THE DRAINAGE OF FENS AND LOW LANDS BY STEAM POWER.

By W. H. WHEELER, M. INST. C.E.

No. VI.[1]

IN 1868 Mr. Samuel Naylor, the superintendent of the Morton Car drainage district on the Trent, took out a patent for a somewhat similar arrangement, which is thus described in the patent specification: "At the end of the channel or chase of the wheel is formed a face, and at the bottom thereof, in a horizontal axis, is arranged a flap or valve constructed so that it will float, and jointed at intervals. This flap floats in the water, allowing the water in the wheel to pass it in an upward direction. When the level of the water falls by the stopping of the wheel, and the flow tends towards the wheel, the flap floats up to its face and makes a tight joint, and so prevents the return of the water—Patent specification, 11th March, 1868, No. 839." The difference between Mr. Naylor's plan and that already described is that the former is self-adjusting, and also supplies the place of the self-acting doors placed across the outlet. The wheel for draining the Morton Car district in the Trent has been fitted with this arrangement. Mr. Naylor also included in his patent a curved guide for causing the water to enter at the under side of the wheel, so that the scoops should not "come in contact with the water until they have ceased to descend, and are travelling horizontally, or nearly so, on the under side of the axis." The blades or arms in the wheel are curved backwards, or in the opposite direction to that in which the wheel revolves, so that the water may leave them advantageously on the rising side of the wheel.

The wheels at Katwig, in Holland, have been fitted with a somewhat similar arrangement to that here described, the floor in front of the wheels being movable, and hung on hinges, so that it can rise up automatically, and have an adjustable breast, suitable to the varying level of the water in the outlet.

Very few of the old wheels have been fitted with shuttles to regulate the supply of water to the wheel. With a varying height of water it is not possible, without this arrangement, to work the wheel to the best advantage. By means of the shuttle the depth of immersion of the scoops can be controlled, and the wheel prevented from being overloaded. The shuttle is also useful in adjusting the load either at first starting, before the wheel has got into full swing, or, in the case of a tidal outfall, in diminishing the supply to the wheel as the height of lift increases with the rise of the tide. The shuttle consists of a wooden framework, with a sliding door fitted in the raceway close up to the wheel, sloping at such an angle as to be tangential to the circumference of the wheel. The door is provided with friction rollers, which work on a frame in the side next the wheel, and is provided with a balance weight and lock and pinion for moving and adjusting the shuttle. A shaft can be carried into the engine house and geared to the pinion, so that the shuttle may be adjusted in the engine-room, a flange with float being also placed there to show the height of the water.

The diameter of the wheel is regulated by the "head and dip," that is, the distance from the lowest point of the ladles to the maximum height to which the water has to be lifted. Sig. Cuppari quotes a formula of Mr. Forster's for calculating the diameter $D = 9{\cdot}82 \sqrt{i + p}$, in which i is the immersion of the scoops, or the dip, and p the lift $= 9{\cdot}82 \sqrt{H}$, in which H = the height from the lowest point of the wheel to the highest external level to which the water has to be raised, the measurements being in feet. The constant in the formula gives a larger diameter than is generally to be found in either the Dutch wheels or those in use in the Fens. A constant of 8·75 gives a result more nearly approaching the Dutch and English practice. The wheels at Zuidplas, which have curved scoops and are of recent construction, have a dip of 3·28ft., and a head of 11·8 = H 15·08, with a diameter of 32·80ft., equal to about 8·5 times the square root of H. The wheels at Katwig erected in 1880 have a head and dip of 11ft., and a diameter of 29·50ft., equal to 8·92. Taking twenty-five of the principal wheels in England having an average extreme head and dip of 15·0ft., the mean diameter is 34·0ft., equal 8·77 the square root of H. The new wheel at Wexford Harbour has a diameter of 40ft. for 14·50ft. head and dip, equal to a constant of 10, or slightly greater. Wheels with curved ladles require a less diameter than those with flat.

The Italian wheels generally have a larger diameter in proportion to the lift than the Dutch or English. The largest wheels in Holland do not exceed 33ft. in diameter. In England the largest diameter is 50ft., and several examples of wheels 35ft. and 40ft. exist. The limit for efficient working may be taken at 36ft. It is not advantageous to use scoop wheels above 12ft. When the height is greater than this, centrifugal pumps are more effective and economical in working. Before the introduction of pumps, where the lift was great, it was usual to divide it into two, and to employ a double set of wheels, one working at some distance behind the other.

In 1872 a patent was taken out by Mr. G. Hamit, the superintendent of the Haddenham Drainage district, to meet the case of alterations required in existing wheels owing to the subsidence of the soil. By his proposal he claims to save the expense of increasing the diameter of an existing wheel, with the consequent lowering to the masonry of the trough. His invention is described as consisting of "the application of an auxiliary wheel at the entrance to the wheel race to feed the water to the scoop wheel, the efficiency of which is, moreover, increased. This auxiliary wheel is provided with curved blades, and is rapidly rotated, the water being admitted to it through a sluice protected by a grating"—patent specification, 3764, 1872. So far as the principle is concerned, there is nothing new in this, as examples of double lifts already existed in the Fens. The object sought could be obtained more efficiently by lengthening the scoops, as has been done in Deeping Fen and other places. The existing machinery of the old wheels being well and strongly constructed, is easily adapted to the increased work by simple alterations, and by using steam at a higher pressure. By judicious alterations to the engine and wheel a large saving of coals may be effected, notwithstanding the increased work.

The greatest quantity of water raised by scoop wheels, so far as the author's experience goes, is at Katwig, the six wheels raising each over 333 tons, or a total of 2000 tons a minute, 4ft. high, or 1200 tons 7ft. high. The greatest quantity of water lifted at one station in England is at Deeping Fen, the larger wheel raising 300 tons a minute to a height of 5ft., and the two 560 tons a minute. The wheel at the 100 Foot River in Norfolk discharges 120 tons a minute at a height of 17ft., and 200 tons at the ordinary lift of 13ft. The two Italian wheels at Adria discharge 300 tons a minute each, the maximum lift being 10ft. The Egyptian wheels recently erected at Atfeh, on the Nile, can each discharge 254 tons a minute, or a total for the eight wheels of 2030 tons.

The speed at which wheels with flat scoops run should not exceed 8ft. per second at the periphery. When this is exceeded, too great an impetus is given to the water, and part of it is lifted higher than necessary. The best results are obtained with a slower rate of speed than this. The slower the speed the less the water is dashed about. It is, however, contended by some makers of wheels that a slow speed involves additional friction from the gearing required to reduce the speed of the engine to that of the wheel. In the old engines the number of revolutions of the engine to those of the wheel was 3 or 4 to 1. This has been increased to 6 or 7 to 1. A high velocity, it is also contended, has the advantage of the head due to the velocity with which the water leaves the wheel, provided the outlet channel is of suitable form. Thus with a speed of 8ft. per second, the water will pass through a regular and smooth waterway into an outfall, the surface of which is nearly 1ft. higher than the water at the wheel. Wheels in England having a diameter of 30ft. generally make 4 to 4½ revolutions a minute, equal to a speed of 6·27ft. to 7ft. per second. Some of the Dutch wheels run at as low a speed as 3·46ft. per second. Four of the new wheels at Atfeh make 2·29 revolutions a minute, and the other four 1·91 revolutions, equal to a speed of 3·93ft. and 2·95ft. respectively. Wheels having curved scoops can be run at a higher velocity than those with flat blades. Where the discharge is into a tidal stream, wheels are regulated to run at varying speeds, according to the height of the water in the outfall, so as to adapt the power of the engine to the varying lift.

The work done by a Scoop wheel is measured by the quantity of water lifted in a given time. To ascertain this it is necessary to know the head and dip of the scoops. The "dip" is the depth the scoops are immersed in the water when vertical in the troughs. The "head" is the difference in level of the surface of the water on the inner and outer side of the wheel. The cubical quantity of water lifted each revolution is ascertained by multiplying the mean circumference of that portion of the wheel which is immersed by the width of the scoops and by the length of the immersed part. From this must be deducted the space occupied by the start posts and scoops. Mr. Wilfrid Airy, who paid considerable attention to the performances of scoop wheels, and published a pamphlet[1] giving the result of his investigations into their working some years ago, considered that a deduction should also be made for leakage of the water which falls from the wheel in the "clearance," or space left between its sides and bottom and the masonry. He estimated this as equal to an amount due to the area of such clearance multiplied by the velocity due to the head, or height the water was lifted. Thus taking a wheel 30ft. diameter, with scoops 4ft. wide, and having a clearance of ½in., the lift being 5ft. and the dip 5ft., the calculation for loss from this source would be as follows:—The area between the scoops and the masonry would be $5{\cdot}0 + 5{\cdot}0 + 4{\cdot}0 \times \frac{1}{2}$in. $= {\cdot}583$ft. The velocity due to the head $8\sqrt{5} = 17{\cdot}89$ft. per second. The area multiplied by the velocity gives a quantity equal to 625·7 cubic feet a minute, or nearly 11 per cent. This is greater than is found to be the case in practice. If the theoretical velocity as found above be reduced 30 per cent., to allow for the friction of the water against the sides of the masonry, it would bring the result more in accordance with the results which have been obtained from the best constructed wheels. Signor Cuppari states that the actual discharge of the wheels at Zuidplas, which have curved scoops, is 92 per cent. of the theoretical. The author has seen these wheels at work, and does not consider their work as calculated to give out the best results.

Taking the dimensions as given above, the gross discharge of this wheel would be 5764 cubic feet per minute, found thus:—Mean diameter of the immersed part of the wheel 30ft. 0in. – 5ft. 0in. dip = 25ft. 0in., of which the circumference is 78·54ft. Area of the scoops $5{\cdot}0 \times 4{\cdot}0 =$ 20ft. 0in.; $78{\cdot}54 \times 20{\cdot}0 = 1570{\cdot}80$. Deducting the area occupied by the scoops and start posts, 129·80ft., gives 1441 cubic feet for each revolution of the wheel. This multiplied by four, the number of revolutions, gives the discharge as 5764 cubic feet per minute. If the leakage be taken as that due to 70 per cent. of the theoretical quantity found above, say 438ft., the net discharge would be 5326 cubic feet per minute. The lift being 5ft., the horse-power in water lifted—W. H. P.—would be

$$\frac{5326 \times 5 \times 62{\cdot}5}{33{,}000} = 50{\cdot}43.$$

The power required, in addition to that for lifting the water, in overcoming the frictional resistance of the machinery of the engine and wheel, and also for useless work in lifting water too high, varies considerably.

Mr. Airy estimated the percentages of loss due to unnecessary lifting of the water, friction, and other causes as follows:—From leakage, 8; unnecessary lifting of the water, 19; friction on the gudgeons, 5; resistance from the shape of the course, 8; a total of 40 per cent. To this must be added 10 to 15 per cent. for the friction of the gearing, making a total loss for the wheel alone of 55 per cent. There is no doubt that in many of the old unimproved wheels the loss from the working of the engine and wheel amounts to 70 per cent. of the power applied; on the other hand, in the best wheels, this has been reduced to 20 per cent.

Messrs. Watt and Co., of the Soho Engineering Works Birmingham, who have had considerable practical experience in the working of scoop wheels, having altered several of the older wheels in the Fenland, and thereby added largely to their efficiency, are of opinion that the merits of the scoop wheels are not sufficiently valued. Having carefully measured the quantity of water flowing down the feeding drains, and taking the power of the engine as indicated at the cylinder, they have found an efficiency of 75 to 80 per cent. in wheels with flat scoops and worked by beam engines using steam at a pressure of from 20lb. to 25lb. on the square inch. The details of one of these trials will be given in the description of the 100 Foot wheel. Messrs. Watt consider that in a Scoop wheel the flow being continuous from the feeding drain to the actual delivery, as good an effect should be obtained in a well constructed wheel as with a reciprocating pump, where the motion of the water is not only changed in direction, but where frequently masses of water as between the pumps and air vessels or other pipes have to be put in motion. Their experience gained from fitting up 460 waterworks, leads them to rely on obtaining with such pumps 80 per cent. of effective work. With regard to the loss by leakage, Messrs. Watt entirely disagree with Mr. Airy. They consider that in a well-made wheel the loss from this cause is practically nothing. The head that causes the leakage they consider is only that between the level of the water in one space between the scoops and the level in the next succeeding space, and that the general motion of the wheel and the upward current of the whole mass of water practically overcome the leakage. Further, they consider that in calculating the discharge of a wheel a greater quantity must be allowed for than the exact dip of the scoop, as owing to the velocity imparted to the water by the outer diameter of the scoops, combined with the gradual contraction of the feeding drain increasing the velocity of the water, the cavities between the scoops are filled from a fourth to a fifth more than the actual dip. The other deduction from the gross power applied for friction of the gearing between the motor and the wheel for the gudgeons and for water lifted too high they consider also as much overrated. Mr. Korevaer, in a paper read before the Dutch Institution of Civil Engineers, gives the useful effect of four Scoop wheels and engines in the Netherlands at a mean of 67 per cent. of the indicated horse-power, the greatest being 69·6, and the least 60·0, the lifts varying from 3·66ft. to 6·0ft. At Katwig the percentage varied from 33 to 70 according to the height of lift, the mean being 50. At Gouda, with curved scoops, the percentage was 56·3 per cent. with the wheels as recently altered to flat scoops, and with new engines an efficiency of 81·97 per cent. was obtained, the lift being 5·80ft., and the quantity discharged 598 tons per minute. Mr. Huet, in his description of the Scoop wheel at Adria, in Italy, which has a diameter of 39½ft. and width of 6¼ft., with a lift of from 4ft. to 6ft., states as the result of working that the proportion of horse-power of water lifted to the indicated horse-power is 72 per cent. In the Wexford Harbour trials, when the wheel was first started, the percentage of useful effect was 68·2.

[1] For article No. V., see THE ENGINEER, March 25th.

[1] "Remarks on the Construction of the Course and Design for a New and Improved Scoop Wheel," by W. Airy. 1870.

THE INSTITUTION OF NAVAL ARCHITECTS.

THE annual meeting of this Institution was resumed on Thursday, the 31st ult. The proceedings of the previous day we published last week. The first paper read on the Thursday was by Mr. Dixon Kemp, entitled

FIFTY YEARS OF YACHT-BUILDING.

This paper was of much interest to yacht builders and yachtsmen. It reviewed the changes that have been made in the half-century past, and showed the effect on speed and performance generally by departure from the older notions concerning form, and the effect of the old adherence to the cod's-head and mackerel's-tail theory in this respect.

The few yachts above 20 tons in existence fifty years ago, were modelled after brigs, schooners, or cutters of the Royal Navy. The brigs were about the size of those of the Royal Navy, and were considered superior in point of sailing qualities. One of the best known of these brigs was the Waterwitch, built by Mr. Joseph White, of Cowes, in 1832. This brig had a great reputation for speed and weatherliness, and beat H.M.S. brig Pantelon about four miles in a six hours' sail to windward. The Waterwitch was purchased by the Admiralty, and subsequently Mr. White built other brigs for the Royal Navy, notably the Daring. This vessel and the Waterwitch performed the best to windward in a strong wind and head sea in the experimental sailing of 1844.[1] The cutter rig was so vastly superior in point of weatherliness that its adoption for almost all yachts intended for racing was a matter of natural selection. Between 1815 and 1837 there was seldom any time allowed for difference of size, and the result was that with anything like a breeze the largest vessel came in first and won. As there was no tax of any kind on any of the dimensions there was no inducement on that score to alter the proportions of length, breadth, and depth from the prevailing Admiralty type. These proportions were from 3 to 3½ beams to length of water-line, and the greatest transverse section was placed ahead of the middle of length, varying in distance from one-tenth to one-fiftieth of the length. The

[1] *Vide* Parliamentary Paper, No. 394 (B), 1845.

centre of buoyancy was generally situated at about the centre of length, and it appears to have been an aim of the designers to keep the displacement of the fore-body and after-body equal. The upper horizontal water-lines of the bow were short and full, and the load water-line aft was generally full, but the buttock or vertical lines were long and flat. The Fair Rosamond schooner of this cod's-head type was designed by Mr. Fincham, and built in 1846 by Mr. Campe, of Gosport, for the late Duke of Marlborough. Mr. Fincham stated that the centre of buoyancy of the Fair Rosamond was ·004 in terms of the length abaft the centre of length, and that she would have performed better in a head sea had her centre of buoyancy been farther forward. In 1847 he designed the Novice schooner for the Earl of Desart, and placed her centre of buoyancy ·01—9in.—ahead of the centre of length. There is no doubt that Mr. Fincham was much mistaken in attributing so much subtle influence to slight variations in fore and aft positions of the centre of buoyancy. About this time the theory of the late Mr. John Scott Russell—that the bow should be longer than the stern—began to be accepted as nearer the truth than the old theory of the cod's head; and in the year 1847, whilst Mr. Fincham was designing the Novice, a very remarkable vessel was built on the Thames as an exponent of Mr. Scott Russell's theory. This was the Mosquito cutter, of 59ft. water-line and 15ft. 4in. beam, built by Mr. Mare, of Blackwall, and launched in 1848. The Mosquito was like one of the cutters of the period turned end for end; her bow was long, and showed considerable hollow, and her after-body was short, showing great fulness both in the horizontal and buttock lines. Her midship section was placed 4ft. 6in. abaft the centre of length of water-line, and her middle of buoyancy was 2ft. abaft it. According to the old practice, the Mosquito should have had no good qualities at all, especially in strong winds; but the fact is, she excelled in all the good qualities claimed for the bluff-bowed craft; she was faster than any other yacht of her length, on any point of sailing, and in a strong wind to windward was a marvel compared with other yachts. However, so strong was the prejudice against the "long, lean bow," and so alarming the predictions—that some day the Mosquito would take a dive and never come up again—that no one could be found to try the experiment on a more extensive scale. It thus seemed likely that the old type would be continued in spite of the Mosquito having, in a superior degree, all the good qualities it was contended a yacht should have. So far as can be learned, the first American yacht race took place just fifty years ago, and it does not appear that any yachts existed in the States before 1835, and those built subsequently, up to the year 1844, were small schooners. In the year named, however, a remarkable vessel was built by Hoboken named Maria, on the lines of the flat-bottomed coasters. She was 100ft. on the water-line, with an extreme beam of 26ft. 8in., and draught aft of 5ft. 3in. She was fitted with a centre-board which dropped 16ft. below the keel, and also had a small one aft to prevent her griping. She had a long hollow bow, and was sloop rigged, with jib and mainsail only. The foot of her mainsail was 92ft. long and the foot of her foresail or jib 70ft. This vessel may be said to have been the original of the American centre-board yacht; but although she showed extraordinary speed and weatherliness there appears to have been a conviction that more depth of body and less beam would be better for good sea-going qualities. At any rate George Steers—the son of a Devonshire shipwright who had settled in New York—produced the keel yacht America, which was destined to have such an important influence on British yacht building and sail-making. In the America the principles so successfully carried out in the Mosquito were embodied with equal success; she had a long and somewhat hollow bow, a short run, and the centre of buoyancy was considerably aft of the middle of length, as will be gathered from the accompanying table:—

	Mosquito. Feet.	America. Feet.
Length on water line	59·2	87·3
Breadth, extreme	15·3	22·2
Draught of water, extreme ...	11	11·5
Proportion of beam to length ...	0·257	0·254
Midship section aft centre of length in terms of length of L.W.L.	0·076	0·071
Centre of buoyancy ditto	0·032	0·041

The America visited us in 1851, and achieved a remarkable success at Cowes over our schooners. This success was no doubt mainly due to the qualities of her hull, but the unusual flatness of her sails contributed greatly to her fine weatherly qualities. The immediate effect of the America's success was rather startling; almost every yacht in existence at that time was lengthened by the bow, her masts raked, and sails laced to the booms; and the principles which had been so strikingly exemplified in the Mosquito three years before were now adopted as a new discovery of infallible merit. This marked the commencement of a new era in yacht designing, and the subsequent development of yachts into the now fashionable type has shown no considerable departure from the principles observed in the design of the Mosquito. As soon, however, as yacht racing became a general summer pastime, a rating for size became a necessity, and the size test adopted was simply the registered tonnage of the day, or what we now know as builders' measurement. This measurement is $\frac{(L - \frac{3}{5} B) \times B \times \frac{1}{2} B}{94}$. This took no account of depth, but assumed that it always equalled half the breadth. Frequent competition, and the teachings of investigators of naval science, impressed yacht builders very forcibly with the fact that the element of size which gives speed is length; and that if two yachts were of equal tons, but one should happen to be longer than the other, then the longer boat would be certain to prove the faster, all other things being equal, such as sail spread, stiffness, and fairness of lines, &c. Or if two vessels were of equal length and one measured fewer tons than the other, then her rating would be smaller, and she would receive a compensating time allowance. Although lead keels had some years previously—about 1846—been introduced as a means of increasing stiffness, after shifting ballast to windward during match sailing had been abolished; but up to 1870 no yacht was to be found with more than about a tenth of her ballast on the keel, and the majority had none at all. A better knowledge of the good effect of concentrating the ballast in the middle third of the length of the vessel rapidly led to a larger quantity of lead being placed outside, until at last the whole ballast was placed outside on the keel. This lowering of the ballast, and consequently of the centre of gravity, enabled the designer to dispense with a considerable quantity of breadth and add to the length, for any given tonnage, until in some of the smaller yachts the length has been equal to 6½ beams, and in the larger, 5¾ beams. The power to carry an effective quantity of canvas in narrow yachts has not, however, been entirely due to placing the ballast outside; for any given nominal tons the displacement has been largely added to this. These large additions to the displacement, whilst the power for getting through a head sea may have been increased, have had a prejudicial effect on the attainment of high speeds, mainly on account of the enormous wave-making it induced. Thus, so recently as 1880, the Arrow has been driven in strong winds as fast and sometimes faster than the Formosa or Samœna, and with very considerably less wave disturbance. The lead keel of one of these long narrow yachts, it should be explained, is in breadth about one-third of the main breadth of the vessel, and in weight is equal to about 0·5 of the total weight of vessel in a yacht like the Galatea, to 0·7 of the total weight in a 3-tonner. The Americans did not much alter this centre-board type of yacht and keel yacht during the period between 1845 and 1885. Accordingly, when in 1885 the owner of the British cutter Genesta challenged for the cup won by the America at Cowes, in 1851, the Americans set to work to produce a compromise yacht, but distinctly more American in type than British. This yacht in section was of the broad V character—very like the America of 1851—with almost twice the draught of water that the ordinary shallow centre-board yacht had. Beyond this, she had nearly the whole of her ballast outside, in the form of a lead keel, supplemented by a centre-board of considerable area. This yacht was named Puritan, and, so far as can be judged, she defeated the Genesta on her merits. The same fate befel the Galatea last year, the Americans having built another yacht of this new type to meet her.

The discussion on this paper was not of much importance, chiefly because most of the speakers seemed to be of opinion that a vessel made for speed cannot deserve the name of yacht. They seem to have a notion that there is merit in adhering to the old notion as to form, for any purpose whatever, and that the modern yachts won the races because they are not yachts but something uncanny. They seem to resent the notion that a vessel of proportions other than those of fifty years ago, and with ballast outside instead of inside, should be compared as yachts with the yachts that do not win races. They consequently devoted a good deal of ingenuity in inventing unappreciative names for the modern vessel. The Yacht Racing Association rules also came in for a good deal of obloquy. There is no advantage derivable from an adverse criticism of form or of proportions, when its basis has nothing more definite than the speaker's notions as to what are "reasonable," or are "not excessive," and so on. Mr. Dixon Kemp's paper was followed by one by Mr. Vernon B. Lewes on the "Corrosion of Iron and Steel Ships and their Protection." Neither the paper nor the discussion upon it added anything noteworthy to the papers, which commencing with that by Mallet ("Trans." Inst. N.A., vol. xiii., p. 90) and followed by those by Mr. J. Farquharson and Mr. W. J. Norris in the same "Transactions," and by numerous other papers before the Institution of Civil Engineers, Iron and Steel Institute, and many other societies.

The next paper read was by Sir Nathaniel Barnaby on

FUEL SUPPLY IN SHIPS OF WAR.

This paper was an explanation of the reasons for the excess in draught of water of some ships for which the author is responsible, and including the Imperieuse and Warspite.

He contended that the question of fuel supply underlies the case, as it does that of the other vessels which have been said to be too deeply immersed; and to make the matter clear he gave, as it was officially given to him, a comparative statement of promise and fulfilment in the case of these ships, as follows:—

H.M. Ships Impérieuse and Warspite.

	As designed.	Impérieuse as completed May, 1886.
	Tons.	Tons.
Weight of hull	3574	3700
,, armour and backing ...	1501	1505
,, machinery	1210	1316
,, armament...	365	525
,, coals	400	400
,, general equipment (430 men)	550	(507 men) 569
Total tonnage	7600	8015
	Ft. in.	Ft. in.
Mean draught of water	24 11	25 10½
Depth of armour below load water-line amidships...	4 9	5 8½
Height of armour above load water-line	3 3	2 3½
Speed in knots per hour	16·0	17·1

The 11½in. excess in draught of water is made up mainly of three items:—

Excess on hull	127 tons, or 3½ p.c. on the original estimate.	
,, machinery...	106 ,, 9 ,,	,,
,, armament...	160 ,, 44 ,,	,,

The First Lord of the Admiralty informed Parliament as follows:—"At the time the design was passed sufficient allowance was not made for the number of complement, weight of guns, machinery, and engines. If fuller consultation had taken place between the designer and the officers responsible for these weights and details before the ship was laid down, a more accurate estimate could have been made, and the extra weights afterwards found necessary would have been anticipated. Regulations insuring this co-operation have now been made." The Controller, and the First Sea Lord concurred as to the design in all stages, but his first estimate was for guns of 9·2in. of 18 tons. The guns actually made for the ship were 9·2in., but they are 24-ton guns. The final result is as follows:—"With the important exception of being more deeply immersed than was anticipated, the Impérieuse in her trials fully realised the expectations of her design. Notwithstanding her deep draught, she is now, taking the essentials of speed armament, and armour into consideration, if not actually the most powerful, one of the most powerful ironclad cruisers afloat of her tonnage." The deeper immersion to which he refers is not, however, the 11½in. coinciding with the 400 tons of fuel, but that caused by an increased coal supply. With 400 tons of fuel the ship has a knot higher speed than was promised, her main deck gun ports are more than 12ft. out of water, and the barbettes over which the heavy guns fire are from 20ft. to 25ft. out of water. As to stability, she may be immersed 20in. deeper, with 900 tons of fuel, and she has a range of 84 deg. To so lofty a ship 11½in. is an insignificant extra immersion. Lord George Hamilton goes on to say:—"The principle adopted by successive Boards of Admiralty since 1870 of selecting as their legend weight of coal, in new ships that they proposed to build, an amount considerably less than that which the bunkers were constructed to carry, originated when compound engines began to be used in her Majesty's ships. The substitution of improved engines for the older types effected such an economy of fuel in relation to the engine-power developed, that a very much less quantity would carry a ship so fitted the same distance as a ship of identical form and size with the simple engines previously in use. This seems to have influenced the Admiralty to accept, when designing new ships, as the legend weight of fuel, a quantity which gave as great a radius of action as was possessed by earlier ships, though it was at the same time decided to provide for exceptional conditions by the construction of reserve bunkers. Thus, although the position of the belt may have been correctly calculated for the weight of coals it was at the time decided to carry, and which was adopted as their deliberate policy by the then Board of Admiralty, the same is undesirably low if coals to the full stowage—which is the policy of the present Board—are put on board." It comes to this, then, that the ships are designed according to the policy of one Board of Admiralty, and their conformity with the design is to be tested by the different policy of another Board. This is exactly what has been done. The whole question of whether 400 tons was to be the normal quantity of fuel, and 900 tons the bunker capacity, was debated before the ships were begun. When they are completed, and after their responsible designer has left office, a new Board refuses to accept the 400 tons, and puts 900 tons on board for the trials of the ship. This would give the Impérieuse 560 tons for her full bunker capacity. No one can contend that the coaling facilities for British ships are inferior to those possessed by other Powers, or that for fighting on equal terms with other ships there is any reason why they should carry more fuel. But the Board of Admiralty is not content with the Impérieuse as being in fighting condition until they have added to this amount in fuel a weight equal to that of the designed armament of the ship. Can anyone contend that the whole weight of the armament of an armoured ship of war can be wisely added in fuel after she has on board as much as her rivals? The proper full bunker capacity of the Admiral class, judging from the most recent French ships, would be 700 tons, but their bunkers will hold 1200 tons. According to the policy referred to, 500 tons will be added to that carried by their rivals. This 500 tons would have enabled us to increase the armament of the ships by 60 per cent. at the load draught of water. Who, in designing a ship, asks Sir Nathaniel, would deliberately increase the fuel in this manner? What he might do is to provide as much space for fuel as possible, taking care not to sacrifice efficiency, and remembering that fuel can be made to assist in giving stability and in resisting shot as truly as, although less efficiently, than armour. This it was the deliberate intention of the Board of Admiralty of 1881 to do. This policy the present Board declines to accept. It fills the bunkers, and then objects that the ships are evidently deeper than had been anticipated.

The French ships of recent type—Bayard, Turenne, Duguesclin, and Vauban—which are of near 6000 tons displacement, only carry 400 tons of fuel, according to the most authentic public statements, and that the average amount does not exceed 7 per cent. for such ships generally. The ruling fact is, that no more of the weight of foreign ships at their load draught is devoted to fuel than the amount he had given; and his contention is, that this, and not the opinion of any sailor, shipowner, or other person, however eminent, should decide the quantity for British ships.

Thus it will be seen that Sir Nathaniel Barnaby is inclined to measure the coal necessities of British men-of-war by those of foreign nations; but almost everyone who spoke in the discussion upon his paper took the view that British ships have a larger area of operations and responsibilities than those of any other nation, and ought to carry the means of remaining longer at sea and of repeating long runs without being forced to find a coaling station. Captain Colomb, R.N., pointed out that instead of comparing or measuring the coal capacity on our ships with that of foreign ships, we ought to measure it by reference to our geographical distribution. He mentioned cases of loss due to want of coal, and said that the Shah was prevented from following the Huascar for that reason. Mr. W. H. White did not think that Sir Nathaniel had been happy in his choice of a subject and of place for its discussion, but he sympathised with him as to the facts; and Captain Anderson and others emphasised the reasons given by others for insisting on the paramount importance of coal as a main element in a fighting ship.

On Thursday evening three papers were read, one being that of Professor Cotterill, F.R.S., on the "Changes of Level on the Surface of the Water surrounding a Vessel produced by the Action of a Propeller and by Skin Friction." This paper we published in our last impression. In the discussion upon it Professor Greenhill entered at some length into the subject, dealing more especially with the note which Professor Cotterill appended to his paper, specially referring to the papers by Professor Greenhill, which have lately been from time to time published in our columns.

Professor Cotterill's paper was followed by one by Mr. G. A. Calvert on the forces acting on the blade of a screw propeller. This paper contained a good deal that is of interest on the subject, and dealt especially with the results of experiments with a variable and adjustable blade moved rectilinearly through water at different known velocities by apparatus which recorded the pressure on the blade at different angles and speeds by means of an adaptation of a Richard's indicator, the apparatus being carried upon a frame travelling on rails over the water, and downwardly projecting a vertical blade. The discussion upon the paper was brief, and it did not seem that those who are practically acquainted with the performances of screws hoped for much from the experiments and deductions from them, although their indirect value was acknowledged. The last paper read was by Mr. A. Spyer, "On the Machinery of Small Steamboats for Ships of War." This was chiefly a historic paper, and does not call for any special remark.

STOP WATCHES AND CHRONOGRAPHS.

Most engineers use stop watches or chronographs. A description of these instruments will not, we think, be without interest and value.

Watches for recording short intervals of time have been in pretty general use for various purposes ever since the advance in the horologist's art rendered it possible to gauge such intervals with any degree of accuracy. But the numberless methods for effecting this object which have from time to time been invented, and many of them reinvented, differ very little from one another, save in details and arrangement, and it is only necessary, or indeed practicable—besides describing the construction of the principal watches of the kind now made—to give a summary of the arrangements which are sufficiently distinctive to warrant a description, or which differ in principle. In this latter respect there has been practically no variation since the cam action was invented by Winnerl, a well-known French horologist, nearly sixty years ago. Before the year 1822 the only arrangement for stopping a watch from the exterior of the case was by means of a slide having a thin piece of metal attached to it, which, when the slide was pushed round, intercepted the fourth or seconds wheel. This piece was also made to come against the rim of the balance, which is even now held to be a good arrangement by many people, who imagine that a minuter subdivision of time is thereby rendered possible from the fact that the balance is arrested in whatever position it may be at the instant the slide is pushed round. But this is a fallacy, the train wheels with which the hands are connected, and consequently the hands themselves, are at rest during nearly the whole of each vibration, advancing by jumps when released by the action of the escapement, and the intervals of time between the jumps are regulated by the number of vibrations the balance makes in a given time.

What is known as a 14,400 train, *i.e.*, one allowing of that number of vibrations being made by the balance in an hour—gives divisions of a quarter of a second; and an 18,000 train gives divisions of one-fifth of a second; the latter being the train universally used in all the modern stop watches. There is no way of dividing the intervals between the beats, and the only mode of obtaining smaller divisions is by increasing the number, as it is called, of the train. But the variation in this direction is necessarily restricted, owing to the difficulty of obtaining good timekeeping results from watches with excessively fast trains. Thus, the instruments for measuring the velocity of projectiles manufactured by Messrs. Dent and Co., of the Strand, register twentieths of a second, and have 72,000 trains. They are constructed to go for six hours without rewinding, but are merely useful for these special observations, and are not intended to be used as ordinary timekeepers.

But if it were possible to construct a trustworthy timekeeper with a stopping action which would register infinitesimal periods of time, there would be nothing gained by it. In the first place, one-fifth of a second is found to be as short a space as our perception will allow us to appreciate, and is therefore quite as small a division as is required for any mechanical measurements; and secondly, however perfect in its action the mechanism itself may be, our means of actuating it cannot be so prompt, and is as likely to produce an error one way as the other. The first departure from the primitive stop watch was the independent centre seconds—a few of which watches are still made in answer to a small demand for them—but its place has virtually long been taken by the chronograph, the modern improvements in which will doubtless finally displace it altogether. This watch has a second, or auxiliary train of wheels, the last arbor of which carries a "flirt" which takes into a tooth, or leaf, of a pinion of six on the axis of the 15-toothed escape wheel; the flirt thus makes a revolution at every second, and the independent seconds hand, which is carried by a wheel which runs freely on the centre arbor under the dial, beats full seconds. The stopping of this hand is effected by a piece which intercepts the flirt, holding it free of the pinion on the escape wheel axis, and the normal train is not interfered with in any way. But, although there is no reason why a properly constructed watch of this kind should not perform very well with careful treatment, with rough or careless usage it is very liable to get out of order, and being, from its complications, difficult to repair, is not well adapted for general use. The intermittent action of the independent train and the impact of the flirt on the escapement are likewise constant sources of irregularity; the centre seconds hand should therefore never be kept going when not required for observations.

The ink-marking chronograph, invented by a Paris watchmaker named Rieussec, in 1822, and its modification, patented shortly afterwards by Breguet, were not destined to do much more than mark an attempt to obtain trustworthy recording instruments. They had a double hand, the lower part of which had in it a small reservoir filled with ink, into which the point of the upper part dipped, the action of the mechanism causing this point to go through a hole in the bottom of the reservoir and leave a small dot of ink on the dial. Breguet's arrangement differed from Rieussec's in having a stationary dial, the hand travelling in the ordinary manner, whereas that of the latter had a rotary dial with a fixed hand. Both of these contrivances were very complicated, and were never held in much favour for obvious reasons.

The first mechanical advance in the construction of stop watches was marked by the improvements of Winnerl, whose inventions established the principle of the action of all the chronographs subsequently made. The first of these, of which Fig. 1 is an illustration, was invented about the year 1830. The hand is stopped at will by the pressure of a stud in the case, and released by the pressure being removed, when it is instantly brought to the point it would have travelled to had it not been arrested; C represents the seconds wheel, whose arbor B is hollow, having its upper end shaped to form the inclined planes *b*; the arbor *a* a^1, to whose pivot the seconds hand is fixed, and which carries the ferrule *g*, goes freely through a hole in a cock, which is not shown in the drawing at *a*, its lower end fitting loosely into the arbor B, and the pressure upwards of the spring *h*, which is actuated by a lever communicating with the pressing stud, holding it firmly against the cock until the pressure is removed. On the release of the stud, the spring *h* presses the ferrule *g* downwards until its point, traversing one or other of the planes, falls into the notch *i*, when the arbor *a* a^1 is carried round with the wheel C. The spring *h* is prevented from pressing on the ferrule *g* by the corner *x* falling on a small projecting cock or tongue.

But this plan, besides being inadequate to present public requirements, is objectionable on account of the greatly increased height of the movement and the very thick pivots it entails for the seconds wheel. Winnerl's second invention was a further development of the cam action, and was the immediate precursor of the chronograph proper. Its action is the same as that of the foregoing, save that it allows of the addition of a normal seconds hand; it is shown in a modified form in conjunction with a seconds chronograph, as at present made by Messrs. Baume and Co., of Hatton Garden, in Fig. 5.

In 1844, the late Adolphe Nicole, of the then firm of Nicole and Capt, of Soho-square, invented and patented a split seconds watch, in which the additional seconds hand could be made to arrive at and start from a given point instantaneously, which is the distinctive feature of chronographs, as compared with other stop watches; and in 1862 he patented the chronograph as now generally made. Fig. 2 shows the mechanism of an ordinary centre seconds chronograph. The chronograph hand is carried on the prolonged pipe of the serrated wheel A, which runs freely on the centre arbor under the cock H, and carries the cam *h*. At the end of the pivotted lever B are the two wheels *z* and *i* on the same axis, the latter of which is in constant gear with the fourth wheel *f*, which carries the normal seconds hand, and the former is shown gearing with the wheel A.

On pressing a push-piece at P, the jointed claw *g*, at the end of the lever L, draws the cog-wheel C round, and the tail of the lever B being raised, the wheel *z*, is thrown out of gear with the wheel A, and simply turns with the wheel *i*, which is geared with *f*, and the chronograph hand stops; at the same time the lever *m* falls against the circumference of the wheel A and prevents it from shifting. On again pressing the push-piece, the cog-wheel is drawn round a little further, the lever *m* is raised and the lever *l* falls on the heart-shaped cam and brings the hand to zero. The third pressure of the push-piece allows the tail of lever B to fall between two of the cogs, and throws the wheels *z* and A into gear again, when the hand is started. The spring *d* holds the ratchet wheel steady; the springs *s* and *r* produce the ratchetting action, and the springs *n*, *k*, and m^1, actuate the levers. The accuracy and promptness of action of this chronograph depend on the wheels being strictly proportional, the correct planting of the lever *m*, the careful adjustment of the lever stops, and the form of the heart. The action and correct shape of this piece are shown enlarged in Fig. 3.

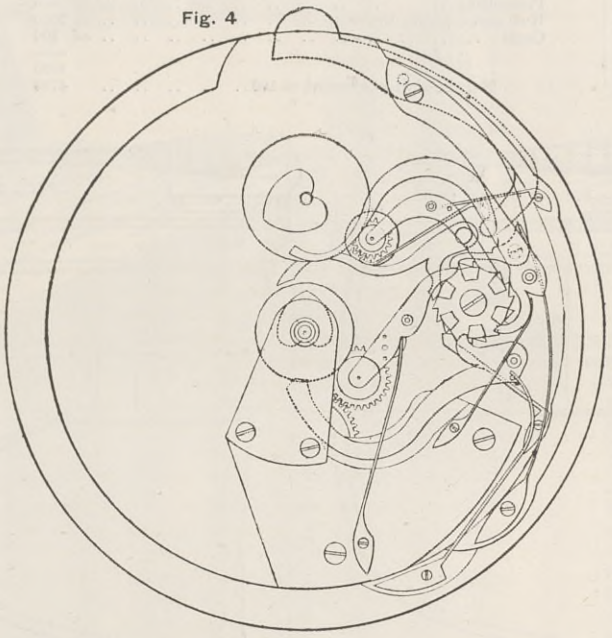
Fig. 4 shows a minute chronograph, the action of which will be understood from the former description. The arrangement of the levers, &c., differs slightly from the usual form, the drawing being copied from a movement of a new calibre recently invented and patented by Mr. C. H. Golay, of 46, Myddelton-square, E.C. The minute chronograph hand is carried on the cam-wheel shown—above the centre—which is kept from rising from the plate by the pressure of a very weak spring, not shown in the drawing. The only objection to this form of watch is in the increased complications it involves in a place where there is never any room to spare. Fig. 5 is an illustration of a new combination by Messrs. Baume and Co., in the shape of a joint-split seconds and centre-seconds chronograph.

Although acting in a similar manner to the ordinary chronograph, this one differs from it in several important particulars. The extra wheels are mounted on the top plate at the back of the watch, which is a distinct improvement, as allowing of more room for the motion wheels, &c., under the dial. The wheel on the seconds wheel axis and the intermediate wheel which goes into and out of action with the cam-wheel which carries the chronograph hand are cut with very fine teeth, instead of being serrated in the usual way, the latter wheel being pivotted into a carriage or lever, which acts concentrically with the former; thus the intersection or depth of these wheels with one another is not altered by the action of the lever. The cam-wheel is serrated, the teeth of the intermediate wheel spanning either two or three of the serrations, according to the designed fineness with which they are cut. The action together of the toothed and serrated wheels is, if anything, easier than that of two serrated wheels, and there is not so much risk of dust and small particles producing irregularities in the going or causing the hand to jump backwards or forwards on the wheels coming into action. This arrangement was first introduced in the Longines machine-made chronographs, of which the above-named firm are the sole consignees.

The split seconds mechanism is a modification of Winnerl's plan. The split seconds hand may be made to coincide with the chronograph hand, or stopped at will by pressing on a push-piece at P. The arbor of the wheel A goes freely through the hollow arbor of the cam-wheel of the chronograph, and carries the split seconds hand at *p*, Fig. 6, the arbor of the cam-wheel carrying the chronograph hand on the prolonged pipe *a*, and going through a hole in a cock beneath it in the watch. On the cam-wheel arbor is a second small cam *h*. The lever L draws the cog-wheel round, which opens or closes the clips C, which are shown holding the wheel A. When the split seconds hand is stopped by the wheel being held by the clips, the chronograph hand continues to travel until stopped by the observer, the weak spiral spring *s* having a small roller *i* at the end to minimise the friction, allowing the cam *h* to turn.

On the clips being opened by a second pressure on the push-piece at P the wheel A is released, and the action of the spring against the cam *h* brings the wheel A round until the hand on its arbor coincides with the chronograph hand, when the two hands act as one. The reason for having the two clips is to prevent as much as possible the side pressure on the arbor that one only would produce. This cam action is a better plan than the usual one, where a long spiral spring is employed to bring the hand to position, as the number of revolutions on the dial of the chronograph hand, or of the centre seconds hand, as the case may be, is not limited; but, as in all these complicated

Fig. 4



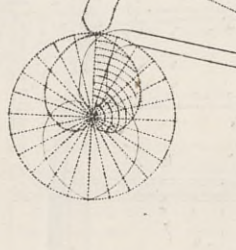


Fig. 3

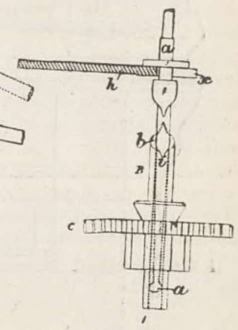


Fig. 1

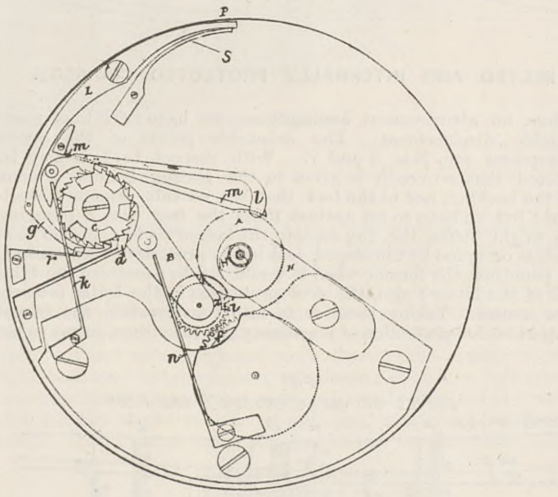


Fig. 2

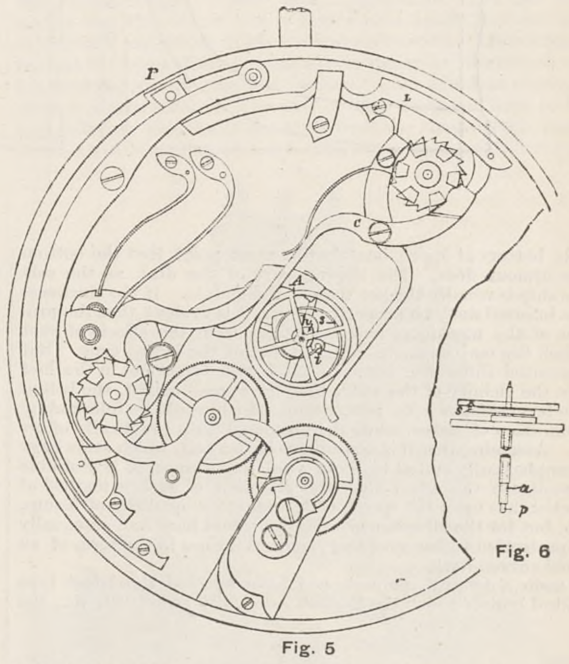


Fig. 6

Fig. 5

STOP WATCHES AND CHRONOGRAPHS

arrangements, the workmanship requires to be very perfect throughout to ensure a satisfactory result, and such a watch as this will only perform well in the most careful hands.

The foregoing comprise most of the principal methods of any practical value which have been adopted by manufacturers since the introduction of stop watches, and although a great many others have been, and are still, made, they are all more or less either modifications or complications of the same devices. In conclusion, it is necessary to warn intending purchasers of the utter worthlessness of the great majority of the commoner kinds of chronographs which are at present being put in the market. The utility of such a watch depends on the accuracy of its performance as a combined stop-watch and a good timekeeper, and these qualities are dependent on such a careful adjustment of its several parts as is incompatible with a hurried and competitive system of production, and which the makers of these low-priced watches have neither the desire nor the means of attending to.

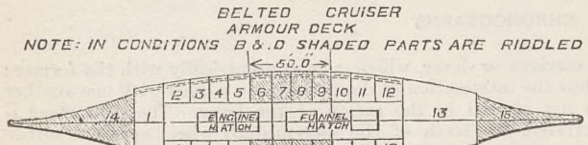
COMPARATIVE EFFECTS OF BELTED AND INTERNAL PROTECTION UPON THE OTHER ELEMENTS OF DESIGN OF A CRUISER.[1]

By Mr. J. H. Biles, Member.

The question of the best method of protecting cruisers is a subject which has caused a considerable amount of discussion. The widespread interest in naval circles which this question naturally arouses must be my excuse for venturing to bring this subject before this Institution. The belted type of protection may be described as a belt or strip of vertical armour, forming the side of the ship in the vicinity of the water-line, and surmounted by a flat deck of about one-fifth of the thickness of the belt, forming with the belt a shield over the machinery and magazines of a ship. The internal type of protection is usually represented by a steel deck extending from side to side of the ship, but, instead of ending with a belt of armour, it is sloped down at the side, joining the outside bottom at approximately the same point that the bottom of the armour does. The sloping part of the deck at the side of the ship is usually thicker than at the middle. If the thickness of the internal deck be properly chosen, it is evident that the protection of the machinery and magazines from the effects of shot and shell fire may be made equal to that of the belted type. But the essential difference between these two types lies in the fact that in the vicinity of the water-line, for a small height, the belted ship offers resistance to penetration, which would be followed by the admission of water, while the protected ship practically offers none. Assuming that it is desirable to have a belt, which some have very emphatically stated to be of vital importance, it is desirable to investigate the effect that the adoption of such a method of protection has upon the speed, cost, and other qualities of a ship, which, but for the adoption of this belt, would have had an equally good protection to her machinery and magazines in the form of an internal curved deck.

To make a definite comparison, I have selected the latest type of belted cruiser which the English Admiralty have built, viz., the

FIG. 2
BELTED CRUISER
ARMOUR DECK
NOTE: IN CONDITIONS B & D SHADED PARTS ARE RIDDLED



Aurora type. The particulars of these vessels have been already published, but, for purposes of reference, they are given here:—

	Ft. in.
Length between perpendiculars	300 0
Breadth, moulded	56 0
Depth, moulded at side	37 0
Draught, mean	21 0
	Tons.
Displacement	5000
	Ft. in.
Thickness of belt armour	0 10
Thickness of backing	0 6
Height of belt above L.W.L.	1 6
Depth of belt below L.W.L.	4 0
Length of belt, about	200 0
Thickness of deck above belt	0 2

Note.—Before and abaft the belt the deck becomes an internal protective deck, and slopes down at the sides. The thickness of the sloping part is 3in.; that of the flat, 2in.

Armament—Two 9·2 B.L. guns, one forward and one aft; ten 6in. B.L. guns; and a number of small guns.

	Tons.
Coals, normal supply	500*
Coals, full supply	1000*
	Ft.
Metacentric height in intact condition	2*
	Knots.
Speed	18½*
I H P.	8500
Weights, approximate—	
Provisions, stores, outfit, armament, and auxiliary machinery	Tons. 660*
Machinery and engineers' stores	830
Protection	880
Hull and conning tower	2130
Coals	500
* Estimated by the author.	5000

[1] Read at the twenty-eighth session of the Institution of Naval Architects, April 1st.

Starting upon the basis of these figures, I have estimated the corresponding particulars for a vessel of the protective deck type, which fulfils, as nearly as possible, the same essential conditions as the belted cruisers, except in the matter of side protection. The comparative assumptions upon which this design is based are—(1) Length and draught of water to be the same; (2) armament to be the same, carried at the same height above water; (3) protection to be the same thickness on the flat as the deck of the belted cruiser; the sloped part to be at an angle of 28 deg., and its thickness, measured horizontally, to be the same, viz., 10in.; (4) crew to be the same; (5) metacentric height, in intact condition, to be the same, viz., 2ft.; (6) speed to be the same; (7) the capacity of coal bunker above the protective deck is the same; (8) forms to be similar. Upon these assumptions, the principal elements of the design will be as follows:—

Design 2.

	Ft. in.
Length between perpendiculars	300 0
Breadth, moulded	53 9
Depth	34 3
Draught, mean	21 0
Displacement	4790 tons

Thickness of belt on slope = 4 69in.
Thickness of belt on flat = 2·0in.
Height above W.L. at centre = 0ft. 0in.
Depth below W.L. at side = 6ft. 0in.

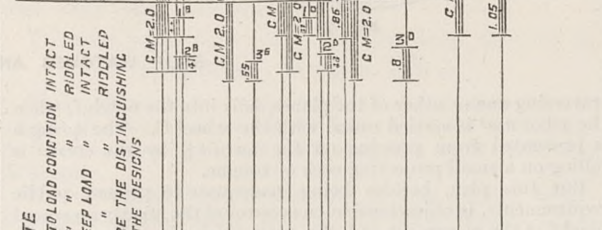
Note.—Before and abaft the distance that the belt extends in the belted cruiser the decks are assumed to be of the same character and thickness in the two ships.

Armament, same as belted ships.
Coals, normal supply = 500 tons.
Coals, full supply = 1000 tons.
Speed = 18½ knots.
I.H.P. = 8250.
Weights, approximate—

Provisions, stores, outfit, armament, and auxiliary machinery	= 660
Machinery and engineers' stores	= 805
Protection	= 675
Hull and conning tower	= 2050
Coals	= 500
	4690
Margin of displacement = 100	4790

Thus, on above-named assumptions, we have 100 tons more available displacement. The debatable points of the above assumptions are Nos. 3 and 7. With respect to 3, it may be objected that no credit is given to the plating behind armour and the backing, nor to the fact that the outside armour is steel-faced; but we have to set against these the fact that a plunging shot might strike the 2in. deck in the belted cruiser, in the part which is occupied by the sloped deck in the protective deck cruiser, and penetrate the former when it would fail to penetrate the 4⅔in. deck of the latter; also, the coal protection in the latter is likely to be greater. Taking these facts into consideration, the fairest comparison for protection of machinery and magazines seems to me

FIC I
CURVES OF METACENTRES ½ ONE FOOT



to be as in assumption 3. With reference to the bunker capacity, the assumption 7 is based on the consideration that the amount of coal which can be carried is ultimately limited, not by the space available, but by the weight which the commander considers it desirable to carry for the special purpose of the voyage he is about to undertake, and also by the consideration that the best arrangement for fighting is that which gives the greatest proportionate amount of coal above the armoured deck for a given initial metacentric height. In other words, the lower bunkers should have as little coal as possible, and consequently the total space occupied by coal is independent of the difference in size of the lower bunkers in the two ships.

From the foregoing list of weights it has been shown that 100 tons of displacement is to spare in favour of the internally protected type. This weight is capable of either—(1) Adding 40 per cent. to the thickness of the flat part of the armoured deck amidships; (2) or adding about a six-tenth of a knot to the speed of the ship; (3) or adding one 9·2in. gun and two 6in. guns to the armament. But it may, perhaps, be claimed that, in the comparison of the two types, the condition of equal draught of water should be set aside in favour of that of equal displacements. This would make available a very much larger amount of displacement for additions of the nature of the above. Dealing only with the second one—increase of speed—and adhering to all the other assumptions, excepting the equality of draught, which is replaced by equality of displacement, we are led to the following as the elements of the design:—

Design 3.

	Ft. in.
Length between perpendiculars	300 0
Breadth, moulded	53 0
Depth	34 3
Draught, mean	21 10
Displacement	5000 tons

Thickness of belt on slope = 4·69in.
Thickness of belt on flat = 2·0in.
Height below W.L. at centre = 0ft. 10in.
Height below W.L. at side = 6ft. 10in.

Note.—Decks at ends same as before.

Armament same as belted cruisers.
Coals, normal supply = 500 tons.
Coals, full supply = 1000 tons.
Speed = 20·0 knots.
I.H.P. = 11,600.
Approximate weights—

Provisions, stores, outfit, armament, and auxiliary machinery	= 670
Machinery and engineers' stores	= 1125
Protection	= 670
Hull and conning tower	= 2035
Coal	= 500
	5000

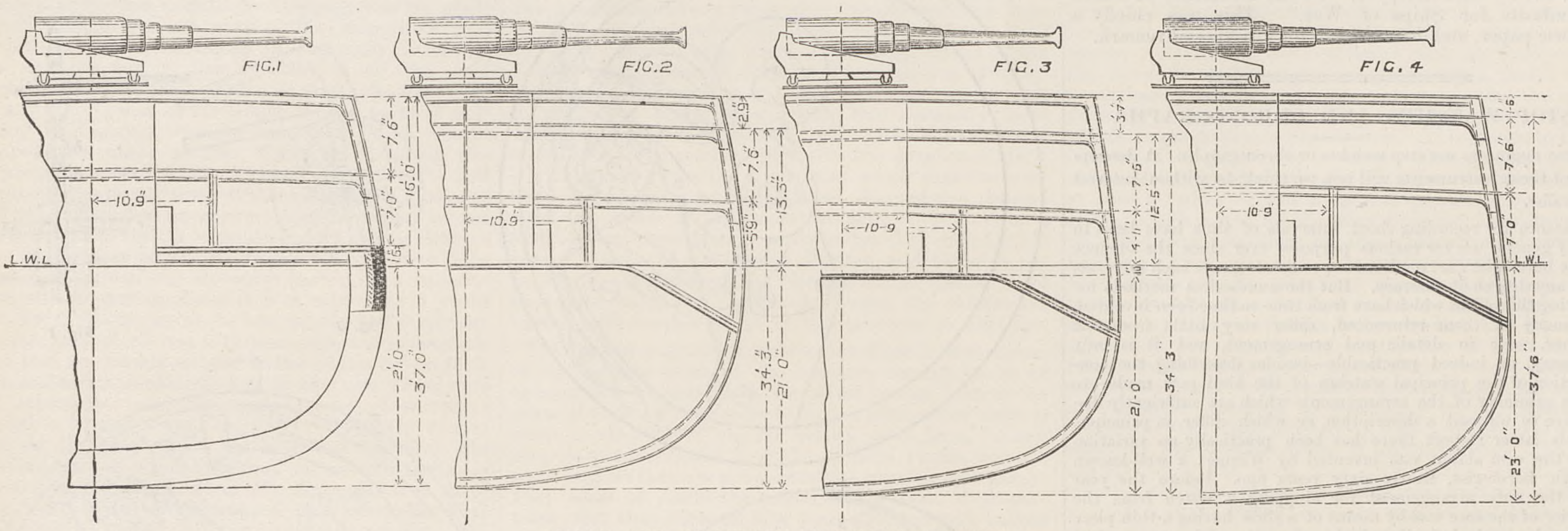
Thus an increase of speed of a knot and a-half may be obtained in the internally protected type over the belted cruiser, on the above assumptions, at the same displacement. In the Design 3, if the protection be added to instead of the power of machinery being increased, about 44 per cent. may be added to the thickness of the whole of the deck plating. The question of relative cost of the two types is of importance. The Aurora's estimated cost is, for hull, £215,550, and for machinery £64,000, or £279,550 The cost of hull is made up of what may be called the armoured and the unarmoured part. The former consists of the conning tower and protecting tubes, which in all the comparisons in this paper are assumed to be the same—the armoured deck and the armour and backing on the side. I think the unarmoured part of the hull will cost £169,500; the conning tower, protecting tubes, &c., which are the same in all the cases, will cost £6000, and the armoured deck and side will cost £40,000. The hull is £82·7 per ton, and this rate may be assumed without great error for the hulls of the other designs. From this basis the cost of No. 2 design is estimated to be, for hull, £162,919; for conning tower, &c., £6000, and for protective deck £10,125, or a total of £179,044. The machinery in this case is £62,060. Total cost of vessel is £241,104, against £279,500 for the belted ship. It is therefore evident that, as a question of first cost, the internally protected ship is £38,396 cheaper. In other words, a vessel of much greater size and increased powers of offence and defence can be built for the same money of the internally protected type than of the belted type. I have determined the elements of the design of a vessel of about the same first cost as the Aurora upon the same data as above, and they are shown in Table A, Design 4, the other three designs being placed with this one for facility of comparison:—

	No. 1.	No. 2.	No. 3.	No. 4.
Length	300	300	300	316
Breadth	56ft. 0in.	53ft. 9in.	53ft. 3in.	56ft. 0in.
Depth	37ft. 0in.	34ft. 3in.	34ft. 3in.	37ft. 6in.
Draught, mean	21ft. 0in.	21ft. 0in.	21ft. 0in.	23ft. 0in.
Displacement	5000	4790	5000	5800
Thickness of belt	10in.	4·69in.	4·69in.	5·63in.
Thickness of backing.	6in.	—	—	—
Top of belt above or below water	above 1ft. 6in.	0in.	below 10in.	0in.
Bottom of belt below water	4ft. 6in.	6ft. 0in.	6ft. 10in.	6ft. 0in.
Length of belt	200	200	200	230
Thickness of deck	2in.	2in.	2in.	3in.
Armament	2–9in. guns 10–6in. guns	2–9in. guns 10–6in. guns	2–9in. guns 10–6in. guns	4–9in. guns 10–6in. guns
Coals, normal	500	500	500	750
Coals, full	1000	1000	1000	1200
Speed	18½	*18½	20·0	19½
I.H.P.	8500	*8250	11,600	11,500
Metacentric height in load condition	2·0	2·0	2·0	2·0
Length of riddled bunker before metacentric length vanishes	79	86	93	93
Weights	—	—	—	—
Provisions, outfit, armament, &c.	660	660	670	772
Machinery and engineer's stores	830	805	1125	1118
Protection	880	675	670	1000
Hull and conning tower	2130	2050	2035	2160
Coal	500	500	500	750
	5000	*4690	5000	5800

* If the 100 tons surplus displacement be used for machinery, speed will be 19·1 knots.

No. 4 Design.

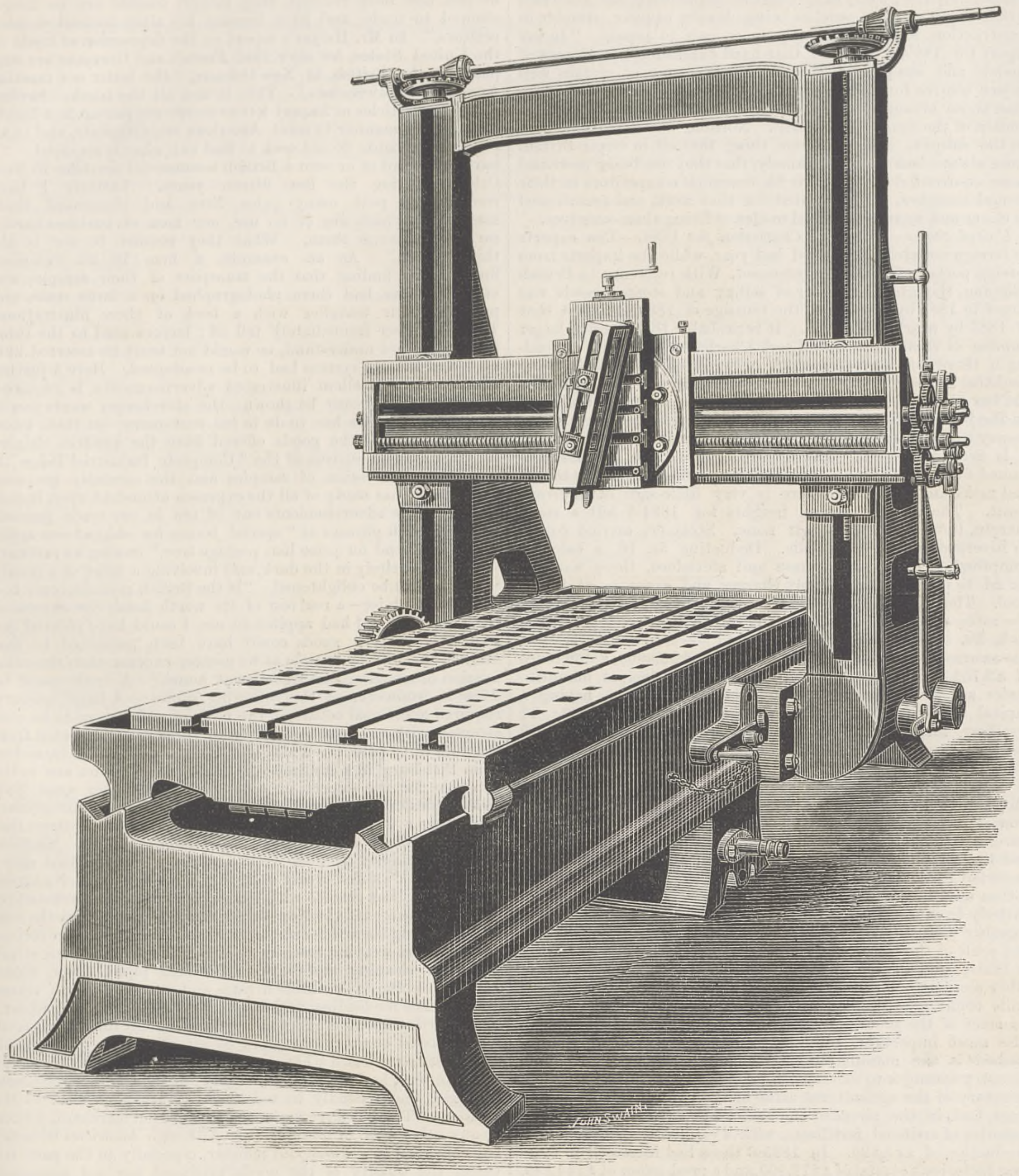
	£
Cost of hull	= 172,000
,, conning towers, &c.	= 6,000
,, deck protection	= 15,000
,, machinery	= 86,600
	279,600



BELTED AND INTERNALLY PROTECTED CRUISERS.

DOUBLE CUTTER PLANING MACHINE.

MESSRS. BUCKTON AND CO., LEEDS, ENGINEERS



two storeys, and is made of steel-plate 10 mm. thick. The lower storey contains the steam steering apparatus, and the upper storey serves as the commander's quarters, and contains speaking tubes, the steering-wheel, and the compass.

The Toussaint L'Ouverture is capable of carrying 120 tons of coal, a quantity which would enable her to traverse a distance of 3000 miles at 10 knots. Although the despatch boat is especially constructed for steam navigation, she is sufficiently rigged for sailing; the surface of her sails is 500 square metres.

The boat obeys her helm with the greatest facility; at full speed she describes a circle of about 200 metres in four minutes. The helm is worked by a steam motor of the Dunning-Bossiere system. There is a steam hoist which can be used as a windlass. The Toussaint L'Ouverture carries a steam launch made of steel plate 8·50 m. length, and capable of a speed of seven knots. This boat fully armed weighs only 2000 kilogrammes with its engine; it is constructed without ribs, after a new system, which secures to it great rigidity in spite of its small weight. The Toussaint L'Ouverture was constructed, armed, and equipped in ten months after the order was given for her. Hull, engine, and guns were all executed by the Company of Forges et Chantiers, and all the materials and divers objects used in her construction and armament are exclusively French products. She was handed over completely fitted, so that on sailing out of the port of Havre she was absolutely ready for service.

During the transit from Havre to Port-au-Prince the despatch boat experienced bad weather, which tested her nautical qualities. She rises well to the sea, ships no water, and rolls but little. The whole voyage, in spite of several days of storm, was accomplished at an averge speed of over ten knots. During the voyage her engines acted perfectly.

The Toussaint L'Ouverture, as before stated, is the first specimen of a war vessel constructed entirely in a French private yard; and the care with which she has been designed and constructed by a company the excellence of whose work is universally recognised, has induced us to publish a description of her in some detail.

BUCKTON'S DOUBLE ACTING PLANING MACHINE.

It is somewhat remarkable that although the late Sir Joseph Whitworth introduced his jim-crow tool-box some half century ago, yet at the present day probably ninety-nine planing machines out of every hundred in use are made to take the cut in one direction only, and to return idle, though at an increased speed. There is, however, one type of planing machine in which it is true that cutting both ways is commonly practised, and that is the plate edge planing machine; and here a turn-over tool-box is used on the same principle as Whitworth's jim-crow, only that it is generally thrown over by hand to avoid the complication and trouble of maintaining the cord which Whitworth used for automatically reversing his tool-box. With the exception, however, of this turnover tool-box used in plate edge planing machines, all arrangements devised for planing on both strokes have failed to come into any extensive use. Yet the desirability of cutting both ways, both to save time and to produce better work, as will be explained, is so obvious that very costly planing machines have been constructed having a complete double set of uprights and cross slides facing each other in order to take advantage of the principles. These advantages are more than might appear at first sight, and may be enumerated as follows:—(1) The belt power, consumption of oil, and wear and tear, usually incurred in running back the idle stroke at an increased speed, is utilised for effective work. (2) The time consumed by the idle return stroke, which

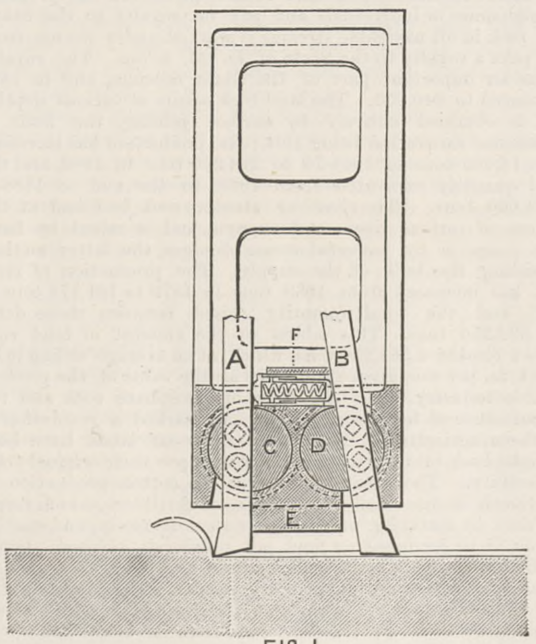


FIG. 1.

amounts to from 25 per cent. to 50 per cent. of the total time, is employed in shortening by that percentage the time during which the work occupies the machine. (3) By cutting with a separate tool on each stroke of the machine, the number of cuts taken by one cutting edge in traversing over a given surface is reduced by half, and hence less imperfection of surface arises from the wear of the tool as between the first and last cut on the surface. (4) As the tools cutting in opposite directions enter the work and break through it on opposite sides it happens that each tool in turn chips away the scale at the edge of the work as it leaves it, and thereby leaves clean metal for the other entering tool to strike upon. These two last properties of the double-cutting principle lead to an important consequent advantage, viz., that a rough casting may be brought into truth with fewer times traversing over than is ordinarily requisite, that is to say, that irregularities which would cause unequal spring upon the finishing tool are practically got rid of in the first traversing over instead of in the second.

Enough has now been said to call attention to the saving that may be effected by cutting on both strokes, assuming that no counterbalancing inconveniences attend it, and assuming that the machine can be made as efficient for the backward as for the forward stroke. It is needless to say that if the conditions here assumed had been easy of achievement the practice of double cutting would have been general at the present time, which it is not. These favourable conditions, however, appear to be fully

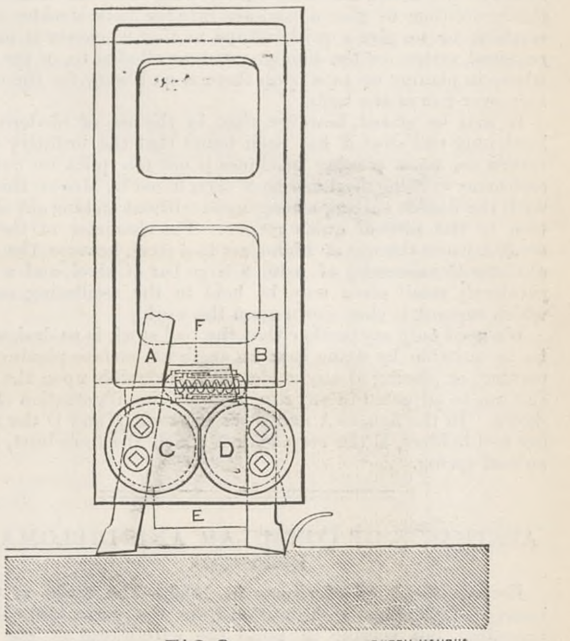
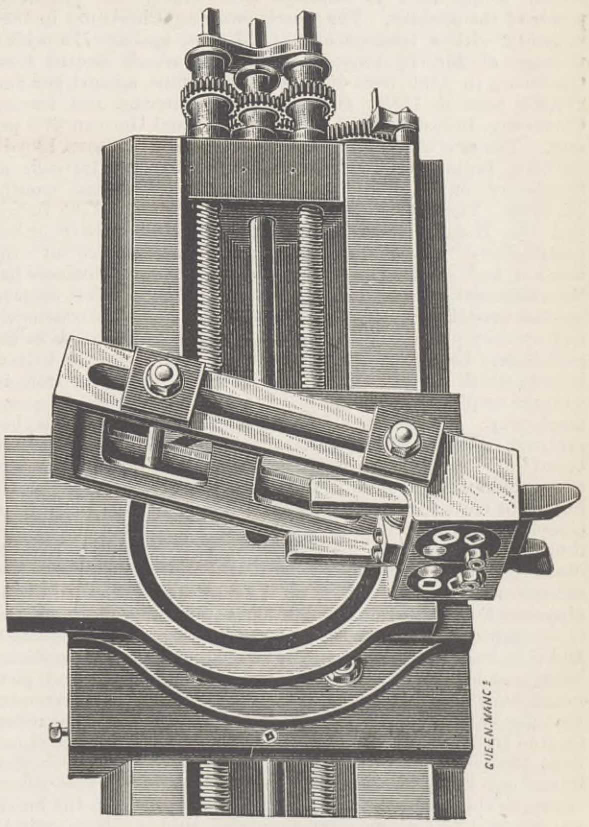


FIG. 2.

realised by the arrangements of the machine illustrated herewith. Upon the tool slide of this machine the ordinary flapping tool-box is entirely dispensed with, and a strong tool-stock of cast steel is bolted directly upon the slide. This tool-stock carries at its lower end two strong oscillating tool sockets which form the subject matter of English and foreign patents by Mr. J. H. Wicksteed, of the firm of Joshua Buckton and Co., and of Mr. Joseph Angus. These oscillating sockets hold the tool in such a way that either tool is firmly held against its cut, but is as free as a pendulum in the contrary direction. The self-acting feed to the cross slide is made substantially as Whitworth made his, and it gives an effective traverse to the tool-box at the end of each single stroke. The two cutting tools are back to back, and follow in identically the same track, so that at each traverse the one tool is cutting a track in which the other tool follows with-



out rubbing upon uncut work. The cross slides, V's, and uprights of all good modern machines are amply strong enough to take the stress of the cut in either direction with indifference. In practice there is not the slightest difficulty in supporting the tool against the cut as efficiently in one direction as in the other—Whitworth found no difficulty in this. The difficulties in using the Whitworth semi-revolving tool have been the maintenance of the cord, the nice adjustment of the tool to be symmetrical with the axis of the semi-revolving box, and the expensive shape of the tool itself. In the tool-box under notice each tool is of the ordinary shape that can be laid against a grindstone and formed with a proper entering angle both sideways and on the bottom. No nice formation of the tool is required, as there is an independent adjustment in each socket holder.

In setting the tools one tool is first secured in its holder and set down to make a cut; all that is necessary for the adjustment of the other is then to drop it into the groove of the cut so made, and fix it in that position by its own independent set screws. It will occur to engineers that it might be a delicate operation to set two broad-edged finishing tools down to the same level with such a degree of nicety as would produce work that required no hand scraping for sliding surfaces, and it is an open question whether it be not better to take the finishing cut with one tool only. The patent oscillating socket, however, and the other arrangements of the machine are peculiarly favourable for taking a broad scraping cut even if used in one direction only. The provision for feeding the traverse at each end of the stroke gives the command of an exceptionally wide self-acting traverse, and the position of the axis on which the tool socket oscillates in relation to the edge of the tool is such that when the tool is dragging idle on the back stroke over the unfinished surface of the work, the rub that takes place does not affect the edge of the tool, but only that part of the tool which is immediately behind the cutting edge. At the first touch of the tool on the back stroke the edge lifts clear, and the rubbing at most only acts as on a whetstone, *i.e.*, parallel with the relief angle at the bottom of the tool, with no tendency to rub away the cutting edge. In order then that in all circumstances the utmost gain of time may be effected, Messrs. Buckton construct their new machines with gearing that can be instantly changed either to give a uniform rate for both strokes of the machine or to give a quick return motion whenever it may be required, either for the finishing cut as alluded to, or for cases where in planing up to a stop there is no liberty for the necessary over-run of the tools.

It may be stated, however, that by the use of modern self-hardening tool steel it has been found that the ordinary quick return on most planing machines is not too quick for cutting, and many existing machines have been fitted by Messrs. Buckton with the double cutting arrangement without making any alteration to the rate of quick return. The character of the tool stock favours the use of high-class tool steel, because the stock obviates the necessity of using a large bar of steel, and a comparatively small piece may be held in the oscillating sockets which support it close down upon the work.

We need only say further that the tool stock is so designed as to be suitable by fixing it at an angle for surface planing, side planing, or planing at any angle. It is reversible upon the slide, and can be adjusted in any direction, as the illustration clearly shows. In the figures A and B are the tools, C and D the rotating tool holders, E the stop against which the tools butt, F the pull-off spring.

ABSTRACTS OF CONSULAR AND DIPLOMATIC REPORTS.

France—Trade of Cherbourg in 1886.—The trade of Cherbourg in 1886 shows a diminution from the years immediately preceding, but bearing in mind the withdrawal of the daily steamers to Weymouth, the trade may be considered to have maintained a fair amount of steadiness. The cessation of the Weymouth steamers is a mistake, though perhaps the service might have been conducted more economically. One of the main reasons for cancelling the agreement with the Great Western Railway Company was that the reduced tariffs granted to the trade *viâ* Cherbourg, injured the carrying business of the Ouest Railway of France with Granville, Havre, Honfleur, and Saint Malo in a greater degree than compensated for the advantages that railway company derived from the increased business connected with Cherbourg. The discontinuance of the steamers to Cherbourg has not benefitted the trade at the other ports, consequently it is presumable that the large amount of produce conveyed by the Weymouth route was not such surplus produce as had that route not existed would have been conveyed to other ports, but was in part created by the facilities of transport which those steamers afforded. A re-establishment of the service would tend to develope considerably the producing power of the country. The vessels entering Cherbourg in 1886 were 612, with a tonnage of 224,757 tons, against 775 with a tonnage of 268,172 tons in 1885. The vessels cleared from Cherbourg in 1886 were 601 and 226,061 tons, against 802 and 272,450 tons in 1885. Of the tonnage entering and leaving Cherbourg, British formed 52·6 per cent., and German 38·5 per cent. The new line of steamers of the North German Lloyd's between Bremen and New York made experimental calls at Cherbourg on their outward voyages in the last months of 1886. The Royal Mail steamers from the West Indies, and the Hamburgh and New York steamers have called continuously throughout the year. The service of the London and South-Western Railway Company's steamers has been augmented to five vessels each way weekly. The deepening and dredging of the outer channel and port has constantly and steadily progressed thoughout last year. The work in the port is very heavy, for after the removal of the mud the bottom is rock, which is worked upon by hand labour, chiefly by Italians, who are employed in a large bell or coffer dam assisted by steam machinery. The rock is a laminated schist, easily divisible, but carrying on the work under water is very expensive. The new broad and deep entrance to the commercial floating basin is now completed, but is not open, as the channel thereto requires deepening on the entrance or northern side. The work is expected to be completed in the spring, when vessels of larger beam and heavier draught can enter the floating basin, and no longer have to discharge their cargo in the roads. The enlargement and extension of the eastern jetty to the deep sea has remained in abeyance for want of funds. So far as the trade of Cherbourg is concerned, this is the most important work contemplated; and if it had been further carried out, the great expenditure being now incurred in deepening the outer channels and piers might have been in some measure obviated. It was intended that the jetty should be first formed and enlarged by the refuse derived from the deepening of the port; but instead the stones from the port are thrown outside the breakwater to strengthen it, and are likely to be swept into the sea on the first severe storm, as the immense weight of water heaped upon the breakwater would in retiring carry away such rubble. It is only by placing heavy rocks outside that the breakwater will be permanently strengthened.

France, Havre—Impediments to British trade.—The impediments to an extension of our trade are two-fold, those arising from the pressure of Customs duties, or from the preference given to French over English goods, and those arising from want of energy on our part. As an instance of the first causes, orders have been issued forbidding foreign firms from tendering for the cement used in the new docks, unless it was found that there was a coalition among French manufacturers to charge an excessive price, or that the quality fell below the standard. In my last year's report I stated "that the visit of a commercial traveller from the United Kingdom was a rare occurrence."[1] Further inquiry among dealers in agricultural implements, cutlery, and ironmongery of all kinds, leads me to believe that while pushing German travellers are most numerous, a singular want of energy exists among our manufacturers. Catalogues and price lists are well enough in their way, but being printed in English, cannot be compared in usefulness to a clever traveller speaking the language fluently and able to explain all details. Our manufacturers must bear in mind that while they trust solely to catalogues in the English language, their foreign competitors are represented by clever travellers taking notes of all they see. In cutlery our imports have fallen off from the pressure of the duty, the improvements made in the higher grades of French manufacture, and from the quantity of cheap German goods, marked as English steel, sold by German travellers. In ironmongery, the Germans are also beginning to compete with us; while in agricultural implements the American article is preferred to ours, as being cheaper in price, simpler in construction, and consequently more easy to repair. "In my report for 1885, I observed that fixed exhibitions or depôts of models and samples of British manufactures at certain well chosen centres for foreign countries would be of more advantage than those arranged on board ships visiting different ports. I remain of the same opinion still. Nothing has been done here on the subject. There is one thing that all in Great Britain must always bear in mind, namely, that they are being more and more confronted everywhere by energetic competitors in their several branches, well educated for that work, and accustomed to closer and more economical modes of living than ourselves.

[1] Commercial Paper, No. 5, April, 1886, page 123.

United States—Trade of Charleston for 1886.—The exports to foreign countries decreased last year, while the imports from foreign ports to Charleston increased. With reference to British shipping, though the number of sailing and steam vessels was larger in 1885 by nine ships, the tonnage of 1886 exceeded that of 1885 by nearly 1000 tons. It is probable that a much larger number of steamships would seek Charleston as a port of loading if there was a greater depth of water on the bar, it being doubtful at present whether vessels drawing over 16ft. can cross the bar except at very high tides. It is hoped that the work on the jetties will progress this year. Congress has appropriated money for the purpose, and much is expected from the work if it is ever completed. The depression in foreign freights continued during last year. It seems impossible for vessels to run and make any profit, and there is very little sign of improvement. The rates of cotton freights for 1884-5 left a small margin, those for 1885-6 left none. Steamers carried cotton to Liverpool at 10s. 3d. a bale. Deducting 5s. 1d. a bale for compressing, insurance at press and stevedore, there was left 6s. 2d. to pay coal, wages, port charges, and expenses at Liverpool. The same state of things applies to sailing vessels, and the rates of freight apply equally to naval stores, phosphate rock, &c. The value of manufactured goods in South Carolina has increased from £3,487,484 in 1880 to £6,239,908, a difference of £2,752,312, or nearly 80 per cent. The principal manufactories are 29 cotton mills, employing 4889 hands, having a capital of £1,060,833 and a production of £1,174,962; 14 fertiliser mills, with 1154 hands, a capital of £604,270 and a production of £744,645; 813 lumber mills, with 6598 hands, a capital of £678,514, and a production of £1,299,307. There are also 44 foundries and machine shops, with 974 hands, a capital of £134,029, and a production of £187,395. The bulk of the products of the South Carolina mills goes by rail to Baltimore, Charleston, New York, and Philadelphia, and a large portion of the goods so sent is exported to China, South America, and other countries. The cotton used in the manufacture of the goods is bought almost entirely from the planters in the vicinity of the mills. This, together with the cheapness of labour, the low cost of living, and some of the mills being exempt from taxation, either county or State, enables the manufacturers to compete with those of other sections. Some manufacturers think that the Southern mills could not compete with foreign factories without a continuance of the protection afforded by the United States tariff. The most important industry comparatively recently established is the manufacture of commercial fertilisers. This industry sprang into existence a very short short time after the discovery of the agricultural value of the phosphate rock on the coast, and in the rivers of the State. In 1870 there were two factories of artificial fertilisers, with a capital of £72,966, and a production of £88,520. In 1885-6 these had increased to fourteen factories, a capital of £812,500, and a production of £744,645. The shipments of fertilisers, exclusive of those manufactured by the cotton seed oil mills, increased from 150,000 tons in 1885, to 196,814 tons in 1886. The various kinds of manures are known to the trade as acid phosphates, acidulated rock, or dissolved bone fertilisers, and guanos. They contain ammonia, phosphoric acid from ground phosphate rock, potash, and sulphur. The ammonia is obtained usually from the Western States and the cotton seed oil mills in South Carolina, the phosphate rock in the vicinity of the factories, the potash from Germany, the sulphur from Sicily and Spain. The phosphate rock deposits are the most important and valuable mining interest of South Carolina. The rock is found on land and in the streams. The land rock deposits are the property of companies or individuals and pay no royalty to the State. The rock in all navigable streams is worked under license from and pays a royalty to the State of 4s. 2d. a ton. The royalty forms an important part of the State revenue, and in 1886 amounted to £40,850. The land rock occurs at various depths, and is obtained entirely by surface mining, the limit of economical excavation being 10ft.; the production has increased from 18,000 tons in 1868-70 to 294,000 tons in 1886, and the total quantity excavated from 1868 to the end of 1886 is 1,991,000 tons. The river or stream rock is found at the bottom of various rivers and streams, and is raised by hand with tongs or by powerful steam dredges, the latter method furnishing the bulk of the supply. The production of river rock has increased from 1989 tons in 1870 to 191,174 tons in 1886, and the total quantity raised between those dates is 1,592,256 tons. This added to the amount of land rock gives a total of 3,583,256 tons, which, at an average selling price of £1 5s. per ton, gives £4,479,070 as the value of the product of this industry. The discovery of phosphate rock and the manufacture of fertilisers from it, has marked a revolution in southern agriculture. Waste and worn-out lands have been brought back into cultivation and nearly into their original state of fertility. The great increase in the cotton production of the South is due chiefly to the use of fertilisers, which forces the crop to maturity much earlier than formerly, and enables cotton to be produced on land not previously planted. Grain of all kinds benefits by its judicious use, and it has been used on sugar-cane with most satisfactory results. The credit of the city of Charleston, its banks, and the State of South Carolina, seems to be in a very excellent condition, the bonds and stocks being constantly in demand and sold daily.

United States.—British trade with New Orleans.—With regard to the opinion that consular officers abroad have not, as a rule, been prepared to give their assistance in the promotion and development of British commercial interests, there is rather a disinclination on the part of the British merchant to make use of the consul. "During fifteen years I have not received more than twenty letters on commercial subjects, half of them relating to shipping. All were answerd to the best of my ability, with the addition that I considered it part of my day's work to give the information required. When the World's Cotton Centennial Exhibition was in preparation I did not receive an application for advice or assistance from the British manufacturer. The advice and observations in my last report have been several times reproduced, but, so far as I am aware, led to no result. Instead of proving that I am wrong, I must persist in my views. The British merchant, spoiled by a long career of prosperity, is not quick to make changes in the conduct of his business, or to accept new methods. It seems as if he has not fully realised that British consuls are no longer allowed to trade, and have become his allies instead of competitors." In Mr. Helyar's report on the depression of trade in the United States, he says that French and Germans are supplanting the British in New Orleans, "the latter not meeting American requirements." This is not all the truth. Several of the few articles of import left to us are not put up in a handy and saleable manner to meet American requirements, and in all others merchants do not seek to find out what is required. "I have not heard of or seen a British commercial traveller in New Orleans during the last fifteen years. Latterly I have received by post many price lists and illustrated trade magazines, which are of no use, our men of business hardly caring to accept them. What they require to see is the thing itself." As an example, a firm in an extensive line of trade, finding that the transport of their samples was very expensive, had them photographed on a large scale, and provided their traveller with a book of these illustrations. Their business immediately fell off; buyers used to the thing itself could not understand, or would not trust its asserted likeness, and the old system had to be re-adopted. Here a further advance than excellent illustrated advertisements is required. The thing itself must be shown—the storekeeper wants you to do to him what he has to do to his customers—let them know by touching that the goods offered have the qualities claimed for them. The success of the "Comptoir Industriel Belge" is due to its possession of samples and the carefully prepared estimates it has ready of all the expenses attendant upon importation. Nine advertisements out of ten in our trade journals end with such phrases as "special terms for shippers on application; or send for price list, postage free," leaving an ordinary purchaser entirely in the dark, and involving a delay of a month before he can be enlightened. "If the British manufacturer had valued my advice—a real test of its worth being the success of the Belgians—and had applied to me, I could have pointed out a means whereby goods could have been presented to this market and sold by sample at no greater expense than the commission of a commercial traveller at home." A trade could be done in ironwork, as the following shows:—A large brewery required additional cellarage, the roofs of which were to be constructed with wrought iron girders; these were imported from Belgium duty paid for £520 less than the estimate furnished from Pittsburg in a contract of £3125. Cotton ties are indispensable for the export of cotton. Last summer some New Orleans dealers had a conference with Sheffield manufacturers respecting a direct importation by the consumer of these ties, and everything was settled but the terms of credit. Sheffield wanted its money as soon as the goods were on board ship; New Orleans wanted credit until they were delivered. No agreement having been come to within twenty-four hours, a German firm steeped in, accepted the New Orleans terms, and secured the contract. Among the articles recommended for this market are cotton-spinning and weaving machinery, fine cutlery, designs for street pavement cleaning and drainage, draining pipes, traps, tanks, valves, machine tools, stable fittings and utensils, steam cranes and winches for loading and discharging ships from the wharf.[1] "With little difficulty, and no deviation from my duties as consul, I could assist our manufacturers to establish an agency in this city, first to ascertain what description of goods can favourably compete with native productions and imports from continental countries, and secondly to sell them by sample direct to the retailers." There is no room for the commission merchant, jobber, or any other class of middleman. Although American industry has expanded in a wonderful manner, especially in the past ten years, the quality of the goods produced has not improved. They are handily put up, ingenious, and showy, but economies have been introduced for which durability is sacrificed, especially in textile fabrics. British shipping in 1884 increased 41 vessels and 68·987 tons, the highest amount ever reached.

United States—Mobile—Advance of trade in Alabama.—Since 1885 Alabama has made unparalleled progress, owing to the development of the great natural advantages and mineral wealth of the State. The coalfield of Alabama consists of several fields 8860 square miles in area, divided by long, narrow valleys holding inexhaustible beds of limestone and brown and red iron ores. In the heart of this region are the cities of Anniston, Florence, Sheffield, and Tuscaloosa, grouped around at short distances, Birmingham has increased in population from between 700 and 1000 in 1871 to 40,000. In November, 1880, the first furnace was erected. To-day there are twelve furnaces in full blast, fourteen more building, the capital aggregating £1,250,000, twenty-three factories and foundries. These, with a number of other enterprises, promise to make Birmingham the centre city of the South. Though British shipping in Mobile fell off slightly in 1886, business as a general thing has been satisfactory. Industrial affairs have much improved; the regular line of steamers to and from Liverpool enables us to export double the amount of cotton, and the agent of the line promises an increase of steam tonnage in the future.

United States.—Pensacola.—Regular steam communication with Liverpool.—During the past year there was a falling off in the arrival of British vessels through owners refusing to accept the low rates of freight. New life seems to have been awakened, and there are many projects in view for the advancement of Pensacola and the extension of her export trade, and it is expected that the place will shortly be doubly prosperous. It is the opinion here that with direct regular steam communication between Pensacola and Liverpool, or some principal port in the United Kingdom, Brazil, and other parts, a brisk import business would be established between this and other southern and western markets direct with the United Kingdom and Brazil and other parts.

GREAT WESTERN RAILWAY, WOLVERHAMPTON, STAFFORD-ROAD JUNIOR ENGINEERING SOCIETY.—A meeting of this society was held on Wednesday, March 30th, under the presidency of Mr. Joseph Armstrong, when a paper was read by Mr. E. Yates on "Dynamo-Electric Machinery." Through the kindness of Messrs. Elwell, Parker, and Co., who supplied storage batteries, the room was efficiently lighted by the electric light. A number of dynamos and motors of various designs, together with a plentiful supply of electrical apparatus, were exhibited at work. The paper dealt in an interesting and exhaustive manner with the principles and advantages of the different forms of dynamos; and, in addition, some valuable information was given as to their practical working. After an address from the president, the meeting terminated with the usual votes of thanks.

[1] For a more detailed report on this subject, see Commercial Paper No. 5, April, 1886, pages 171—181.

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CONTENTS.

THE ENGINEER, April 8th, 1887. PAGE

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MEETING NEXT WEEK.

CIVIL AND MECHANICAL ENGINEERS' SOCIETY.—Wednesday, 13th inst., at 7 p.m.: Ordinary meeting. Paper to be read:—"The Forth Bridge," by R. E. Middleton, M.I.C.E., M.I.M.E.

DEATH.

ON the 4th April, at his residence, Moorside, Bushey Heath, Herts, ABRAHAM FITZ GIBBON, Mem. Inst. C.E., in his sixty-fifth year. Australian papers, please copy.

THE ENGINEER.

APRIL 8, 1887.

EXTERNAL AND INTERNAL ARMOUR.

ON Friday, the 1st inst., Mr. J. H. Biles read before the Institution of Naval Architects a paper which is not more interesting in itself than remarkable for the importance of the discussion which followed its perusal. The paper itself will be found on another page. It deals, as will be seen, with the question of the best method of protecting those high-speed, semi-armoured, ships, on which it is universally agreed Great Britain must mainly rely for the protection of her merchant fleets in case she goes to war. Such ships must be very fast, and carry a good supply of coal; they must, too, be moderate in price and handy. These conditions limit their dimensions, and the quantity of armour which they can carry. Two systems of using armour are in use. In the belted or externally protected cruiser, a strip of armour-plate, seldom more than 6ft. wide, is carried round the ship, or at least round the most vital portions of her, at the water line. This is the external system. A ship protected on the internal system has a thick steel deck, which slopes down at each side joining the hull at about the level which the bottom edge of the belt would take. A glance at the diagrams on page 268 will make the peculiarities of the two systems more intelligible than a page of description.

Both systems have their advocates; and both were represented on Friday in the hall of the Society of Arts. On the one hand were Sir N. Barnaby and Mr. White, ex-Chief Constructor and present Chief Constructor of the Navy; on the other side were ranged two admirals and a post captain; around these skirmished smaller craft. Mr. Biles put his paper into a tentative form; he did not assert; he asked questions. Sir N. Barnaby had one answer to give; Admiral Sir John Hay another answer. The merits of the question are easily got at. It is not like a host of other questions connected with ships and guns, hard to understand, or difficult to form an opinion about. Mr. Biles shows very clearly that when internal protection is adopted a very considerable advantage may be gained in the offensive powers of a ship of war. This advantage presents itself in various ways. Mr. Biles has no fewer than three alternative designs, from which a selection may be made. In the discussion no one seemed to quite see that the internally-protected ship had greater powers of *offence* than her rival with a belt. The various points in her favour were recognised, but they were not valued by the naval men present. They seemed to think it was much more important that a cruiser should be safe herself than that she should be able to do much injury to an enemy. Mr. Biles pointed out that one of his ships could carry twice as many heavy guns as a belted cruiser, but this did not appear to strike admirals or captains as a thing of much importance. This is a remarkable phase of naval opinion; and we are glad to find that neither Sir N. Barnaby nor Mr. White would admit that the naval officers present were representative of the drift of opinion among officers of the English Navy. Putting fighting powers on one side, the two types of ship may be regarded purely from a mechanical point of view. The whole question is, which can be sunk most readily by an enemy's fire. Before sinking either one or the other may be capsized. This, however, is merely a detail. It may be said of the internally-armoured ship that she would capsize before she sank, and that the belted ship would probably sink without capsizing; but this would make very little difference to a crew. The chief contention of the advocates of the belt is that the internally-armoured ship can be riddled at or about the water-line by the projectiles of small quick-firing guns, say 6-pounders, that water could then get in above the deck, make the ship top heavy, and upset her. That as regarded heavy guns, a 2in. steel horizontal deck would be better than a 4½in. inclined deck, because if there was a plunging fire the angle of impact on the inclined portion of the deck would be more favourable to penetration than the horizontal position of a 2in. deck would be. The answer to this is that the small guns could not make holes very quickly in a ship's side. That the lower angle where water could lodge, can be provided with cork or some similar material which would retard the entrance of water; and that in the meantime the ship could do a good deal of fighting and possibly beat off or sink her enemy. While as regards heavy guns there was, in the first place, no danger of plunging fire save from forts which cruisers would not attack, and that battles would not be fought at sea when the ships were more than 1100 yards apart, and this is the range of a 10in. gun with 1 deg. of elevation.

Captain Fitzgerald is an admirable speaker, and he was beyond question the most powerful foe the internal system had; yet he seemed to forget that his own argument in some respects cut both ways. He began by pronouncing the Aurora type of belted cruiser as a burlesque, and we really think he is not far wrong, seeing that the ship when ready for sea has the top of her armour belt 18in. under water. He argued very forcibly that there was very little to be feared from big guns at sea, because there was first the great difficulty of hitting a ship at all, even if she could be seen clearly. If there was a stiff breeze blowing, the gun platform would be unsteady, and it would be difficult to take aim; and if it was calm, in three minutes after the action began the ships would all be wrapped in an impenetrable cloud of smoke. The chances, too, were 1000 to 1 against any projectile hitting a plate at right angles, and even 8in. or 10in. of armour would be a tremendously powerful protection against very heavy shot striking at an angle. The belted cruiser would be better off than the internally-armoured ship, because machine guns could not sink her and big guns could not hit her. But quick-firing guns could destroy the internally-armoured ship by admitting water, which would capsize her. Captain Fitzgerald held that the armoured deck would do more harm than good, because it would not let the water down below, where it could be got rid of. Concerning water-line protection, it was pointed out by another naval officer that it was little wanted, because conoidal-headed projectiles always rose on hitting the surface of the sea. It was remarked that during the bombardment of Alexandria not one shot fired from the forts touched a ship if it previously touched the water, all rising high in the air and going over the ship. It is to be feared, however, that if the shot struck first anywhere near the ship it would not rise time enough to miss her; and it seems to be probable that at close quarters a gun sufficiently depressed would easily punch a ship below a belt 6ft. deep.

Sir N. Barnaby and Mr. White defended the internally-armoured system with as much ability and success as its attackers manifested. Sir N. Barnaby pointed out that naval progress had been very rapid since 1885, and that it was a suggestive fact that not a single belted cruiser had been built by any of the Great Powers since that year. All the cruiser class were protected by armoured decks. It was scarcely to be supposed that such a man as Admiral Brin, the Chief Constructor of the French Navy, was a fool. Naval officers continually ignored the question of cost; but no naval constructor, public or private, could do this. In fact, how to get most power, offensive and defensive, for a given sum, was *the* problem. Mr. White showed that, as far as quick-firing guns were concerned, the chances were that the belt would soon be no better off than the inclined deck. Already a 40 lb. gun had been made which would fire as many as fifteen rounds in a minute, and 6in. quick-firing guns are being made. No one could put a limit in this direction. Furthermore, there is no mystic virtue in a 6ft. armour-belt; and if a ship of the Aurora class rolled only 8 deg. she would bring the bottom of her belt out of water, and of what use was it then as protection? and under all circumstances, the belted ship must cost a great deal more than the protected ship.

It may be asked, how does it happen that so great a difference of opinion exists on a question of such vital importance? The answer is that nobody knows, as the result of actual trial, which system of protection is the best. It is purely a matter of opinion from beginning to end; and it appears to be very remarkable that scarcely any attempt has ever been made to set the matter at rest by experiment. Years ago, when there was a keen discussion about the Inflexible, certain small models were made and tested in a tank on the Admiralty premises near Trafalgar-square. It was then shown that in still water a certain form of deck-protected ship was quite safe, although her sides were riddled, so long as the water was calm. When it was agitated the curious fact came out that the water got into the ship faster than it escaped as she rolled, and accumulated on her deck till it stood above the level of the water outside; then the model capsized and sank. At a very moderate cost the question could be settled. Let a miniature hull be built, say 50ft. long and all in proportion; let this be fitted with a belt, say of 1in. armour, taken out into the Solent when it was rough enough to make her roll 8 deg. or 9 deg., and fired at say with a Gardiner or Nordenfelt or some gun incapable of getting through the belt, though it would pierce her skin. Let a similar craft be protected by a deck, and attacked in the same way. In less than half-an-hour an enormous amount of valuable information could be obtained in this way for an outlay of, say, £1000, or the hundredth part of that of one of the ships which we go on building without any practical data to guide us in deciding which system is the better of the two. In gunnery experiments very large sums are spent without hesitation. Is the Admiralty less desirous of arriving at the truth by actual experiment than the War-office is?

THE GREAT EASTERN.

THE history of the Great Eastern is full of surprises. It is always that which is most unlikely to happen to her which occurs. Not long since we recorded her sale by auction in Liverpool for £26,000. It was stated that her purchasers were going to fit her out for the Australian trade, and that she would at once be sent from Dublin to Glasgow to be fitted with new engines and boilers, and to undergo thorough renovation. Lord Ravensworth in his address to the Institution of Naval Architects spoke last week of the bright future before her in that Australian trade for which she was specially built. Yet at this moment the Great Eastern is lying in her old berth in the Sloyne at Liverpool, and unless something else at present quite unforeseen takes place, she will once more play the undignified part of a floating music hall. It seems that although she was certainly sold, as we have stated, the transaction was not completed. Her owners then cast about for the next highest bidder, who at once took her. He is, we understand, a Manchester cotton spinner, and he paid £25,500 for her. It is no secret that Messrs. Lewis made a considerable sum out of the ship last year, and the knowledge of this fact has no doubt induced her present owner to follow their example. The ship left Dublin on Sunday evening under her own steam and in tow of two Liverpool tugs, the Brilliant Star and the Wrestler, and arrived in the Mersey without accident on Monday, after a passage of only thirteen hours. Mr. Reeves, formerly her chief officer, has been made captain. Mr. Jackson is still chief engineer. We cannot at present explain the fact that she went more than twice as fast as she has done recently, her engines making as many as 36 revolutions a minute, save on the assumption that while lying at Dublin, much of the enormous growth of seaweed on her bottom died off, as will sometimes happen as a result of change of water. Her engines and boilers too have had a good overhaul by Mr. Jackson, and this may account in part for this improvement. It is much to be regretted that the scheme of using the ship for her legitimate purpose has not been carried out. It is not, however, yet too late. The Great Eastern was not a success in Dublin, for one reason, that a beer and spirit licence could not be obtained for her. It is said that notice has been given at the Birkenhead police-court that any application for a licence of a similar kind will be opposed. Whether the ship will be as popular a resort without as she was with a licence we cannot pretend to say; and we may add that all our predilections are against her degradation to the status of a floating music hall. The greater her failure as such, the greater the chance of her being put to a better use; and it may help to that desirable end if we say here something concerning the way in which she could be rendered a commercial success as a trader.

It may be taken as proved that the present value of the ship is about £26,000. Mr. De Mattos gave, we understand, £27,000 for her, and he bought her by auction. The last sale gives nearly the same figures. If we assume that there are 10,000 tons of iron in her, we may also assume that if broken up it would not fetch more than £3 a ton at present rates; but even if we say £4, we have as a total but £40,000. To break the ship up would be a herculean task; we very much doubt if it could be done for the difference between £26,000 and £40,000; her engines would only sell for old iron, being entirely worthless for any other place than the foundry once they were taken out of her; as for her boilers, the less said about them the better. In one word, she would not pay to break up. On the other hand, by a comparatively moderate further outlay, she might be made the finest trading ship afloat. There are two harbours at all events into which she can always get—namely, Milford and Sydney. There are others, of course, but these will do; and the ship could trade between these two ports. By taking out her paddle-engines, she would be relieved of a weight of 850 tons. The removal of her paddle-engine boilers would further lighten her, and would give in addition an enormous stowage space. By using her both as a cargo and a passenger ship, the whole of the upper portion could be utilised for emigrants, let us say, and the lower decks for cargo, of which she could carry nearly if not quite 20,000 tons. She would possess the great advantage that, notwithstanding she was a cargo ship, she would be nearly if not quite as fast as any save a few of the most recent additions to the Australian fleet. There is every reason to believe that she has been driven at 14 knots by about 6000-horse power. We are inclined to think that the power has been over-stated, and we have it on good authority that she has more than once attained a speed of 15 knots. Let us assume, however, that her speed is to be 13 knots, or about fifteen miles an hour. Assuming the power required to vary as the cube of the speed, if 6000-horse power gave 14 knots, then about 4800 would give 13 knots—say 5000-horse power. Now, good compound engines of this power ought not to burn more than 2 lb. per horse per hour, or, say, 4·5 tons per hour, or 108 tons a day. Allowing the trip to Australia to take forty days, we have 4320 tons of coal—say 5000 tons for the trip. The Etruria burns about this quantity in the run to New York and back. For each ton of coal burned in the Great Eastern about 15,000 tons of cargo and 3000 passengers could be moved about 3¼ miles. There is, we need hardly say, nothing afloat which can compare in economy of fuel with this. Taken on another basis, we may compare her with an ordinary cargo boat. In such a vessel about 3000 tons of grain can be moved at 9 knots an hour for 600-horse power—that is 5 tons of cargo per horse-power. Reducing the speed of the Great Eastern to 9 knots and about 2000-horse power, we have 9 tons of cargo moved at 9 knots per horse-power; so that in the relation of coal burned to cargo moved she would be nearly twice as economical as any other vessel afloat.

The important question is, What would the necessary alterations cost? Much, of course, would depend on what was done. A very large part of the present screw engines could be used. For example, the crank shaft, some 2ft. in diameter, is a splendid job, and no difficulty need be met with in working in nearly the whole of the present framing. If the engines were only to be compound, two of the existing cylinders might be left where they are, two high-pressure cylinders being substituted for the others. If triple expansion were adopted, then new engines would be wanted, but the present crank and screw shafts would answer perfectly. The present screw would have to be removed, and one of smaller diameter and less pitch put in its place. All things considered, we believe that for about £75,000 the Great Eastern could be entirely renovated and remodelled inside. Her owners would then have for, say £100,000, a ship without a rival. Her freights might be cut so low that she would always have cargo enough, and her speed and moderate fares ought to attract plenty of passengers. Sum up the matter how we may, there appears to be a good case for further investigation and inquiry as to the prospects of success for such a ship in the Australian trade, and the opinion of merchants and others in Melbourne and Sydney ought to be obtained. Something would be gained even if the opinions of unprejudiced experts were adverse. We might then rest content to regard the ship as an utter failure, and not object to see her sunk and filled with concrete to play the part of a breakwater. Until, however, such an opinion has been expressed after full discussion, we must continue to regard the ship as fit for something better than a music-hall and dancing saloon.

THE SIZES OF STEAMERS.

Lloyd's returns of ships built under their survey have been compiled for the first two months of the year, and they show that the increase in the average size of the vessels built, which were in progress last year, is still continuing. The whole of the vessels launched in the first two months of 1886 averaged 1412 tons, whilst in the previous year the average over the same area and period was 952 tons only. In the present year the average is 1307 tons only, which is slightly less than this year, owing to the falling-off in the average size of the sailing vessels. But when we come to the steamships apart from sailing vessels the remark made above is fully justified. The steamers launched in 1886 averaged 1439 tons each, whilst those launched in the same period of this year averaged 1661 tons each. The number of the steamers built last year in that period was 15 per month, whilst this year the number was 16 per month, so that the average may be said to be fairly drawn; but the sailing vessels this year are much fewer in number than they were a year ago. The conclusion, then, is that the large demand for sailing vessels has been for the present gratified, and that the demand in shipbuilding is for a class of steamers which on the average are larger than they were. In degree, this is due to the fact that there has been for some time a tendency to take advantage of the low price of iron and steel by building large "liners." But concurrently there has been an equal tendency to build small vessels, especially on the Clyde, where yachts, barges, and dredgers have been built in larger numbers than usual. Thus, the class of ocean-going vessels which have of late been built have been very considerably over the average. They have been built very cheaply, and in order to enable the owners to carry at a profit at the present low rates of freight. The fact will have its influence on the shipbuilding of the immediate future. If we look at another official record—that of the Registrar-General of Shipping—we shall find that for the latest month reported on, the average of the vessels added to the registers of the United Kingdom and the colonies was far above that of vessels removed from the registers. In that month there were added 61 vessels of all kinds—steam, sailing, iron, and wood; these were 21,641 tons; whilst the removals were to the extent of 49,510 tons, but they numbered 204, so that the average size was much less. The number of the vessels in the mercantile navies alike of the United Kingdom and of the colonies has been thinned of late, but the numerical loss has been far larger than that of the tonnage. In a sentence, our commercial fleets are more and more tending to larger average size, and this in spite of the registration of numbers of fishing vessels and allied craft. It may be on the whole believed that this thinning of the fleets is an advantage, because it is certain that large numbers of vessels are broken up and otherwise removed which could not be considered in any way as efficient. But it is probable that in time we shall find the need for some vessels of moderate size, and if so our shipbuilders may have orders of the kind they were wont to have.

AMERICAN RAILWAY GUIDES.

In our "American Engineering News," an unfavourable comment was made upon an English guide to American railways, and as a result of inquiries on the subject, we learn from the writer of the article referred to that the "Travellers' Official Guide," of which he has sent us a copy, seems to be the most generally useful guide to the United States railways. The American railroad systems are so numerous and so interwoven by traffic and running power arrangements and leases, that in order to obtain anything approaching an accurate idea of the travelling facilities it is necessary, not only to refer to the main town and city index given in this guide at pp. 525—582, but to consider the maps and to refer to the time-tables of the roads mentioned. As one instance our correspondent takes Chicago, as connected with which neither the Pennsylvania nor N.Y. Central and Hudson River railroads are mentioned; but both these roads (among many others) run through trains from New York to Chicago, the latter by way of the Michigan Central R.R., and the former over lines in its own control. In fact, nearly every road from New York has a connection; but these can only be made out, even for approximate accuracy, by a thorough investigation. Another guide he mentions is the "Monitor," which consists of two parts—(1) a list of 80,000 places, with railroads, express companies, &c., and (2) a weekly bulletin of time-tables and other information. The subscription is 6 dols. per annum in advance. There are others, but the "Traveller's" and "Monitor" are the best, and there is no one that gives the indirect modes of access, but for a thorough knowledge of the travelling facilities these are necessary. The only way to obtain these is from the individual publications of the companies. Fares are rarely given; the reason for this is that, unlike English arrangements, the fares are ever varying, owing to competition. As a rule, there is a peaceable arrangement, but should one line cut rates, the others follow suit. In 1884 there was a New York Chicago rate war, which resulted in a west-bound rate of 1 dol., the average being from 15 dols. to 20 dols. On the N.Y. Central "Limited," which makes the run in twenty-four hours, the fare is 25 dols., exclusive of expenses for meals—in the dining-car—and sleeping berths. There are some steamboat routes in great favour, one of which, as an instance, is that to Boston by boat up Long Island Sound to some railroad point, and thence by rail, avoiding the long route round Cape Cod. Of these the Fall River Line, running in connection with the Old Colony R.R., is the best. These boats are floating palaces, and strongly built for the occasional rough weather they experience. Leaving one city in the evening, passengers are deposited at the other next morning, without the fatigue and noise of a long railroad journey.

THE RAILWAY BILL AS AMENDED.

The opposition of traders and agriculturists to the Railway and Canal Bill will be greatly strengthened by the alterations made in the measure by the House of Lords. They will not like the strengthening of the legal element in the Railway Commission, although we fail to see any objection to having a Judge in place of a man "experienced in the law" who is not a Judge. Still less will they approve of the alteration in subsection 6 of Clause 24, directing the Board of Trade to make new schedules and classifications "on the whole equivalent to" the old maximum rates and charges, instead of leaving it to the judgment of the Board to allow such rates and charges as seem "fairly applicable" to the circumstances, subject to the approval of Parliament. What will be said of the omission of Clause 29, authorising the Board of Trade to hear complaints from the customers of railway companies, and to endeavour to arrange the disputes amicably, is doubtful. In our opinion omission is desirable, as the proposed interference of the Board was extremely annoying to the companies, and could not have done much good, seeing that the Board would have no power to do anything beyond reporting cases to Parliament, if an amicable arrangement could not be made. The powers of the Board of Trade to arrange charges and classification to submit to Parliament are not affected by this alteration. With respect to the striking out of Clause 29, requiring the publication of rates and charges and their exhibition at stations, it appears to us a great mistake. As it stood, the clause was declared by representatives of the companies to be impracticable, and it might possibly have needed modification. But it is of the utmost importance to the public to be able to ascertain without difficulty what the rates on different classes of goods for various distances are; and it is a pity that no attempt to meet this want is to be made. After all, however, traders and agriculturists will be more annoyed at the refusal of the Lords to make the changes in the Bill than at anything which they have done. The right of a double appeal from a decision by the Railway Commissioners, which gives an enormous advantage to the largest purse, has been confirmed so far. Worse still, the subsection to Clause 25, proposing to legalise undue preference on the excuse that it is necessary in order to obtain traffic, has been retained on a division by 49 votes to 11. This decision, if confirmed by the House of Commons, will render the Bill obnoxious to the vast majority of the customers of railway companies, as it will authorise and extend the unfair advantage at present illegally given to one town or person to the disadvantage of another, and the handicapping of the home producer for the benefit of the foreigner. It is probably safe now to regard the Bill as doomed to be shelved for the present session, as the most determined opposition will certainly be offered to it in the House of Commons.

LOCOMOTIVE BOILER EXPLOSIONS IN THE UNITED STATES.

Locomotive boilers explode pretty frequently in the United States, even on railroads that are esteemed as first class. Even new engines frequently blow up, showing that either the design or the material, or the workmanship, or all three, must be bad. There is little excuse for an old boiler blowing up, as hydraulic testing and proper examination will reveal its dangerous condition, but there is absolutely no excuse for the explosion of a new boiler. Yet cases such as that quoted below are of frequent occurrence:—"A large new passenger engine, the William H. Sayre, on the Lehigh Valley Road, jumped the track near Hazelton, on the afternoon of February 26th, and was overturned, and immediately afterward the boiler exploded, completely demolishing the engine. The engineer and fireman of the locomotive were badly injured, and the life of the latter is despaired of. The engine had been completed at the Hazelton shops here only three days before." A new Wootten engine built by the Baldwin Locomotive Works blew up while running an express train on the Baltimore and Ohio on Sept. 26th, 1886. A few days afterwards a new boiler blew up on another road paying a good dividend and carrying a large number of passengers. Even the incomplete newspaper returns show fully thirty locomotive boiler explosions per annum, which are therefore about ten times as numerous in the United States as here, taking the relative number of locomotives into account; and still Americans maintain they are the best railway engineers in the world. With marine engines which break down, bridges that tumble into fragments, and locomotive boilers that burst on all sides, it seems difficult to prove the statement.

ENGLISH GIRDER MANUFACTURE.

The advance of the steel age, which has placed so many iron-works *hors de combat*, is just now showing itself in a wholly new direction, and it is only in keeping with past experience that the new development should date from the north-east coast. Constructive engineers and architects are now to be supplied with steel instead of iron rolled girders and joists of native manufacture. In the competition which North of England makers have of late been conducting against Belgian girders intended for the English market, it has now been found that the terms of the contest are such that native makers must retire if they are not to lose money. The inferior quality of the Belgian iron compared with the English product is enabling the foreigners to accept prices which are impossible to North of England makers. It has now therefore been resolved to pretty much discontinue the competition as against the imported iron girders. But a vigorous attempt is to be made to gain the market in another direction by the manufacture of steel girders and joists. Messrs. Dorman, Long, and Co., who have just determined upon this departure, estimate that steel girders will carry, weight for weight, 40 per cent. more than girders of iron, yet the increase in cost is only 25 per cent. A further obvious saving in the use of steel over iron occurs in the matter of carriage. The new Siemens-Martin steel works which the firm have started will ultimately have a capacity of 1200 tons of steel per week, and more than thirty different sizes of steel joists will be turned out. This new move in the progress of steel *versus* iron is very suggestive.

LITERATURE.

A History of the Theory of Elasticity and of the Strength of Materials, from Galileo to the Present Time. By the late Isaac Todhunter, D.Sc., F.R.S. Edited and completed for the Syndics of the University Press, by Karl Pearson, M.A., Professor of Applied Mathematics, University College, London. Vol. I., Galileo to Saint Venant, 1639-1850. Cambridge, at the University Press. 1886.

This is a book that should be in the hands of the theoretical engineer and architect engaged in the scientific designs of structures; for although intended by Dr. Todhunter to be only a history of the mathematical theory of the subject, analogous to his other histories of the "Theory of Probabilities," the "Calculus of Variations and Attractions," and the "Figure of the Earth," yet the editor, Professor Pearson, has been unable to exclude the work of practical men like Tredgold, Barlow, Hodgkinson, Vicat, Gerstner, and the Iron Commissioners, concluding that the mathematical theory of the strength of materials originated from the practical problems presented to these men for solution.

Dr. Todhunter would have begun the history with James Bernouilli, 1695, but Professor Pearson carries it back to Galileo, 1638. At this rate we should like to see what Albert Durer and Leonardo da Vinci wrote on the subject. Galileo's treatment of the problem of the beam, built into a wall at one end, and supporting a weight at the other, is exactly the same as that now employed for determining the bending moment, or breaking moment, as it was formerly called. For a long time, however, the compression of the material was neglected, and the neutral plane taken in consequence in the bottom plane of the beam; and Dr. Todhunter is very sarcastic in his references to Tredgold, Barlow, and the English writers for perpetuating this error long after the foreign theorists had assigned the true theoretical position. Nevertheless, theory and experiment have always been at variance in the flexure of beams, and it is only quite recently that Professor Unwin has cleared up the difficulty by showing that Tredgold and Barlow were after all not so very incorrect in their reasoning, as the difference of the modulus of elasticity for extension and for compression, which Professor Pearson calls the stretch and squeeze moduli, now revealed by his experiments, has the effect of throwing the neutral plane into a position somewhere between its position formerly pointed out by theory and that assumed by practical men. Lamarle, however, in 1845, seems to have been on the right track, but his writings have not received the attention they deserve.

Dr. Todhunter speaks of the perusal of English text-books on practical mechanics of the first half of this century as a dispiriting and hopeless task, but appears to enjoy the metaphysical speculations of pure theorists on the constitution of matter, and on ether, molecules, and electric affinities. It is interesting to find, notwithstanding these predilections of the author, the names most honoured by engineers—like Bramah, Clapeyron, Fairbairn, Moseley, and Stephenson—as having contributed by theory properly connected by experiment to the advance of the subject; many of these experiments being carried out while the design of the Britannia tubular bridge was under discussion. The name "tubular" still applied to this bridge is historically interesting as recording the fact that in Robert Stephenson's first design of the bridge the cross-section was circular or elliptical, afterwards changed to the rectangular section in consequence of Fairbairn's experiments and theoretical reasoning.

Students of Rankine's works should consult the "Handbuch der Mechaniks," by Gerstner, Prague, 1833, and will find Rankine's method of mathematical treatment of applied mechanics anticipated by Gerstner to a great extent; but Rankine appears not to have studied the German writers, perhaps from ignorance of the language, or he would have found that Gerstner had anticipated him so long ago as 1802 in the treatment of the trochoidal waves in water. The principal part of this history is naturally occupied with the analysis of the purely theoretical investigations of mathematicians like Navier, Poisson, Caneby, Lamé, Stokes, and Saint-Venant. Of these, the name of Saint-Venant is perhaps best known to engineers, from his researches on torsion and on the effect of the shearing stress, the great *crux* in the theory of beams.

The work of the most practical interest by Stokes is a discussion of the effect on a beam or bridge of a load moving rapidly along it, undertaken about 1849 in consequence of the failure of some railway bridges. In small bridges this is an important consideration, but may be disregarded in structures like the Forth Bridge, where the weight of any train is relatively so insignificant, the chief effort of the structure being directed to keeping itself from collapse by its own weight.

The mathematical theory of elasticity is built up from an assumption of Hooke's law, as geometry is built upon the foundation of Euclid's axioms. While, however, a geometrical theorem is true, whatever be the scale to which the figure is drawn, we cannot assert the same of a mechanical theorem, the law of mechanical similitude being much more complicated, small bodies being relatively much stronger than large bodies.

An interesting application is given of this law of mechanical similitude by Euler to the growth of trees; and at the present day it is this law which guides the engineer, as the ships, guns, and bridges he is called upon to design are made of constantly increasing size. A limit must very soon be reached, and for the same reason that the limiting size of the birds of flight is reached in the comparatively insignificant size of the eagle.

Recent experiments of Wöhler on the fatigue of metals, and of Unwin and Kennedy on the elastic limit of metals, prove that Hooke's law can only be supposed to hold between comparatively small limits, and further, that we must take different moduli for extension and compression. An interesting appendix by Professor Kennedy directs attention to these facts, and explains their modification in the theories and formulæ of the mathematicians.

Professor Pearson has taken great pains with the editing, having really re-written the book as left by Dr. Todhunter, and given great attention to uniformity of terminology and notation; and we hope he will not be deterred from completing the subsequent volume to bring the subject up to date, as the present volume, we repeat, is indispensable to all designers of large structures in steel and iron.

Algebra for the use of Schools and Colleges. By WILLIAM THOMSON, M.A., B.Sc., F.R.S.E. Professor of Mathematics, Stellenbosch College. London: Sampson, Low, Marston, Searle, and Rivington. Cape Town: J. C. Juta and Co., 1886.

THIS is an excellent treatise on Elementary Algebra, suitable for students in university matriculation examinations, and containing sufficient of the subject for practical purposes without venturing too deeply into purely abstract theorems. Had it appeared two or three years ago this book would have commanded a great sale in this country, but now the field is already occupied by the treatises of Charles Smith, Hall, and Knight, and also of Prof. Chrystal, to whom the present work is dedicated, all covering very much the same ground, and planned on similar lines.

Prof. Thomson goes at once, with as little preliminary definition as possible, to the practical applications of the algebraical operations of addition, subtraction, multiplication, involution, division, evolution, factors, greatest common measure, least common multiple, fractions, indices and surds, necessary to the worker for the manipulation of algebrical expressions, and wisely spares us the metaphysical disquisitions that usually hamper the way.

The remainder of the volume is devoted to the solution of single and simultaneous equations, with numerous practical illustrations, Part II. being presumably intended to begin on the binomial and its kindred theorems. The illustrative examples are carefully selected, and a complete list of answers given at the end of the book.

The A B C of Modern Photography. The London Stereoscopic Company, London. 1887.

THOSE who have just taken up, or are about to take up, that most interesting branch of modern art, Photography, will find in the "A B C," published by the London Stereoscopic Company, a useful and interesting little volume. Many amateurs who have no friend to help them in the selection of their apparatus will derive from this book good advice and trustworthy guidance. The company perhaps refers more particularly to its own manufactures, but then from its long-established "might," it has perfect "right" to do so, and as it gives to its purchasers free access to a model suite of dark rooms, &c., we have no doubt that many will take advantage of this opening. The "A B C" gives a short description of the dark rooms referred to, and a great deal of ingenuity has been displayed by the deviser, who has got so many perfectly fitted rooms into so little space. They appear to be all that can be desired by the photographer who wishes to use them for nothing greater than the development of his plates. The hints given on portraiture merit the attention of many amateurs, and at the same time a careful study of the chapter on lenses will not be amiss. We may say in conclusion that the whole is carefully and very well illustrated.

Triangulation and Measurements at the Forth Bridge. By REGINALD E. MIDDLETON, M. Inst. C.E. London: E. and F. N. Spon. 1887.

IN books on surveying, levelling, and setting out of engineering works of large base, few, if any, afford a complete account of the various steps taken in a special case of importance. This was done by Mr. Middleton in the articles published in THE ENGINEER of the 8th, 29th, and 15th of October, 12th November, and 3rd December of last year. These articles are reproduced in this book with additions, presenting the whole in a handy form, but the author has not, as he should, given the book an index.

BOOKS RECEIVED.

Joint Scientific Papers of James Prescott Joule, D.C.L., F.R.S. Published by the Physical Society of London, and Messrs. Taylor and Francis. 1887.

Triangulation and Measurements of the Forth Bridge. By Reginald E. Middleton. London: E. and F. N. Spon. 1887.

Key to Engines and Engine Running: a Practical Treatise upon the Management of Steam Engines and Boilers. By Joshua Rose, M.E. London: Sampson Low and Co. 1887.

Notes on the Lithology of Gas Coals, with List of Commercial Analyses. By James Paterson, C.E., F.G.S. London: Walter King. 1887.

Colonial and Indian Exhibition. Reports on the Colonial Sections of the Exhibition. Issued under the supervision of the Council of the Society of Arts, and edited by H. Trueman Wood, M.A. London: W. Clowes and Sons. 1887.

A Practical Treatise on Petroleum, comprising its Origin, Distribution, Chemistry, Mining Uses, and Transportation. By Benjamin J. Crew. London: Sampson Low, Marston, Searle, and Rivington, 1887.

Journal of the Iron and Steel Institute, 1886. No. 2. London: E. and F. N. Spon. 1887.

Laxton's Builders' Price Book for 1887*; containing about* 72,000 *Prices.* Originally compiled by William Laxton. Seventieth edition. London: Kelly and Co. 1887.

The Plumber and Sanitary Houses. A Practical Treatise on the Principles of Internal Plumbing Work, or the Best Means for Effectually Excluding Noxious Gases from our Houses. By S. Stevens Hellyer. Fourth edition. London: T. B. Batsford. 1887.

Locomotives and Locomotive Building: a Brief Sketch of the Growth of the Railroad System and of the Various Improvements in Locomotive Building in America: together with a History of the Origin and Growth of the Rogers Locomotive and Machine Works, Paterson, New Jersey, from 1831 *to* 1886. New York: W. S. Gottsberger.

The Separate System of Sewerage: its Theory and Construction. By Cady Staley and G. S. Pierson, C.E. New York: D. Van Nostrand. London: Trübner and Co. 1886.

Arithmetic for Schools. By Rev. J. B. Lock, M.A. London: Macmillan and Co. 1886.

THE GLASGOW INTERNATIONAL EXHIBITION.

SOME important steps in the practical carrying out of this undertaking have just been completed by the selection of a design for the Exhibition buildings, and by the preparation of a detailed prospectus of the scheme. In response to the Executive Council's invitation for competitive designs of proposed buildings, some twelve sets of plans were sent in some weeks ago, and the result of adjudication upon them has just been made known. Premiums of £150, £100, and £50 were offered for the best three sets of designs that might be submitted—the author of the successful design to have the right to carry through the work of erection at the rate of 2½ per cent. on the cost of the buildings, which was limited to £30,000. These conditions were demurred against by a considerable number of Glasgow and other architects, who maintained the commission ought to be 5 per cent., and the total cost considerably more than stated; but the Committee adhered to their first conditions. On this account the number of competitors was much smaller than it otherwise would have been. The firm which has been awarded the first premium of £150 is that of Messrs. Campbell, Douglas, and Sellars, architects, Glasgow, associated with whom is Mr. James Barr, C.E., for their set of plans bearing the motto, "Bishop's Palace." Running this hard for first place came the firm of Messrs. Burnet, Son, and Campbell, Glasgow, with a set of plans bearing the motto, "Industry, Science, and Art," Mr. Burnet, it will be remembered, being the architect for the recent Edinburgh Exhibition.

The site for the buildings, which has been granted by the City Corporation, is one of exceptional beauty and convenience, comprising about sixty acres of the western portion of Kelvin-grove Park and the slopes of Gilmore Hill, on which stands the imposing edifice of Glasgow University. The buildings themselves will cover about ten acres of ground, and will consist, as per Messrs. Campbell, Douglas, and Sellars' design, of a main building 880ft. long by 360ft. maximum breadth, a machinery annexe, 300ft. long by 250ft. maximum breadth, and a further annexe for electric lighting machinery of 140ft. long by 50ft. broad. The general plan of the main building resembles the Crystal Palace at Sydenham in this respect, that it has a great central avenue along its entire length, intersected by transverse avenues. These main avenues are 60ft. in width, and at their intersection a dome 80ft. in diameter, rising to a height of 110ft., is placed. On either side of the central avenue are a series of transverse courts, of a uniform width of 50ft., and varying in length from 80ft. to 120ft. At the east end of the main building, and in effect simply a continuation of the central avenue, will be a Grand Hall, so arranged that it can be open for promenading purposes, or isolated, as circumstances may require. It provides sitting accommodation for about 3300 persons. At the south-east angle of the main building, substantially constructed galleries for fine art exhibits are situated. These comprise a main picture gallery 150ft. in length by 36ft. in width, a sculpture gallery of the same dimensions, and eight other galleries, varying in lengths from 100ft. to 50ft. There will be four main entrances to the buildings, one on each side in the centre of the length of the main avenue, and one at each end of same. The buildings generally are proposed to be constructed of timber, with the exception of the fine arts section and the principal dome, which will be of brick and malleable iron respectively. The architectural treatment is Oriental in character, a style well adapted for this class of building, and one which lends itself readily to execution in wood. The main feature is the large dome, round which are grouped four octagonal towers, surmounted by minarets. Flanking the south and east entrances are square towers with dome-shaped terminations; and similar towers break up the long length of the great avenue, giving interest to the design, and adding greatly to the picturesque effect of the whole composition.

A noteworthy feature in connection with the site and with the scope of the Exhibition is the intersection of the grounds by the river Kelvin, which it is proposed to place at disposal for the more effective exhibition of objects connected with shipbuilding, shipping, and marine industries. The reach of river which can be utilised for this purpose is some 1500ft. long, 90ft. wide, and 6ft. average depth. Practical demonstration with small craft or working models of larger types of vessels, with lifeboats and life-saving apparatus of all kinds, can be given and witnessed to advantage.

From the prospectus of the Exhibition, which has just been prepared, it appears that, as regards object and scope, the forthcoming display will be very similar to other undertakings of a like nature held within recent years. One important deviation, however, from accepted usage is the stated intention of not issuing awards to exhibitors. Whether this may or may not interfere with the success of the project as an exposition of the highest and best to which we have attained as a nation of manufacturers and shopkeepers, results alone will show. The objects of the Exhibition are declared to be the promotion and fostering of industry, science, and art by exciting inventive genius to a still further development in arts and manufactures, and to stimulate commercial enterprise by inviting all nations to exhibit their products both in the raw and finished state. Examples of the manufactures by which Glasgow and the surrounding districts have become famous—chemicals, iron, and other mineral products, engineering, shipbuilding, electrical and scientific appliances, and textile fabrics—will be exhibited both in process of manufacture and in the finished state, while similar and more varied exhibits may be expected from other parts of Great Britain and from the Continent. America, India, and the Canadian, Australian, Cape and other colonies have given hearty promises of support. The division and enumeration of the several classes into which the exhibits will be divided are very fully detailed in the prospectus. There are as many as twenty-two different classes, under each of which are numerous sub-sections, covering practically the whole field of industry, science and art. In addition to the general body of exhibits there will be sections devoted to exhibits of woman's industries and the work of artisans. Locally the scheme has received the heartiest support, and a general council elected from the body of subscribers to the guarantee fund are working with enthusiasm to further the interests of the undertaking. The guarantee fund now reaches considerably over £230,000, and is daily growing. This large fund is certainly tangible evidence of the hopeful light in which the undertaking is regarded by the moneyed and commercial classes of Glasgow and the West of Scotland.

CAUTION.—A person giving the name of Philip Barry has been appealing for alms among civil engineers, stating that he is a member of the Institution, and is well known to the secretary, both of which assertions are unfounded.

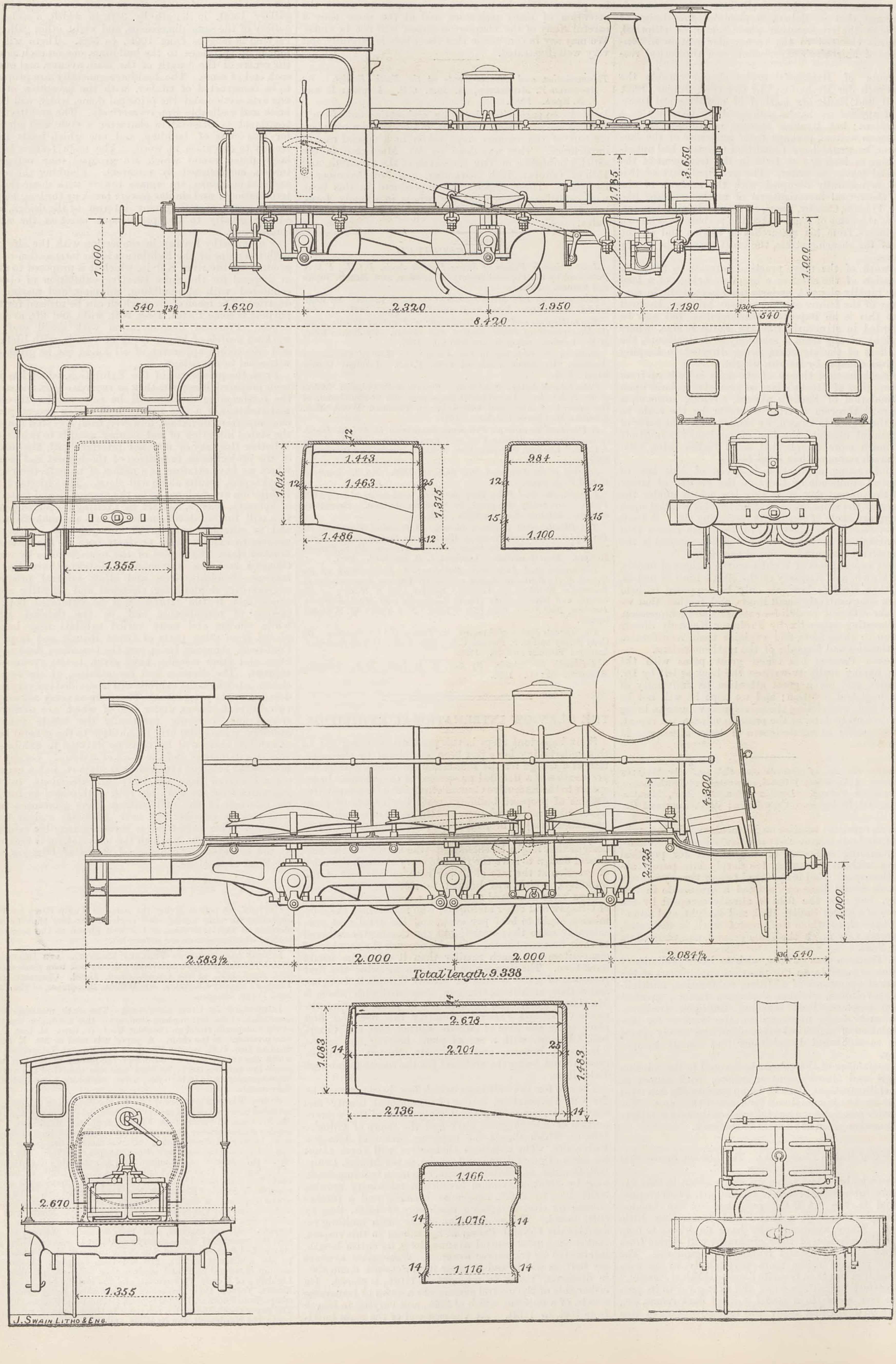
LONDON ASSOCIATION OF FOREMEN ENGINEERS AND DRAUGHTSMEN.—The thirty-fourth anniversary dinner will take place on the 30th April, 1887, at the Cannon-street, Hotel. Chairman, Lord Thurlow; deputy-Chairman, Mr. William Beardmore, of the Parkhead Forge, Glasgow.

INSTITUTION OF CIVIL ENGINEERS.—The sixth meeting of the association of the Birmingham students of this institution was held at the Colonnade Hotel on the 4th.; Mr J. W. Gray, M. Inst. C.E., vice-president, in the chair. A paper was read by Mr. E. Dodd, Student Inst. C.E., upon "The Past and Present Telegraphy," in which the author gave an outline of the history of the first telegraph line constructed in England, and also described the various improvements made in batteries, wires, insulators, poles, and other instruments.

JUNIOR ENGINEERING SOCIETY.—On the 25th ult. a numerously-attended meeting of this society was held, when a paper was read Mr. W. Chas. C. Smith, "On Torpedo Boats and Machinery. The leading characteristics of torpedo boats—lightness, limited dimensions, high speed of machinery, and great manœuvring power—were first enlarged upon, and their sizes and types classified. The necessity of the adoption of a standard type was receiving the attention of the maritime Powers, but opinions as to the utility of torpedo boats had been considerably altered since the experiments on the condemned ironclad Resistance had been carried out. The value of the torpedo as a destructive agent was stated at some length, and a description was given of some recent experiments with it; after which the author proceeded to point out the risks to which torpedo boats are exposed, and their means of defence, stating that the question of the necessary armament to resist machine gun attacks had been considered, but owing to loss of speed occasioned by the additional weight, had not been adopted. A detailed account of several boats and engines then followed, including the Lightning of Messrs. Thornycroft, and the torpedo boat catcher of Messrs. Yarrow, their respective performances being given, and comparisons drawn with other types of marine propelling machinery. The paper concluded with a reference to three types of submarine boats, the Nordenfelt, the Nautilus, and Peacemaker.

LOCOMOTIVES ON THE BELGIAN STATE RAILWAY.

(For description see page 279.)



EXHAUSTING AND BLOWING FANS.

MESSRS. HODGE AND CO., LONDON, MANUFACTURERS.

Fig. 1

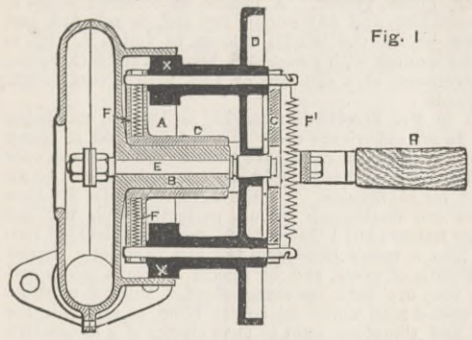


Fig. 2

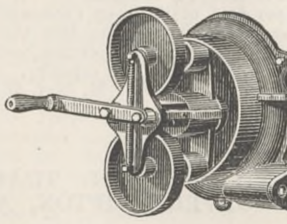
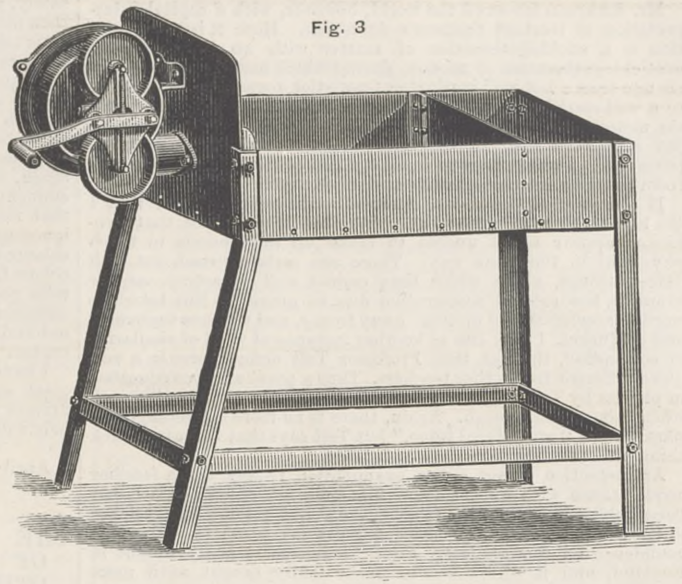


Fig. 3

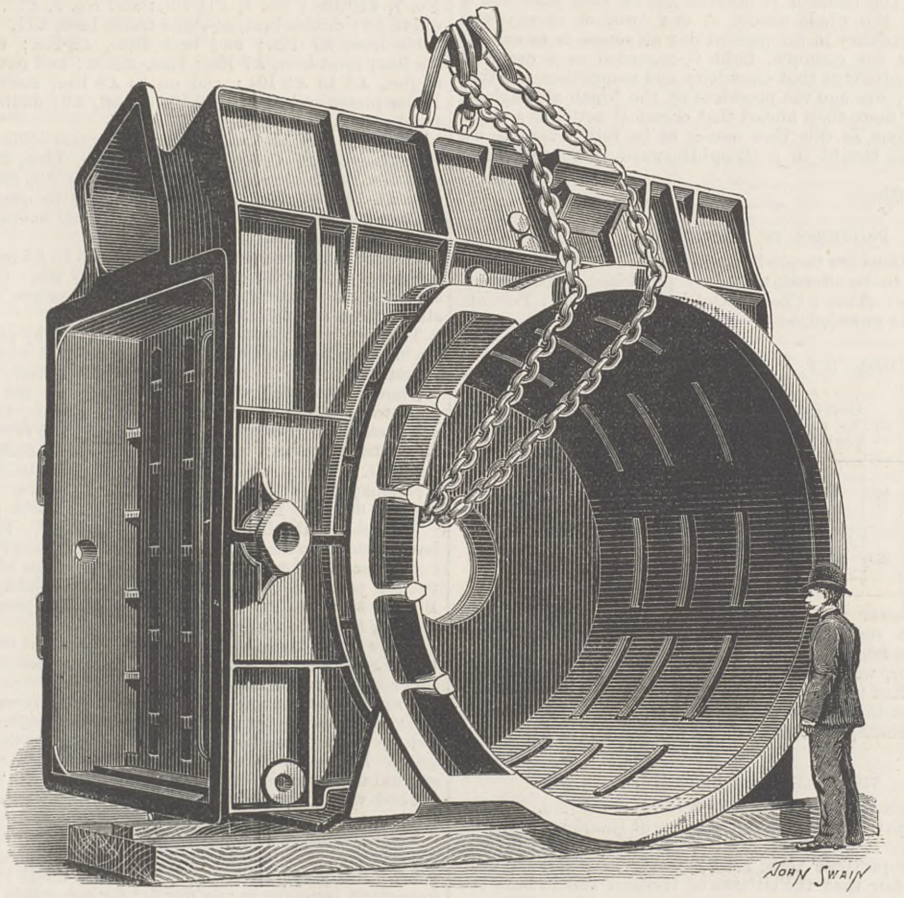


HODGES' EXHAUSTING AND BLOWING FANS.

THE accompaning engravings illustrate Hodges' system of hand-driving gear for fans as applied to a fan and to a forge. From the engravings it will be seen that the fan spindle is driven and runs in equilibrium, which reduces the friction and wear to a minimum. Fig. 1 is a section of a fan and the driving gear; Fig. 2 is a perspective view of the gear and fan; and Fig. 3 shows the gear and fan with a forge, as made by Messrs. Hodge and Co., London. From Fig. 1 it will be seen that a projecting ring A is cast on the side of the fan casing, the inside of which is turned true, together with the central boss B, which forms a substantial bearing for the fan spindle E. On this boss revolves the driver C C, driven by the handle H, which carries in slots two small steel spindles, on which the roller wheels D revolve; the smaller rollers X X are pressed outward against the ring A by two spiral springs F F; the larger rollers D are pressed on to the fan spindle pulley by the tension spring F[1], which gives an equal pressure on opposite sides of the pulley. The fan and driving gear are thus self-contained, and being independent of the framing, can be attached to any existing forge. They are in use in several places, and, we are informed on good authority, work very easily and produce a strong blast.

A LARGE CASTING.

HYDE PARK FOUNDRY COMPANY, GLASGOW, ENGINEERS.



A LARGE CASTING.

THE accompanying engraving, reduced from a photograph, shows a very large and fine casting, made by the Hyde Park Foundry Company, Glasgow. It is one of two large cylinders for a compound diagonal marine engine, and has been made to the order of the Fairfield Shipbuilding and Engineering Company—John Elder and Co. Each cylinder required 40 tons of melted metal to cast it, and if perhaps we except the cylinders of the Ireland, Holyhead mail steamer, they are the heaviest ever made. Our engraving shows the cylinder without the liner, the working diameter of which inside is 112in., with a stroke of 72in. The finished weight of the cylinder with the liner in, lids, &c., will be about 42 tons. The slide valve weighs 59 cwt. The casting reflects much credit on the Hyde Park Foundry Company, which has had large experience in this kind of work, having turned out some of the heaviest castings ever made for marine engines for the Navy and merchant service.

BELGIAN STATE RAILWAY LOCOMOTIVES.

IN connection with the Railway Congress held at Brussels in 1885, to commemorate the fiftieth anniversary of the opening of the first railway in Belgium, we published a table giving the leading dimensions of the various types of locomotives in use on the Belgian State railways.[1] We have already reproduced the drawings of four of these engines;[2] and we now publish on the preceding page those of two more, viz., the passenger tank engine with four coupled wheels, and the passenger tender engine with six coupled wheels for steep gradients. The former, at the top of the page, has the following leading dimensions:—

Diameter of coupled wheels.. ..	1·45m.	= 4ft. 9in.
Diameter of cylinders	0·32m.	= 12½in.
Stroke..	0·46m.	= 1ft. 6in.
Mean diameter of boiler	1·078m.	= 3ft. 6in.
No. of tubes	145	
Length of tubes	2·75m.	= 9ft.
Outside diameter of tubes	0·045m.	= 1·77in.
Fire-box heating surface	5·874m.q.	= 63 square feet.
Tube heating surface	49·3248m.q.	= 538 square feet.
Capacity of boiler	2·827m.c.	= 100 cubic feet.
Capacity of tanks	3·6m.c.	= 135 ,,
Capacity of coal bunkers	1200 kilogs.	= 1 ton 3 cwt.
Weight on leading wheels	9600 ,,	= 9 tons 8 cwt.
Weight on driving ,, ...	11,600 ,,	= 11 tons 8 cwt.
Weight on trailing ,, ...	10,700 ,,	= 10 tons 10 cwt.
Total weight in running order	31,900 ,,	= 31 tons 6 cwt.
Weight of locomotive empty	26,000 ,,	= 25 tons 11 cwt.

This engine has three longitudinal frames; but the axle-box of that in the middle has no spring; and the inside cylinders are inclined 1 in 33. The valve gear is that of Walschaert, in which the slide valve is actuated both by the crosshead and a single excentric; the slide-valve rod being guided by the stuffing-box of the steam chest, and by a bracket on one of the slide bars. By way of experiment, some of these locomotives have their slot links, slide-valve frames, slide-valve rod guides, crossheads, pistons and axle-boxes cast in phosphor bronze. The bearing springs consist of twelve steel plates 900mm. × 100 mm. × 10 mm. = 35½ × 4 × ⅜in. The top plate is turned up so as to engage in the link—made of best iron and screwed in the lathe—by which the springs are adjusted. These engines have neither compensating beams nor counterweights to the driving wheels. The grate and heating surfaces are proportioned to the diameter of the cylinders. The fire-box wrapping plate is made of iron plate 12 mm.—½in. thick; and the boiler shell of 11 mm. thick, with lapped joints, the horizontal joints having double seams of rivets. Both safety valves are placed on the dome, one weighted by a plate spring acting directly and the other by a spring balance. The engine is provided with a Westinghouse brake acting, by four blocks, on the coupled wheels; but a hand wheel and screw are provided in case of derangement to the air cylinders.

The engine shown at the bottom of the page is a six-wheel coupled passenger engine for steep gradients, having the leading dimensions as follows:—

Diameter of wheels..	1·7m.	= 5ft. 7in.
Diameter of cylinder	0·45m.	= 18in.
Stroke	0·6m.	= 1ft. 11½in.
Diameter of boiler	1·3m.	= 4ft. 3in.
Number of tubes	226	
Length of do.	3·5m.	= 11ft. 6in.
Outside diameter of tube	0·045m.	= 1·77in.
Fire-box heating surface	10·92m.q.	= 118 square feet
Tube heating surface	98·463m.q.	= 1060 square feet.
Boiler capacity..	5·58m.c.	= 194 cubic feet.
Weight on leading wheels	12,800 kilogs.	= 12 tons 12 cwt.
Weight on driving wheels	14,400 ,,	= 14 tons 3 cwt.
Weight on trailing wheels	12,300 ,,	= 12 tons 2 cwt.
Weight in running order	39,500 ,,	= 38 tons 17 cwt.
Weight of engine empty	35,800 ,,	= 35 tons 3 cwt.

As in the previous case, there is a central longitudinal frame besides the two outside; and the inside cylinders are inclined at an angle of 1 in 9 with the horizon. Each cylinder has its separate steam chest. Engines built before 1882 have only one side cover to the valve chest; but those constructed after that date have two, one of which, forward, serves for the customary inspection of the slide valves, while the second is rendered necessary by the use of slide valve buckles in one piece. The slide valves are of gun-metal, many engines of this type being fitted with the double admission Trick valve. The slide valve is kept tight against the valve face by a plate spring attached to the frame. Stephenson valve gear is employed. The axle-box bearings are cast in gun-metal containing 84 per cent. of copper and 16 of tin. The wheels have their spokes forged without counterweights; and the tires of Bessemer steel, are attached to the wheel rim by threaded bolts passing through the rim and entering 15 mm. into the tire. The axle-boxes are entirely of cast iron with wedges for taking up the wear. The outside bearing springs measure 900 mm. = 2ft. 11½in. between the links, and consist of thirteen plates 100 by 10 mm. = 3·9 by 0·39in. and yield 8·4 mm. = 0·33in. per ton. The spring for the axle-box in the central frame has four plates 610 by 75 by 10 mm. = 2ft. by 3in. by 0·39in., and bends 12 mm. = 0·47in. per ton. There are no compensating beams. Latterly inverted springs have been substituted, made of twenty-two plates, 100 mm. by 10 mm. = 4in. by ⅜in. and 1·5m. = 4ft. 11in. long, with a flexibility of 22 mm. = 0·86in. per ton. The internal spring has necessarily been somewhat modified, and now consists of five plates of 100 mm. by 8 mm = 4in. by ⅜in. and 660 mm. = 2ft. 2in. long. It is finished with a curve of 30 mm. = 1·18in. and a flexibility of 21 mm. = 0·8in. per ton. The new long outside bearing springs of the leading and driving wheels have been provided with compensating beams, as shown by the drawing. The thickness of the front, side, and roof-plates of the copper fire-box has in recent engines been increased from 12 mm. to 14 mm. = ·47in. to ·55in. The copper tube plate is 25 mm. = 1in. where the tubes occur, and 14 mm. = ·55in. elsewhere. The boiler and outside fire-box plates must stand a minimum breaking strain of 33 kilogs. per square mm. = 21 tons per square inch in the direction of the rolling, and 28 kilogs. = 18 tons transversely, with elongations of 9 and 5 per cent. respectively; and the copper used in the fire-box must stand a minimum strain before fracture of 22 kilogs. per square mm. = 14 tons per square inch, with an elongation of at least 22 per cent. Wilson safety valves have lately been fitted to the fire-box wrapping plate, and Westinghouse air brakes act by six blocks on the six wheels. Locomotives of this type are capable of easily drawing 80 tons up a continuous gradient of 1 in 62 at a speed of 55 kilos. = 34 miles an hour.

[1] See THE ENGINEER of February 19th, 1886, p. 142.

[2] See THE ENGINEER of September 11th, 1885, p. 197, and April 23rd 1886, p. 320.

LETTERS TO THE EDITOR.

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

ENGINEERING IN CANTON.

SIR,—There now appears to be a revival of commercial activity in progress at this port, which may benefit foreign trade to a small extent at least. I have met a Mr. T——, who has just ordered a set of mining pumps from a firm of engineers and machinists at Hong Kong, and intended for use in the far-off Province of Kuei Chou. The mineral wealth of Kuei Chou is very great, and might be worked with some chance of profit if there were any roads by which machinery could be brought into the Province and the produce of the mines exported to suitable markets. At present the lack of water communication, and even ordinary land roads, is a great drawback to every mining undertaking, and numerous capitalists have already reason to be sorry of their enterprise.

Here in Canton a spirit of genuine enterprise, mixed with a considerable amount of mere speculation, has manifested itself in various ways. The one grand thing, however, is mining, I hear that no less than eighty-two mining licences have been granted to various companies by the Mining-office within the past few months, and some machinery has already been ordered for use in some of the localities selected for mining operations.

Many of these mining companies will no doubt prove ruinous concerns. The law forbids foreigners, and even native Christians, from having any interests in mining affairs; and when we take into consideration the fact that modern mining requires the greatest amount of intelligence procurable to make it a successful operation, and that the ordinary heathen lack those very qualities that are indispensable, we must be prepared to hear some discouraging news from the mining districts before long.

Repeating arms have been inquired for lately, probably for use in Tungking, where the Knights of Righteousness are giving the French troops more work than they expected to have of late. Various kinds of breech-loaders and ammunition are also in demand from Yun-nan, and armourers' tools for Kuang-Si. Copper smelting furnaces and coining machinery have also been inquired for; and the manufacture of copper cash is to be undertaken without delay in various quarters.

The native mints are of the most primitive order. Cash, native copper, or brass coins, are made by pouring molten metal into moulds instead of stamping, or impressing the device and superscription on the prepared metal discs by machinery of a suitable kind. The coins made in the old-fashioned native style have to be ground and trimmed by hand, and thus require a lot of labour to do very imperfect work. By the use of proper machinery, time and labour would be saved, and a better class of coins made than those produced by the native method. Counterfeit or false coins would also be more difficult of production. At present it is not unusual for the very men who are engaged in making coins for the Government to go home and make some on their own account in the evening. The counterfeit coins are smaller in size and made of baser metal than those made by the Government, but they pass all the same, a certain number of them being strung together with the real coins on strings containing one hundred each. The difficulty about the matter is that there are so many different sizes of Government coins made, in different provinces of course, and different qualities of metal, varying from nearly pure copper, and bronze, down to half copper, half zinc, brass, or even of a lower grade of alloy.

An order for six new armed revenue cruisers has been given to one of the Hong Kong shipbuilding firms, I am told. The cruisers are for use in these waters, where smuggling is rife and flourishing, owing to the excessive venality of the officials and the lax manner in which the laws are administered. The cruisers are to be about 100ft. long, and built for swiftness rather than for fighting qualities. The price is said to be very low, or rather reasonable, for Hong Kong. Nearly all the material required for their construction will be imported from Britain, I believe, and the frames will probably come out ready-made, to plans, and they can thus be put together very rapidly when the whole of the material has arrived. There are now several establishments in Hong Kong where vessels of 150ft. long can be built in a substantial manner. W. Mesny.

Canton, China, February 21st.

OLD BRASSES.

Sir,—Seeing that no one has as yet replied to the query addressed to you by "W. A.," in your issue of the 11th inst., I will, with your permission, endeavour to supply the information sought.

I am not sure that I thoroughly understand all that "W. A." says, but I think that I have grasped it sufficiently to give a practical reply. First let me remind "W. A." that gun-metal is by no means malleable, and therefore will not submit to be hammered when in a heated state. The apparent change in the metal which "W. A." suggests to have taken place is no change whatever. The change from the comparative silky appearance to the fibrous state is due to fracture having taken place when hot, and not to any fault or defect in the casting itself. Whether from want of lubrication or owing to bad fitting, clipping of the journal by the bearing, or any other abnormal friction producing heat, these semi-fractures, together with the apparent change in the metal, is sure to be the result. Each vibration of the engine, either from the thrust of rods or the compression of weight, acts as a blow upon the bearing when in a fragile state, and so produces the innumerable small semi-fractures, into which the oil rushes,—and hence the "spluttering," &c., when re-heated, as pointed out by "W. A." Phosphor bronze or any other bronze or alloy for engine bearings is not proof against these evil effects under conditions just named.

Perhaps it may here be necessary for the information of some of your readers to define the meaning of "clipping," the word being technical as here used. It is that state into which a loose brass or a solid box eventually gets by wear, when the two extremities of the semicircle of the bearing cease to be in contact with the journal, it having passed below these two points. If an engine be not lifted in due time, and the two sides of the bearing eased or freed, the evils pointed out by "W. A." are almost sure to follow.

March 29th. Foundryman.

THE RIACHUELO BRIDGE.

Sir,—Will you kindly allow me to make the following reply to Professor Kernot's letter, which appeared in your issue of the 25th ultimo. (1) As to the general design of the bridge. I am glad to hear that there is a remarkable resemblance between this bridge and recent American practice, as this fact points to the conclusion that American bridge designers appreciate and follow good examples. I have used this form of truss and general arrangement of parts, where circumstances permitted of my doing so, for many years. If Professor Kernot will refer to Fol. 29 of the "Minutes of Proceedings" of the Institution of Civil Engineers, Session 1869-70, he will find in a paper entitled, "Studies of Iron Girder Bridges, recently executed, illustrating some applications of the Modern Theory of the Elastic Resistance of Materials," a full description and detailed drawings of a 30 metre bridge, designed by Professor Reilly, the author of the paper. A glance at this example will, I think, at once satisfy him as to the origin of the general design and arrangement of parts I have adopted, and will also, I trust, convince him that he was somewhat hasty in designating the Riachuelo "an American bridge Anglicised." It was my good fortune, now some twenty years ago, to be engaged in working out the details of the 30 metre bridge referred to, under the immediate supervision of Professor Reilly. So this can hardly be called a recent design.

Next, as to depth, I have found that in long, or moderately long, spans, about one-tenth of the span is practically the most economical depth. If it is increased much beyond this, the metal saved in the booms is more than compensated for by that lost in the web, in which metal has to be sacrificed beyond that required to resist the direct shearing stresses, to ensure the necessary stiffness in the compressive members. Consideration should also be given to the practical difficulties of erecting girders of 40ft. and 45ft. deep. I am perfectly aware that some of the American bridges are much deeper in proportion, but in view of the constantly recurring notices in the press of failures of railway bridges in America, with disastrous results, bridge designers should, in my opinion, be cautious in blindly following American practice, simply because it is American, but should remember that there are undoubtedly good and bad examples in America, just as there are in English practice. (2) With reference to the so-called ladder bracing, I quite agree, Sir, with your editorial note. The form of bracing adopted is one that is simple of construction, and amply strong enough for the duty it has to fulfil. Professor Kernot seems to entertain rather confused ideas—judging from the analogy in his third query—as to the work required from stiffening bracing and that from a web plate; possibly he tested the model struts he speaks of by submitting them to bending, and not to compressive stresses. (3) As to the bracing of the compressive members of the web in a plane transverse to the length of the bridge, Professor Kernot's analogy is not a happy one. The web of an ordinary plate girder has to transmit the shearing stresses to the abutments. The plates under consideration are introduced to prevent the channel irons bending, and at the same time to give transverse stiffness to the truss, considered as a whole, they do not transmit direct stresses. W. Hugh Woodcock.

Victoria-street, Westminster.
April 5th.

PROFESSORS AND STUDENTS.

Sir,—I see with pleasure that you are using your pen in the cause of the student. The discussion between Professor Greenhill and "G. P. T." cannot fail, I think, to have a good effect. The things which we have to learn in physics are, after all, very simple, and would be easily learned if they were adequately taught. It would seem, however, that many text-books have been written on the same principle as that produced by the old alchemists. Truth is hidden under a mist of words and formulæ to which it is difficult to find the key. An amusing instance of the abuse of language in this way is supplied by Herbert Spencer's definition of evolution, which may be new to some of our readers. Here it is:—"Evolution is an integration of matter with a concomitant dissipation of motion during which the matter undergoes a change from a definite incoherent homogeneity to a definite coherent heterogeneity, during which motion undergoes a parallel transformation." This reminds me of the lines in "Azim, Prince of Tartary," in "The Bab Ballads":—

> "His gentle spirit rolls
> In the melody of souls,
> Which is pretty, but I don't know what it means."

Mr. Kirkman favoured the world, however, with a capital interpretation of Herbert Spencer's definition. Here it is:—"Evolution is a sticktogetheration of matter with an accompanying unsticktogetheration of motion, during which matter undergoes a change from a not-well-marked-out-not-stick-together-all-alikeness, to a well-marked-out-stick-together-not-all-alikeness, during which the motion undergoes a like change." There is an old and vulgar, yet expressive saw, to the effect that "fine words butter no parsnips." I would have it hung up conspicuously in every class-room for the benefit of teacher and pupil alike.

It is not with the use of inflated sentences, however, that I would now concern myself, but with the circumstance that professors appear to be unable to make up their minds to teach physics all in the same way. There are certain broad, yet well defined things, about which they cannot well go astray—as, for example, the rate of acceleration due to gravity. But take the words "acceleration of motion" away from *g*, and we have vagueness and confusion. I may cite as another instance of want of similarity of conception, the fact that Professor Tait defines force in a way quite different from other teachers. Thus a pupil who was educated in physics by Tait might not be able to pass an examination anywhere save at Edinburgh. Again, there is no more commonly-used phrase than "centrifugal force," but Tait says that there is no such thing, and that the words are monstrous.

An inspection of not a few examination papers, and a familiar acquaintance with almost every text-book of physics which has been published in the last twenty years, and extended experience of students and their difficulties, enables me to write with some confidence on this subject. Physical science is badly taught in England, and it will continue to be badly taught until more common-sense is used by the teachers. I could easily name several exceptions. I am personally acquainted with one professor of chemistry who stands head and shoulders above other teachers. Three professors of physics and engineering I class among my personal friends. With the teaching of none of them am I quite satisfied, but there is this to be said, that all three denounce the methods they themselves use, and say as an excuse, "We have no chance; we have only one object in life, viz., to enable students to pass examinations."

I am not a professional grinder, though I have helped students out of their difficulties. I have made puzzles as clear as the sun at noon-day by a rational treatment of student and puzzle alike. I can speak with some authority on this subject, and I say that a more rational method of teaching physics is needed than is used now. The key to the whole lies in the fact that beyond the range of our own senses we can have no knowledge of anything. We may imagine we have, but we have not. Now as far as physics are concerned, the great thing we have to deal with is energy, and all the information we possess on the subject goes to show that energy is not only the cause of motion, but motion itself in some shape or form.

So long as caloric was held to be a thing—an entity—progress was impossible. The moment it became known that heat was a mode of motion, the whole aspect of one form of energy was changed. The tendency in the present day all round is to extend this view. Thus, for example, light is regarded as a mode of motion, and it is admitted that electricity and magnetism possibly are. Some five years ago the president of the North of England Chemical Society more than hinted that chemical action is a mode of motion. As soon as this view comes to be fully adopted, we shall have physics taught in a straightforward, intelligible way; not till then. J.

London, April 4th.

PROGRESS IN MACHINERY.

Sir,—If exhibitions are to produce ultimate results, it appears to me prizes ought to be offered, and duly published, somewhat on the following lines:—Thus: Class I., Quick Speed Motors: Possible points, with marks awarded, at —— Exhibition:—

Weight of Engine and Generator.		Brake H.P.		Revolutions and space.		Smoke, &c., absence.	Name and kind.	No.
50 Engine.	50 Generator.	60	Cost per hr. run per H.P.	60 Revs.	60 Space	150		
30	40	40	7d.	50	45	140	Gheist's 6 C. Gas.	1
30	10	35	5½d.	50	35	30	Rector's 4 C. Steam	2

For larger and slower machines, it might be better to have the marks obtainable somewhat differently arranged, say in Classes II., III., and IV., &c., to suit the different views of buyers. The principle, however, would still remain about the same, the public would not be invited to criticise the verdict of juries in the absence of evidence of how the award was arrived at. J. V. H.

Preston-road, Southport, April 1st.

THE DATES OF PATENTS.

Sir,—In the official journal of the Patent-office, No. 338, the application for a patent is advertised to a firm at Haarlem, Holland, No. 17,167, 1886. This application was received March 25th, 1887, and ante-dated September 28th, 1886, "under International Convention." Is it fair that the citizens of Holland should have the privilege of ante-dating a patent in this country, when patents are not granted to either natives or foreigners in Holland? Then should the Comptroller ante-date a patent without giving the date, name, and country of the prior patent upon which this ante-dating is based? Should not this right of ante-dating be left to the courts of law in case of infringement? The patentee claiming the privilege of ante-dating his patent should be asked to produce in court the foreign patent upon which he bases his claim to have his English patent ante-dated.

The English and foreign patent should be for the same invention, and the foreign and British specifications of the invention should be identical. If they are not, there is an opening for fraud in ante-dating an English patent, which may be a larger or different invention from that of the foreign patent. I think the Comptroller takes upon himself too much—more than he ought to do—in ante-dating a patent. I do not see the necessity for ante-dating English patents under the Convention. If a foreign patentee applies for an English patent let him do so in the ordinary course, and should his patent be infringed, then let him claim the privileges under the International Convention, and produce his foreign patent or patents as the ground of such claim against publication prior to the date of his English but subsequent to the date of his foreign patent. Instead of the Comptroller ante-dating a patent, would not it fully meet the case if the application or patent was advertised, and the complete specification, when printed, had remarks to this effect:—"The applicant claims all privileges under the International Convention based on his patent in—say, for instance—France. No. —, and dated —." P. J. L.

Manchester, March 31st.

ENGINE DRIVERS' EYESIGHT.

Sir,—Referring to Mr. Stretton's letter on this subject in your issue of March 25th. On the railway I am connected with the eyesight of all drivers and firemen is tested periodically, the method adopted being as follows:—Cards with sixteen to eighteen black spots ⅛in. square, and placed irregularly, are exposed in full daylight 15ft. from the man under examination. He is required to count the spots with each eye separately, and if he can do so accurately his sight is considered right for distance. At the same distance—15ft.—he is required to distinguish, with each eye separately, red, blue, green, yellow. A bundle of coloured wools is then placed before him, and any colour, say red, is selected, and he is told to pick out of the bundle colours to match it. He is tried in a similar manner with green and blue. The black spots, ⅛in. square, correspond at a distance of 15ft. with a surface 2ft. square at 600 yards.

With regard to Mr. Stretton's remarks, as to men not being fairly tested. In my experience every care is taken, and in many cases men who had doubtful sight have been tested over and over again, and if there was still any doubt, they have been sent to an eminent oculist for his opinion. I quite agree with Mr. Stretton that many men can distinguish colours perfectly well, but are ignorant of their names; but I think that if you put a decided red-coloured wool into a man's hand, and tell him to select a similar colour from a bundle of wools, and he selects a bright green and tells you that they are both the same colour, I think it must be admitted that such a man would be colour blind, at any rate for red and green, and therefore unfit to have charge of a locomotive engine. I have known several instances of this kind.

I have found that about 97 per cent. of the men examined had good sight. This may be accounted for by the fact that all drivers have their sight tested when joining the service, and any lads with defective sight are not employed in that capacity.

M. Inst. M.E.

April 4th, 1887.

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

(*From our own Correspondent.*)

The nearer we get to the quarterly meetings—and these come off next week—the slower are orders in arriving at the finished ironworks. This, however, is only a natural state of things, and does not therefore excite any surprise. The extent of business done on the Wolverhampton and Birmingham exchanges this week has been light, and the gatherings themselves have shown a disposition on the part of ironmasters to anticipate the Easter holidays.

The sheet makers, who have hitherto been well occupied, are now being influenced by the lessened demand. The quietude of the Australian buying is affecting makers somewhat seriously, the galvanisers being decidedly less active than awhile ago. The trade with South America and India is curtailed by the unfavourable rates of exchange. Prices keep at £6 easy for singles, £6 5s. to £6 10s. for doubles, and £7 5s. for trebles. Plates are unimproved at £6 10s. for tank sorts and £7 10s. to £8 10s. nominal for boiler qualities.

Marked bar prices at the quarterly meetings are likely to continue at £7. The list of Messrs. W. Millington and Co., Summerhill Ironworks, stands at: bars, £7; small rounds and squares, £7 10s.; $\frac{5}{16}$in. bars, £8; ¼in., £8 10s.; No. 5, £9; $\frac{3}{16}$in., £9 10s.; No. 7, £10 10s.; No. 8, £11 10s.; and No. 9, £13. Best bars they quote £8; double best, £9; and treble best, £11. Plating bars and cable iron, £7 10s.; and best ditto, £8 10s.; with double best, £9 10s.; rivet iron, £7 10s.; best, £8 5s.; and double best, £9 15s.; angles, £8 to £8 10s.; and on to £9 10s., according to quality. Boiler plates and sheets, £8 10s.; best, £9; double best, £10; and treble best boiler plates, £12.

The New British Iron Company quotes:—Slit rods, £6 5s. for Congreaves, £7 C.G.C. brand, £7 10s. Lion, £9 best Lion, and £11 10s. best charcoal. Steel rods are £8, and iron horseshoe rods £6 10s., £7 10s., and £9, according to quality. Hoops the company quote £7, £8, and £9 10s. Steel hoops are £8 10s., and best charcoal £8.

The price of common bars keeps at £5 to £5 5s.; gas tube strip, £5 upwards; and hoops, £5 7s. 6d. to £5 10s. Ordinary nail rods are also £5 5s. to £5 10s. Puddled bars are quoted by some strong firms at £3 7s. 6d. to £3 10s.

The heavy purchases made some time ago by pig iron consumers are causing less new business to be done just now in pigs than is customary before the occurrence of the quarterly meetings. Most consumers are well covered, and they do not care to further operate to much extent at present. Sellers, too, on their part, are abstaining from pressing for orders. The furnaces have plenty of contracts to run at, and makers are therefore pretty independent. Prices are fairly steady at 38s. to 39s. delivered for Northamptons, and 39s. to 40s. for Derbyshires. Best native sorts are 52s. 6d. now, medium 40s., and common 30s. per ton.

The old-established firm of Messrs. J. W. Sparrow and Sons have decided to blow out the only blast furnace remaining at Millfields, near Bilston, of the forty-seven furnaces which were in blast twenty years ago. There is also a probability that the firm's Bilston Mill Ironworks will also be closed, preparatory to their retiring from the trade.

There is no trade feature so conspicuous at the present time in this district as the way in which steel is coming to the front to supersede iron. While I have to report decreasing activity at the ironworks, I have to note a corresponding increased activity among the steelmakers. On all hands there is a better demand for the new metal, and prospects of the steelmakers may be said to be good. For constructive engineering purposes than for other more general uses steel is steadily making headway. Some makers are booked with their full make ahead for some months to come, and fresh orders are continually arriving.

The demand is occasioning preparations for an increased output at several of the chief works, and everything promises well for this year. The preparations that are being made by one of the most important concerns in the district for going into the Siemens steel trade with increasing vigour will, when completed, I am credibly informed, give to the concern a capacity of output not far short of 1000 tons per week.

The Basic Steel and Ingot Company, Bilston, is meeting with a largely increased demand for plates, bars, and channel and angle sections. Much of its product is being used up by the constructive engineers of this district in work which they are at the present time undertaking for India. The metal is also being rolled into sheets for working up and stamping purposes. The company is making an enlarged turn-over weekly, working its basic converters with more rapidity than before. It is also progressing with its preparations for entering upon Siemens basic steel manufacture. It will commence with one 8-ton furnace, and hopes to make a start in six weeks' time. Two additional ingot reheating furnaces are also being built to facilitate an increased output in the mills.

Basic steel prices of native manufacture are at date. Plates, £6 10s. to £7 10s.; bars, £5 10s. to £6; and angles and channel, about £6. The sizes of bars go up to 13in. for plates, 6½in. diameter for rounds, and 5in. for squares, while angles are up to ten united inches.

At the works of the Staffordshire Steel and Ingot Iron Company, a machine plant has just been erected for the reduction to a fine powder of basic slag for fertilism purposes. This is practically a new industry, not only for the district but for England, since, although slag is being exported in large quantities from the works of the North-Eastern Steel Company, Middlesbrough, for this purpose, the product is exported almost wholly to Germany, where, by special plant, it is reduced to an exceeding fineness, sufficient for agricultural purposes, and is exported back again to this country, where it is commanding a price of 30s. per ton, delivered in the Thames, and is having a large sale.

The plant has been supplied by Messrs. Morris Brothers, engineers, of Doncaster, and is very similar to that employed in grinding super-phosphates. It consists of one preparing mill fitted with

Wood's patent separator; one magnetic separator; and one Morris and Wood's patent fine mill. The whole is driven by a powerful compound engine by Robey and Co., of Lincoln, of about 30 nominal horse-power, or 80 actual horse-power. The process of pulverising the slag is divided into three stages—first, the slag is fed into the preparing mill in its rough state, and is reduced to about $\frac{3}{16}$in., and any pieces of steel exceeding that dimension accumulating in this mill are taken out at intervals. During this preliminary reduction a quantity of fine slag is produced, and is extracted by the separator before the reduced material passes to the second stage, during which a magnetic separator extracts the small pieces of steel. The reduction of the material at the last stage enables it to pass through a mesh of 10,000 holes to the square inch—an obvious advantage, since the value of the material greatly depends upon its fineness.

An extensive plant for similar purposes is also, I understand, being erected at the North-Eastern Steel Works, who intend to supply the ground material to home agriculturists, instead of allowing the Germans to do the trade.

Great hopes are excited among iron and steel masters and engineers concerning the extensions of the Indian railways. The opinion is gaining ground that those extensions will work greatly to the benefit of this district. Reports are in circulation that at a comparatively early date orders "for many thousands of tons" of iron and steel work for the empire will be upon the market. These reports are assisting considerably just now to buoy up makers' hopes of the future of the trade.

At the present time there is a good deal of work being turned out in this district of one sort or another for the Indian lines, conspicuous among which is heavy bridge and railway wagon wheel and axle work.

The Patent Shaft and Axletree Company, Wednesbury, is understood to have some capital orders under execution in its wheel and axle departments for South American, Indian, and other distant railways.

Admiralty machinery requirements are scarcely so actively expressed at the moment, either in Birmingham or in the surrounding townships, as they were in the autumn; still there is good ground to hope for a distinct improvement when the contracts about to be placed for dockyard necessities have reached the makers' hands. Where current briskness is noticeable it has reference in much part to torpedo-boat needs—engines and steel boilers coming to the fore in this relation. Messrs. James Archdale and Co. and Messrs. George E. Billiss and Co., both of Birmingham, stand well in the Admiralty and arsenal work they are and have been doing for the British Government and for foreign Governments.

Small-engine power is still much sought after for multifarious uses. Spiel's petroleum engines, which Messrs. A. Shirlaw and Co., of Birmingham, are making in great numbers, are more than ever in request. Messrs. Blaiberg and Marson, also of Birmingham, encouraged by the demand for handy motors, have taken up the agency for the "Elland" gas engine of Dempster and Sons; and the steady growth in the adoption of electric lighting more than upholds the former demand for the "Gülcher" electric-light system, which has for some time past been affording good work to Messrs. W. and J. Player, of Birmingham.

The war authorities at Woolwich have intimated to the Wolverhampton Chamber of Commerce that all rejected goods, sent under contract, shall be returned securely packed to the manufacturer. This is a welcome innovation in the ordinary practice of the contract department, since manufacturers have occasionally sustained serious loss and inconvenience through careless packing. The new arrangement, however, does not entitle the contractor to damages in case of loss.

The operatives engaged in the Birmingham building trades—numbering between three and five thousand—are turning out on strike against a reduction in wages of 1d. per hour. Attempts have been made to settle the question by arbitration, but the great difficulty has been in the refusal of the masters and men to recognise each other's adjudications.

The chainmakers of Cradley Heath, alleging that a section of the employers are enforcing a further reduction in wages, have determined to call the whole trade out again on Monday week.

Satisfactory progress is being made with the construction of the central station of the Birmingham Compressed Air Power Company, and in the course of the next two or three months operations will have been so far advanced that consumers will be supplied with the new motive-power to the extent of 6000 I.H.P. Already applications for 3500 I.H.P. have been received. As the area for supplying compressed air is limited under Act of Parliament to about one and a-half square miles, the operations of the company will at first be confined, but on their enterprise being attended with success, steps will doubtless be taken to acquire powers for extending the area.

At the central station the air will be compressed to a pressure of four atmospheres by large air-compressing engines, to be supplied by Messrs. Fowler, of Leeds, and will be conveyed in mains through the principal streets of the locality, and from these mains service pipes are to be taken to the premises of the company's customers. The works will have a railway siding from the Midland line, from which coal will be tipped direct on the charging platforms of thirty-one of Wilson's 8 cwts. patent gas producers. Underground flues will carry the gas from the producers to the furnaces of the boilers. The steam injection to the gas-producers will be taken from a separate boiler, and will be governed by air pressure, so that when the air pressure rises the steam injection will be reduced and the fires under the boilers lowered throughout the whole range, and *vice vervu.*

When the station is completed there will be fifteen engine-houses, built in rows, of strong concrete walls, in the spaces between which will be placed forty-five Lane's patent water-tube boilers. Each engine-house will be constructed to receive one triple-expansion beam air-compressing engine of 1000 I.H.P., driving six single-acting air-compressing cylinders, coupled to opposite ends of the beams, and capable in the aggregate of delivering 2000 cubic feet of air per minute at 45 lb. per square inch above atmospheric pressure. The free air will be drawn into the compressors from the top of each engine-house through casings, in which will be inserted filtering screens to clear the air of solid impurities. When the full 15,000 indicated horse-power is at work, six million gallons of water will be used daily for the feed, for condensing, and for cooling the air cylinders. The mains will vary in diameter from 7in. to 24in., and will extend about 18 miles. They will be placed in concrete troughs, supplied with removable covers, as near as possible to the surface of the road; and means will be adopted by which, in the event of the bursting of a pipe, the general supply shall not be interrupted. Service pipes will be connected in the usual manner, and Forster's patent joints will be used, so as to allow for expansion, contraction, and for any subsidence or other disturbance. Consumers will have the air supplied through meters of the character of Beale's gas exhauster, corrected in the readings according to the varying pressure.

Full particulars have been issued on behalf of the Birmingham Town Council of the proposed new waterway between Birmingham and the Bristol Channel. The original scheme contemplated improvements between Birmingham and Worcester, but discussion has led to an enlargement of its scope by including improvements downwards to the sea by making a new entrance to the port of Gloucester at a point upon the Severn, which shall command ample depth of water at all tides. The whole cost of the work, including the purchase of the undertaking of the Sharpness New Docks and Gloucester and Birmingham Navigation Company, will be £1,890,000. Considering that the present weight of goods, estimated at 5,000,000 tons annually carried to the ports by rail from this district, will probably be augmented by 500,000 tons per annum, it will be seen that this expenditure will be amply compensated by increased profits. At the annual meeting of the Birmingham Chamber of Commerce, the President, Mr. Elliott, alluded at length to the question of constructing canals between Birmingham and the ports. Unless such canals were provided Birmingham would, he contended, soon cease as a manufacturing town to exist. He believed that many of the railway rates were not excessive, but the companies had, by refusing to revise the present system of classification, failed to meet the manufacturers in respect to goods of great weight conveyed to the coast for shipment.

NOTES FROM LANCASHIRE.

(*From our own Correspondent.*)

Manchester.—Business for the present is practically in abeyance, and until after the holidays and the ensuing quarterly meetings there will be little or nothing doing. During the past week the iron market has again been extremely slow in all departments, with prices weak and irregular. In pig iron, operations are only practicable at excessively low figures, and there is continued underselling both in common and hematite qualities. The position of the finished iron makers remains unchanged, and certainly without improvement. Amongst engineers slackness of trade continues the general complaint; boiler makers and locomotive builders are perhaps rather better off, but it is on work taken at excessively low cut prices, and in the general condition of the engineering branches of industry there is still no real improvement that can be reported. Brass founders report a rather better demand, both locally and for export, for boiler fittings, but in other classes of goods this branch of trade is still very quiet; nut and bolt makers, who a short time back were getting busier, report trade again quiet, with only a very slow demand generally; and with ironfounders trade continues in a very depressed condition, all descriptions of castings being cut down to wretchedly low prices. In steel castings and in steel work generally there is a fair amount of activity, and the prices in this district are mostly well employed.

There was only a very slow iron market at Manchester on Tuesday, and a general dearth of inquiries of any weight. Prices were almost untested and practically unchanged from last week, but there is a continued weakness of tone. For Lancashire pig iron prices remain nominally at about 39s. to 40s., less 2½ per cent., for forge and foundry qualities delivered equal to Manchester, and about the same figures are also still quoted for one or two district brands, but these prices are altogether above the market, and are only got on occasional small special sales. Lincolnshire iron can be bought as low as 36s. 6d. to 37s. 6d., less 2½ per cent., delivered here, and the quoted prices of most of the makers are not more than 6d. per ton above these figures. In outside brands offering here there is continued underselling, and both Scotch and Middlesbrough ironmakers are gradually being forced to follow the downward course of the market. For hematites some makers still hold firmly to late rates, but there are re-sale lots offering in the market at a couple of shillings under the quoted list rates. Some of the principal finished ironmakers are still kept fairly employed, but the very slow demand in the market causes an increased anxiety to secure any orders that are to be got, and prices in all cases are not being very firmly held to where there are anything like good specifications to be got. For delivery into the Manchester district bars average £4 17s. 6d. to £5; hoops, £5 5s.; and sheets, £6 5s. to £6 15s. per ton.

The ordinary monthly meeting of the Manchester Geological Society, held on Tuesday, brought forward a number of questions of special interest to mining engineers. The chair was occupied by Mr. Joseph Dickinson Hill, Chief Inspector of Mines, and there was a numerous attendance of mining engineers connected with collieries in the Lancashire district. After a short discussion on a paper read at a previous meeting by Mr. G. H. Kinahan, on "Marsh or Natural Gas," Mr. Geo. H. Hollingworth exhibited specimens of Mr. Hunter Spence's patent solid water-tight cartridge cases for glycerine dynamite blasting. The object of these cases, he said, was to overcome the difficulty arising from leakage in water cartridges, which had proved so great an objection on the Continent as to have led to an abandonment of the use of the water cartridge. The cartridge cases which he had shown were, by a special process of manufacture, made perfectly water-tight by weaving them without a seam before they were vulcanised, so that there was no stitching of the sides, which was one of the principal causes of leakage. The chairman remarked that the great secret of the water cartridge was that the cartridge should be kept isolated in the centre of the water, and not allowed to fall to the bottom or lie against the side of the case, as in such a position the cartridge was not safe. In the Settle cartridge this difficulty was overcome, as the cartridge was held in the centre of the water, and this was the only safe method of using a cartridge. From all the experiments made with the Settle cartridge, he had never seen a spark given off. Mr. Hall, Inspector of Mines, observed that if there was a difficulty in preventing the water from leaking out, they ought to seek a remedy. The chairman added that there had been so many explosions from gunpowder that it was quite evident something would have to be done, and the only efficient remedy seemed to be the use of high explosives, protected by the water cartridge. Mr. Cookson remarked that he had not been able to do the work with a water cartridge that he could do with gunpowder. Mr. J. S. Burrows said they got a better result with bobbin gunpowder than with dynamite, There was no doubt a loss of power owing to the cartridge not fitting tightly, and the water round the cartridge would also have a tendency to deaden the force of the blow. The safety lamp question next occupied the attention of the members, Mr. Wm. Duxbury, C.E., exhibiting and explaining the "Argus" safety lamp, which has been the subject of recent experiments at Sheffield. Mr. Mark Stirrup, one of the hon. secretaries, read a description of a new French safety lamp, styled the Cambassédès, and Mr. Thew, of Farnworth, near Bolton, exhibited and explained a new lamp he had invented. Some little animated discussion arose between the representatives of wire lamps, of which there are now so large a number in the market, one speaker observing that on an average two new safety lamps were now being brought out every week, but the time of the meeting had been so much occupied that there was no opportunity for discussion, which had to be adjourned, the chairman observing that one of the great needs of the district was an efficient testing apparatus, when anyone on the payment of a certain sum could have his lamp put to an independent and effective test. This was an important question, which he hoped would be taken up by someone.

On Saturday last a presentation of plate, subscribed for by the members of the staff of the Duke of Bridgewater's trustees, was made to Mr. George Fereday Smith, the general manager, to commemorate the completion of his fiftieth year of service under the trustees. The presentation consisted of a centre bowl for a dining table, two ewers, and two small fruit dishes, all in solid silver, with the following inscription:—"Presesented to George Fereday Smith, M.A., J.P., D.L., by the members of the staff of the Duke of Bridgewater's trustees, as a tribute of esteem and respect, on the completion of his fiftieth year of service as general manager of the landed, mining, and commercial interests of the trustees." The presentation took place at a meeting held in the Court House at Worsley, Mr. George Bowker, of the colliery department, presiding, and the Hon. A. Egerton, the acting trustee and superintendent, in a highly eulogistic speech, making the presentation in the name of the members of the staff, who were all present.

Business continues fairly steady in the coal trade of this district, and although prices are not absolutely firm, it is only in isolated cases that there have been any actual reductions in price since the commencement of the month. For house-fire coals the demand still keeps up, and except in some of the best sorts colliery proprietors generally are moving away their present output without much difficulty. The common classes of round coal are also moving off fairly well, owing to the demand for shipment being maintained, if not with quite the same briskness as a few weeks back, still sufficiently good to relieve the market from any pressure of surplus supplies of common round coal which would otherwise be thrown upon it by the indifferent local requirements for steam and ironmaking purposes; engine classes of fuel are also generally moving off pretty freely, and although at some collieries slack is rather plentiful, it is only in very exceptional cases where colliery proprietors find any great difficulty in moving off their present supplies. In most cases pits are being closed from Thursday until Tuesday next for the Easter holidays, and this has caused a little extra pressure during the last few days, but the actual condition of trade may be said to remain without material change. Of course, as the season advances there is the natural declining demand for house fire consumption, but the protracted cold weather has prevented this from so far having been felt to any really appreciable extent, and, as a rule, collieries have still sufficient orders to keep them going about five days a week, and prices, although there is, perhaps, more disposition to meet buyers with some slight concession, rather than allow business to pass into other hands, are tolerably steady at late rates. At the pit mouth some of the best qualities of Wigan Arley might possibly be got at 8s. 6d. per ton, but the average figure still remains more nearly at 9s. per ton; seconds Arley and Pemberton four feet coals average 7s. 3d. to 7s. 6d.; common house coals, 6s.; steam and forge coals, 5s. 6d.; burgy, 4s. 6d. to 5s.; best slack, 3s. 6d. to 4s.; and common 2s. 9d. to 3s. per ton. For shipment, 7s. 6d. is still quoted for good qualities of steam coal delivered at the high level, Liverpool, or the Garston Docks, but 7s. 3d. is becoming a price which is being taken pretty freely, and orders are being competed for more keenly than they were.

Barrow.—There is no improvement to note in the position or attitude of the hematite pig iron trade of the Furness and Cumberland district. As a matter of fact, the quieter tone noticed last week is somewhat more evident. There is a quiet demand from America, and it is not expected to improve for some little time, as the difficulty as to carriage previously noted renders it impracticable to do much business with British makers. There is, however, a good demand for hematite in America, if once this question of inland carriage is settled so as to enable British makers to compete on favourable terms in that market. There is a fair inquiry for iron on colonial, continental, and home accounts, and it is probable that with the orders already held, and the business offering from various sources, makers will be able to keep in full blast the furnaces which have been blown in during the past few months with a view of increasing the production. Speculative sales are damaging the position of makers at present, as these are being effected at a few shillings per ton less than makers are disposed to accept. The quotations of makers, however, have this week been reduced to the extent of 6d. per ton. Parcels of mixed numbers of Bessemer iron in equal weights are offered at 48s. 6d. per ton net, f.o.b., prompt delivery, and No. 3 forge at 47s. 6d. per ton. Stocks of iron are large, and are likely to increase unless heavy shipments are made in the early spring months, and of the latter there is every prospect. Shipping is beginning to be busier, especially to America and the colonies. There is a full maintenance of activity in the steel trade, and there is no scarcity of orders for the three chief articles produced—rails, blooms, and billets. Makers are, however, well sold of the first and last-named goods; and as to blooms, they are not in a position to offer any great tonnage, owing to the fact that the rail mills, which are busy, are consuming a very large proportion of the blooms made. The value of rails is quoted at £4 6s. per ton net f.o.b. for ordinary heavy sections, the rate last week being £4 5s. per ton. There is still a quiet demand for shipbuilding material of steel. Shipbuilders have not secured any new contracts, although overtures are taking place which it is believed will cause an increased activity in this branch of industry. At present very few orders indeed are in the hands of builders. The business doing by engineers—either marine or general—is very small, but with a revival of shipbuilding an improvement is expected in the subsidiary industries of the district. Iron ore finds a brisk market at from 10s. 6d. to 12s. 6d. per ton net at the mines. The coal trade is improving, and coke is in fuller request.

THE SHEFFIELD DISTRICT.

(*From our own Correspondent.*)

THE ironworkers in the Sheffield district have been holding several meetings of late in Attercliffe, which is the headquarters of the industry in this quarter. They are very reticent about the business for which they have met; but it is pretty well understood that it has to do with the re-arrangement of working, which practically means higher wages. An ironworker who attended the gathering tells me there was a very large representation from all districts, except Parkgate, and that the reports presented as to the state of trade were most gratifying, with the exception of Sheffield. Another meeting is to be held prior to the conference fixed to take place at Manchester.

Sheffield trade with the United States continues to in ease in value. For the quarter ending March last the exports reached a total of £205,787 19s. 11½d., against £121,971 8s. 6d. for the corresponding quarter of last year. Steel was exported to the value of £72,897 14s. 10d., and cutlery £44,767 13s. 10½d., against £62,272 11s. 3d., and £36,181 1s. 7½d. for the quarter ending March, 1886. For the previous quarter, ending December 31st, 1886, the total value was £180,928 10s. 8d., of which steel was exported to the value of £73,474 12s.; and cutlery, £48,783 13s. 8½d. A large portion of the steel was in blooms and billets. The demand for sheet steel has fallen off considerably for the States since January. There was a good demand up to the end of the year.

One of the oldest and best known of the Sheffield plate businesses has been disposed of during the week.—Messrs. Creswick and Co., silversmiths and platers, of Sheffield and London, who received the medal for the Sheffield plated trade in the great Exhibition of 1851. Their mark—six arrows crossed—was registered in 1877, under the Trades' Mark Registration Act, 1875, and has been used since the year 1807. In the report of the Select Committee—House of Commons—on gold and silver hall marking, 31st July, 1878, it was stated in evidence, "I could give you the name of a first-class Sheffield house—Messrs. Creswick and Co.—who work under a distinct trade mark, 'six arrows crossed.' It is well known in the trade as 'Creswick's Plate.' That is the very best electro-plate you can buy."

The trade mark has been sold for £115—a moderate figure, considering the reputation it had attained. The finished goods were about the finest I ever saw, not only in quality, but in beauty of design and adaptability of the articles for the purposes they were intended to serve.

The Rotherham Guardians have been stipulating for British girders to be used in the new workhouse hospital, with the result that they have got into a little difficulty. The architect, Mr. Tacon, reported that the contractor was unable to obtain girders of English manufacture for the building. He was told that they did not roll the section required—14 g.b. The contractor said English girders ran up to 12in., but when they got beyond that size there was difficulty in getting them. It was suggested that steel ones should be taken, but it was added that steel ones could not be got. Some of the guardians expressed doubt of the inabilty to obtain English girders, whereupon the contractor offered to hand over the money to get the English manufactured girders, adding, "perhaps some of you can get them." Ultimately the matter was referred to the Building Committee.

Sheffield armour-plate makers are again called upon to stand up for their compound plates against French all-steel plates. As far back as November 29th last, it was stated that the "War-office were asking for 18in. steel plates, and no one could be found in this country to make them." This charge is refuted. After inquiring of both firms am informed that the Government has never asked for 18in. steel plates, and that the moment they ask for 18in. or any other steel plates, their order will be taken and executed. About twelve years ago steel plates were made for our Government—a section of a 9in. steel plate can be seen at the Cyclops Works—and the results, after trial, were not satisfactory. This caused the Government to adopt compound armour, which, they contend, has more than held its own against all steel plates in all trials. Special mention is made of Spezia. There the compound armour was cracked, while the projectile went clean through the all-steel plates. It was stated that this was an advantage for all-steel, as the hole was a clean perforation, and could be "plugged." But then the live shell was inside the ship. Surely the duty of a plate is to keep the shell out. It had better die in the doing of it than not do it. Its mission is to keep the shell out of the ship, otherwise the vessel might as well not be armoured at all. The difficulty with steel plates is this :—If made hard to resist the projectile, they go to pieces ; if made soft, the projectile goes clean through. If a soft plate is wanted, such as the steel sample sent to Spezia, the Sheffield firms had better go back to iron ; but as they aim, not at letting the shell in, but at keeping it out, they find compound armour the most effective. Even in France the compound armour is preferred to Schneider's plates, by a ratio from 1880 to 1886 inclusive, of 14,957 tons in favour of the Sheffield plates against 7860 tons of the Creusot. As for the statement that Russia is adopting all steel plates, it is only necessary to remind the world of the arrangement made between Messrs. Charles Cammell and Co. and the Russian Government, by which the plates for the Russian marine are made on the compound principle—one-half at Sheffield, and one-half at Kolpino, near St. Petersburg. This arrangement has several years to run.

Good Friday begins the Easter holidays, which will be utilised as usual for stocktaking by several of our largest firms in the iron and steel industries. Business in some departments of the lighter trades is again quiet.

THE NORTH OF ENGLAND.

(*From our own Correspondent.*)

A SOMEWHAT better feeling has been noticed in the Cleveland pig iron trade since the middle of last week. The reports of increased business done at Glasgow and the satisfactory nature of last month's shipments have had a favourable effect upon the market. The demand for warrants has suddenly increased, especially at Glasgow. On Tuesday, the 29th ult., the price was as low as 33s. 9d. per ton, but by the 31st sales were effected at 34s. 9d. and 35s., and these figures have been so far maintained. Makers' iron is also firmer, but it does not fluctuate to the same extent as warrants. Last week business was done at 34s. for prompt delivery, but on Tuesday 34s. 6d. was the lowest accepted. Buyers are now freely offering 35s. for delivery to the end of June, but makers will not entertain any such figure.

The stock of pig iron in Messrs. Connal and Co.'s Middlesbrough store on March 31st was 323,923 tons, being an increase of 11,535 tons during the month. At Glasgow on the same date their stock amounted to 856,966 tons, or an increase of 10,847 tons.

The shipments of pig iron from Middlesbrough were last month highly satisfactory, the total quantity sent away being 67,896 tons, as against 52,620 tons shipped during February, and 8000 tons more than in March, 1886. Scotland, which imported 33,492 tons, was the best customer; and Germany took 10,893 tons, as against 756 tons in February. The United States took 5010 tons; Holland, 4465 tons; Portugal, 3500 tons; Italy, 1640 tons; and Belgium, 1174 tons. Manufactured iron and steel exports were about the same as in February, the total being 35,791, as against 35,901 tons previously. India received 9162 tons; Turkey, 4406 tons; and America, 3700 tons.

Inquiries for finished iron are fewer than ever, and, except as regards bar iron, prices are slightly weaker. Makers have the utmost difficulty in getting sufficient specifications to keep their mills in regular operation.

The electric installation at the Newcastle Exhibition will include a novelty in the shape of an electrical smithy. It will be there shown to the public that iron and steel can be welded by means of the heat derived from electricity. Bars of iron so united will be placed in a testing machine, and it will be shown that the weld so obtained is as strong as any other part. The difficulties and expense of electric welding are, however, likely to be too great to admit of the extension of the system to ordinary commercial purpose. There will also be an electric railway in the exhibition grounds; and the model lead and coal mines, which are now being constructed, will be lighted throughout by electric lamps.

The deputation of mineowners and miners, who endeavoured to convince the Home Secretary that the Cleveland district might safely be excluded from the operation of the new Mines Regulation Bill, as regards the use of safety lamps, and the special provisions as to blasting, seems to have been successful as regards the latter point. The text of the Bill, which has now been printed and circulated, contains a provision that "stratified ironstone mines in the lias formation are exempted from the special provisions as to blasting."

A meeting of the Cleveland Institution of Engineers was held at the rooms of the Institution, Newport-road, Middlesbrough, on Monday evening, the 4th inst. A paper was read by Mr. R. H. Froude, of London, on "Dynamometrical Measurement." Three systems were described, namely :—1st, the ordinary fly-wheel brake, with a spring at one end, and a weight at the other; 2nd, the hydraulic brake, invented by the late Mr. Froude, of Torquay, father of Mr. R. H. Froude; and 3rd, a system of pulleys and weights, whereby a proportion of power taken from a main shaft by a particular machine can be exactly ascertained. The hydraulic dynamometer was described at considerable length, and its principles explained. It was aptly defined as "the very worst centrifugal pump which could possibly be devised." The blades of the fan and the internal surface of the casing are of such form that the maximum resistance to the rotation of the former is given by the latter. The power imparted to the fan is really expended in heating the water, a constant flow of which through the casing is maintained. The spindle of the fan is driven by the motor to be tested. The casing, which is delicately suspended or supported, tends to be rotated with the fan. Its rotation, however, is resisted by a spring acting at the end of a lever attached to it. The pressure on this spring in pounds, multiplied by the circumference in feet of a circle, whereof the distance from the centre of the fan spindle to the point in the lever at which the spring acts is the radius, and divided by 33,000, gives the dynamometrical horse-power. If the number of revolutions of the engine being tested can be maintained about constant, and if the spring remains steady at one indication, it is obvious that the dynamometer must be a simple, convenient, and effective one. Inasmuch as the fan does not touch the casing, there is no internal friction whatever, except what is due to the weight of the fan upon the journals. The whole thing being exceedingly small, light, and compact, in proportion to the power it is able to absorb, it can be very easily carried about and applied to different motors. After an animated discussion, a hearty vote of thanks to Mr. Froude was moved by the President, Mr. Howson, and carried unanimously.

NOTES FROM SCOTLAND.

(*From our own Correspondent.*)

THERE was a marked improvement in the Glasgow warrant market towards the close of last week. Prices had fallen so far that an impression was created that they might possibly have reached the lowest point for the present, and this induced a certain amount of speculative buying which sent up the quotations in two days about 1s. per ton. This week, however, there has been a relapse due to various causes. Among these is the increase in the stocks that has been getting more pronounced week by week. It was alleged some weeks ago, that although the quantity in the warrant stores was undoubtedly increasing, a partial decrease was at the same time being effected in the private holdings of the makers. Now, however, when a number of additional furnaces have been put in blast, this position cannot be maintained, and the depressing effect of the increase of stocks is aggravated by the fact that the stocks are at the same time being steadily augmented in the North of England. This week's advices from the United States are likewise unfavourable for our market, the demand for Scotch iron there being slow, while a portion of the arrivals is being sent into store. The past week's shipments of pigs from Scotch ports have been very small, amounting to only 4709 tons, as compared with 5655 in the corresponding week of 1886.

Business was done in the pig iron market on Monday at 41s. 10d. to 41s. 6d. cash, sellers being at 41s. 10½d. cash at the close. A good effect was produced by the issue of the Cleveland ironmasters' returns, and the prices subsequently became firmer.

The current values of makers' iron are as follows:—Gartsherrie, f.o.b. at Glasgow, per ton, No. 1, 48s., No. 3, 43s.; Coltness, 55s. and 45s.; Langloan, 51s. and 45s. 6d.; Calder, 51s. and 42s.; Carnbroe, 44s. 6d. and 40s. 6d.; Clyde, 46s. 6d. and 41s. 6d.; Monkland, 43s. and 39s. 6d.; Govan, at Broomielaw, 43s. and 39s. 6d.; Shotts, at Leith, 48s. 6d. and 44s. 6d.; Carron, at Grangemouth, 52s. and 44s.; Glengarnock, at Ardrossan, 47s. 6d. and 41s. 6d.; Eglinton, 43s. and 39s. 6d.; Dalmellington, 45s. and 41s.

The arrivals of Middlesbrough pigs at Grangemouth for the past week were 7960 tons, against 6865 in the same week of last year.

The output of hematite pig iron in Scotland is being increased, and the quantity produced is nearly all going into consumption at the steelworks, there being very little of this iron in stock.

Although the principal steel works are very busy with the execution of contracts at present on hand, the prospects of additional work are not very bright at present. There has accordingly been a little slackening of price, strip angles being quoted by makers at £4 17s. 6d. No doubt some large contracts now running are as low as £4 15s.; but since the improvement of trade began to foreshadow itself in the autumn of last year, the lowest rate quoted for angles until now has been £5. It is expected that an order for steel rails and sleepers for Brazil will be placed in Glasgow by an agent of that Government, who is here at present also ordering some machinery.

The iron and steel goods shipped from Glasgow in the past week embraced machinery to the value of £7400; sewing machines, £2186; steel goods, £7050; and general iron manufactures, £22,500.

The coal trade continues fairly active, although the requirements of shippers are more easily met than they were a week or two ago, in consequence of the larger outputs at the collieries. The past week's coal shipments were, at Glasgow, 25980 tons ; Greenock, 112 ; Ayr, 7873 ; Irvine, 3433 ; Troon, 5375 ; Burntisiand, 12,252, Leith, 1904 ; Grangemouth, 7135 ; Bo'ness, 5698 ; Granton, 1813 ; and Port Glasgow, 200—total, 71,875 tons, against 59,384 in the corresponding week of last year. Prices are rather easier at the ships' side, and the price of household coals has been reduced 6d. per ton.

Delegates representing the coalmasters and miners of the districts of Airdrie, Slamannan, and Bathgate Cove, at a meeting held in Glasgow, agreed upon a sliding scale for the regulation of wages and the avoidance of strikes. The agreement is that at the end of each three months the wages shall be advanced or reduced by 1d. per ton for every reduction or addition of 3d. in the price of coals, the scale to remain in force for a year to March 31st, 1888; and that the average prices of coals be ascertained by an accountant mutually chosen and paid by both parties. It was agreed that the scale should only be put in force if the men and masters at the whole of the collieries should be induced to agree to it.

WALES AND ADJOINING COUNTIES.

(*From our own Correspondent.*)

COAL and iron have been in little demand this week, but orders come to hand freely.

In the matter of coal, there has been a greater briskness at Swansea than at Cardiff comparatively, while Newport has remained about the same as usual. The "drop" in the foreign coal exports at Cardiff last week amounted to 30,000 tons, so the slackness can be well imagined, and the consequent depression in coal circles. Prices, too, have fallen, which is a bad sign. Best steam coal, screened, has been sold for 8s. 3d. f.o.b. in Cardiff, and some of the weaker coals for fully 1s. less. As for small steam, my fear that a good deal would have to be tipped is being realised, as being less costly than wagon hire. The price has declined to 4s., and does not seem likely to stay at that.

I note that a large house colliery near Pontypridd is in the market.

In the Monmouthshire district a little more animation has been shown in the coal trade, especially in the neighbourhood of the tin-plate works which have been re-started.

I am glad to note that Mr. Whitehouse's tin-plate works have been re-started. The strike has lasted twenty-three weeks, and great suffering brought upon families and upon the district generally. The men have gone back at the old rate of wages. These re-startings are not without an adverse influence on the Swansea tin-plate trade, in particular as they afford reasonable excuse to buyers for "holding back." Swansea has shown a more weakened trade of late, but so long as stocks are low and makers firm, I do not apprehend any harm.

The shipments last week included 1100 tons of tin-plates to New York from Swansea, and I see seven large vessels will load next week. That plates are wanted is evident, buyers offering to give large orders; some for prompt, others for forward deliveries, at a reduction; but this week makers are stubborn, and prefer quietness to animation with no profit. The prevailing quotations are, cokes and Bessemer, 12s. 9d. to 13s.; Siemens 13s. 6d. to 14s.

Charcoal sheets range from 14s. 3d. to 15s. 9d.; ternes fetch 13s. 6d. to 13s. 9d. Coke wasters are as usual in demand, and cases have come to my hearing of sales effected at the same price as cheap brands, namely, 12s. 3d.

In iron and steel little has been done, but a good deal is expected. Some makers are of opinion that a few weeks will bring about a change, others that it will only come later on. All agree that mills and furnaces are to be busy. I was pleased to see renovating measures going on at Treforest last week; that, and renovating, and preparing at other works, with the large purchases of foreign ore going on, show what is coming. Coupled with this, too, cokes, furnace and foundry, keep firm in price.

A consignment of 1100 tons of rails for America, and 1000 sleepers for Vera Cruz have been the chief exports this week, with small "parcels" of bar for Carthagena, Santos, and elsewhere.

A meeting of Rhondda steam colliers was held last week. The principal matters were brought forward by Mr. W. Abraham, M.P., but one only appeared of any consequence, and that a recommendation that the workmen examining collieries should do so in their usual state, and not after the management has "put them in order."

Discussion on the Ynyshir accident continues, and I find that the belief is extending that watering coal dust should be more thoroughly done.

Another of the old house coal leases has just run out—the Wingfield—but some acres are left at the extremity, and will be won, doubtless, from another taking.

Rhymney Valley house coal trade is good, and the steam coal output of Sir Elliott's pit ranks with the best.

The colliery plant and machinery of the Bishwell Colliery, Gowerton, are to be sold consequent upon the abandonment of that colliery. This is in the neighbourhood of Swansea, and, I imagine, near the spot where coal was first worked in Wales A.D. 1305, under a charter of De Breos.

NOTES FROM GERMANY.

(*From our own Correspondent.*)

CONSIDERING the situation of the iron markets in general, it is a happy circumstance to be able to report that those of this country are still enjoying a moderately good business without any change in prices having yet taken place. Formerly values were at once affected by the quotations on the English markets, but that has all changed now-a-days, and like it is in other countries, it seems that only the demand from America has any influence on those of this country.

The iron market in Silesia is represented to be in a very healthy state and some of the works are preparing to blow in more furnaces in order to supply the increased domestic consumption of the puddling works and rolling mills. The latter have received a large influx of orders, and a tendency in wrought iron prices to rise is visible, and for many articles considerable contracts have been entered into. For puddling iron M. 48 to 49 is being paid; for foundry pig, 50 to 54; and for castings, 140 to 150; for wrought iron, 110 to 113; and for plates, 150 to 160 p.t. The foundries and mechanical workshops are pretty busy, caused in part by the renovations and new arrangements being carried out at several blast furnaces and other works. Through disagreement the newly established wrought iron convention has already been in danger of collapsing, but fortunately an arrangement seems to have been patched up again. It is quite extraordinary that sound business men can still be found, after all the experience already gained in the matter, to pin their faith on such conventions as a panacea for the evils arising out of competition.

In Belgium the iron market and the general run of business is completely satisfactory, which, however, cannot be said of that of France ; it is therefore pleasing to be able to note that the neighbouring market of Rheinland-Westphalia is so stable. The iron ore trade is developing favourably, the sales are gradually increasing, and therefore it is justly expected that they will soon reach a price which, after a long period of loss, will allow the mines to be again worked to a profit. The deliveries of Spanish ores are not so brisk as they were. Since the fears of war have disappeared, pig iron has been in better demand at pretty firm prices. The furnaces have sold all their make for the second quarter, and some have contracted for their output for the next six months, and indeed even for a year. Forge pig is in special request, and is here and there becoming scarce, and there is every appearance of its becoming so generally in the course of the quarter. Also in other sorts there is a good demand, except for spiegeleisen, which is somewhat neglected just now, but this is looked on as only temporary, as, generally speaking, there is great activity in the steel branch. The prices have remained stationary, with a tendency to rise. In wrought iron, merchant bars, girders, and construction iron of all sorts have the preference, and so many new orders for bars have been to give out that some works are asking twelve weeks for delivery at M. 112, and even 115, although 110 is the base price of the convention. Girders are noted M. 110, and angles 120 p.t. This state of things is, however, exceptional, for as a rule there have not yet been many contracts made even at the base price, and generally it is only for small lots that this price is obtained. Thin black sheets are still in moderately good request, and are noted up to M. 140 in the Siegerland, and 115 in Rheinland-Westphalia, while boiler plates are in the same position as last week, the mills being moderately engaged, a few very busy, and prices maintained at M. 145 p.t. There are no stocks of very thin sheets either at the mills or in merchants' warehouses ; so in spite of the season for this speciality being over, the prices are not expected to fall. The Western group of ironworks produced in February 25,766 tons, and sent away 26,387 tons of bar iron in the same month. The fall in the American market has had its influence on some of the iron wire rod mills here, inasmuch as the demand has slackened a little. Still steel rods appear in America to hold their own, as their price of 42·50 dols. has remained stationary for the last few weeks, whilst pig and bar iron have fallen considerably. The works are still well supplied with orders for abroad, and these prices are rather on the rise than otherwise. The steel works are well employed, though there is nothing remarkable to note about them this week. They are busy making billets for America, but, as in the case of wire rods, the orders are not so frequent as they were a short time back. The prices of rails, sleepers, &c., are unchanged. The machine and boiler shops, foundries and constructive works, are moderately employed for the moment, as many works have determined to increase, repair, or renew their appliances.

Great things are expected from the restriction in the coal output, but the advantages of it will only be felt gradually when the coal and coke industry again revive in full force, which, however, now appears on the point of being realised if no replacing take place in unison with some of the chief foreign markets. Gas coal costs M. 6·40 to 7·80; furnace coal, 5·40 to 6·00; lumps, 7·60 to 8·40; good slack, 5·20 to 6·00; patent coke, 7·40 to 8·20; ordinary coke, 6·80 to 8·50; breezes, 6·80 to 7·80 p.t. at pits.

On the 25th ult. the second of the armour-plated corvettes for the Chinese Government was launched from the Vulcan Shipyard at Stettin. The two vessels built here are the sister ships to those furnished by Messrs. Sir W. Armstrong and Co. on the Tyne. From the published accounts it would appear that shipbuilding at Stettin is not very profitable, as the two first vessels built for the Chinese Government and the six for the Bremen-Orient Line were a dead loss to the Vulcan Company.

Another example of the restless activity—it might be said mania—of German firms to establish branch manufactories abroad is to be seen in the Grüson Company having commissioned a Captain E. A. Piorkowski to proceed to Pittsburg and Philadelphia to endeavour to purchase a suitable works wherein to manufacture his chilled cast iron specialities. Up to now it has often been believed that America was *par excellence* the land of chilled castings. Whilst on the subject of cast iron turrets, it may be noted, though perhaps taken *cum grano*, that whilst paying his congratulatory visit to the Emperor, Crown Prince Rudolph of Austria, has been inspecting military works of various kinds in this country, and amongst other visits, he paid one to the Artillery Shooting-ground of Kummersdorf, where he was present at some trials made against a "homogeneous" steel armour-plate, manufactured by the Hoerde Company, of Dortmund, with a 15 c.m. gun at a very short range (distance not given). So far so good. The following part of the paragraph announcing this feat is literally translated. "In spite of greatly increasing powder charges, the plate resisted a number of shots most excellently and proved itself enormously superior to the compound plates, so that the Prince, and especially the military experts, could not withhold their candid acknowledgments." After this, Sheffield must look to its laurels and will be put upon its mettle.

CHROME STEEL PROJECTILES.—Messrs. Holtzer and Co., of Unieux, have delivered 200 of their chrome steel 12in. armour-piercing projectiles at the Royal Arsenal, Woolwich. The projectiles have been quickly completed, look well, and have passed the firing test at Shoeburyness—on Saturday, March 26th last—well; *i.e.*, they have got through 16in. of compound metal. Messrs. Holtzer and Co. claim to be the inventors of chrome steel projectiles. We hardly know if this claim would be conceded by other makers of shot. Most of them now depend on the effect of chromium to obtain uniformity of quality. Krupp is said by other makers to use chromium, but we can answer for the absence of it in the Krupp projectiles that performed so well at Spezia last year. Our representative at the Spezia Grüson trial secured fragments of the projectile, brought them home, and got them analysed, with the result that about 0·87 per cent. of carbon was found, but no chromium.

AMERICAN NOTES.

(From our own Correspondent.)

NEW YORK, March 25th.

THE subsidence of orders and inquiries during the past two weeks has created some apprehension among furnace and millowners throughout the country who are about completing their winter contracts, as to whether the high range of prices reached since February 1st will continue. As yet, no weakness is observable. In fact, telegrams to-day exhibit an advancing tendency in structural iron, wrought pipe, Bessemer pig, and old rails. Chicago markets are showing greater activity as the spring season is at hand, though Lake navigation will not open until about May 1st. Business continues at restricted proportions, on account of the absence of fixed freight rates. Much business is transacted on the basis of prices at shipping points. The Railroad Commissioners have been named by the President. The supervision of the rates of 130,000 miles of railways scattered over such a territory as the United States is a problem of no small proportions.

The iron trade continues rather light, although crude and finished products are held at full winter quotations, and buyers show no anxiety to order for summer delivery. The pig iron production is increasing every week by the blowing-in of new or repaired furnaces. Foundry quotations are 22 dols. for No. 1; forge iron is 19 dols. to 19·50 dols. Merchant steel for tools has advanced 10 per cent. Steel rails for winter delivery could be had at 38·50 dols., though makers are not soliciting orders. Old rails are weaker under heavier foreign offerings. Scrap in cargo lots is quoted at 23 dols. for shipment. Transactions in foreign material are light, and buyers will await developments before placing orders for more than current requirements. There is great activity in real estate throughout all the larger cities and towns, and this indicates great building activity, with a consequent active demand for iron, steel, lumber builders' hardware, and building material generally. Blocks of houses are frequently "run up" in sixty to ninety days, and heavier work, such as mill work, is done with unusual speed. In Boston, New York, and Philadelphia about one hundred million dollars will be expended in new buildings. Every industrial establishment is crowded, and fresh business at good rates is daily offering.

NEW COMPANIES.

THE following companies have just been registered:—

Alvarez Patent Life Raft, Jury Rudder, and Sea Equipment Company, Limited.

On the 25th ult. this company was registered, with a capital of £25,000, in £1 shares, to acquire the British patent rights of Captain Y. Alvarez, granted for a jury rudder and life-saving apparatus. Power is taken to carry on business as general shipbuilders, repairers, brokers, merchants, &c. The subscribers are:—

	Shares.
*W. Price, 58, South John-street, Liverpool, shipowner	1
*J. B. de Abaitua, 85, Jordan-street, Liverpool, marine superintendent	1
*B. French, 39a, South Castle-street, Liverpool, shipowner	1
*C. de Gruchy, 34, James-street, Liverpool, sailmaker	1
*J. J. G. Little, 138, Islington, Liverpool, merchant	1
J. C. Harker, 28, Chapel-street, Liverpool, steamship agent	1
*H. J. Gell, Liverpool, overlooker	1
W. C. Munro, 18, Hardy-street, Liverpool	1

The number of directors is not to be less than three, nor more than seven; qualification, 100 shares; the first are the subscribers denoted by an asterisk, and Mr. Isidore Alvarez; remuneration, 10s. each per meeting.

South Wales Import Company, Limited.

At Cardiff and other places this company proposes trading as iron ore and mining timber importers. It was registered on the 30th ult., with a capital of £25,000, in £10 shares, with the following as first subscribers:—

	Shares.
*P. Morel, Cardiff, shipowner	248
A. R. Chenhalls, Cardiff, clerk	1
O. Philp, Cardiff	1
W. Rutter, Cardiff, accountant	1
J. Wood, Cardiff, clerk	1
G. Williams, Cardiff, clerk	1
*T. Morel, Penarth, shipowner	247

The subscribers denoted by an asterisk are the first directors.

United Anglo-Continental Ice Company, Limited.

This company was registered on the 28th ult., with a capital of £350,000, divided into 92,500 "A" or 8 per cent. cumulative preference shares of £1 each, such shares to have priority in the distribution of assets; and 257,500 "B" or deferred ordinary shares of £1 each. It proposes to establish ice and refrigerating works and stores in Munich, Frankfort, Hanau, Dresden, Buda Pesth, Prague, Brunn, Breslau, or at any other place on the Continent, or in the United Kingdom. The company will take over the businesses of the following companies, viz.:—The Buda Pesth Ice Company, Limited, the Munich Ice Company, Limited, the Prague and Brunn Ice Company, Limited, the Breslau Ice Company, Limited, the Dresden Ice Company, Limited, and the Frankfort and Hanau Ice Company, Limited. The subscribers are:—

	"A" shares.
Captain P. Saltmarshe, Carlton Club	500
Rev. A. C Baillie-Hamilton, Pall-mall Club	100
B. Weekes, Temple-street, Birmingham	500
J. Wightman, 17, Villa-road, Nottingham	200
C. W. Empson, 3, Cleveland-gardens, Hyde Park, barrister	500
A. Smith, 3, Myrtle-terrace, Tottenham, clerk	1
W. Taylor, Blendon-terrace, Plumstead Common	1

The number of directors is not to be less than five, nor more than ten; the subscribers are to appoint the first. After payment of the preference dividend, the directors may receive such remuneration as the company in general meeting may vote, but after payment of 5 per cent. per annum on the ordinary shares, they will be entitled to such sum not exceeding £1000, as they may determine; qualification, £100 in shares or stock.

Matlock Waterworks Company, Limited.

This company was originally constituted by the Matlock Waterworks Acts, 1860 and 1881, and on the 30th ult. was registered as a limited company. The capital is £7600, divided into 800 shares of £5 each, and 360 shares of £10 each, all of which are taken up and are fully paid.

Zaruma Gold Mining Company, Limited.

This is a reconstruction of the Great Zaruma Gold Mining Company, Limited, carrying on operations in Ecuador, South America. It was registered on the 30th ult., with a capital of £300,100 in £1 shares, with the following as first subscribers:—

	Shares.
F. J. Manning, 40, Glenthorne-road, Hammersmith, solicitor	1
J. B. Broad, 43, Norcott-road, Stoke Newington	1
C. W. Morgan, 63, Jeffreys-square, Clapham, accountant	1
T. B. Provis, C.E., 76, Finsbury-pavement	1
W. Reeves, 280, Dalston-lane	1
T. P. Cooper, 2, Maitland-place, Lower Clapton	1
E. E. Venables, 13, Copthall-court	1

The number of directors is not to be less than three, nor more than nine; the subscribers are to appoint the first, and act *ad interim;* qualification, 500 ordinary shares; remuneration, £1000 per annum.

THE FINEST FIBRES.

AT the meeting of the Physical Society, March 26th, a paper was read "On the Production, Preparation, and Properties of the Finest Fibres," by Mr. C. V. Boys, M.A. The inquiry into the production and properties of fibres was suggested by the experiments of Messrs. Gibson and Gregory "On the Tenacity of Spun Glass," described before the society on February 12th, and the necessity of using such fibres in experiments on which Professor Rücker and the author are engaged.

The various methods of producing organic fibres such as silk, cobweb, &c., and the mineral fibres volcanic glass, slag wool, and spun glass, were referred to, and experiments shown in which masses of fibres of sealing wax or Canada balsam were produced by electrifying the melted substance. In producing very fine glass fibres, the author finds it best to use very small quantities at high temperatures, and the velocity of separation should be as great as possible. The oxyhydrogen jet is used to attain the high temperature, and several methods of obtaining a great velocity have been devised. The best results obtained are given by a cross-bow and straw arrow, to the tail of which a thin rod of the substance to be drawn is cemented. Pine is used for the bow, because the ratio of its elasticity to its density—on which the velocity attainable depends—is great. The free end of the rod is held between the fingers, and when the middle part has been heated to the required temperature, the string of the cross-bow is suddenly released, thus projecting the arrow with great velocity, and drawing out a long fine fibre. By this means fibres of glass less than $\frac{1}{10000}$in. in diameter can be made.

The author has also experimented on many minerals, such as quartz, sapphire, ruby, garnet, feldspar, fluorspar, augite, emerald, &c., with more or less success. Ruby, sapphire, and fluorspar cannot well be drawn into fibres by this process, but quartz, augite, and feldspar give very satisfactory results. Garnet, when treated at low temperatures, yields fibres exhibiting the most beautiful colours. Some very interesting results have been obtained with quartz, from which fibres less than $\frac{1}{100000}$in. in diameter have been obtained. It cannot be drawn directly from the crystal, but has to be slowly heated, fused, and cast into a thin rod, which rod is attached to the arrow as previously described. Quartz fibres exhibits remarkable properties, as it seems to be free from torsional fatigue, so evident in glass and metallic fibres, and on this account is most valuable for instruments requiring torsional control. The tenacity of such fibres is about 50 tons on the square inch. In the experiments on the fatigue of fibres great difficulty was experienced in obtaining a cement magnetically neutral, and sealing wax was found the most suitable.

An experiment was performed illustrating the fatigue of glass fibres under torsion, and diagrams exhibited showing that the effect of annealing them is to reduce the sub-permanent deformation to about one-tenth its original amount under similar conditions. Annealing quartz fibres does not improve their torsional properties, and renders them rotten. Besides the use of quartz for torsional measurements, the author believes that quartz thermometers would be free from the change of zero so annoying in glass ones. He exhibited an annealed glass spiral, capable of weighing a millionth of a grain fairly accurately, and also a diffraction grating, made by placing the fine fibres side by side in the threads of fine screws. Gratings so made give banded spectra of white light.

The author regretted that his paper was so incomplete, but thought the results already obtained would be of interest to the society.

OPENING OF A SECTION OF THE ASSAM-BEHAR STATE RAILWAY.—The Manihari Kasbah section of the Assam-Behar State Railway was recently opened for passenger traffic by the Lieutenant-Governor. This section, which is fifty-three miles in length, has been for about nine months doing a fair goods traffic. Manihari is a point on the left or north bank of the Ganges, opposite Sahibganj station of the East Indian Railway (loop line.) These two points are connected by a steam ferry. From Manihari the new line runs northward a distance of fifteen miles to Kattiyar, which was the head-quarters of the staff of Engineers and other railway servants, and also a junction.

THE PATENT JOURNAL.

Condensed from the Journal of the Commissioners of Patents.

Application for Letters Patent.

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

29th March, 1887.

4629. ADJUSTMENT of SWING FRAMES, J. A. Macmeiken, London.
4630. AUTOMATIC FIRE-ALARM, J. Holmes, Skipton-in-Craven.
4631. SELF-CLOSING WATER-GAUGE FITTINGS, R. W. Bell, Bradford.
4632. ROUTING MACHINES, G. K. Birge, London.
4633. BROILING RANGE, E. Calone, M. E. Bourgeois, and F. Danton, London.
4634. PRESSING BRICKS and TILES, &c., T. C. Fawcett, Halifax.
4635. TELEGRAPHIC CALL APPARATUS, C. L. Baker and F. Bryan, Manchester.
4636. ELECTRIC SAFETY PISTOL, E. Hollanders, Portsea.
4637. CONVERTIBLE SOFAS, &c., W. G. Hudson and C. R. Feay, Cheetham.
4638. WASHING MACHINES for LAUNDRIES, J. Heselwood, Manchester.
4639. COMBINED WINDOW LIFT and WEDGE, J. W. and W. Carmichael, Parton.
4640. SHEDDING MOTION for LOOMS, J. and E. Horrocks, Bradford.
4641. LIFE VESSEL, W. Holderness, Ulverston.
4642. MOUNTING DOOR KNOBS to SPINDLES, E. Taylor and S. Davis, Birmingham.
4643. SNATCH BLOCKS, T. J. Turner and M. Douglas, Bootle.
4644. CYLINDER BRAKES of LITHOGRAPHIC PRINTING MACHINES, G. Brayshaw, Leeds.
4645. ADJUSTABLE SPANNERS, T. Norman, Sheffield.
4646. GAS BOILING STOVE, A. Hill, Birmingham.
4647. POTATO ROASTER, T. C. Greaves, Manchester.
4648. PRIMARY BATTERIES, C. L. Tweedale, Manchester.
4649. PAPER, T. McDougal and F. Lindley, Glasgow.
4650. DRYING or AIRING CLOTHES, &c., T. Wilde, Oldham.
4651. BRUSHES for BRUSHING CUT PILE FABRICS, T. Schofield and F. Barker, Cornbrook.
4652. CIGAR and CIGARETTE CASES, &c., W. H. Ireland, Birmingham.
4653. CONTROLLING the PRESSURE of COAL GAS, J. J. Butcher, Newcastle-upon-Tyne.
4654. RAISING LIQUIDS, G. S. Hendry and A. Faulds, Glasgow.
4655. BOXES COMPOSED of CARDBOARD, L. Gunn and J. Perry, London.
4656. KNIFE and BOOT CLEANING MACHINE, G. Litting, Stevenage.
4657. WHEELS, R. A. Townsend, London.
4658. ARTISTIC MOTTO CARD for ATTACHING FINGER RINGS, W. G. Pilcher, Southsea.
4659. MOTIVE POWER ENGINES, J. Maynes and C. L. Watchurst, London.
4660. VALVES for STEAM ENGINES, J. Maynes and C. L. Watchurst, London.
4661. COMPOUND ENGINES, T. W. Worsdell, London.
4662. SECURING the CORKS of BOTTLES, A. D. Mestre, London.
4663. STEAM ENGINES, W. P. Thompson.—(*G. Smith, United States.*)
4664. ELECTRIC FURNACES, W. P. Thompson.—(*E. H. and A. H. Cowles, United States.*)
4665. BICYCLE LANTERNS, F. P. Prindle and C. H. Koyl, London.
4666. FELT HATS, &c., A. Fielding, Manchester.
4667. GALVANIC BATTERY SOLUTIONS, W. P. Kookogey, London.
4668. LOADING CARTRIDGE SHELLS, G. M. Peters, London.
4669. ADVERTISING, A. Bruckner, London.
4670. INCANDESCENCE of GAS FLAME, W Cluse, London.
4671. COCKS or CAPS, E. C. Urry, London.
4672. LAMP, T. G. Pinn, London.
4673. DOOR of WATER-TIGHT BULKHEADS, J. H. Sharrock, Liverpool.
4674. PREPARING, &c., FIBROUS MATERIAL, T. Bentley and S. Makin, London.
4675. WATCHES, O. Imray.—(*Waterbury Watch Company, United States.*)
4676. AUTOMATIC BRAKE MECHANISM, G. Westinghouse, London.
4677. LINK MOTION for STEAM ENGINES, S. T. Price, London.
4678. BOXES, &c., for ALIMENTARY and other SUBSTANCES, D. Clark, London.
4679. RAISING, &c., SHUTTERS, &c., J. de Burgue.—(*J. E. Blache, France.*)
4680. RIDING BREECHES, &c., W. W. Crisp and R. L. Wood, London.
4681. SPINNING COTTON, &c., J. White and T. Randall, London.
4682. CLIP for use when LUTING PIPE JOINTS, A. C. Emery, London.
4683. SASH or DOOR LATCH, B. H. Holmes, London.
4684. STOPPERING of BOTTLES, W. C. Wood, Nunhead.
4685. FURNACES and GRATE BARS, E. W. V. Duzen, London.
4686. CHLORATES of the ALKALIES or ALKALINE EARTHS, H. Gall and Viscount A. de Montlaur, London.
4687. GENERATING GAS, A. A. Harwood and M. D. V. Tassel, London.
4688. TYPE CONTAINING CHANNELS, J. C. Mewburn.—(*A. A. Low, United States.*)
4689. MARBLE-LIKE OBJECTS, L. Preussner, London.
4690. TOBACCO PIPES, G. H. Batley, London.
4691. TOOTH BRUSHES, G. F. Horsey and E. H. Horsey, London.
4692. HOT-AIR ENGINES, R. L. Howard, E. Howard, and R. S. Lloyd, London.
4693. PISTONS for ENGINES or PUMPS, G. W. McQuaker, Glasgow.
4694. GAS-BURNERS, R. B. Main, Glasgow.
4695. PREVENTING or EXTINGUISHING FIRE, K. McLennan, Glasgow.
4696. ELECTRIC INDICATING APPARATUS, H. H. Lake.—(*J. T. Murray, United States.*)
4697. METALLIC PISTON PACKING, W. W. St. John, London.
4698. RAILWAY and other VEHICLES, H. H. Lake.—(*C. V. Boucaud, France.*)
4699. REGULATING the FLOW of GAS, &c., W. von Oechelhaeuser, London.
4700. BICYCLES, E. C. Hernandez, London.
4701. DRAIN TRAPS, H. H. Lake.—(*H. C. Weedon, United States.*)
4702. LOCKING the FACING POINTS of RAILWAYS, G. Edwards, London.
4703. GLOVE FASTENERS, S. Porter, London.
4704. GAS CHECKS for GUNS, A. Noble, Newcastle-upon-Tyne.
4705. PRODUCING ARTIFICIAL SMOKE in TOY LOCOMOTIVES, &c., H. H. Lake.—(*D. H. Murphy, United States.*)
4706. PRODUCTION of PRINTED DESIGNS upon WOOD VENEER, R. Giesecke, London.
4707. WINDING of THREAD, H. H. Lake.—(*M. V. Palmer, United States.*)
4708. RUDDERS, R. Fleming, London.
4709. BOXES, F. W. Powell, London.
4710. MEASURING DISTANCES, W. T. Unge, London.
4711. FIRE-ESCAPE, T. Melville, London.
4712. SETTING OUT COURTS for LAWN TENNIS, &c., C. Lassell and D. Pearce, London.
4713. EXPLOSIVE COMPOUND, C. D. Abel.—(*H. Schöneweg, Germany.*)
4714. ELECTRICAL SIGNAL BELL, F. A. Amoric, London.
4715. PIANO PEDAL, O. Schmidt, London.
4716. STOPPERS, &c., for HOLLOW VESSELS, H. L. Phillips, London.

30th March, 1887.

4717. GIVING LEAPING ACTION to HOBBY HORSES, W. Woulds, Lincoln.
4718. PHOTOGRAPHIC CAMERA, C. Cushworth, London.
4719. HINGES for EXTENSION STEP LADDERS, A. Edmondson, J. B. Moorhouse, and T. A. Proctor, Skipton-in-Craven.
4720. CIGARETTE CASE, J. Howson, London.
4721. MACHINES for GRINDING TWIST DRILLS, J. W. Newall, London.
4722. LIGHTING, W. and F. W. Wright, Manchester.
4723. RAILWAY SIGNAL APPLIANCES, C. J. Howe, Sunderland.
4724. PANS and KETTLES, S. Morley, Horsforth Woodside.
4725. FOCUSSING ARRANGEMENT, T. N. Armstrong and G. Mason, Glasgow.
4726. MULTIPLE PLY FABRICS, H. Hardwick, Manchester.
4727. TOBACCO PIPES, W. P. Smith, Burnham.
4728. CLIP or HOLDER for SUSPENDING BILLIARDS, &c., W. Buttery and J. H. Smith, London.
4729. FASTENING NECKTIES, J. Clegg, London.
4730. HANDWRITING, E. Cockersoll, Stockton-on-Tees.
4731. CLOSING BOTTLES, C. E. and W. P. Cherry, Kingston-upon-Hull.
4732. BOILER TUBE STOPPER, T. Dixon, jun., Newcastle-on-Tyne.
4733. EXTINGUISHER for OIL or SPIRIT LAMPS, R. L. Cozens, Taunton.
4734. TRIMMING FINGER and TOE NAILS, C. McDermott, Sheffield.
4735. METER for DRAWING any STATED QUANTITY of OIL, &c., J. Ralls, Bridport.
4736. SUN SHADES, &c., J. W. Stark, Barrow-in-Furness.
4737. SPRING MATTRESSES and their FRAMES, W. Waterhouse and T. W. Blantern, Birmingham.
4738. SIGNALLING APPARATUS, T. D. Weir, Glasgow
4739. BRACELETS, I. Greenbury, Edinburgh.
4740. DAMPING PADS, J. S. Downing, Birmingham.
4741. FLATS employed in CARDING ENGINES, J. Hall and J. Ripley, London.
4742. PRESSING CLOTH and other FABRICS, J. Longtain, Leeds.
4743. AUTOMATIC BOILER FEED REGULATORS, T. Parker.—(*E. Dumas, France.*)
4744. SUPPORTING, &c., ELEMENTS in ELECTRIC BATTERIES, H. I. Harris, London.
4745. KNITTING MACHINES, J. Dalby and W. Hunt, London.
4746. PUMPS, J. West, London.
4747. STOPPERING BOTTLES, &c., J. Leytz, London.
4748. MAKING INFUSIONS or DECOCTIONS, F. W. Gibbons, London.
4749. PREVENTING the EMISSION of FLAME and SMOKE from CHIMNEYS of FURNACES, A. M. Clark.—(*P. Oriolle, fils, France.*)
4750. SLITTING or CUTTING and DAMPING PAPER, W. W. Colley and M. Hart, London.
4751. LIGHTING, E. Davies, London.
4752. LEG and FOOT POULTICE for HORSES, &c., E. Adcock and W. H. Crawcour, Nottingham.
4753. PEDESTAL, &c., VALVE CLOSETS, R. G. L. Burn and J. Macdonald, London.
4754. STONE-BREAKING, N. J. Gorgeon, London.
4755. DRAWING MACHINES for WOOLLEN, &c., THREADS, J. Y. Johnson.—(*J. Imbs, France.*)
4756. CASES or HOLDERS for PENCILS, &c., J. Spear, London.
4757. GAS, &c., ENGINES, E. Casper.—(*A. E. Tavernier, France.*)
4758. THREE-LEGGED COMPASS, G. F. Redfern.—(*A. Dubanton, France.*)
4759. MOTORS for UTILISING the FORCE of WATER, W. H. Sleep, London.
4760. ROUNDABOUTS, G. F. Lütticke, London.
4761. BILLIARD TABLES, F. Barrett and T. F. Garrett, London.
4762. BOBBIN-NET or TWIST-LACE MACHINES, A. C. Henderson.—(*H. S. La Serve, France.*)
4763. HEATING, &c., RAILWAY CARRIAGES, R. Ashton, Manchester.
4764. MORDAUNTING, DYEING, &c., RAW COTTON, G. Jagenburg, London.
4765. DECK SEAT, J. W. Shepherd, Glasgow.
4766. BENDING LEAD, &c., PIPES, &c., W. E. Heath, London.
4767. DENTAL FORCEPS, H. H. Leigh.—(*G. Poulson, Germany.*)
4768. ADJUSTABLE QUADRANT, T. D. Ogden, Manchester.
4769. WOOL COMBING MACHINES, W. R. Hamilton, London.
4770. FOLDING TABLES and SEATS, R. Haddan.—(*Simon and Vivenot, France.*)
4771. HAIR-PINS, P. Stéphany, London.
4772. WATER METERS, J. W. Stawitz, London.
4773. DOOR CHECKS, A. J. Boult.—(*G. R. Elliott, United States.*)
4774. DUTCH OVENS, D. Rogers, sen., D. Rogers, jun., J. Shaw, and J. Owen, Liverpool.
4775. DETACHABLE HANDLE BARS for VELOCIPEDES, &c., A. J. Boult.—(*P. Focke, Germany.*)
4776. FORK for STEERING WHEELS of BICYCLES, &c., C. M. L. Palmers, London.
4777. DRIVING GEAR for TABLE MACHINES for SEWING, &c., P. A. Dohis, London.
4778. AUTOMATIC and other GUNS, H. S. Maxim, London.
4779. AUTOMATIC COIN FREED APPARATUS, for INDICATING WEIGHT, &c., M. R. Marelle, London.
4780. REFRIGERATING, PRODUCING, and UTILISING COLD, R. Matthews, London.
4781. ELECTRIC BATTERIES, The Electrical Power Storage Company and H. W. Butler, London.
4782. LOADING GUNS, G. B. Rennie, London.
4783. DIMINISHING the CLICKING NOISE in TREADLE SEWING MACHINES, C. Kahn, Germany.
4784. GAS, H. B. Sheridan and E. Rawlings, London.

31st March, 1887.

4785. TOBACCO PIPE, O. C. Mootham, Bournemouth.
4786. KNITTING MACHINES, G. Riley, Leicester.
4787. BEDSTEADS, I. A. Read, Manchester.
4788. TYPE-WRITERS, G. J. Purser, Birmingham.
4789. BEDS, I. Chorlton and G. L. Scott, Manchester.
4790. TEST VALVE, W. Robertson, Dublin.
4791. MECHANICAL TOYS, G. Cole, London.
4792. GLASS and WOOD LETTER, J. Edmett, London.
4793. GILL-BOXES, W. Gawthorp, J. Reddihough, and S. Wade, Bradford.
4794. BOOTS, J. Sainty, Norwich.
4795. MOTOR WHEEL, F. F. Lee, Salisbury.
4796. GUN, PROJECTILE, &c., R. Low, Dundee.
4797. RAISING BEER, J. Crawford, Glasgow.
4798. SCREENING CINDERS from ASHES, R. Soans, Northallerton.
4799. BRUSHING YARNS, &c., C. Binns, Manchester.
4800. COMBINED MOTOR, &c., W. H. Elliott, Thurles.
4801. COVERING for GONGS, G. R. Unite, Birmingham.
4802. END for REGULATING DISTANCES, &c, J. R. Elliott, Taunton.
4803. AIR-TIGHT STOPPERS, J. T. Mantle, Birmingham.
4804. SLIDE CARRIERS for MAGIC-LANTERNS, W. J. Coles, London.
4805. CONVERTING RECIPROCATING into ROTARY MOTION, S. Dobson, Manchester.
4806. LACES, J. Halliwell, Manchester.
4807. CARTRIDGES, E. R. Butler, Germany.
4808. REGULATING HORIZONTAL SWING of PHOTOGRAPHIC CAMERAS, C. Sands and J. J. Hunter, London.
4809. INSULATING ELECTRICAL CONDUCTORS, E. Tortora, London.
4810. PREVENTING the WASTING of CANDLES, G. H. Elphick, London.
4811. FLUID MOTORS, C. Hawkins, London.
4812. MECHANICAL OVENS, R. Goburth, Germany.
4813. TAKE-UP for SEWING MACHINES, A. F. Wileman, Ealing.
4814. MOTOR ENGINE, J. Roots, Gunnersbury.

4815. Coupling Apparatus, J. Y. Johnson.—(*La Compagnie des Appareils d'Accrochage Automatique des Wagons de Chemin de Fer, France.*)
4816. Billard Cues, J. H. Smith, London.
4817. Flower Stands, E. Agar, London.
4818. Metal Covered Roofs, S. Taylor, London.
4819. Meat Toaster, J. J. Furney, London.
4820. Rolling Roads, T. Perkins and J. E. S. Perkins, London.
4821. Opaque Glass, E. Moore, London.
4822. Opaque Glass, E. Moore, London.
4823. Galvanic Battery, C. H. Cathcart, London.
4824. Generating Electro-magnetic Currents, O. C. D. Ross, London.
4825. Paper Cutting Machines, H. J. Salmon, J. Capper, and W. H. Duffett, Manchester.
4826. Capsuling of Bottles, G. Y. Simon, London.
4827. Combined Envelope and Letter Sheet, H. H. Lake.—(*J. P. T. Guillot, France.*)
4828. Shuttles, G. Langlands and W. Webster, Glasgow.
4829. Screw-propeller Bosses, T. Dobie.—(*J. G. Dodbie, India.*)
4830. Duplexing Needle Telegraphs, J. Fleming, Glasgow.
4831. Lubricators, M. H. Smith-Krohg or Smith-Krog, Middlesex.
4832. Electrodes, H. Liepmann, Middlesex.
4833. Fabrics, T. Stevens, London.
4834. Trousers Stretcher, W. W. Horn.—(*E. C. Weston, United States.*)
4835. Brick-making Machine, T. Le Poidevin, London.
4836. Barrels, P. E. Estable, London.
4837. Regulator, A. E. Barker, London.
4838. Moulding Machines, G. Guntz, Washington.
4839. Moulding Machines, G. Guntz, Washington.
4840. Indicating Payment, J. L. Davies and C. H. Fitzmaurice, London.
4841. Cutting Shovel Plates, L. Wache and R. James, London.
4842. Opening Bottles, A. Alexander, London.
4843. Motors, E. Stevens, London.
4844. Screw Conveyers, L. Rössler and H. Reinhard, London.
4845. Removing Roots from Grain, L. Rössler and H. Reinhard, London.
4846. Coating Iron with Tin, A. Gutensohn and E. Cox, London.
4847. Driving Gear, J. C. Stevenson, J. Marshall, and M. F. W. Bristed, London.
2244a. Latches, F. Taylor, London. 12th Feb., 1887. [Received April 2nd, 1887. This application having been originally included in No. 2244, a.d. 1887, takes under Patents Rule 23, that date.]

1st April, 1887.

4848. Watch Protector, R. H. Padbury, London.
4849. Switches, H. Tipper, Birmingham.
4850. Lamps, F. W. H. Durant, Bradford.
4851. Fire Drawer, T. Baker, Cardiff.
4852. Socks, W. Sutcliffe, Halifax.
4853. Machinery for Rolling Rims, D. Elliott and W. Ainslie, Leeds.
4854. Destroying Insects, N. Procter, Derbyshire.
4855. Cramp, W. B. and N. N. Haigh, Manchester.
4856. Covering Rollers, T. Briggs and E. Webb, Manchester.
4857. Soles for Shoes, R. Kieserling, Barmen.
4858. Poultices, C. Westrook, Sheffield.
4859. Heating, A. Fehlen, London.
4860. Delivering Articles Automatically, C. Ingrey, Middlesex.
4861. Racks, J. A. Gordon, Glasgow.
4862. Needle Threader, J. Darling, Glasgow.
4863. Brewing, F. Faulkner and W. Adlam, London.
4864. Cooking Apparatus, T. G. and R. C. Smith, London.
4865. Casks, C. Godbolt, London.
4866. Lamps, T. V. Hughes, London.
4867. Tea Urns, H. C. Willmott, London.
4868. Ice-making, H. M. Thomas, London.
4869. Velocipedes, G. Hoggan, London.
4870. Bottle Holders, J. H. Middleton, Birmingham.
4871. Fastenings for Metallic Trunks, W. B. Williamson, London.
4872. Saddles for Bicycles, J. F. Whitehead, London.
4873. Boring Rock, &c., J. A. McKean, London.
4874. Gas Ovens, S. Leoni, London.
4875. Gas Lamps, C. T. Robinson, London.
4876. Files, A. J. Boult.—(*G. Custer, J. S. Napier, sen., and N. Napier.*)
4877. Holders for Newspapers, A. Novotny and W. Schoen, Liverpool.
4878. Enabling a Constant Watch to be Kept by the Man at the Wheel in Respect to the Side Lights of Ships, S. A. Johnson, London.
4879. Hermetically Sealed Cans, T. Dence and J. J. Mason, London.
4880. Rings for Spinning Machines, P., R., and J. Eadie, Manchester.
4881. Production of Hydrogen Gas, W. Majert and G. Richter, London.
4882. Flour-dressing Machines, S. Samuel-Atkins and R. Driver, London.
4883. School Bags, J. Spear, London.
4884. Gas for Lighting, G. F. Redfern.—(*A. Goutierre, Belgium.*)
4885. Securing Flexible Tubes on Hose Couplings, N. Howitt, London.
4886. Lighting and Heating by Gas, J. Wybauw, London.
4887. Detaching Coal, T. and R. W. Bower, and J. Blackburn, London.
4888. Obtaining Hydro-carbons from Gases, F. Friedlaender and J. Quaglio, London.
4889. Trashing and Cutting Sugar-cane, T. Tomlinson, London.
4890. Automatic Friction Cord Rack, W. Fraser, London.
4891. Automatic Adjustable Button, W. Fraser, London.
4892. Lubricator, W. Fraser, London.
4893. Adjustable Alarm Egg Timer, W. Fraser, London.
4894. Metallic Boxes, W. H. Lloyd and J. Wylde, London.
4895. Picker and Shuttle Cushioner, J. H. Paige, London.
4896. Lasts, E. Newberry, J. W. Sharp, T. H. Salmon, and F. Jackson, London.

2nd April, 1887.

4897. Life-buoy for Saving Lives at Sea, E. S. Copeman, London.
4898. Fixing Handles to Table Cutlery, H. J. Perry, Brighton.
4899. Machines for Punching, &c., W. F. Gilmer, London.
4900. Lubrication of Journal Bearings, N. Rix, Colney St. Albans.
4901. Pocket Guard, W. J. Orwin, London.
4902. Sliding Guard for Fireplaces, &c., M. W. Maylard, Croydon.
4903. Cord-holders for Blinds, &c., J. J. James, Birmingham.
4904. Awnings for Vehicles, T. M. Norris, Liverpool.
4905. Dyeing and Printing, A. Ferrie, Manchester.
4906. Driving Merry-go-rounds, &c., J. Rushworth, Sowerby Bridge.
4907. Oil Lamps and Extinguishers, E. Sherring, Manchester.
4908. Call Bells, A. Nicholas, Birmingham.
4909. Door and Till Bells, A. Nicholas, Birmingham.
4910. Machines for Brushing, &c., Leather, H. T. Roberts, Halifax.
4911. Removal of Refuse, E. Vigers, Stoke-upon-Trent.
4912. Belts for Driving Machinery, M. Gandy, Liverpool.
4913. Movable Studs, A. Reynolds, Birmingham.
4914. Switches, R. D. Smillie, Glasgow.
4915. Production of Photographs in Colours, W. Trenemen, London.
4916. Dredging Apparatus, D. Cunningham, Glasgow.
4917. Axle Pulleys, W. Hawkins, W. Fisher, and A. Ashmore, Birmingham.
4918. Winch, J. Smith, Keighley.
4919. Oil Lamps, W. Devoll, Erdington.
4920. Breech-loading Small-arms, T. Woodward, Sutton Coldfield.

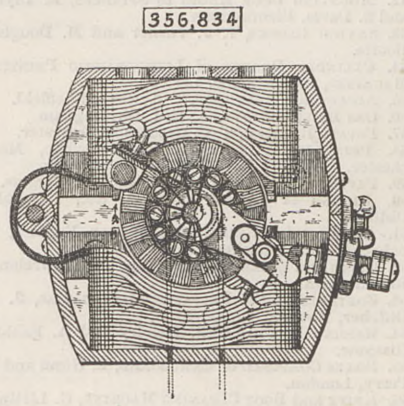
SELECTED AMERICAN PATENTS.

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

356,834. Electric Motor, *W. W. Griscom, Haverford College, Pa.—Filed August 25th*, 1885.

Claim.—(1) In an electric motor, a field magnet, the cores of which are expanded so as to form a divisible box or casing adapted to contain all the working parts of the machine, as set forth. (2) In an electric motor, the two-part box field magnet core *a a*, having field cores A, suitably faced to receive the armature, and having transverse air passages A^1, and vent-holes A^2 A^3, and provided with the hinge a^1 and a suitable fastening, as set forth. (3) In an electric motor, the combination, with a two-part box field magnet divided on its central line and suitably hinged, and formed with the hollow extensions R R, of the armature shaft E, and the removable bearings H H^1, fitting into and adapted to be securely held within the projections R R when the box is closed, as set forth. (4) In an electric motor, the combination, with a commutator, a suitable armature and field magnet, of a pair of commutator brushes, an adjustable support there-

356,834



for, said support being also provided with a contact device adapted to close a circuit between the binding posts when the brushes are in their position of least sufficiency, at zero, a wheel to be driven, and a brake normally opposing the movement thereof, a pivotted lever, and a retracting spring and mechanical connections between the brush-holder and the lever, and the lever and brake, whereby the movement of the lever by the operator will carry the commutator brushes away from their normal position at zero, and at the some time remove the brake from the wheel and allow the apparatus to start, and when released said spring will automatically return the brushes to zero and close the by-pass circuit and simultaneously apply the brake to the machine being driven, as set forth.

356,902. Armature for Dynamo-electric Machines, *E. Thomson, New Britain, Conn.—Filed May 25th*, 1883.

Claim.—(1) An armature core or body consisting of thin or flexible iron ribbon or tape set edgewise to the axis of the armature, and formed, as described, at one or both edges so as to compensate for the difference in the length of its inner and outer circumference. (2) An armature made up with flat wire or tape set on edge and curved to the outline of the armature, said tape having a sinuous or indented surface upon its inner portion, as and for the purpose described. (3) An armature core made up of tape or ribbon set edgewise and crimped, curved, or corrugated at its inner portion, so as to lessen the circumferential space covered thereby. (4) In an armature, the combination, with a frame having longitudinal bars or ribs, of flat ribbon or tape wound edgewise thereupon, as and for the pur-

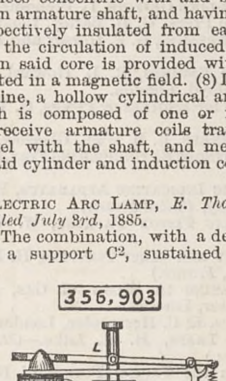
356,902

pose described. (5) In an armature, the combination, with the longitudinal supporting-ribs, of the ribbon or tape wound edgewise upon the same and given a crimped or wavy form by impingement upon the ribs. (6) An annular or cylindrical armature core or carrier formed of a helix of thin iron plate or ribbon set on edge concentric with the armature shaft and having its successive turns insulated from one another. (7) A hollow cylindrical armature core composed of iron spirals or helices concentric with and suitably supported upon an armature shaft, and having their convolutions respectively insulated from each other, so as to prevent the circulation of induced currents in the core when said core is provided with induction coils and rotated in a magnetic field. (8) In a dynamo-electric machine, a hollow cylindrical armature, the core of which is composed of one or more helices adapted to receive armature coils traversing said helices parallel with the shaft, and means for supporting the said cylinder and induction coils upon the shaft.

356,903. Electric Arc Lamp, *E. Thomson, Lynn, Mass.—Filed July 3rd*, 1885.

Claim.—(1) The combination, with a derived-circuit magnet and a support C^2, sustained thereby in

356,903

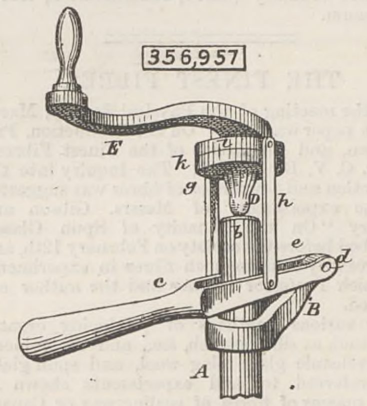


position dependent upon the strength of current in said derived circuit, of an intermediate magnet by whose magnetic influence the part C^2 is mechanically connected to the derived circuit magnet, so that movements of the armature or equivalent portion of the latter may be communicated through the intermediate magnet to the support C^2. (2) The combination of a lever C^2, a lever L, for a derived-circuit magnet, and an intermediate magnet by whose magnetic influence the lever C^2 is sustained, so that movement of the lever L may be communicated to it. (3) The combination of the lever or support C^2, a lever or support L, controlled by a derived-circuit magnet, and an intermediate main-circuit magnet by whose magnetic influence the support C^2 is kept in mechanical connection with support L, so that movements of the latter will be communicated to lever C^2.

356,957. Device for Trimming the Ends of Tubes, *E. Q. y Delgado, Brooklyn, N.Y.—Filed June 26th*, 1886.

Claim.—(1) The tool D, having a head *k*, provided with an annular recess *m*, in its inner face, cutters *g* around the outer margin of said annular recess, and a reaming cutter or cutting projection *f*, arranged to project centrally from within said recess, substantially as and for the purpose specified. (2) The tool D, having a head *k*, provided with an annular recess *m*, in its inner face, cutters *g* around the outer margin of said annular recess, a reaming cutter or cutting projection *f*, arranged to project centrally from within said recess, and an outer stem extension or shank *s*, essentially as and for the purpose herein described. (3) In a combined hand tool and holder for removing the burrs from or finishing the cut ends of tubes or pipes, the combination of an arm or jaw adapted to slip over the pipe and to hold on to the same, a pressure lever attached to said arm or jaw, a swinging frame carried by said lever, and a rotatable finishing cutting tool having its bearings in said swinging frame and provided with means for rotating it, substantially as specified. (4) In a combined tool and holder for finishing the cut ends of tubes or pipes, the combination of the eye or sleeve-like arm B, having a clamping

356,957

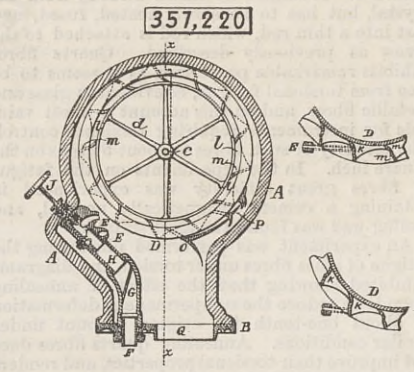


projection *c*, the pressure lever C, the links *h h*, and collar *i*, and the rotatable cutting tool D, provided with means for rotating it and having inner and outer cutters *f g*, essentially as described. (5) In a combined tool and holder for finishing the cut ends of tubes or pipes, the combination, with the clamping arm B, lever C, and swinging frame *i h h*, of the rotatable cutting tool D, having means for rotating it, and provided with an annular recess *m*, and inner and outer cutters or cutting projections *f g*, adapted to operate upon the inside and outside of the cut end portion of the pipe, substantially as described. (6) In a combined tool and holder for finishing the cut ends of tubes or pipes, the combination of the rotatable crank or handle E with the pressure lever C, the clamping jaw or arm B, a swinging frame carried by said lever, and a finishing cutting tool arranged for rotation within or through said swinging frame by the crank or handle E, essentially as herein set forth.

357,220. Water Motor, *W. J. Mingle, Lancaster, Pa.—Filed March 30th*, 1886.

Claim.—(1) In a water motor, a wheel having a series of peripheral buckets, each of which is provided with two curves *m* and m^1, arranged in the same vertical plane transverse to the axis of the wheel, one of said curves being outside of the other, and their curvature and inclination varying in order that each may receive a distinct central stroke of the water jet, substantially as set forth. (2) A motor wheel provided with a series of buckets having openings *l* through the inner parts of their sides, in combination with a series sf deflectors arranged in proximity solely to the solid outer parts of said sides, in order that the water escaping through said openings may not strike them and retard the wheel, substantially as set forth. (3)

357,220

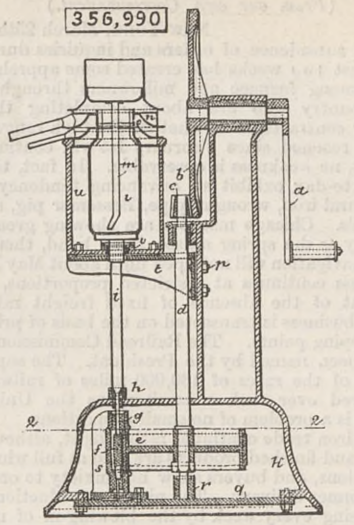


The Z-shaped leakage guard Z, in combination with a spindle or shaft which it is recessed to fit, and a spring which bears against said guard, substantially as set forth. (4) In combination with the wheel and casing of a water motor, a curved stationary deflector provided with a rearwardly extending guide plate which gradually diverges from said wheel, and a second curved deflector arranged just beyond this guide plate, substantially as set forth. (5) In combination with a water motor wheel and casing, a series of deflectors provided with guide plates gradually diverging from the periphery of said wheel, substantially as set forth.

356,990. Motor for Operating Centrifugal Machines, *G. De Laval, Stockholm, Sweden.—Filed October 2nd*, 1886.

Claim.—(1) The combination, with the vertical shaft *i*, of the hollow base *k*, the vertical standard *p*, the bracket *t*, extending out from the side of the standard and containing the bearing for the shaft *i* and supporting the casing *u*, the bearing at the lower end of the shaft, and a small pinion *f*, with fine teeth thereon, the wheel *e* within the base *k*, gearing into the pinion *j*, the vertical shaft *d* and bearings for the same, the bevel pinion *c* and bevel wheel *b* and the crank *a*, and the shaft in bearings at the top of the standard *p* and connecting the crank and bevel gear, substantially as specified. (2) The combination, with the vertical shaft *i*, of the hollow base *k*, the vertical standard *p*, the bracket *t*, extending out from the side of the standard and containing the bearing for the shaft *i*, the shaft *g*, coupled to the shaft *i*, and a small pinion *f*, with fine teeth thereon, and the bearings within the hollow base for the shaft *g*, the wheel *e* within the base *k*, gearing into the pinion *f*, the vertical shaft *d* and bearings for the same, the bevel pinion *c* and the bevel wheel *b* and the crank *a* and the shaft in bearings at the top of the standard *p* and

356,990



connecting the crank and bevel gear, substantially specified.

357,191. Relief Valve for Engine Cylinders, *T. M. Fell, Tenafly, N.J.—Filed June 14th*, 1886.

Claim.—(1) In an automatic cylinder relief valve, the combination of the cylinder with the piston [and the valves, the valves and piston being wholly contained within the cylinder, substantially as described. (2) In an automatic cylinder relief valve, the combination

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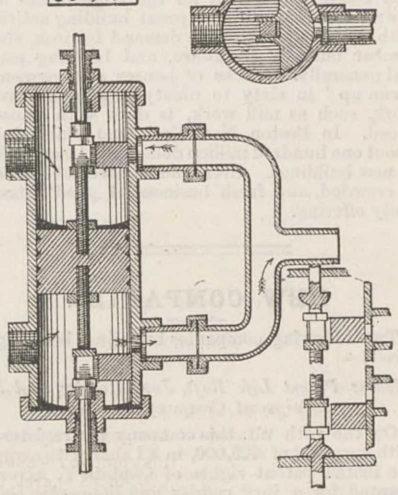
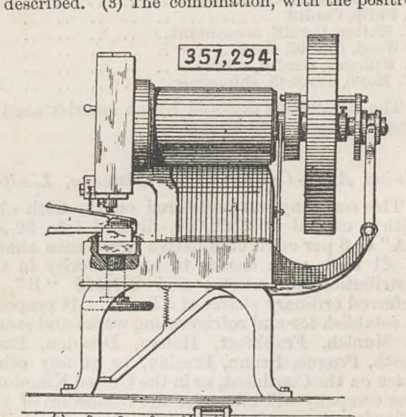


of the cylinder with the piston, the adjustable valve rods attached thereto, and the valves, substantially as shown and described. (3) In an automatic cylinder relief valve, the combination of the cylinder with the piston, the valves, the rod, and means for cushioning the same, substantially as shown and described. (4) In an automatic cylinder relief valve, the combination of the cylinder with the piston, the valve, the valve-rod and cushioning piston, and the cushioning cylinder in the cylinder head, as set forth. (5) In an automatic cylinder relief valve, the combination of the cylinder with the piston, the valve, the valve rods projecting from the cylinder, and the exhaust and inlet ports, as set forth. (6) In an automatic cylinder relief valve, the combination of the cylinder having the main piston and adjustable piston rods, the cushioning pistons and their cylinders, substantially as set forth. (7) In an automatic cylinder relief valve the combination of the cylinder having a piston with rods at each, end the cylinder heads provided with stuffing boxes on their outer sides, and a cylinder on the inder side, as set forth.

357,294. Rivetting Machine, *J. F. Webster, Springfield, Ohio.—Filed January 25th*, 1886.

Claim.—(1) The combination, with a positive reciprocating press having a rivetting tool therein and a table under said press, of an anvil secured on said table, said anvil being so constructed and supported that it is adapted to yield under an undue pressure of said press, substantially as and for the purpose set forth. (2) In a rivetting machine, the combination, with the reciprocating press, of the rivetting tool therein, a yielding anvil adapted to receive the pressure of said press, a table under said tool, and an auxiliary supporting table provided with a guide having an overhanging flange thereon, substantially as described. (3) The combination, with the positive

357,294



reciprocating press, of the table under said press, an elastic anvil adapted to receive the pressure of sai press, and a clamping device on said table adapted to hold the work in position thereon, substantially as set forth. (4) The combination, with a positive reciprocating press having a rivetting tool therein, of a table under said press, and an anvil on said table, said anvil being made in two parts, one of which is adapted to yield under the pressure of said press, substantially as specified. (5) The combination, with the positive reciprocating press having a rivetting tool therein, of a table under said press, a yielding or elastic anvil on said table, and a hinged clamping lever adapted to mark the point of rivetting and hold the work in position, substantially as and for the purpose set forth.