 0

Messrs. Whitwell & Co.'s Stockton net prices (on trucks) are—No. 1, £2 12s. 0d.; No. 3, £2 8s. 0d.; No. 4 Forge, £2 6s.; "Thornaby" No. 4, Forge, £2 16s. 0d. net cash.

Hematite, at works, 2½ dis. for prompt cash.

Millom "Bessemer"—No. 1	3 12 6	
No. 2	3 10 0	
No. 3	3 7 6	
Ordinary No. 3	3 7 6	
No. 4	3 7 6	
No. 5	3 7 6	
Mottled	0 0 0	
White	0 0 0	
Maryport Hematite—No. 1	3 10 0	
No. 2	3 7 6	
No. 3	3 5 0	
No. 4	3 5 0	
No. 5	3 5 0	
Mottled and white	3 5 0	
"Bessemer"—No. 1	3 10 0	
No. 2	3 7 6	
No. 3	3 5 0	

Puddled Bar—

Wales.—At works £5 5 0 to 5 10 0

MANUFACTURED IRON.

Ship Plates—

Pearson & Knowles Co. best (2½ dis. for cash)	9 10 0
Glasgow, f.o.b. £7 10s. 0d. to	8 0 0
Middlesbro', at works £7 5s. 0d. to	7 10 0
Fox, Head, & Co. (at works, cash less 2½)—	
Ship or bridge plates (A)	7 10 0
Mast plates (A MAST)	8 0 0

Boiler Plates—

"Warrington," to 5 cwt. each plate	10 0 0
Do. best best	11 0 0
Do. treble best	13 0 0

2½ per cent. discount for cash. The Pearson and Knowles Co.'s prices of finished iron include delivery at station in Liverpool, Manchester, or Warrington, in lots of not less than 2 tons, or free alongside at Liverpool in lots of 10 tons and upwards.

Bowling & Low Moor, terms in each case 2½ dis. for cash in payment of monthly accounts, or 1½ per cent. dis. for cash in lieu of three months' bill. The Low Moor Co. deliver in London at 10s.; Liverpool, 7s. 6d.; and Hull, 5s. per ton extra.

	£ s. d.
Under 2½ cwt. each per cwt.	1 4 0
2½ cwt. and under 3 cwt.	1 6 0
3 cwt. " 3½ cwt.	1 8 0
3½ cwt. " 4 cwt.	1 10 0
4 cwt. " 5 cwt.	1 13 0
5 cwt. " 6 cwt.	1 16 0
6 cwt. " 7 cwt.	1 19 0
7 cwt. and upwards	2 2 0

Plates exceeding 6ft. wide, 2s. per cwt. extra. Hammered and chequered plates, and all plates differing from a square form or regular taper, extra per cwt. 3s.

Taylor Bros.' boiler plates 6d. per cwt. less; their terms as Bowling and Low Moor.

"Monmoor" best, to 5 cwt., to 4ft. 6in. wide, and to 30 superficial feet, per ton at works	11 0 0
Best best	12 0 0
Best best best, to 4 cwt.	14 0 0
Special, to 2 cwt	17 0 0

Usual extras for overweight, sketches, &c.

Barrows & Sons:	
Best, per ton short, at works	14 0 0
Best best	15 0 0
Best charcoal	23 5 0
Barrows & Sons:	
B.B.H. Bloomfield plates	11 0 0
" Best plates	12 0 0
" Best best plates	13 0 0
Cleveland £8 5s. to	8 10 0
Fox, Head, & Co. (at works, cash less 2½)—	
Boiler shell plates (A BOILER)	8 10 0
Flanging plates (AA BOILER)	10 10 0
Do., special quality (AAA)	14 0 0
Wales, at Aberdare—Coke plates	20 0 0
Glasgow, f.o.b. £8 0s. to	8 10 0

Angle Iron—

Bowling & Low Moor (terms as above) per cwt.	£ s. d.
L and T iron, not exceeding ten united inches	1 4 0
For each additional inch extra per cwt., 1s.	
"Warrington"—less 2½ per cent. for cash—from 1 by 1 by ¼ to 3½ by 3½, per ton	8 0 0
Best boiler do., per ton	8 10 0
Whitwell & Co. (less 2½ discount) per ton	7 0 0
Best	8 0 0
Best best boiler	9 10 0
"Monmoor" (at the works) up to eight united inches	9 15 0
Best do.	10 5 0
Best best do.	11 5 0

T-iron, as above, 10s. extra.
Angle and T bars, 8in. to 9in., 10s. extra.
9in. to 10in., 20s. extra.

Cleveland £6 10 to	7 0 0
Earl of Dudley (terms as below):—	
"Round Oak," not exceeding 8in. wide—Single best	11 10 0
" " " " Double "	13 0 0
" " " " Treble "	15 0 0
Glasgow, f.o.b. £7 0s. to	7 10 0
Aberdare 7 0 to	0 0 0

Bar Iron—

Bowling, Low Moor, & Taylor Bros. (terms as above).

	per cwt. £ s. d.
Flat, round, or square, to 3½ cwt.	1 0 0
Do., 3½ to 5 cwt.	1 2 0
Do., 5 cwt. and upwards	1 4 0
Flats—1½in. by ⅜in. and upwards	1 0 0
" under ⅜in. thick to ¼in.	1 2 0
" under ¼in. to ⅛in.	1 3 0
" under ⅛in.	1 6 0

For each ¼in. less than 1½in. wide extra, 10s. per ton.

Squares—¼in. and upwards	1 0 0
" 7-16in.	1 3 0
" ⅜in. and 5-16in.	1 5 0
" ¼in.	1 7 0
Rounds—⅜in. and upwards	1 0 0
" 9-16in. and ⅜in.	1 3 0
" 7-16in. and ⅜in.	1 5 0
" 5-16in.	1 7 0
" ¼in.	1 9 0

Rivet, same price as above.
Chain iron, same sizes as above, extra per cwt., 2s.
Best bars and rods, extra per cwt., 3s.

"Monmoor," at the works, per ton—	£ s. d.
Bars, ¼in. to 3in. round and square, or to 6in. flat	8 15 0
Best " " " "	9 15 0
Best best " " " "	10 15 0
Rivet iron, usual sizes	10 15 0
Best best	11 15 0

Usual extras.

Glasgow, f.o.b. £7 0s. to	7 10 0
Barrows & Sons, at works, per ton short:	
B.B.H. bars	9 0 0
" best angle iron	11 0 0

All other descriptions in proportion.

Earl of Dudley, 2½ dis., f.o.b., at Round Oak—	
'Round Oak," rounds up to 3in.	9 12 6
" " " Single best	11 0 0
" " " Double "	12 10 0
" " " Treble "	14 10 0
Rivet iron—Single best	12 0 0
Treble "	15 10 0

On separate orders of less than 5 cwt. per ton extra, 10s.

Wales, at College Works, Cardiff—Coke bars, best	7 10 0

Merchant Bars—

"Warrington" (2½ dis. for cash) per ton—	
Flats, from 1in. to 6in. wide by ¼in. thick and upwards	7 10 0
Rounds and squares, from ½in. to 3in., best	7 10 0
Do., treble best	10 10 0

Delivery prices as above.

Whitwell & Co., f.o.b. (2½ dis. for cash), per ton—	
Crown quality	6 10 0
Best "	7 0 0
Rivet iron	8 0 0
Crown quality, "Thornaby"	8 0 0
Best "	9 0 0
Best best "	10 0 0
Wales—Tredegar Iron Company, f.o.b. Cardiff or Newport	6 17 6
No. 2 bars, f.o.b. Cardiff	6 15 0
Owen, delivered at Cardiff or Newport, net cash	5 12 6

Sheet—

	£ s. d.
"Monmoor," to 8ft. long by 3ft. 20 w.g., per ton at works	10 10 0
Do., best	11 10 0
Do., best best	12 10 0

Usual extras.

Barrows & Sons—	
B.B.H. sheets	11 0 0
" best do.	12 10 0
" best best do.	13 10 0
E. P. & W. Baldwin, at works:	
"Severn"—Singles to 20 w.g.	13 0 0
"Wilden" " " "B"	16 0 0
" " "B B"	17 0 0
" " "B B B"	18 10 0
" " "B charcoal"	23 10 0
" " "E B"	25 10 0

Doubles to 24 w.g., 30s.; and
Trebles to 27 w.g., 60s. per ton, extra.

Charcoal Tin—Best "E P and W B" per cwt.	1 13 0
"Unicorn"	1 10 0
Coke Tin—"Stour"	1 6 9

Messrs. Baldwin's terms are 2½ dis. for cash on 10th of the month following delivery.

	£ s. d.
Pearson & Knowles Co. (terms as above)—	
"Dallam"—Singles, to 20 w.g. per ton	10 10 0

Best, 10s.; best best, 30s. per ton extra.

	£ s. d.
Crowther Bros. & Morgan (at works)—	
Coke Tin—Singles, to 20 w.g., to 120in. by 36in, p. cwt.	1 15 0
Doubles, to 24 w.g., to 96in. by 36in.	1 17 0
Trebles, to 26 w.g., to 84in. by 33in.	1 19 0
Charcoal Tin—Singles, as above	2 0 0
Doubles "	2 2 0
Trebles "	2 4 9
Do. Best singles, as above	2 5 0
Best doubles "	2 7 0
Best trebles "	2 9 0

Terms, 2½ dis. for cash on 10th of the month. Orders of 2 tons and upwards, for shipment free in 10 cwt. cases.

	£ s. d.
J. Tinn, Bristol, delivered in London, 2½ dis. for cash—	
Doubles	11 10 0
Trebles	13 0 0
Wales—Treforest Tin-plate Works—	
Charcoal tin (at Cardiff), per cwt. £0 19 6 at works.	
£1 in London, less 2½.	
Lydney: Charcoal tin, IC £1 8 6 to	0 0 0
Terne 1 1 0 to	0 0 0
Coke tin 1 0 6 to	0 0 0
Swansea 0 18 6 to	0 19 6

Engine Iron—

Kirkstall Forge Co. (from cold blast, pig, refined, and selected).

Plain bars, rolled, viz.:	Per ton. £ s. £ s.
Rounds, from ½in. to 6in. diameter	20 0 to 22 0
Squares, from ½in. to 5in.	20 0 to 21 0
Drawn hammered bars, as above, per ton extra	1 0
Rivet iron	20 0 to 22 0
Angle iron, 1½in. to 4in.	20 0 to 0 0
Forgings—Plain shafts under 5 cwt.	20 0 to 0 0
" " 10 cwt.	22 0 to 0 0
" " 20 cwt.	26 0 to 0 0
" " 30 cwt.	30 0 to 0 0
" " 40 cwt.	34 0 to 0 0

Plain shafts, above 50 cwt., prices according to weight and dimensions.

Piston rods, under 5 cwt.	22 0 to 0 0
" " 10 cwt.	26 0 to 0 0
" " 20 cwt.	30 0 to 0 0
Cranks, under 5 cwt.	27 0 to 0 0
" " 10 cwt.	30 0 to 0 0
" " 15 cwt.	34 0 to 0 0
" " 20 cwt.	37 0 to 0 0
Crossheads, under 5 cwt.	26 0 to 0 0
" " 10 cwt.	30 0 to 0 0

All othe uses according to pattern and weight.

Wire—

Whitecross Wire & Iron Co., delivered in Liverpool. Terms 2½ dis. for cash.

Best best WW W drawn telegraph, in long lengths, galvanised	per ton	£ s. d.
0 to 6		17 5 0
7 to 8		18 5 0
9		19 0 0
10		19 15 0
11		20 5 0
12		21 5 0
Best annealed drawn fencing	per ton	
0 to 6		11 10 0
7		12 5 0
8		13 0 0
9		13 10 0
10		14 10 0
11		15 0 0
12		15 10 0

Dipping in boiled oil 5s. per ton extra.

Best galvanised do.	per ton	
0 to 6		15 10 0
7		16 5 0
8		17 0 0

The Pearson & Knowles Co.	
"Dallam" fencing, Nos. 0 to 4, B.W.G.	8 10 0

Rylands Brothers, Limited, Warrington—Prices of iron wire, &c., delivered free in Liverpool:

Best RB W iron wire, bright or annealed—

Per bundle of 63 lb.	7/6	7/9	8/0	8/3	8/9	9/0	9/3
Nos.	0 to 6.	7.	8.	9.	10.	11.	12.
Per bundle of 63 lb.	9/6	10/0	10/6	11/3	12/0	12/9	13/6
Nos.	13.	14.	15.	16.	17.	18.	19.
Per bundle of 60 lb.	14/6	15/6	16/6				
Nos.	20.	21.	22.				

Best best drawn killed galvanised telegraph wire (joined in half mile lengths to No. 9 inclusive with Rylands' Patent Joint)—

Nos. 0 to 6	£17 5 0 per ton.	No. 10	£19 15 0 per ton.
7 & 8	£18 5 0 "	11	£20 5 0 "
9	£19 0 0 "	12	£21 5 0 "

Terms of payment, 2½ per cent. for cash on 10th of month following delivery.

Nail Rods—Glasgow, f.o.b.	7 15 to 8 0
Cleveland	6 15 to 7 0

Nails—

Whitecross Wire & Iron Co.
Wire Nails, or Points de Paris, per 112 lb.:—

6	7	8	9	10	1	12	13	14	15	16	17	18
14/0	14/9	15/6	16/3	17/0	17/9	18/9	19/9	21/0	22/6	24/6	26/0	29/0

Packing in casks 1s. per cwt. extra.

Rails—Glasgow, f.o.b.	7 0 to 8 0
Cleveland	6 0 to 6 5
Wales—Tredegar Iron Company f.o.b. Newport or Cardiff.	6 5 to 6 10
At Aberdare and Merthyr (Davenport)	6 0 to 6 7/6
For colliery sidings (works)	5 0 to 0 0
New and perfect permanent way rail (at works)	5 12 6
Bridge rails to 30 lb. per yard run (at works)	6 0 0
Fishplates (at works), any section	7 10 to 7 12/6
Railway Chairs—Glasgow, f.o.b.	3 17 6 to 4 0
Pipes—Glasgow, f.o.b.	6 0 to 7 5

STEEL.

	£ s. d.	£ s. d.
Sheffield—At works—		
Spring steel	15 10 0 to	20 0 0
Ordinary cast rods	14 0 0 to	21 0 0
Fair average steel	24 0 0 to	32 0 0
Sheet	30 0 0 to	65 0 0
Second-class tool	28 0 0 to	45 0 0
Best special steels	40 0 0 to	70 0 0
Fine rolled, for clock springs, &c.	60 0 0 to	70 0 0
Rails—Siemens (at works)	9 0 0 to	9 5 0
Bessemer, ordinary	7 10 0 to	7 15 0
Do. superior	8 0 0 to	8 5 0
Do. best	9 0 0 to	0 0 0
Wales—	£ s. d.	£ s. d.
Rails, f.o.b., Cardiff or Newport	8 0 0 to	8 7 6
Rails, at works, Bessemer	6 18 0 to	7 5 0
Heavy	7 10 0 to	7 17 6
Best, from 40 lb. per yard, at works (Davenport)	8 2 0 to	8 3 0
Steel colliery bridge rail, works	7 7 6 to	0 0 0

PRICES CURRENT OF MISCELLANEOUS METALS.

	£ s. d.	£ s. d.
Copper—		
Chili bars per ton	72 0 0	73 0 0
B.S. ingots	78 0 0	
Tough cakes or bars	77 0 0	
Tin—		
Straits	73 0 0	73 10 0
British	76 0 0	77 0 0
Lead—		
Best English soft pig	21 5 0	
"Panther"	0 0 0	
Antimony—		
Regulus star	0 0 0	0 0 0
Spelter—		
Silesian	22 15 0	
English	23 0 0	0 0 0
Quicksilver per bottle	8 0 0	0 0 0
Phosphor Bronze—Bearing metal per ton	112 0 0	
Other alloys	£120 to 140	0 0

Castings according to pattern and quantity.

Muntz's Metal—Prices nominal.

Zinc Sheets, for paper glazing (polished)—	
1st quality (per cwt.), from	41s. to 47s.
2nd quality	35s. 6d.
For Engravers	37s.

G. Daihm, Cologne and London.

PRICES CURRENT OF COAL, COKE, OIL, &c.

	£ s. d.	£ s. d.
Coke—		
Cleveland, at works	0 10 0	0 12 0
Derbyshire	0 13 0	0 0 0
Wales	0 9 6	0 10 6
Best Rhondda—		
No. 3	0 12 0	0 13 6
Gas coke, at works	0 6 0	0 0 0
Sheffield	0 15 0	0 0 0
Coals, best, per ton—		
Birmingham	0 13 0	0 15 6
South Durham	0 5 6	0 10 6
Derbyshire—		
Best (at pits)	0 14 0	0 16 0
Converting	0 11 0	0 0 0
Other sorts	0 9 0	0 11 0
Slack	0 3 0	0 5 0
Glasgow—At the pits—		
Ell coal, per ton	0 7 0	0 9 0
Main "	0 5 3	0 6 3
Splint "	0 5 6	0 7 6
Dross "	0 0 9	0 3 0
Do.—At Glasgow—		
Household, per 24 cwt., delvd.	0 13 3	0 15 9
Do., wholesale, per ton	0 8 6	0 11 0
Splint	0 8 0	0 8 9
Steam	0 9 3	0 10 9
Wishaw main	0 7 0	0 7 6
Smithy	0 13 6	0 13 9
Lancashire (Wigan pit prices)—		
Arley	0 10 0	0 11 0
Pemberton 4ft.	0 9 0	0 9 3
Furnace coal	0 6 6	0 7 0
Burgy	0 5 6	0 6 0
Slack	0 3 6	0 4 6

	£ s. d.	£ s. d.
London—Best	0 0 0	0 0 0
Other sorts	0 19 6	1 0 9
South Yorkshire—At the pits—		
Best ordinary	0 12 0	0 16 0
Converting	0 3 0	0 11 0
Slack	0 3 0	0 5 0
Wales, all at pit	0 0 0	0 0 0
Steam (less 2½)	0 6 0	0 7 3
House	0 6 6	0 7 0
Small steam	0 1 7	0 2 2
Do. bituminous	0 2 0	0 2 6
Lard	64 0 0	0 0 0
Oils, tun—		
Seal, pale	34 10 0	0 0 0
Brown	29 10 0	30 10 0
Yel. to tinged	31 0 0	33 0 0
Linseed	24 5 0	24 7 6
Olive, Gallipoli	0 0 0	0 0 0
Spanish	0 0 0	0 0 0
Palm	39 0 0	0 0 0
Rangoon engine (C. Price and Co.'s), per gal.	0 3 6	0 0 0
Rapeseed, Engl. pale	38 5 0	38 10 0
Brown	36 10 0	36 15 0
Foreign pale	38 0 0	39 0 0
Brown	0 0 0	0 0 0
Sperm, body	0 0 0	0 0 0
Whale, South Sea, pale	34 10 0	35 0 0
Brown	29 0 0	30 0 0
E. I. Fish	23 0 0	0 0 0
Yellow	32 0 0	34 0 0
Tallow	30 0 0	54 0 0
St. Petersburg, Y.C., new	52 15 0	53 0 0
Old	50 10 0	51 0 0

PRICES CURRENT OF TIMBER.

Per Load of 50 cubic feet.	1876. £ s.	£ s.
Baltic Fir Timber—		
Riga	3 10	4 4
Dantzic and Memel, crown	4 4	5 10
Best middling	3 5	4 10
Good do. and 2nd	3 3	4 0
Common middling	2 15	3 0
Undersized	2 12	2 15
Small	2 6	2 10
Stettin	3 3	3 10
Swedish	2 10	2 15
Do. small	2 5	2 15
Swedish and Norway balks	1 15	2 5
Baltic Oak Timber—		
Memel crown	5 10	8 0
Brack	5 5	6 0
Dantzic and Stettin, crown	5 10	8 0
Brack & unsquared	5 0	6 0
American Timber—		
Red pine for yards and spars	4 12	5 0
Mixed and building	3 10	4 0
Yellow pine, large	5 0	5 10
Waney board	4 4	5 0
Small	3 15	4 0
Pitch pine	3 0	3 16
Do. for masts and spars	4 0	5 10
Elm, rock	4 10	6 0
Quebec oak	6 0	7 0
Ash	4 0	5 0
Birch, Quebec large	4 10	5 10
New Brunswick & P.E. Isle	3 0	3 10
Small averages	2 10	2 15
Masts, red pine	4 10	5 0
Oregon	7 10	8 10
Kawrie	8 0	10 0
Norway spars	2 0	3 0
Indian teak	11 5	13 0
British Guiana, greenheart	8 0	9 10
Australian, ironbark	6 0	7 10
Deals, &c., per Petersburg Standard—		
Archangel, 1st yellow	16 5	16 10
2nd do.	13 0	14 5
Petersburg, yellow	14 5	17 0
Wyburg, do.	11 10	12 10
Petersburg and Riga, white	9 10	11 0
Christiana, yellow and white deals, best sorts	13 0	14 10
Norway deals, other sorts	8 5	11 10
Battens, all sorts	5 5	8 10
Swedish deals, mixed	12 10	16 10
3rd	12 0	13 10
Inferior and 4th	9 10	11 0
Battens 30s. less than deals.		
Finland deals, 1st	11 10	14 0
Battens	9 0	11 15
Hand-sawn deals	7 10	8 10
Hand-sawn battens	7 0	8 0
Dantzig crown deck deals, per 40ft. 3in.	1 6	1 12
Brack do.	0 17	1 2
Per Petersburg standard.		
Quebec, 1st bright pine	21 0	25 15
2nd do.	12 10	15 15

Per Petersburg standard.	1876. £ s.	£ s.
Deals, &c. (continued)—		
Quebec, 3rd do.	9 0	11 10
1st floated pine	19 0	25 10
2nd do.	11 10	14 10
3rd do.	8 15	11 5
1st spruce	10 0	12 0
2nd do.	8 10	9 10
3rd do.	7 15	8 5
St. John's, spruce	7 10	8 10
Nova Scotia and Prince Edward's Isle, spruce	8 0	8 10
United S. pitch pine planks	12 0	14 0
Staves, per mille of pipe—		
Memel, crown	180 0	200 0
Brack	130 0	160 0
Odessa, crown	200 0	0 0
Dantzic, Stettin, and Hambro	155 0	160 0
Canadian, standard pipe	85 0	87 10
Do. per 1200 pieces—		
Canadian, puncheon	21 0	23 10
Bosnia, single barrel	30 0	31 0
Wainscot Logs, per 18ft. cube—		
Riga, crown (Eng. and Dutch)	5 15	6 10
Brack	4 15	5 0
Memel, crown	4 15	5 10
Brack	3 15	4 5
Lathwood, per cubic fathom—		
Petersburg	9 5	10 10
Riga, Dantzic, Memel, &c.	7 10	8 10
Mahogany and Furniture Woods—	s. d.	s. d.
Per superficial foot.		
Mahogany, Honduras, cargo av.	0 4	0 6
Mexican, do.	0 4	0 5
Tabasco, do.	0 6	0 9
Cuba, do.	0 6	0 9
St. Domingo, do.	0 6	0 9
St. Domingo, curls	0 10	1 6
Cedar, Cuba	0 4	0 4½
Honduras, Mexican, &c.	0 4	0 4½
Pencil	0 2	0 4½
Walnut, Italian	0 4½	0 5½
Black Sea	0 3	0 4
Canadian	0 3	0 4
Maple, bird's-eye	0 4	0 8
Satinwood, St. Domingo	0 9	1 3
Per ton.	£ s.	£ s.
Satinwood, Bahama	6 0	9 0
Rosewood, Rio	14 0	20 0
Bahia	12 0	18 0
Tulip wood	15 0	20 0
Zebra wood, Brazil	10 0	12 0
Puerto Cabello	6 10	10 0
Lignum Vitæ, C. St. Domingo	6 0	10 0
Ebony, Ceylon	12 0	20 0
African billet	12 0	16 0
Cocus wood, Cuba	6 0	8 0
Boxwood, Turkey	6 0	20 0
	s. d.	s. d.
Lancewood spars, each, fresh	10 0	20 0
Do., ordinary to fair	3 0	4 0