THE METRIC SYSTEM.

By PROF. A. G. GREENHILL.

THE fundamental measures of the Metre and the Kilogramme as units of length and weight are now so firmly established as part of our modern civilisation that it cannot do any harm to the extent of unsettling the minds of scientific or practical men if we make a few remarks on certain defects avoidable at the outset of its invention, by which the Metric System could have been made much more useful and cosmopolitan in its character.

For scientific purposes the introduction of the C.G.S.—*i.e.*, centimetre, gramme, second—system of units, with the derived absolute units of the dyne, erg, watt, ohm, volt, ampère, &c., has been of extreme use in giving a cosmopolitan character to all measurements, particularly of electrical quantities, now of such practical importance.

Maxwell says that the symbols of modern civilisation are the foot rule, the pound weight, and the chronometer; or, in the metric system, the metre rule, and the kilogramme weight. It will be noticed that the division of the mean solar day into twenty-four hours, each of sixty minutes, and each minute of sixty seconds, is universal; and the attempt to change from this sexagesimal division of time to the centesimal division was a failure from the outset. It has not been universally recognised that allied to the units of time, the sexagesimal division of the right angle into 90 degrees, and then of the degree into 60 minutes and the minute into 60 seconds, was intimately bound up with the sexagesimal measurement of time, and depended upon fundamental geometrical considerations connected with the equilateral triangle and the hexagon. The metric system having been introduced on the decimal idea, it was unfortunately decided that the decimal division of the angle was to be adopted.

For the inventors of the metric system were determined upon a thoroughly consistent decimal measurement of all physical quantities; and the first to be changed was to be the measurement of time. Instead of the universal system hitherto—and still in use—of a day of twenty-four hours, the day was to be divided into forty hours, each hour into 100 minutes, and each minute into 100 seconds.

Following on the centesimal measurement of time came the centesimal division of the circumference into 400 degrees, called grades, so that the right angle contained 100 grades; and each grade was divided into 100 centesimal minutes, and each minute into 100 centesimal seconds. Then, to convert time into longitude, or *vice versâ*, the navigator would have merely to multiply by ten.

The centesimal nautical mile—one centesimal minute of latitude on the earth's surface—was now divided into 1000 equal parts, called metres; and thus the unit of length was fixed; a metre being one ten-millionth part of the earth's quadrant, and a kilometre the centesimal nautical mile.

Next, to determine the unit of weight—or mass—water was taken as the standard substance of unit density, being the most widely diffused substance in nature; and a decimetre cube—the litre—of water was taken as the standard weight, and called the kilogramme—a centimetre cube of water being called a gramme.

Thus we see how the kilogramme and the metre are the logical outcome of the consistent decimal system of the centesimal division of the day and of the circumference insisted on by the inventors of the metric system.

But unfortunately for this idea, the world, as we see, has refused to have anything to do with the centesimal hour, and insists on retaining the sexagesimal division of time—the day of twenty-four hours, the hour of sixty minutes, and the minute of sixty seconds. The centesimal hour being gone, the centesimal degree must go also, so far as it is required in navigation; and the centesimal division of the angle being gone, the kilometre can no longer be used by navigators as the nautical mile.

The trigonometrical tables in centesimal degrees and minutes prepared for use in navigation, at great labour and expense by the originators of the metric system, were thus so much waste paper; and the whole idea would have been forgotten long ago, but that the centesimal division of the angle is still explained in some elementary trigonometries, under the idea that it forms a useful exercise to the young mathematical student. As for the centesimal division of time, it was never used in real life, and can only be found occasionally employed by Laplace in his "Mécanique Céleste," to the great confusion and annoyance of his readers.

What is, then, it may be asked, the fundamental nature of the sexagesimal measurement of time and angle, that the whole civilised world should have reverted to this system? Why should the day have twenty-four hours and the circumference 360 deg.?

We derive this method of division from the Arabian astronomers and navigators. The division of the circumference into six equal parts is the most natural, because if a circle is struck with compasses, then six steps of the compass round the circumference complete a circuit. On a dial each of these parts was divided into four hours, making twenty-four hours to the day; while later each part was divided into sixty degrees, each degree into sixty minutes, and each minute into sixty seconds, by analogy with minutes and seconds of time; and thus to convert time into angle, or *vice versâ*, as in longitude, we multiply or divide by fifteen. Of course all these fifteens and sixties were objectionable to the pure decimalists, but will nevertheless survive; while the extreme awkwardness of the angle of an equilateral triangle or of a hexagon, being an incommensurable angle in the centesimal system, was a great drawback to this latter method.

Notwithstanding that, in consequence of the use of sexagesimal time and angle, the metre has lost its physical connection with astronomy and navigation, it is not to be expected that the metre can now ever be changed, as its use has taken too firm a root in our civilisation; on the contrary, it is an important question for our engineers to consider to what extent the retention of the British foot keeps their works out of Continental markets.

Suppose, however, that in framing the metric system the inventors had recognised that it was useless to change the sexagesimal measurement of the angle and time, the kilometre would then have become the nautical or geographical mile, and the metre would have been practically the same as our *fathom*, or the old French unit of length, the *toise*.

The fathom—in old English "fadom," in French the "toise," in Greek ὀργυιά, meaning the stretch of the arms—is naturally used in measuring the length of a rope, and thus we find the fathom at present used only as a measure of *depth*, for mines or soundings—"Full fathom five thy father lies," &c. Not being a parliamentary unit of length, there would be no legal objection to slightly stretching the fathom, so as to make it exactly the one-thousandth part of a geographical or nautical mile; for soundings on old charts the error would be on the safe side.

The good old measure, the fathom, would thus become the useful unit of length in navigation, and Mr. James Crocker in his "New Proposal for a Geographical System of Measures and Weights" (Macmillan and Co., 1864), proposes to call a hundred such fathoms the *stadium* or *stade*, which would be the equivalent of the furlong, while ten stadia or stades would make the nautical mile, and three nautical miles the league.

The nautical mile of one minute of latitude being 1000 fathoms, the earth's quadrant would be $90 \times 60 \times 1000 =$ 5,400,000 fathoms; the earth's circumference 21,600,000 fathoms, the speed of one knot would be 1000 fathoms an hour, or $1000 \div 120 = 8\frac{1}{3}$ fathoms per half minute, and therefore $8\frac{1}{3}$ fathoms would have to be the distance between the knots on the log line with a half-minute sand glass or stop-watch.

It is disheartening to find even nautical authorities like Lord Brassey (*vide Times* Dec. 15th, 1887) using the word "knot" improperly as a measure of *length*, the equivalent of the nautical mile.

The knot is the cosmopolitan unit of *speed* at sea (*nœuds* in French, *knoten* in German, *nodi* in Spanish and Italian, &c.), and one knot is a speed of one nautical mile an hour. It derives its name from the knots on the log line, and a ship is said to be going so many knots when that number is counted over the taffrail in half a minute, the knots being spaced as above (*vide* Falconer's "Marine Dictionary," "knot"). It is generally near enough to make the knots 50ft. apart, so that a knot is roughly a speed of 100ft. a minute.

Marine engineers are partial to translating knots into land or statute miles an hour, and thereby the number expressing the speed is increased, and can be mentally compared with the speed of a train. The land mile being 1760 yards, against a little over 2000 yards for the sea mile, a speed in knots can be increased about 15 per cent. to convert it into land miles an hour.

The land mile is the measure which exhibits the greatest variation in different countries, as may be seen by reference to a table of measures.

By a statute of Elizabeth, the English land mile was defined to be 1760 yards, under an erroneous notion that this was the length of a minute of latitude. The more accurate determinations of Snellius and Norwood soon showed that there were about 69 English statute miles to the degree of latitude. Of this correction, however, Newton appears to have been ignorant, when in 1665 he made his first celebrated attempt to extend the law of gravitation to all the heavenly bodies. According to the traditional version, Newton, being driven from Cambridge by the plague in 1665, was sitting in his garden at Woolsthorpe, when the fall of an apple led him to speculate as to the distance to which the attraction of gravity extended, whether, for instance, it extended as far as the moon. Now, the moon's parallax being known to be such that its cosecant is about sixty, the distance of the moon is about sixty times the earth's radius, and assuming that gravity diminishes inversely as the square of the distance from the earth's centre, it follows that if an apple falls 16ft. towards the earth in one second the moon should fall 16ft. in one minute. Taking the minute of latitude as 1760 yards, or 5280ft., and the moon's periodic time as twenty-eight days, Newton found that the deflection of the moon in one minute was only about 14ft., so he laid his calculations aside, although he must have known that the law of diminution of gravity according to the inverse square of the distance was the most natural law to take for any effect emanating from a centre by analogy with the corresponding phenomena of light, heat, sound, &c., besides being immediately deducible from Kepler's third planetary law, "the squares of the periodic times vary as the cubes of the mean distances," if the orbits of the planets round the sun be supposed circular. It was not till nineteen years afterwards that Newton's attention was called to Picard's measurements of the length of the meridian made in Peru in 1670, and then on resuming his calculations with the correct length of the minute of latitude, and finding his theory likely to prove true, it is related that he was so agitated as to be obliged to ask a friend to finish the verifying calculation for him.

The first attempt at the determination of the size of the earth was made by the astronomer Eratosthenes, B.C. 300, who observed that when the sun was in the zenith at Syene it cast a shadow at noon in Alexandria which indicated the sun's zenith distance was 7° 12′, thus giving the difference of latitude of the two places. Taking Alexandria and Syene as being on the sam meridian and 5000 stadia apart, Eratosthenes gave the earth's circumference as 250,000 stadia against 216,000 stadia as defined by Mr. Crocker, the error being less than taking one statute mile as a minute of latitude; the length of the stadium employed by Eratosthenes is however uncertain.

It is sometimes confusing that the words minute and second are used for divisions of time and angle, especially in longitude; a minute of angle and a mile on the earth's surface being convertible in navigation, it is becoming customary at sea, to avoid confusion, to express longitude in degrees and miles, using the word mile instead of minute; but in this way a mile of longitude is proportional to the cosine of the latitude.

An article on the subject of units of length, by M. de Freycinet, in the *Comptes Rendus*, 14th Nov. 1887, may be consulted, in which he proposes to substitute for the metre a unit of length derived from the value of the acceleration of gravity at Paris. Provided M. de Freycinet gives a name entirely different to metre to his new unit of length no harm will result, but it is futile to attempt to change the metre or foot now.

In the United States the foot is the engineer's unit of length, divided into decimals, the fathom of six feet not being used now even by miners. So long as the fathom is exactly six feet and the yard is three feet, they are unnecessary as measures; but the arithmetician loves to make the measures fit into a table as exact aliquot parts of each other, and thus the yard, originally the measure of a man's single pace, becomes enlarged so as to be exactly three feet. A thousand double paces is the Roman *mille passus*, whence our word mile; and an average pace, being rather less than a yard, would bring the Roman mile very nearly to the same as our statute mile.

In conclusion, nothing now can alter the foot or the metre as units of length; the pound, or kilogramme as units of weight; but no harm can result in resuscitating the fathom, and making it a little more than six feet, so that 1000 fathoms make a nautical mile; but the nautical mile must not be taken as synonymous with knot, as is too often to be seen in reports of trial trips, the true sailor looking upon this mistake as characteristic of the engine-room.

WATER SOFTENING.

No. I.

THE correspondence that has taken place in the columns of THE ENGINEER shows pretty clearly that public opinion on the question of the softening of water, is as yet in but a very crude condition; and it is perhaps not too much to say that probably the majority of people do not even know what is meant by the expression. Everyone knows that there is such a thing as hard water and such a thing as soft water; but what it is that constitutes the hardness of the one, and why the other is called soft, few people who are not chemists will be able to say off-hand; and yet it is of the greatest importance that we should know to what category the water we daily use belongs, and it is even desirable that we should be able to test it for ourselves, so that we could determine whether it was too hard for us, and might be able to soften it at our pleasure. Analytical chemists will probably say that the question is too complicated and fraught with too many technical difficulties and dangers to make it either practicable or safe for every householder to be his own water examiner. But until every householder does investigate for himself the water he is supplied with, we shall remain at the mercy of the water companies and of those technical experts whose opinion is of so elastic and flexible a character that it will often stretch in any desired direction and to any given extent. It is rather arbitrary to expect us to pay for an article without being allowed to discover whether we are getting value for our money.

As rain falls to the ground it absorbs carbonic and sulphuric acid in different proportions from the atmosphere and in the soil, and as it percolates through the earth it dissolves some of the earthy salts which it meets with, forming bicarbonates, sulphates of lime, magnesia, &c. These dissolved earthy salts give the water, which comes to us originally soft, the quality of hardness. When the quantity of matter thus dissolved and taken up by the water is over seven grains per gallon it is called "hard;" when under seven grains it may, for all practical purposes, be considered "soft." When one grain of solid matter is held in solution in one gallon of water, that water is said to have one degree of hardness. The hardness due to the presence of bicarbonates is called temporary, because it can be removed by boiling; but the hardness due to sulphates is usually called permanent, as it cannot be removed in that manner.

Professor Wanklyn, in his book on "Water Analysis," says "that the usual manner in which lime is determined in drinking-water is faulty in detail, and is not calculated to yield the most accurate results." The manner of proceeding is as follows:—A considerable volume of water having been measured or weighed out, is evaporated to dryness in a platinum dish. A little hydrochloric acid having been added so as to impart a distinctly acid reaction, the residue is then moistened with a few drops of acid treated with distilled water, and passed through a filter. To the filtrate excess of ammonia is added, and then the liquid is boiled and passed through a second filter. In this way silica, alumina, oxide of iron, and phosphoric acid are got rid of as precipitates, and the filtrate is next mixed with oxalate of ammonia, which throws down the oxalate of lime. But this plan is considered very objectionable by Professor Wanklyn, and he recommends the following plan:—He takes 700 cubic centimetres of the water, and having ascertained that it is quite light, he adds about half a gramme of crystals of oxalic acid, and some two or three cubic centimetres of strong ammonia, taking care, however, to have excess of both reagents. Then he stirs up and filters through a small filter, and when the filter has run through he washes with a very little distilled water. The filtrate is meanwhile set to evaporate down in a large platinum dish, and is evaporated to some ten cubic centimetres in bulk. If necessary a drop or two of hydrochloric acid is added, and the liquid is got into a small beaker and mixed with a little ammonia, which will throw down a fresh quantity of oxalate of lime, which is got on a very little filter and washed, and the filtrate and wash-water sent through this filter should not much exceed some 30 cubic centimetres altogether. By this method of operation Professor

Wanklyn points out that several advantages are gained. Most of the oxalate of lime is precipitated in very dilute solution, and the completest washing is ensured; and by making the second minute precipitation the great disadvantage of complete washing, namely, the loss of some of the precipitate in virtue of its solubility, is avoided.

The presence of magnesia in drinking-water, Professor Wanklyn believes, there can be little doubt is also very badly determined; but all these tests are much too technical for the ordinary householder. The simplest, most satisfactory, and least technical method of testing the hardness of water is the method invented many years ago by the late Dr. Clark, and known as the soap-test. We all know that hard water requires more soap to make a lather than soft water. On this fact Dr. Clark based his test. He ascertained by direct trial how many measures of a standard solution of soap were required by a gallon of water in order to make a lather. This method has now been so simplified that the relative degrees of hardness of water can be registered simply by the number of soap measures consumed by a gallon of the water in yielding a permanent lather, and the quantity of the soap in one soap measure is the quantity required to precipitate one grain of carbonate of lime.

The destruction of soap is due to the formation of insoluble salts, by reaction between the lime and magnesia of the water and the soap. No lather will be found until the lime and magnesia salts present in the water have exhausted themselves upon the soap—forming insoluble lime, or magnesia salts of the fatty acids of soap. For the soap test Professor Wanklyn uses a "standard soap solution" which he has himself prepared. It has for its basis Castile soap, which contains 60 per cent. of olive oil. Ten grammes of this soap are dissolved in a litre of weak alcohol, and the solution thus obtained contains exactly sufficient soap in one cubic centimetre to precipitate one milligramme of carbonate of lime. The alcohol should be about 35 per cent in strength. Of course it is of the greatest importance that all the soap should get properly dissolved. This standard soap solution may be purchased at any chemist's. Should it be considered desirable to verify the strength of the standard soap solution, this may be done by means of a solution containing a known quantity of carbonate of lime, or of chloride of calcium equivalent to a known quantity of carbonate of lime.

The solution may be prepared by dissolving 1·11 gramme of pure fused chloride calcium—lime—in a litre of water. This solution contains calcium chloride at the rate of one milligrame of carbonate of lime in one cubic centimetre. Or it may be made as follows:—Take one gramme of finely powdered marble, a pure carbonate of lime, and dissolve carefully in slight excess of dilute hydrochloric acid, and neutralise the excess of acid by a slight excess of ammonia, dilute the whole with water so as to occupy the volume of one litre. In order to verify the soap solution a number of cubic centimetres of this standard solution of lime, say 12 cubic centimetres, should be put into a 70 cubic centimetre measure and filled up to the 70 cubic centimetre mark. In this way 70 cubic centimetres of water are made to contain lime equivalent to 12 miligrammes of carbonate of line. The 70 cubic centimetres of distilled water itself consumes soap equivalent to one milligramme of carbonate of lime in forming a lather. Therefore this 70 cubic centimetres of solution is equivalent to 13 milligrammes of carbonate of lime, and should consume exactly 13 cubic centimetres of standard soap solution. Should the soap solution not be of the right strength, it must be made either stronger or weaker until it is correct in strength.

For the purposes of analysis 70 cubic centimetres of water, while much more convenient to handle, serve as well as a gallon, for this contains as many milligrammes of water as there are grains in a gallon. Having obtained this miniature gallon of 70 cubic centimetres, the standard soap solution described above will be found to contain exactly sufficient soap in one cubic centimetre to precipitate one milligramme of carbonate of lime. The operation of measuring the degree of hardness of water is very simple. Take a stoppered bottle of a capacity of about 200 cubic centimetres which has been cleaned and rinsed with distilled water, and pour into it 70 cubic centimetres of the sample of water which it is desired to analyse. The stopper should be put into its place, and then the bottle should be shaken up. The standard soap solution should then be measured into the water by means of a burette or pipette, graduated into cubic centimetres. After each addition of the soap solution the bottle containing the water must be shaken up, and the point when lather forms can by-and-bye be noted. In order to observe the formation of the lather the bottle should be laid on its side, and the lather to be satisfactory should persist for five minutes. For practical purposes, when there is no previous information as to the degree of hardness of the water, it is most convenient to run in the soap solution in proportions of five cubic centimetres at a time, and to make out approximately and rapidly the degree of the hardness of the water. After this, a second more careful experiment should be made, when the soap solution can be at once run in almost up to the required quantity, and then small additions of the soap solution should be carefully made, and the exact state of the lathering carefully observed after each addition. Thus the degree of hardness of the water can be easily and rapidly determined.

Should the water be very hard, and the hardness exceed 16 degrees, a dilution with distilled water is required in order that the lathering may take place regularly. If after the addition of 16 cubic centimetres of the soap solution no lather be found, 70 cubic centimetres of distilled water must be poured into the bottle, and the addition of the standard soap solution proceeded with. But afterwards, in writing down the degree of the hardness of the water, an allowance of one degree must be made for the addition of 70 cubic centimetres of distilled water. The reason why this dilution is necessary is because too large a proportion of insoluble lime salts interferes with the lathering, and the rule is therefore that water must be diluted appropriately, so that 70 cubic centimetres of water should never take more than 16 cubic centimetres of soap solution. Having shown how to discover hardness in water, and how accurately to determine the degrees of hardness of any given sample of water, it will next become necessary to show by what means it is proposed to artificially soften water which we have ascertained to be too hard for domestic use. In a paper read at the International Health Exhibition of 1884, by Mr. John Henderson Porter, the author states that there are only two methods by which lime can be removed from hard water while leaving it fit for drinking and for culinary purposes—the one being the Porter-Clark process, and its various modifications, and the other is humorously described as being carried out more or less completely in every London kitchen, with a result to be seen in the "scale" and "fur" on the boilers, kettles, and hot-water pipes. Since then, however, two other methods have come prominently before the public, and it would therefore not be fair to leave Mr. Porter's statement unsupplemented. The two other systems are the "Anti-Calcaire" system of Mr. Maignen, and the method of the Stanhope Company, which consists of treating the water continuously with a mixture of caustic soda and lime. For reasons which will appear later on, we will take the Porter-Clark and the Stanhope Company's process first, and deal with Mr. Maignen's method later.

THE PNUEMATIC DYNAMITE GUN.

A paper on "The Dynamite Gun" was read by Captain Haig, R.E., at the United Service Institution on the 27th ult. As this dealt chiefly with the result of the experiments up to the present time, and only touched briefly on the practical uses claimed for the weapon by its advocates, we propose to examine this important portion of the subject a little more in detail than has hitherto been done.

For some years experiments have been carried out with high explosives for the bursting-charges of shell, not only to increase the power and destructive effect of such projectiles, but also because it was clear that, in the necessity of making the walls of the shell sufficiently strong to withstand the concussion of the large charges now used, and also to carry the shell intact through a moderate thickness of armour, the interior capacity would not contain sufficient gunpowder to produce a violent disruption of the projectile into a great number of pieces, if indeed it would cause a burst at all. Could, however, the same quantity of a high explosive, such as gun-cotton or dynamite, be employed, there was no doubt of the shell bursting with great violence. To obtain the full power of such explosives they must be exploded with a detonating material such as fulminate of mercury, which is exceedingly sensitive to concussion. It has been found, therefore, that though no difficulty has been experienced in firing shell charged with gun-cotton or dynamite with a small powder charge, without a premature ignition of the detonator, it has not been accomplished with the heavier charges, which now range from 100 lb. to 800 lb. of gunpowder. This has caused attention to be turned to some less violent propelling force, such as compressed air. It appears that the idea of propelling shells by such means originated with Mr. Mefford, of Ohio, United States, who made a brass tube 28ft. long and ¼in. thick, with a calibre of 2in. There was a small reservoir for compressed air connected with the gun with an india-rubber hose. The projectiles were made of brass, with wooden diaphragms at the base to act as gas checks. The pressure of air, admitted by an ordinary stop-cock when desired to fire the projectile, was 500 lb. to the square inch, which, with an elevation of 30 deg., gave a range of about 2000 yards. This result was sufficiently satisfactory to lead to improvements by Lieut. Zalinsky, an artillery officer, to whom the task of experimenting with the weapon was entrusted. The next gun had a 4in. calibre and was 40ft. long. The air pressure was increased to 1000 lb. Attention was at the same time turned to devising a fuze which would explode the charge whether the shell struck the ship or fell into the sea. It was necessary to ensure the impossibility of the charge prematurely exploding in the gun. Experiments had also shown the increased effect of the charge being ignited from the base. The problem was solved by two electric circuits in the projectile, either of which when completed ignites an electric detonator in the charge. One is actuated by striking any hard substance, the other circuit is completed by water entering a dry battery when the shell falls into the sea.

The results obtained with the 4in. gun led to another being constructed of double that calibre to throw 100 lb. of dynamite. The barrel consists of a ⅝in. wrought iron tube with a brass liner ⅛in. thick. The barrel terminates in a cast iron breech-piece, which has two trunnions. The breech is closed with a hinged door opening inwards. The total length of this 8in. gun is 60ft., and convenient mechanism is fitted for elevating and training. The air reservoirs, consisting of eight wrought iron tubes, have a total capacity of about 137 cubic feet. They are connected with the air-valve of the gun by one of the hollow uprights on which the trunnion rests. This gun, with an elevation of 33 degrees, and an air pressure of 1000 lb., throws a brass case containing 100 lb. of explosive a distance of 3000 yards. The experiments with this gun have been duly recorded, so that it is unnecessary to detail them at length. The last were on the 27th September, 1887, when an old schooner was used for a target. She was moored 2200 yards off the gun. Two blank shell were first fired to get the range, which fell ten and eight yards short respectively. The next round was with 55 lb. of blasting gelatine at an elevation of 14 degrees, and with a pressure of 600 lb. The time of flight was 13 seconds. The projectile fell close under the starboard quarter of the schooner and exploded, causing her serious injury. The next shot fell in nearly the same place and caused her complete destruction.

The experiments show that with compressed air as a propelling agent great accuracy can be obtained when the range is known and other conditions are favourable. It would be difficult to pitch successive shots from an ordinary gun in the same spot, using the same amount of gunpowder each time, as very slight variations in the manufacture or state of moisture of the explosive would affect the velocity and result. With air, however, provided gauges are accurate, there is absolutely uniformity of pressure. It is not stated what was the force and direction of the wind on this occasion, but it is obvious this element must play an important part in the case of a large mass moving comparatively slowly through the air. It is claimed that this weapon can be usefully employed for coast defence, and as a ship or boat weapon. Let us examine how far this claim can be made good.

As regards coast defence, this paper states it would be a valuable adjunct to submarine mines, superior to the Whitehead or a controlled locomotive torpedo, as the Brennan. We are of an opinion, however, that the value of submarine mines has been considerably diminished by the increased range of modern guns, and the introduction of the torpedo boat. The distance beyond which submarine mines can be controlled and maintained efficient does not in most localities exceed 3000 yards, and except where it is essential to run past forts, vessels would probably find that plenty of damage could be done from a distance of 6000 yards. It is clear that in such a position they would be in little danger from the dynamite gun in its present condition, submarine mines, or controlled locomotive torpedoes. By day the ordinary gun would be the best antidote, mounted in ship or fort; at night the torpedo boat is the answer. But supposing the enemy's vessel arrived within 3000 yards of the dynamite gun without having previously silenced it from the greater range, what are the conditions of a successful shot with the new weapon? If the vessel is so obliging as to remain stationary she may fall a victim, but presuming she keeps moving at the rate of 10 knots an hour she will shift her position fifty yards before the dynamite shell reaches her, assuming its time of flight is ten seconds. If the shell does not strike her, but falls into the water, it must be within 50ft. radius of the hull to do serious damage. The vessel would also have time to stop by reversing the engines on seeing the projectile coming, and assuming that an allowance had been made for her continuing her course. Instruments for finding the range are now efficient, but they cannot be used at night, which is the time a torpedo boat would be most efficient. Unless, therefore, much higher pressures can be utilised so as to reduce the time of flight and increase the range of the air gun we are unable to see any great value in it for coast defence.

The same reasoning applies to its use as a ship or boat weapon. It would be most formidable at close quarters, but, like the torpedo boat, must be exposed to a heavy fire before it could attain the desired position. The sailor would probably fear most the locomotive torpedo with a speed of thirty knots and 200 lb. of explosive, towards which we are gradually working. There is one use, however, for the dynamite gun which has been little alluded to, for which we think it may be found of great value, viz., countermining. This operation is simply destroying an enemy's mines by exploding others in their vicinity. It is usually effected by dropping a number of large mines in a line, a certain distance apart, and then exploding them simultaneously by means of an electric wire. The result is the destruction of all mines within a certain radius of the countermines, thus giving a cleared passage for the ships. It is a difficult operation, especially under fire, and a small defect may render it inoperative. Now a gun which can drop the countermines one after another from a comparatively safe distance and exactly where required would have a distinct advantage for such an operation, and it is worth a trial, though, as stated before, it is doubtful whether ships will force their way through a mine field without having previously destroyed with their guns the positions which control that portion of the defence. They can then deal with the mines at their leisure, but it would be safer to countermine in addition any mines that might have escaped observation. In addition to the complete destruction of the enemy's mines, an essential part of countermining is that of marking the channel thus cleared of these unseen dangers, so that ships may advance without hesitation and immediately the operation is effected. This is now done by a simple and effective means with the system of countermining as practised by the navy of this country, and no doubt some similar method could be employed with the dynamite gun. Much stress has been laid on the fact that the United States are constructing a small vessel to be equipped with three dynamite guns, and it is an example worth following for the purpose we have indicated. Should it not be successful the apparatus can be easily removed, and the vessel remains equally well adapted for ordinary gun or torpedo equipment. Objection has been made to the great length of the pneumatic gun, but it is stated the latest pattern is under 30ft. long, which is a great reduction. There is no reason also why the working pressure should not be greatly increased, and thus diminish the time of flight and height of trajectory. Though great improvement may be expected in this weapon, we do not think it likely to supersede others now in use, either for offensive or defensive purposes.

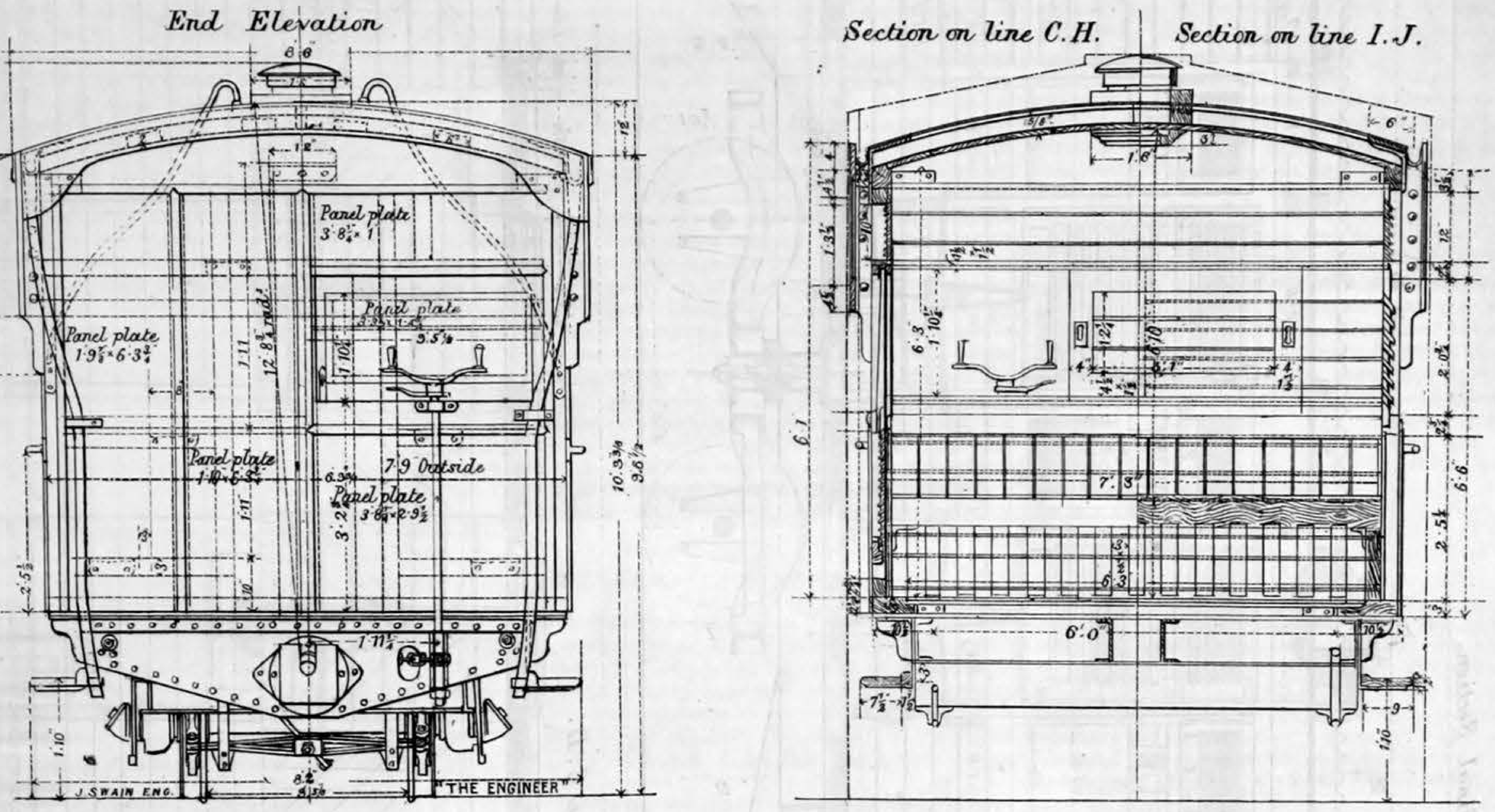
Naval Engineer Appointments.—The following appointments have been made at the Admiralty: William H. Davis, staff engineer, to the Benbow, to date January 25th; A. Spalding and W. Nicklin, staff engineers, to the Excellent, additional, to date February 4th; William Siddorn and Frederick A. Cocks, chief engineers, to the Excellent, additional, to date February 4th; William Bromley (a), chief engineer, to the Reindeer, to date January 8th, and Richard S. Hamm, chief engineer, to the Carysfort, to date January 10th, both reappointed on promotion; and John T. H. Ward, assistant engineer, to the Severn, to date January 21st.

THIRD-CLASS BOGIE CARRIAGES, SOUTH MAHRATTA RAILWAY.

(For description see page 86.)

THIRD-CLASS BOGIE CARRIAGE, SOUTH MAHRATTA RAILWAY.

SIR A. M. RENDEL, WESTMINSTER, ENGINEER.



NARROW-GAUGE BOGIE CARRIAGE.

The South Mahratta Railway Company recently asked for tenders for thirty-two third-class bogie coaches for the South Mahratta Railways. Tenders for these were sent in on the 25th ult. The line is laid on the metre gauge. The principal dimensions will be found on the cross section and end-view above, and the section and plan on page 85. Sir A. Rendel is the engineer-in-chief. The offices of the company are at 31, Lombard-street. The details and conditions of the specification were as usual. This is a very good example of a narrow-gauge passenger coach.

ABSTRACTS OF CONSULAR AND DIPLOMATIC REPORTS.

Norway—Bricklaying in frosty weather.—Building operations are suspended in Great Britain on the slightest approach of frost, while bricklaying is carried on in Christiania in almost the coldest weather that prevails for any time. Building during the winter months has been practised for at least twelve years, but more frequently during the last five. All the buildings erected during the preceding periods have stood remarkably well, there being only one case in which bricklayers' work had to be partly done over again, owing to an uncareful preparation of the mortar. Experience has not shown that walls built in winter exhibit later more dampness than those erected in summer. The reverse may be the case, since the difference between the temperature of the air and of the mortar cools the latter by evaporation, and takes away a great part of its moisture. The principal builders in Christiania are of opinion that bricklayers' work, executed with due care, in winter is superior to similar work done in summer. The whole art of executing bricklayers' work in frosty weather consists in the use of unslaked lime, the mortar prepared with which being made in small quantities immediately before use, and the proportion of such lime is increased—together with the expense of building—as the thermometer falls. The only care required is to utilise the unslaked lime so handily and quickly as to enable the mortar to bind with the bricks before it cools. Another very important condition is that the bricks should always be kept covered on the building site. Bricks which have been out in the rain or exposed to the frost should never be used. The upper courses of bricks that have been laid are not, as a rule, covered with mats or planks for the night, that precaution being only adopted when the work has to be suspended for a certain time, and when it is therefore necessary to prevent rain from penetrating the brickwork and destroying it by the action of frost. When no such covering is used it is absolutely necessary, after a fall of rain or snow—and after the suspension of work on Saturdays—to see that all ice or snow is removed from the walls before the work with warm lime is resumed, to prevent the warmth of the lime from being absorbed. The removal is effected by brooms and spades, but the fire of a brazier is often used. Outside plastering in frosty weather is not possible, as the manual ornamentation of cornices, &c., requires much longer time than does the mortar to lose its warmth. The question as to whether there is any or what limit to bricklayers' work in frosty weather is an open one. Among the members of the Norwegian Society of Architects and Engineers, which has frequently discussed the subject, that limit is variously estimated at between 14 deg. to 18½ deg. Fah. and 1⅞ deg. below to 5 deg. above zero Fah. The advocates of the latter maximum having proved by hydraulic tests that good bricklayers' work can be executed in 33¾ deg. Fah. of frost, the society has arrived at the conviction that the variations in the opinions on the subject are due to the degree of care bestowed upon the preparation of the mortar. The adoption of a maximum limit of frost should therefore depend solely on the possibility of enforcing a fixed rule for the preparation of the mortar by the workmen. As the difficulties in this respect increase with the degree of cold, it has hitherto been accepted in practice that bricklayers' work does not pay in Christiania in more than 9½ deg. to 14 deg. below freezing point Fah. In the case of public buildings at Berlin such work is not allowed when the thermometer registers less than 2½ deg. Fah.; but this is probably owing to the scarcity of unslaked lime in the German market, whereas in Norway lime is always supplied to the market in a burned, not slaked condition. The wages of bricklayers in Norway are for a day of ten hours, first-class hands from 4s. 6d. to 5s., second-class hands from 3s. 4d. to 3s. 11d., hodmen from 2s. 3d. to 2s. 9d., and in winter proportional, according to the number of hours worked.

Russia.—Communication with Archangel.—Steps of a more decisive nature are being taken in reference to the Obi Railway, a project which may be a very successful undertaking. Some permanent channel of commerce connecting Europe with Siberia, and thus obtaining both a new and extensive market for European products, and a secure outlet for those of Siberia, would be of incalculable value. The railway is intended to run from the mouth of the river Voykar to a port in some convenient situation in the bay of Hypoodera. The length will not exceed 240 miles, and the estimated cost is about £2,500,000, or £10,417 per mile. Taking the season for running trains at 180 days only, it is estimated that during that time over 557,570 tons of goods would be conveyed, the receipts being about £360,000, after deducting 50 per cent. for working expenses; the net profits would represent a dividend on the capital of 7·2 per cent. The scientific proofs of the possibility of constructing the line of railway are satisfactory, and valuable evidence to that effect is given by competent authorities; a further survey of the bay of Hypoodera will probably be made shortly. The Obi territory covers 50,000 square miles, and the southern division is one of the most productive parts of Western Siberia. The Department of Railways is charged to estimate the cost of junction lines between Archangel and the northern system, this port being destined to be the *entrepôt* of Siberian product. It is contemplated to prolong the Louniew line in the direction of the Dwina, and also to connect the beds of the Kama and Vytchegda. In both cases the construction will be on a cheap and simple plan, adapted to the light traffic of these thinly populated districts. It must be understood that any attempt to construct a railway to Archangel will, for self-evident reasons, be opposed by the St. Petersburg merchants. It is probable that the project of connecting the White Sea and Lake Onega by a canal will be realised much sooner than was expected. The Zemstvo of Olonetz petitioned last year in favour of the immediate expropriation of the necessary funds, and voted an advance of £1500 for that purpose; and in addition the Ministry of Lines of Communication has contributed £1350 to the same object, the total cost of which is estimated at £700,000. The length of the canal will be thirty-seven miles, the terminal points being the village of Soumy in the Bay of Onega, and Povenatz, near Lake Onega. The waters of various lakes and streams in the district are to be utilised. This new waterway will be indispensable for supplying North Russia with corn, and promoting commerce between the inhabitants and the Norwegians. Hitherto communication with St. Petersburg has been closed for five months in the year, a condition of isolation, that the canal will in a great measure remedy. Facilities will be afforded for exploring the rich mines of Olonetz, a matter of great importance to the manufacturers of St. Petersburg, who are now compelled to buy their raw materials from foreigners. The navigation of Olonetz and the White Sea will also be greatly benefitted by the canal, which will lower the cost of transport from Archangel to St. Petersburg from 2s. to 10d. There are also various schemes for uniting the northern provinces with the more fertile regions of middle Russia. One of these is the junction of the Dwina with the Viatka, an affluent of the Volga; another a junction of the Kama with the Vytchegda, in the direction of the abandoned "Catherine of the North" Canal.

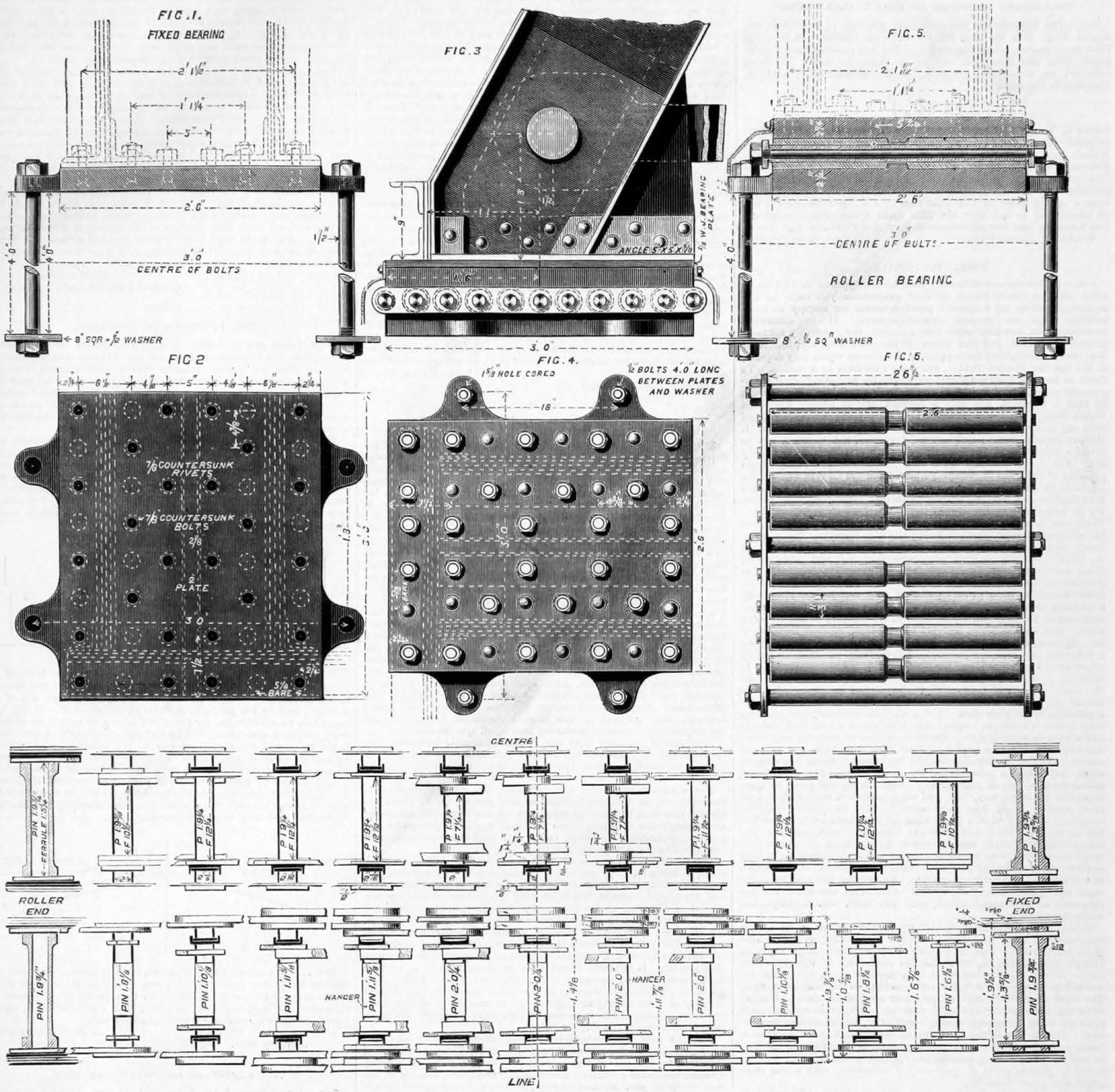
Russia.—Developing British trade with Finland.—In regard to the development of British trade, I can only repeat what I stated in my report of February last year.[1] The hardware trade has not been so much neglected as certain others, but there is still room for improvement, especially in the cheaper sorts, as it is useless to try to force articles above the means or tastes of the population. I regret that there has been but a slight increase in the number of commercial traders and other representatives of British firms reaching Finland of late. One consequence of my recent report has been that I have received a great many letters of inquiry from all parts of Great Britain, to which I have endeavoured to give satisfactory answers, so it is to be hoped that future years will see more such agents in the country. I must again urge the necessity of an early arrival—February being the best month — otherwise it will be found that most of the orders have been given to other countries already. In the spring of 1886 there were twenty representatives of German houses at the same time in Helsingfors, which number represented the total of English travellers who visited Finland throughout the whole year. I must once more insist on the necessity of British firms sending experienced agents to make inquiries and study for themselves the industries and resources of the Grand Duchy, and the tastes and wants of its inhabitants. Finland is not at the Antipodes, and can be reached at little expenditure of money or time, being easily accessible from Copenhagen, Stockholm, and other Baltic ports, in addition to direct and regular communication from Hull by both English and Finnish steamers. Travellers to Russia can easily return to England *viâ* Finland and Sweden, Helsingfors being within fourteen hours' rail of St. Petersburg. Throughout the whole winter communication between Hangö and Stockholm is kept open by means of special steamers, and a new line has lately been started between Hamburg, Copenhagen, and Hangö, the steamers being intended to run regularly summer and winter. The Finnish Government continues steadily to augment its network of railways; and in October, 1886, was opened that of Ullaborg and Nikolaistad—Wasa—by which the former town is connected with all the chief towns of the country. The line is remarkable for its cheapness, as including bridges, stations, &c., throughout its entire length of 211¼ miles it averaged less than £4024 per mile. The rails were supplied by Bolckow, Vaughan, and Co., of Middlesbrough; but a German house at Duisburg-on-the-Rhine obtained the contract for bridging materials, amounting in weight to 2009 tons. The finances of the Grand Duchy, which are entirely independent of those of Russia, are in a very flourishing state, the national debt, most of which has been devoted to public works amounting at the end of 1886 to £2,849,000, and the country has no difficulty in borrowing money at 4 per cent. The Duchy, in common with most European countries, has suffered severely from the still existing commercial crisis, and more especially on account of the great fall in the price of timber, Finland's staple. A further explanation of the depression is to be found in Russia having lately imposed such heavy duties on certain Finnish wares that several industries have been severely crippled. Among the chief sufferers has been the iron trade. Russia being practically closed to the ironmasters, they have been unable to find new fields, though they are making strenuous endeavours and have met with much success in England. The exports of iron and steel, which in 1884 amounted to 27,108 tons, and in 1885 to 25,717 tons, fell to 12,838 tons in 1886. The Dahlsbruks Ironworks, established over a hundred years and the most important in Finland, have been compelled to cease working.

Russia—Trade of St. Petersburg in 1886.—There was a slight increase generally in the importation of British goods into Russia, especially in cast and manufactured iron, lead, and tin-plate. The ever-increasing protective duties under the Russian customs' tariff naturally prevent the importation on a larger scale of British goods, and stimulate native manufactures to an extent beyond the power of absorption by the native customer. The importation of British goods into St. Petersburg is declining. Cutlery, plate and sheet iron were imported in smaller quantities than in the preceding year, and it is only those goods that cannot be produced here in sufficient quantities or of the requisite quality, such as cast iron, hardware, smiths' work, steel, assorted and plates, that continue to be in demand. The chief commodities imported from the United Kingdom in increased quantities into St. Petersburg in 1886 were coals, coke, iron bar and cast, and lead. Much of the increase was due to the anticipation of still higher duties being imposed. The importance of Cronstadt as a port of shipment is gradually diminishing, the sea canal leading to St. Petersburg being more and more used by vessels of all nationalities. Although the new ports of Gutuyevsk and Putiloff, at the mouth of the Neva, still fail to afford sufficient accommodation for the whole shipping trade, the river Neva with its deep bed supplies the deficiency at the terminus of the sea canal. Should the port of Cronstadt be closed before proper harbour arrangements be made at St. Petersburg, serious inconvenience to commercial interests and shipping, of which Great Britain furnishes half, would ensue. The question as to whether the present port at Gutuyevsk is to be extended on a scale commensurate with the requirements of the whole export and import trade of St. Petersburg still remains undecided, through a division of opinion between the commercial community and the engineers of the Government, the former favouring General Paucker's plan for the establishment of a harbour at the mouth of the river at the Old Galley Haven, almost immediately opposite the present Gutuyeff Basin. That the efforts of the Government are directed to the improvement of the canals and harbours within the Empire is evident from the fact that, during the last twelve years, over £4,500,000 has been expended out of public revenue for that purpose.

[1] Engineer, March 11th, 1887, page 186.

SIEE HO BRIDGE, CHINA RAILWAYS.

MR. C. W. KINDER AND MR. JAMES CLEMINSON, MM. INST. C.E., ENGINEERS.



SIEE HO BRIDGE, CHINA RAILWAYS

WE publish this week the remaining details of this bridge. As will have been seen from the perspective view published at page 450 of our last volume, and from the drawings given at page 476, the bridge is of the Murphy-Whipple type. It is designed for a single line of rails and a rolling-load of 3500 lb. per lineal foot. The members are proportioned to sustain the stresses due to this load, the tensile strength of the metal being 22 tons per square inch, and the compressive strength 16 tons per square inch; and in no case is the metal intended to be strained beyond one-fifth of its strength, due allowance being made for loss of strength by flexure in the compressive members. The top chords and end struts are built up in sections for facility of transport, the posts are built of channel bars placed back to back, and stiffened and tied to each other by diagonal bracing bars and plates near the ends, the bars having eye-plates rivetted in their hollows to afford the posts large bearing surfaces on the connecting pins. The links of the bottom chord and likewise the ties, except those which are adjustable, are severally forged in one piece. The connecting pins are of forged scrap iron and turned to standard gauges. The cross girders, except those at the ends of the span which rest on the bottom plates of the end struts, are suspended from the connecting pins by Lowmoor iron hangers, and the rail girders are of rolled H section, and secured to the cross girders by double angle plates. The top chords are brazed together transversely by rolled H bars, and diagonally by angle bars, and in like manner the cross girders and bottom chords are secured diagonally by angle braces. The rails are carried upon timber stringers bolted to cross girders. The whole of the work is drilled throughout, the rivetting having been done by hydraulic machinery. The above engravings show the fixed and roller bearings and the pin connections. The workmanship throughout does the builders, Messrs. Arrol Brothers, of Germiston Works, Glasgow, the greatest credit. This structure is one of a number intended to carry the main line of the China Railways over the Siee River.

THE FORTH BRIDGE—THE FIFE CANTILEVER PIER.

WITH this impression we publish a two-page supplemental wood engraving of the Fife Pier of the Forth Bridge, and the attached cantilevers as far as completed a few weeks ago. This engraving will be found to convey a better idea than anything that has yet been published of the magnitude of the work. All the main tubes and connections of this pier, including the top junction girders, are completed to the full height of 362ft., and the north cantilever carried out about 170ft., of which the greater part is rivetted up. The first struts and the bracing between them have been carried up to a height of about 240ft., and a length of about 130ft. of the internal viaduct has been completed. The first diagonal ties of both cantilevers have now been carried further down than shown in the engraving, those on the right-hand of the engraving being down to the level of the viaduct. The method of building out each of the projecting parts of the cantilevers until they meet each other at their several intersections will be completely understood from this engraving, and it will be readily seen that with the lowest tubes being carried out to the first vertical ties, and the latter connected up at the viaduct level, these parts and the diagonal tubular struts constitute a completely braced structure, to which the ties depending angularly and outwardly from the tops of the pier will be connected, and from which support will be obtained for the projecting top main ties. These are seen on both sides of the top of the pier, projecting out a great distance as cantilevers, and carrying cranes by which the parts are lifted out to their ends. We need not enter into a description of the methods of procedure, as they will have been gathered from our pages,[1] and will be readily conceived by engineers from a study of the engraving we now publish. It may be said that some of the most difficult of all the work has now been completed, and that every foot of progress now reduces the dimensions to be dealt with.

[1] THE ENGINEER, vol. lxiv., p. 438.

TANK LOCOMOTIVE, HUNGARIAN STATE RAILWAYS.

ONE of our supplements this week illustrates a tank locomotive in use on the Hungarian State Railways, designed by Herr V. Kordina — whose vortex blast-pipe we recently illustrated—and built in the State Railways workshops at Budapest. It will be seen that it has the corrugated fire-box introduced many years ago on the Austrian State Railways by Mr. Haswell. Its construction is shown so fully by our engravings that little is left to be said here. The principal dimensions are all given in the metrical notation. We append some of them reduced to English figures:—

Diameter of piston	13·78in.
Stroke	19·0in.
Diameter of wheels	3ft. 8in.
Boiler pressure	150 lb.
Tractive effort	8000 lb.
Grate area	13 sq. ft.
Number of tubes	109
External diameter of tubes	1·75in.
Length of tubes	9ft. 10in.
Total heating surface	550 sq. ft.
Wheel base	9ft. 8in.
Weight of engine in working order	26 tons.

The tank holds 950 gallons of water, and the bunkers about 30 cwt. of coal.

Sixty engines of this type have been built. They are used on the Vicinal Railways in Hungary. The rails weigh 20 kilos. per metre and are of steel. The greatest incline is 1 in 83; the sharpest curves, 180 metres radius—about nine chains; the usual speed, thirteen to twenty-two miles per hour. The locomotive hauls 280 tons, exclusive of engine, up inclines of 1 in 150 with a speed of thirteen miles per hour, with lignite as fuel; evaporation, 4½ lb. of water per 1 lb. of lignite. At the test trial by the Government, the engine was driven up to forty-six miles an hour, without the slightest oscillation or jumping. The peculiar form of the chimney is due to the use of lignite, which is a cross between wood and coal, and produces a very large quantity of sparks and light ashes.

LETTERS TO THE EDITOR.

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

COLLAPSING PRESSURE OF IRON BOILER FLUES.

SIR,—The formula for the collapsing pressure P, in pounds per square inch, of a circular flue of external radius a inches, and thickness t inches, when the length of the flue is considerable compared with the diameter, say seven times or more, has been obtained on theoretical grounds by M. Maurice Lévy and M. Halphen in the form

$$P = \frac{1}{4} E \left(\frac{t}{a} \right)^3,$$

where E, Young's modulus of elasticity, is about 29,000,000 for iron or steel. The formula is obtained in a similar manner to that in Euler's formula for the load on a column just producing flexure is obtained, and the mathematical treatment will be found in the *Journal de l'Ecole Polytechnique*. This formula differs from that submitted by Mr. W. I. Ellis in involving the cube instead of the square of the ratio of the thickness to the diameter, and it will be interesting to see how Mr. Ellis finds agreement between the two formulæ, and the experimental results of Fairbairn and others.

Woolwich, January 24th. A. G. GREENHILL.

STEEL PROJECTILES.

SIR,—In the various articles which have appeared in THE ENGINEER on the manufacture of steel projectiles you refer to the equivocal, not to say shameful position which we occupy as competitors with our foreign contemporaries. It is somewhat humiliating to consider that this country, the generally acknowledged originator, and the home of the steel industry, has to be indebted to foreigners for supplies of articles on which may depend, in the not far distant future, our very existence as a nation. To think of English steel manufacturers quietly accepting such a disgraceful condition of conscious and acknowledged inferiority, with all that it involves, has only a parallel in our history when the Dutch fleet entered the Thames and simply did what they liked with our ancestors in the corrupt and shameless reign of Charles II. History repeats itself; and are we prepared, not to meet, but to invite a repetition of the same weakness and imbecility? Surely not. Yet I can scarcely agree with those who are always complaining of the want of encouragement from the Government. We ought to be and can be second to none in all that pertains to the manufacture and working of steel for its own sake alone. An industry so important as this ought to require no extraneous support. There can be no doubt that the manufacture and working of steel has always been a matter of difficulty and uncertainty. There are so many varieties, and with the so-called "special steels," in which we have combinations with chromium, tungsten, and manganese, these uncertain conditions are thereby greatly increased. Yet notwithstanding the more complicated conditions presented to us, there seems to be a growing feeling that our failure in making sound and trustworthy projectiles lies as much, if not more, in the methods of forging employed than in the quality of the material used. Our workmen can scarcely be surpassed in their methods of forging iron, but the working of hard and brittle steel gives quite a different problem for solution, and it is also one from which by experience we can deduce no general rule for our guidance. In ordinary practice a workman will heat iron and, say, tool steel with the same amount of heat, and work it in the same way, without taking into consideration that the one is fibrous and the other crystalline in its structure. Yet even with ordinary tool steel we may derive a lesson in forging steel which goes a long way towards explaining in a general way the true method of working any steel. Let any one cut two pieces of steel from the same bar to make chisels. Forge one by drawing or flattening it down to a cutting edge, but without hammering on either edge, the superfluous metal must be cut or ground off. Let the second piece be hammered in the usual way, face and edge, and then try which will do most work. Many who have worked steel for years would be surprised to know that a piece of steel cut from a round bar will not do so much work as a piece cut from a square one, for the reason that the latter can be better forged than the round one. Some time ago I was in an engineer's shop where some cast iron chilled rolls were being turned. One or two places on the surface of the rolls no tool would penetrate, and as usual the quality of the steel was questioned. A piece of steel from the same bar was prepared as mentioned above, and the work was accomplished without difficulty.

Taking into consideration the crystalline nature of steel, it is reasonable to think that indiscriminate hammering at a low heat must make it loose and weak, and above all, form large crystals. The problem of forging steel may be explained in the following way. While altering the form of a mass of steel, it should be worked in such a way as will leave it no time to cool and crystallise. The heat ought to be kept up by either a rapid succession of blows from the hammer, by hydraulic pressure, or by cross rolling under pressure while revolving rapidly—especially when making projectiles. Now if the initial heat can be maintained while the steel is being formed into the required shape, and then gradually allowed to cool under a slowly diminishing pressure, the forging will be found to possess great homogeneity of structure, with a fine close grain and great tenacity.

But how are we to obtain or rather combine all these indispensable conditions to secure results so desirable, and particularly with the hard and brittle steels? Chrome steel, for instance, seems to be the favourite material for making projectiles; it has great hardness, combined with considerable power to resist shock, but is extremely difficult to forge. At a recent meeting of the Iron and Steel Institute, some of the speakers pronounced the use of the steam hammer for forging steel "a barbarism" that must give place to something more appropriate. Impact must give way to pressure, for the action of the steam hammer is essentially local and unequal; and this is its weak point. We know that a piece of steel, such as a file, when hammered on one side only, and then tempered in the usual way, will diminish in length on the hammered side, and become concave; and so with heavier masses of steel, the form of which may not allow distortion of form. But the internal and localised strains are present, nevertheless, ever ready under certain conditions to produce unexpected and perhaps undesirable results. The hydraulic press for forging is certainly a great advance upon the steam hammer. It is slower and more costly, acting mainly on the principle of the flow of solids, but it meets all the conditions requisite for producing sound and strong forgings. At the same time, from its slowness of action, it is doubtful if it is the best method of forging projectiles.

For some years I have been experimenting in forging steel and iron with what may be called diagonal cross rolling. For forging articles of conoidal form, such as projectiles, there can be no doubt that properly shaped rollers are best; but hitherto the difficulty has been to prevent the pieces while being cross rolled from becoming hollow or spongy at the point, for unfortunately the shape of the rollers must of necessity be made the reverse of the projectile, the one increasing in diameter when the other diminishes, thus producing the most favourable conditions for rolling a hollow point; the unequal surfaces working in opposition cause a twist of the metal at the weakest part—the point. By an alteration of the form of the pressing surfaces of the rollers, the faults enumerated become really accessories to produce good and sound work. The pressing surfaces of the rollers are reduced in area, so as to roll the projectile diagonally, beginning at the base and finishing at the point, while every successive revolution of the rollers is made to give a new grip equal in pressure every time. It may be called partly a pressing and partly a shearing action, for the surplus metal is rolled off at the point. These continuous acting rollers are apparently the thing wanted for forging hard and brittle material, such as chrome steel. By pressure the piece of steel can be kept at any temperature and gradually allowed to cool, thus answering the conditions for preventing the formation of large and coarse crystals. Projectiles made in this way are well planished and absolutely true to form and dimensions. They have been carefully examined and tested by the acid test, and found free from flaw, and neither spongy or hollow. There is a possibility that by new combinations we may be able to produce a better class of steel castings; and if projectiles could be made in this way, and afterwards rolled to consolidate and harden the surface, they might be found equal to, if not superior to, those which are forged. It must be remembered, however, that forging steel by hammering pressure, or by rollers, does not essentially give increase of strength. If forged steel is in any way better, it is due to the fact that the forging drives out gas or impurities and closes up the surface, making it finer and closer in the grain, and the rapid action of forging prevents by concussion the crystallisation of the mass. Rolling steel castings, such as projectiles, at a high speed, and while at a proper temperature, would certainly simplify and reduce the cost of production, and probably give a superior article.

As regards hollow projectiles or shells, this method of manufacture will, no doubt, in time be adopted. Forging shells in the ordinary way, by hydraulic pressure or by the hammer, involves a higher temperature for the steel than it can have without injury, even if one shell can be finished at one heat. There is a machine recently patented which can bore and tap the end of a 6in. chrome steel shell for the plug, and also chamber the inside for the bursting charge, easily within one hour, and this can be done without risking injury by over heating or otherwise.

In conclusion, when we know what has been done by our foreign contemporaries, the problem of making pieces of steel capable of doing certain work is not very serious. Surely this country will never be satisfied with mere imitation. We ought to lead, to offer the problem for solution, and not have to accept a challenge so humiliating as this. CHARLES FAIRBAIRN.

Maybank, Sale, Cheshire.
January 27th.

WINDMILLS FOR GENERATING ELECTRICITY.

SIR,—The credit of first suggesting the use of windmills for driving dynamo machines to charge electrical accumulators belongs to the eminent physicist and electrician, Sir William Thomson, and dates back to the year 1881—viz., to a presidential address delivered by him before Section A of the British Association for the Advancement of Science, "On the Sources of Energy in Nature Available to Man for the Production of Mechanical Effect." It is true that in the same paper, and at the same time, Sir William threw some cold water on his own suggestion by urging as a difficulty to the adoption of the windmill in its—then—present state of development, that the first cost was too great. In this, however, as I have pointed out in detail elsewhere—see "Note on the Economy of the Windmill," "Trans. Am. Soc. of Mech. Engineers," vol. iii., 1882, and "The Windmill as a Prime Mover," New York: John Wiley and Sons, 1885—he erred in overlooking the fact that interest on capital, not capital itself, is an item, and by no means the only item of current expense by which the economy of prime movers should be judged. I then showed, and now repeat, that when the only correct basis of comparison of the economy of different prime movers is instituted, viz., the cost of obtaining the horse-power developed per unit of time, such cost consisting of the sum of interest, repairs and depreciation of plant, cost of fuel, oil and attendance, and similar items of expense entering the power account, the windmill is the most economical motor for the development of power in moderate and small quantities.

It is safe to maintain that the reason windmills have not thus far been put to practical use for the generation of electricity is not due to the first cost of the motor nor to any lack of economy in operation.

I here wish to emphasize the fact that the non-employment of the windmill, in this connection, is also not owing to the often alleged fact that the rate of revolution of the windmill, according to varying force of wind, is too irregular to run a dynamo for the purpose of charging a storage battery, or that the wind cannot be depended on for a sufficient length of time per day.

The real facts of the case are that in the leading American windmills, as is attested by hundreds of thousands in daily use in pumping practice, governing appliances of various kinds, of approved design and experience, automatically so vary the extent of surface presented to the wind that a practically uniform rate of revolution is obtained, irrespective of direction and varying velocities of wind, for all winds exceeding a velocity of six miles per hour. This latter velocity must be reached before windmills of good design, as ordinarily constructed, operate at the rate of revolution for which they are set. It has been found by experience that on an average for at least eight hours out of the twenty-four hours of each day, the wind exceeds this velocity of six miles per hour, the average velocity of wind during the eight hours of run being sixteen miles per hour. Total calms in excess of two days' duration are practically unknown in the United States.

The fact that the windmill is at rest, often at short intervals, aggregating not quite sixteen hours out of the twenty-four, is no objection to the use of this motor for the purposes of driving dynamo machines to charge electrical accumulators, for one of the very features and acknowledged requisites of such accumulators should be that they can be charged spasmodically at will and at odd times.

The result of study of this question must be that the reason windmills are not used in this way is not that the windmills are not sufficiently economical or reliable, but that the electrical accumulators are not yet a satisfactory and assured success. When they are, windmills will come into extended use as prime movers for the generation of electricity, and electricians will be glad to avail themselves of the most economical motor, utilising the force of wind, otherwise going to waste, for this purpose.

The windmill at the present day is in a developed state, a practical success, ready and available for this new use at once. It awaits the electrical accumulator that is a thorough, practical success.

Just now, and for some time past, the daily newspapers and many technical prints have been quite prolific in accounts which give an opposite impression, viz., as if the accumulator were the accomplished success and the windmill at fault. The reverse is the fact, and I have thought it well to call prominent attention to it at this time. ALFRED B. WOLF.

38, Parker-row, New York, January 15th.

MODERN MACHINE TOOLS.

SIR,—There is a report in THE ENGINEER, January 20th, of a paper by the President of the Manchester Association of Engineers on the above subject, and in treating of planing machines he says:—"Machines adapted for cutting in both directions were introduced by Whitworth many years ago in the famous 'Jim Crow' tool-box, and in recent years an attempt has been made to revive the practice of cutting in both directions; but so far, except on special objects, without very encouraging results." Now, if the author of that paper will pay a visit to the works of my firm in Leeds, I can show him the operation and results of planing in both directions, which have so encouraged us that all our larger planing machines are working on that system, to the great increase of their output. There is a proverb, "Give a dog a bad name and hang him," and it is therefore of importance to prevent the impression obtaining currency that cutting on planing machines in both directions is not successfully accomplished. Nor is the success of the double cutting confined to "special objects," for its advantages come out in nothing so much as in large plane surfaces of cast iron, such as stationary engine bed plates, beds of lathes, planing machines, and, in fact, the bulk of heavy planing in engineering works. The advantage of planing on both strokes is so obvious in principle that it does not require demonstration. But besides the effective use of time during the return stroke, the system, if carried out with two back-to-back tools, has the incidental advantage of only wearing each tool in traversing over a given surface half as much as it would be worn if its companion did not divide the work with it. Again, there is an incidental advantage in the circumstance that each tool chips away the end skin from the casting, and makes clean metal for its companion to enter.

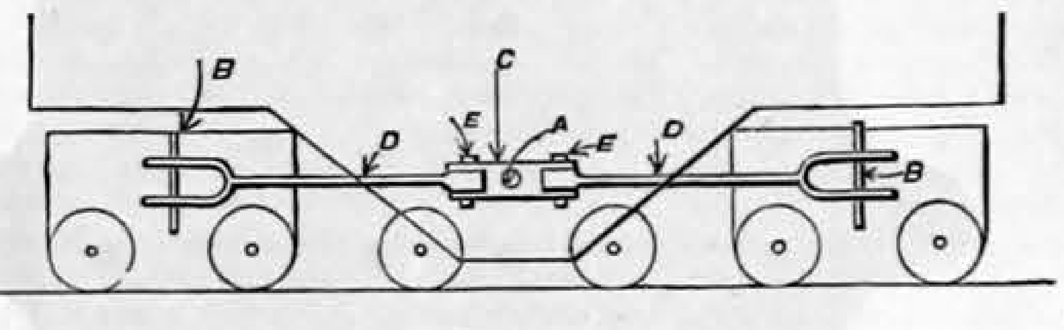
The "Jim Crow" tool-box did not possess the first of these advantages, and it had the drawback of being stiff held and of working with an expensive form of tool requiring some skill to set. But a good principle is not to be condemned because imperfect embodiments of it have been made. It is true that the best double cutting arrangement yet made does not apply to all kinds of work; for instance, in planing a seating between two lugs only one of the two back-to-back tools could be applied, and it is such exceptions as this to the universal application of the double cutting principle which are too apt to take possession of the mind, though 90 per cent. of work may be free from the objection. The successful double cutting tool-box to which I refer was illustrated in THE ENGINEER of April 8th, 1887. Any engineer having large surfaces to plane would find that the cost of the necessary additions which would enable him to have a machine constructed suitably for double cutting, or to have an existing machine, if a good one, adapted for double cutting, would be repaid in a month's working.

Leeds, January 30th. J. H. WICKSTEED,
(Joshua Buckton and Co., Limited.)

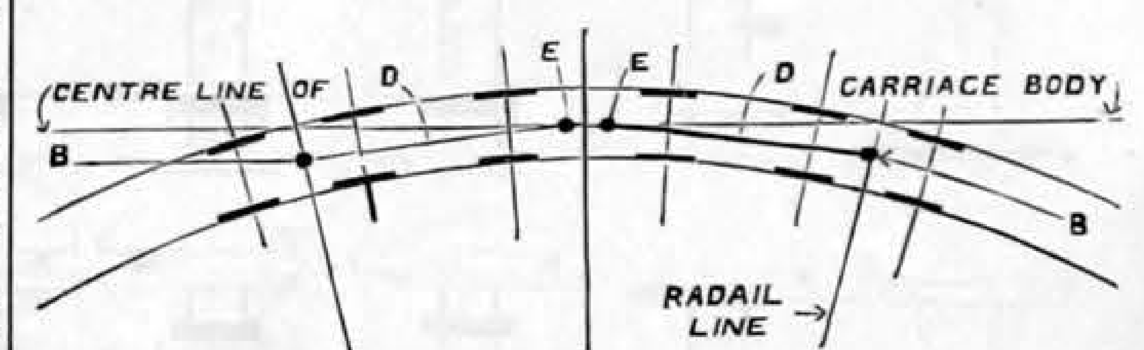
THE 111-TON GUN CARRIAGE.

SIR,—I only now have had my attention drawn to your limited description of the proof carriage for the 111-ton gun in yours of January 20th, and inasmuch as the "further information" you give to your correspondent is in the main quite wrong and may lead engineers and designers to form and arrive at exaggerated opinions adverse to the principles embodied in the carriage, I, as the sole designer of the carriage, respectfully ask you to make the following corrections to your description.

The wheels of the carriage are identical in every respect with those of the bogies and have flanges, for the obvious reasons that owing to the manner of pivotting or connection with the bogies—not as you described it—the carriage otherwise could not be kept on the rails. By such a method of pivotting as you describe the wheels in question would require to be as you state; I therefore give to you and your readers a description and rough outline sketch of the pivotting as below.



The bars D D have at their ends, which enter the body of the carriage, each a half of a double eye, which are united and secured to the carriage by a bolt, A, passing through from one side of the carriage, and by the partially withdrawing the said bolt the rear bogie can be withdrawn, for proof of the gun on racers, as at Shoebury, without disturbing the front bogie, the latter at such times being supported by special means to the carriage, while all the wheels are clear of the racers, while the rear end of carriage is supported on large rollers. Further description of these features I shall reserve for further inquiry of your correspondent, if he needs it. Reverting once more to the pivotting, it will be seen by referring to a plan thereof, the relative positions taken by the carriage bogies and pivotting bars or connecting rods.



It will be seen that the bogies are free to swivel on their own centres B B, while the connecting rods D also swivel on their centre in the body of the carriage at E E; by this special arrangement the enormous carriage, with its load weighing about 130 tons, can go round curves 40ft. radius with comparative ease.

3, Overhill-road, Dulwich, J. T. WILLIAMSON.
January 30th.

THE EXPLOSION ON BOARD THE ELBE.

SIR,—I am inclined to agree with Messrs. Oswald Mordaunt and Co., in their letter in your issue of 21st inst., that water in the pipes was the cause of this explosion. I give two examples which appear to support this conclusion.

In September last, at Greenfield Colliery, near Hamilton, where the steam pipe of a pair of 24in. cylinders burst and killed a man. The steam pipe came from a range of boilers to the centre of the cylinders. At this point there is a knee pipe descending vertically for 12in. next the throttle valve, and then a union pipe branching to the cylinders. On the morning of the accident the engineman was in attendance on the engine, but it had been standing for at least two hours. At that time one of the workmen was about to descend the shaft. The engineman told him to go in the cage, and he was about to do so when he heard a rush of steam in the engine-house. He gave the alarm, and soon after the steam was shut off at the boilers. On entering the engine-house the engineman was found dead near the starting handle, and it was found that a piece 17in. by 4in. had burst out of the horizontal part of the knee pipe close to the bend, and from this the steam had rushed out and scalded the man to death. The pipe had been in position for more than twenty years, and had not before shown signs of failure. It seemed to me that the throttle valve had been tight, and that condensed steam had collected in the pipes above it in the form of water. When the throttle valve was slightly opened by the engineman to start the engine, the rush of steam from the boilers had acted on the water, and by its jerking had burst the pipe. I recommended a drip-cock above the throttle valve, so that the water would be let off before opening it to start the engine.

A precisely similar accident happened at Brownrigg Colliery, near Airdrie, in November last. In this case there was a small 20-horse power engine, which by means of gearing both worked the cage and pumped the water out of a pit 24 fathoms deep. There was here a knee pipe from the line of steam pipes, the throttle valve, and then a pipe to the cylinder, precisely as in the other case. The engine during the Sunday pumped water only, and it worked one hour and then stood two alternately. The engineman was last seen on the Sunday night, and nobody was at the pit but himself all night. About five o'clock next morning, the workmen coming to their work found the engine standing, the steam down, and no one visible. On getting into the engine-house the dead body of the engineman was seen. It was found that a piece of the steam pipe had burst out exactly at the same place and in the same way as at Greenfield, and from this the steam had rushed and scalded the man to death. The engine and pipes had been at work for fourteen years. I think the accident was caused precisely in the same way as the Greenfield one, and I recommended the same remedies. I have read the Government report on the Elbe disaster, and have wanted to hear what the experts have had to say, and I have come to the conclusion that Messrs. Oswald Mordaunt and Co. are right. A MINING ENGINEER.

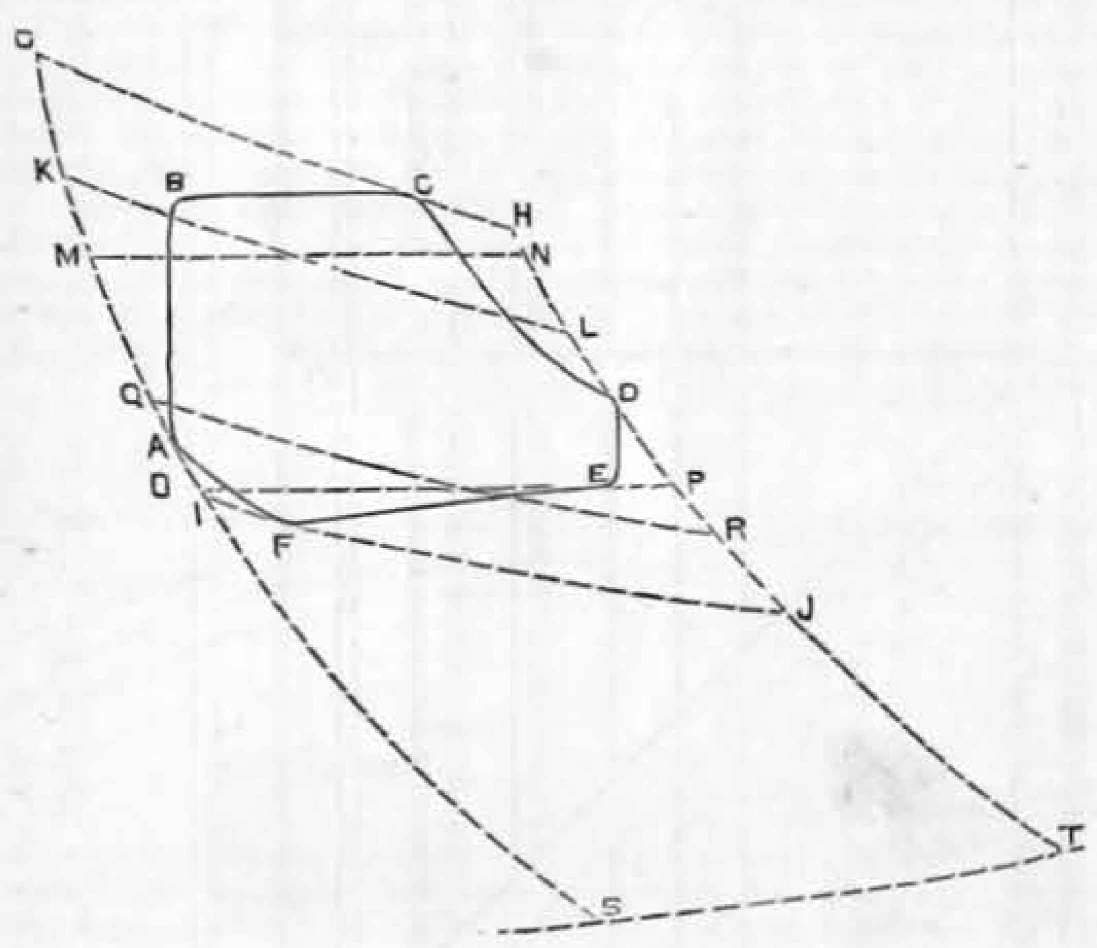
January 31st.

HEAT ENGINES.

SIR,—Your issue of the 27th inst. contains descriptions of two novel engines, Mr. Rigg's "revolving engine," and Mr. Hargreaves' "thermo-motor." The design of the former was explained by Mr. Rigg at the British Association meeting, 1885, and although the details of construction have been developed since, no doubt the principle of the design remains the same. I misunderstood Mr. Rigg's description in 1885, and owe him an apology for the criticism I then offered. Now that I understand the construction, it appears to me that the engine is perfectly balanced. I would only point out that the remark made about the recovery of useful work by the retardation of momentum during the second half of the stroke seems to be a slip on the part of the writer of the article of the 27th inst.

But may I ask what is the advantage of this method of obtaining perfect balance? There are several other methods of obtaining it that involve less complication. A two-cylinder engine, the two cylinders fixed in line with each other, and on opposite sides of the crank shaft, the two pistons of same weight and stroke, and connected to opposite crank pins, gives perfect balance. The one crank pin may be in the central plane of the engine, and the other may be in two parts on the two outside bends of a three-throw crank shaft—the central bend of which forms the former pin—the second connecting rod being forked. Other arrangements of the crank pins of this perfectly balanced two-fixed-cylinder engine are possible. Two opposite crank-pins on opposite sides of a single crank disc, with the two cylinders opposite bent out of line by the thickness of the disc plus the length of one pin, gives zero variation of the total force on the foundation, and only a very small oscillating force couple upon it, the leverage of this couple being the small distance between the cylinder centre lines. Various arrangements of two, three, four, or five-cylinder engines, non-compound or compound, all perfectly balanced and all with fixed cylinders, may be devised by properly adjusting the weights of the pistons and placing the cylinders in proper positions. If the object be only to produce perfect balance, are not two fixed cylinders preferable to two moving ones? If one wishes as well to avoid absolute dead points, then four fixed cylinders seem to me preferable to four rotating ones. Especially as regards simplicity and efficiency of valve-gear, is the fixed cylinder desirable.

As regards the Thermo-Motor I do not wish to criticise its construction adversely; I may merely ask why the air pump A does not draw from the ends of the tubes in the vessel B? What I wish to draw attention to is the incorrectness of the too common idea that the "theoretic" efficiency of a heat engine necessarily equals the range between maximum and minimum temperatures divided by the former. Let A B C D E F be the true indicator diagram, "true" meaning that it truly records all the simultaneous changes of pressure and volume. Let A and D be the points at which minimum and maximum adiabatic function is reached, and let G A S and H D T be adiabatics drawn down to the zero isothermal S T—line



of zero temperature. The theoretic as well as the actual efficiency is the ratio of areas $\frac{\text{A B C D E F A}}{\text{A B C D T S A}}$. This ratio may remain the same for many different shapes of indicator card. For instance, if for the upper boundary A B C D is substituted, any other boundary A K L D with the same adiabatic limits and including under it the same area, the efficiency remains unaltered. A M N D is another such upper boundary. Similarly the lower boundary D E F A may be changed into any other curve, such as D R Q or D P O A, without changing the efficiency, so long as the adiabatic limits are kept the same and the area underneath the curve down to S T between the adiabatics A S and D T unchanged. These changes, which do not affect the efficiency, of course, alter the maximum and minimum temperatures and the range between them, the ratio of range to maximum being also altered.

Let C and F be the points at which the greatest and least temperatures are reached. Call these temperatures measured from absolute zero c and f; and draw the isothermals G C H and I F J. The ratio $\frac{c-f}{c}$ is the same as that of the areas $\frac{\text{I G C H J F I}}{\text{S I G C H J T S}}$. This ratio is greater than the previous one. This means merely that an engine whose diagram is made up of a pair of adiabatics and a pair of isothermals is greater than that of any other engine working between the same temperature limits. There is no reason for calling this *par excellence* the "theoretically perfect" engine. Other limits besides those of temperature may be practically quite as important. The maximum temperature limit is of importance because of the difficulty in getting glands, &c., to stand it, but the minimum is not of a similar kind of importance. A maximum pressure limit is also of importance because of the strength required in the cylinder and piston to withstand it, and a maximum volume limit is of as great, if not greater, importance because of the increased bulk and expense of the machinery.

If in any special design the limits of pressure are considered the most important, the "theoretically perfect" diagram—*i.e.*, that giving the highest possible efficiency under the given conditions—consists of a pair of adiabatics and a pair of level—isobaric—lines. If the engine were to be designed under limiting volume conditions, a diagram composed of a pair of adiabatics crossed by a pair of vertical straight lines would be the best possible. If the maximum pressure were taken as the upper limiting condition and the minimum temperature as the lower limiting condition, then a diagram made up of a pair of adiabatics, an upper level line, and an isothermal as the back-pressure line, would be the best conceivable.

In all these arrangements the pair of adiabatics recur. The necessity of the left-hand curve being an adiabatic for any "theoretically perfect" diagram means that the pressure of the working fluid should be initially raised not by supplying heat by conduction to it, but by mechanical work alone done on it in a compressing pump. To make the operation as nearly as possible adiabatic, the pump should be as quick-acting as may be, and no time should be lost in the delivery into the vessel, where either the work is done or the fluid is stored, properly protected from loss of heat, and where it is supplied with additional heat by conduction or radiation. This is approximately possible with gases and vapours. Whether it be possible with water I will not venture to say; nor even whether it be actually done approximately by the ordinary boiler feed-pump.

The existence of the other adiabatic in the "theoretically perfect" card means that all the expansion carried out after the fluid is cut off from connection with the heat-supplying apparatus should be as nearly as possible adiabatic. The difficulty of getting it so is well understood.

I need hardly point out that the indicator diagrams taken from engines are by no means true records of all the changes of volume and pressure to which the working fluid is subjected. I do not refer to the instrumental errors of the indicator. I refer to the facts that almost invariably there are serious changes of pressure between the boiler or other heat generator and the entrance into the cylinder, and also that during the sudden exhaust the changes of volume are not co-ordinated on the indicator diagram with the changes of pressure. There is a similar sudden expansion on the first opening of the admission valve which, of course, is not recorded.

The chief point on which I wish to insist is that the existence of a large range between maximum and minimum temperatures is no evidence whatever of high efficiency, although engine-makers not infrequently quote it as such. If the heat be supplied at varying temperatures, the bulk of it may be conducted at a low average and a small quantity at an extremely high temperature. This would mean the reverse of efficiency, and the same result is obtained if some of the heat is conducted out of the fluid at a high temperature, however low may be the minimum reached in the condenser.

It seems to me that in many engines of the regenerator type everything possible is done to disobey these elementary laws of heat efficiency. Care is taken that the conduction of heat to the fluid should be at as many greatly differing temperatures as possible, and ditto for the cooling apparatus.

The true law, which we should strive to obey as nearly as we can, I am unable to express more simply than as follows:—Let the whole supply of heat be conducted or radiated into the working fluid in its upper limiting condition—whether this be one of maximum pressure, temperature, or otherwise—and let all the necessary cooling by conduction or radiation be accomplished in the lower limiting condition—*i.e.*, at minimum pressure, minimum temperature, &c.

I hope you will excuse the length of this letter. I have long wished that somebody should publicly correct the false notions unfortunately too prevalent among engineers on this subject.

Mason College, January 28th. ROBERT H. SMITH.

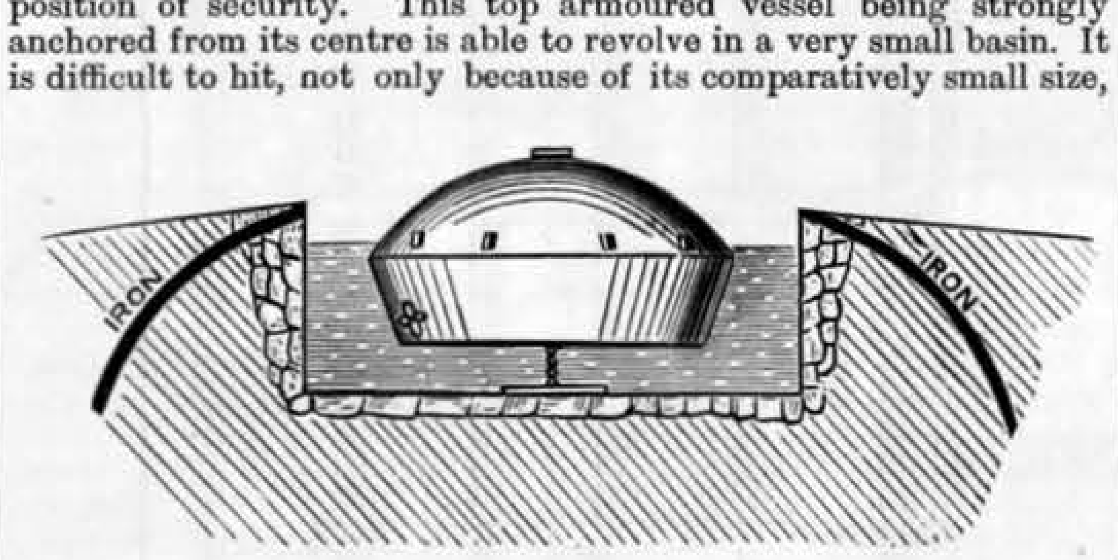
FLOATING BATTERIES.

SIR,—I desire to show how a city may be quickly, and at a comparatively small outlay, perfectly protected from capture by an enemy at sea by means of a few floating batteries, so arranged for coast and harbour defence that they shall be able to concentrate a fire of unparalleled severity from the heaviest modern guns upon hostile vessels, and yet be themselves safe, impregnable, and almost unassailable. These batteries, briefly described, consist of circular, centrally anchored, revolving, top-armoured vessels, each floating in a small, excavated basin, and each surrounded by a continuous protecting line of earthworks, within which the floating battery is sheltered, and above the crest of which it is able to rise

IN ACTION.

quickly to deliver its rapid revolving fire, and below which it can retire when necessary. The vessel enclosed by the wall is lowered below the crest by the usual plan of admitting water into its compartments, and is made to rise into its fighting position above the parapet as the water is ejected by its powerful pumps.

The circular top-armoured vessel is anchored from its centre in the middle of its small excavated basin, and is easily revolved by two ordinary propellers. As it turns it is able to discharge gun after gun of its armament. Since the battery ship is always in still water and has great stability, its fire should be more than commonly accurate, and as its gunners are safe they ought to be cool in action. This arrangement is not complicated, and consequently is not likely to get out of order or be disabled, and it can at any time retire below the crest of its protecting works to a position of security. This top armoured vessel being strongly anchored from its centre is able to revolve in a very small basin. It is difficult to hit, not only because of its comparatively small size,



IN A POSITION OF SAFETY.

but by reason of the fact that but very little of its bulk appears above the parapet. In truth, only its shield is ever exposed, and the strongly curved and inclined surface of this can scarcely be given a direct blow. To a single ship of the enemy only one port hole of the battery can at one time be exposed. Circular vessels have great displacement and stability, and can therefore support armour of the heaviest character. This armour principally consists of the top shield—the unarmoured sides of the vessel are not exposed. The shield cannot be penetrated. It is plain that the crew have nothing to fear from any form of ram or torpedo. Anchored in the middle of its basin, and consequently off shore on all sides, no assault need be apprehended. In the best position a battery of this character would occupy a large shoal or soft swamp. Then even its earthworks cannot be approached by any class of boats. If from some unforeseen accident the circular vessel should sink, its shallow basin does not permit it to be entirely submerged, and the crew would be safe.

These batteries are peculiarly suited to the protection of torpedo plants. Within range of their protected guns, that cannot be silenced, no enemy would attempt the removal of torpedoes. Such batteries placed, outside, at the entrance of a harbour would subject an enemy attempting to force a passage to a very heavy fire. Its concentrated rapidity and force would probably be without precedent. A few of these citadels placed inside of a harbour would render the enclosed waters unavailable anchorage for hostile ships. A harbour protected by these defences, and having also a good torpedo plant under the fire of the guns, could not be successfully attacked by any fleet whatsoever.

In the contest between guns and armour this system aims to give a decisive advantage to armour: (1) By reducing the size and concealing the fortified target, thus making it more difficult to hit. (2) By interposing breastworks to protect at all times the most vulnerable points. (3) To so incline and curve the surface of the armour shield that a penetrating blow shall be impossible. (4) By securing a displacement of the vessel sufficient to enable the heaviest armour-plating to be used—even much beyond the thickness of the present limit.

A revolving battery of this character requires none of the heavy and complicated machinery necessary to manœuvre the turret of the monitor class. The guns themselves are manipulated by the simplest devices, since they have practically the stability of guns on shore—owing to the large displacement of the battery vessel, and its floating always in still water—and they are turned into position by the movement of the vessel. Unlike other forts, and most vessels, none of the guns of this battery are unavailable; all are equally useful, and may be brought to bear as rapidly as they can be loaded. These defences form truly impregnable citadels. Shoals or reefs upon which they can be located are only too numerous in most harbours. The material dredged from the excavated basin will form an important part of the surrounding embankment. Defences of this character can be organised in a short time if the great guns for their armament can be procured.

Kittrel, N.C., U.S.A., Jan. 16th. THOS. L. STURTEVANT.

THE R.A.S.E. ENGINE TRIALS.

SIR,—With regard to Mr. Atkinson's letter, dated 16th inst., I must say that I cannot agree with him in his statement that if the compensating levers be carried round to a stop at b in his sketch, the pressure on b caused by the levers must be taken as acting against the engine, for if the levers were merely extended to b, compensation would be in the wrong direction, viz., tightening the brake strap as the weight rose, and *vice versâ*. The connections of the strap ends would therefore have to be reversed, so that the tail end of the brake strap was connected to the lower ends of the levers, and the leading end to a point nearer the centre of rotation. Now in that case, the resistance offered by a stop at b to the tail ends of the levers would still be in the direction of rotation, and the formula would therefore still read $\frac{(W \times C) - (w \times c)}{33{,}000}$ = B. H. P.

As regards his proposed compensating levers with links, I fail to see that they would work effectively, as, though when the weight rose the links would draw the tail ends of the levers away from the centre of rotation and thereby loosen the straps, yet when the weight fell far enough to push the links—by means of the levers—above their horizontal position, the tails of the levers would still be carried away from the centre of rotation, and thereby loosen the strap and cause the weight to fall still more. H.

January 28th.

SIR,—I am sorry to have "exasperated" "R. A. S." and, not to increase the effect, will abstain from comments on the disinterested summary he gives of my arguments. His last diagram is ingenious, and his reasoning upon it is clear and sound, so far as it goes. But it has no bearing upon the Appold brake. It represents, in principle, the totally different Halpin brake, and with a spring balance at C would give satisfactory results. When the little boys pulled, the scale would show 100 lb., which, deducted from 300 lb.—the weight of M—would leave 200 lb., as the actual weight lifted by the boys, *alias* brake blocks. Necessarily "R. A. S.'s" diagram is wide of the mark.

It is an essential feature of the Appold brake that there is a self-contained stress in the brake band—independent of that arising from the weight—transmitted through the lever to a fixed point at its end. The brake band must be endless. It would be waste of time to continue the argument upon a form of brake in which this essential feature is wanting.

"R. A. S." is tired of the argument, and so am I. We shall not agree. But my purpose has been served. Condemnation of the Appold brake is practically universal, and even "R. A. S.," who began by denouncing the truth as a mare's nest, and who spoke as one having very much authority, now modestly says that he "may be wrong or may be right." I wish heartily I could agree in something he says, but I cannot agree even in this. Still, it is a sign of grace. It is a pretty safe prediction that no more trials will be carried out with the Appold brake; and with this conviction I am fully satisfied to close my contribution to the correspondence, thanking you, Sir, for the space you have given to me. R.

(*For continuation of Letters see page* 99.)

TIENTSIN SWING BRIDGE—CHINA RAILWAYS.

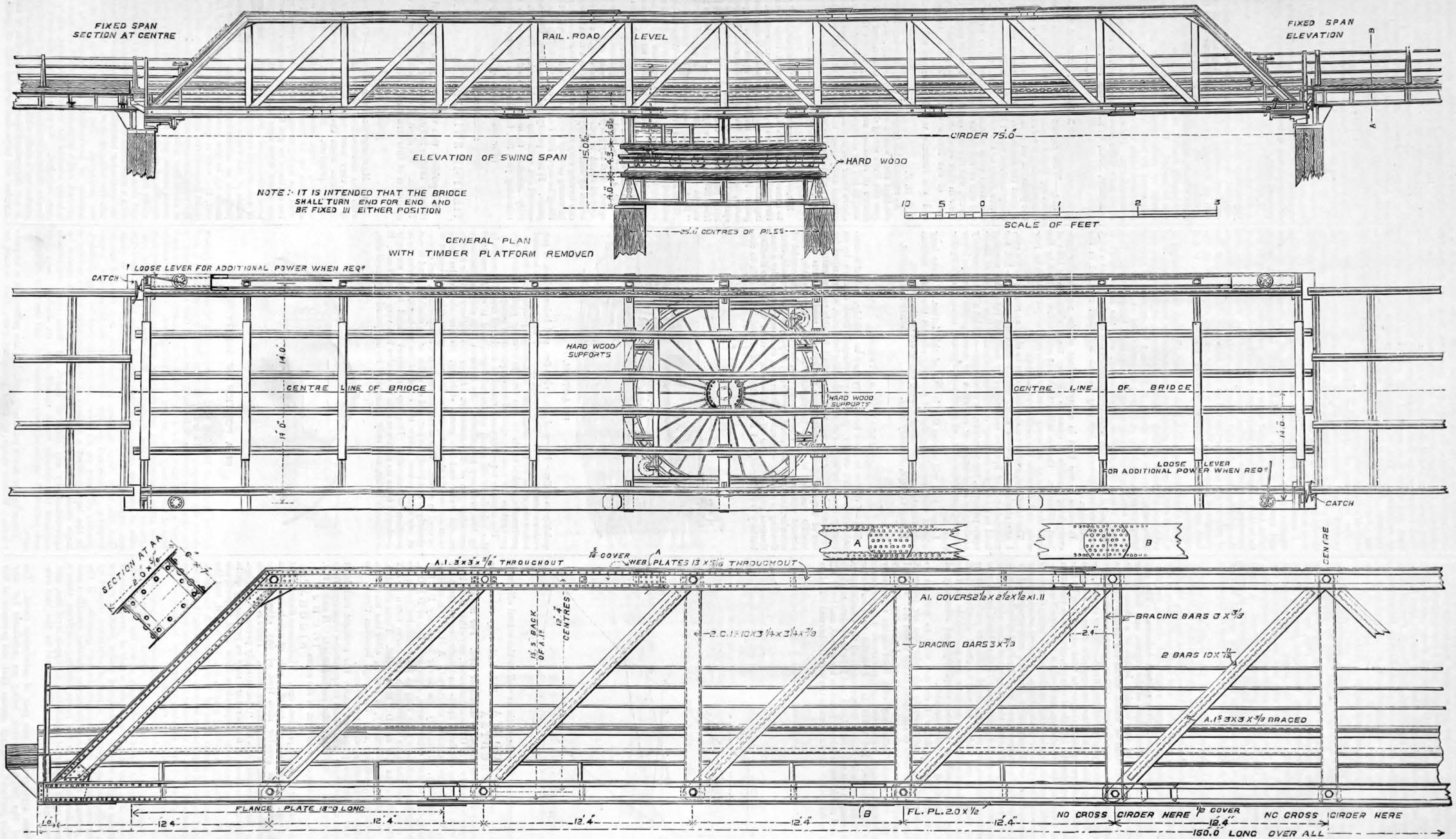
WE publish this week, on page 90, drawings of a road and railway bridge having a swing span and now being erected at Tientsin. We shall give in later issues further details and description of this structure.

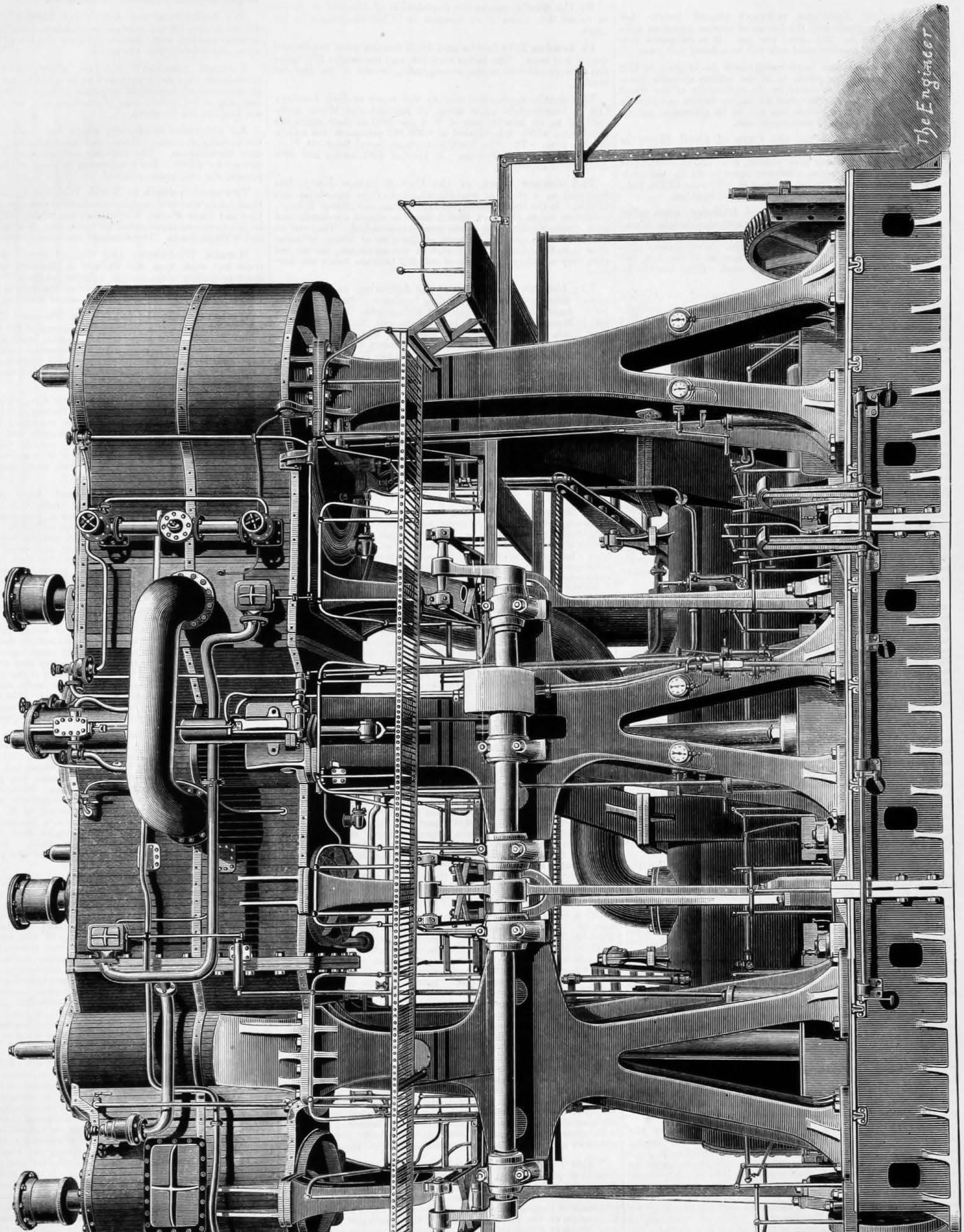
THE MANCHESTER SHIP CANAL.—The works in connection with the construction of the Manchester Ship Canal, although so far they have been mostly preparatory to more extended operations when the season is more advanced, have made satisfactory progress. Mr. Walker, the contractor, intends to have a railway from one end of the canal works to the other, and work up to the present time has been largely in connection with the laying down of this railway and in opening out gullets in the cuttings to get the steam navvies to work. At present there are about 2000 men engaged at different points where work has been commenced; but as the days lengthen out much larger bodies of men will be employed, and it is expected that by April next the whole of the works of the canal will be in active progress. It will perhaps be interesting to state briefly the progress that has been made up to the present. Commencing at Eastham, at the lower end, the work is opened out to Ellesmere port; five steam navvies, eight locomotives, and about 800 men are engaged on this length. Between Runcorn and Warrington the work is opened out a distance of about four miles; five steam navvies, a number of locomotives and steam cranes, and a large German land dredger of great power, capable of moving 2000 cubic yards per day, are at work, and about 600 men are engaged on this division. Above Warrington, and thence to Warburton, work has commenced at various places, with a number of locomotives and steam navvies on the ground, and the contractor has formed a junction with the Cheshire lines to facilitate the bringing on of his plant, &c. On this division about 300 men are employed. The Salford Docks have been commenced, a number of locomotives and wagons have been brought on the ground, and a large excavator which has been constructed in France is being erected for work at this point, where there are about 300 men engaged. We may add that the work has been divided into twelve distinct divisions, each having its independent engineers and contractor's staff, whilst as each division has its own spoil banks, it is not dependent upon any one portion of the work which in each division will be pushed forward with all speed.

TIENTSIN SWING BRIDGE—CHINA RAILWAYS.

MR. C. W. KINDER AND MR. JAMES CLEMINSON, MM. INST. C.E., ENGINEERS.

(*For description see page 89.*)





TRIPLE EXPANSION ENGINES, S.S. CITY OF BERLIN.

MESSRS. LAIRD BROTHERS, BIRKENHEAD, ENGINEERS.

(For description see page 95.)

RAILWAY MATTERS.

THE Supreme Court of Ottawa has made the injunction against the construction of the Red River Valley Railway perpetual.

THE leading American railways placed orders for 90,000 tons of steel rails with the owners of various American mills last week, at £6 8s. (31½ dols.) per ton. It is estimated that 1,500,000 tons of American steel rails will be ordered this year.

AN order, which has been recognised as largely in the interests of the travelling public as of the railway servants benefitted under it, has been issued by the authorities of the Great Northern Railway to the effect that the engine drivers and firemen of the company at King's-cross are not to be allowed to resume duty without an interval of nine hours' rest.

THE Agent-General for the Cape of Good Hope in London has been officially informed that during 1887 the Government railways in the colony have yielded, over and above the cost of working and maintenance, a revenue equal to £4 2s. per cent. on the capital invested. The net earnings in 1886 were £2 16s. 11d., and in 1885 £2 14s. 5d. per cent. on the capital invested.

THE Ballybunnion and Listowel Railway, nine miles long, which is being constructed on the Lartigue principle, is now approaching completion. Considerable difficulty has been met with in providing satisfactory level crossings. In some cases platforms revolving about a horizontal axis parallel to the line, and meeting on the central rail, have been used. These have to be raised whenever a train passes.

NARROW gauge lines have been proposed for Ceylon extensions; but it is said that to start a new system with new rolling stock, when there is an abundance in hand to serve both Uva and Galle, would be false economy in an island like Ceylon. In the low country, it is admitted, the narrow gauge would save little or nothing. Then in the hill country, there are no further districts except Uva to traverse, and no cause therefore to begin a new system.

A MAN was killed last Saturday afternoon on the Great Western Railway, at a level crossing near Hayle, West Cornwall. He was driving a horse and cart over the line, and was run down by the mail train. At the inquest, the jury brought in a verdict of manslaughter against the directors of the Great Western Railway Company, on the ground that while the dangerous state of the crossing had been frequently complained of, in consequence of accidents having occurred there, the directors had taken no steps for the public safety.

A COLLECTION has recently been made for the engine drivers at some of the stations on the Loughton Branch—Georgelane, Snaresbrook, and Leytonstone—and was distributed to them this week, each driver having 10s., each fireman 6s., and every platelayer, signalman, porter, &c., engaged in the district on fog duty, 6s. A correspondent writing to the *Standard* says:—"The thanks of the men on receiving the money were very hearty, especially the drivers, one of the oldest saying, 'I have been thirteen years at this work, and this is the first recognition I ever heard of from the public; the porters get everything.'"

HER MAJESTY'S Chargé d'Affaires at Rome reports that tenders for the construction of the Reggio-Eboli and Messina-Cerda Railways should be transmitted to the Department of Public Works through her Majesty's embassy at Rome. Firms communicating in this manner with the Italian Government will be allowed to inspect the plans and conditions connected with the undertaking. The Messina-Cerda line will be of 136 kilometres, divided into nine sections. Tenders must be made *à forfait*. Applicants will have an opportunity of inspecting the track. No list of prices is supplied. The nine sections must be completed within six years, with the obligation of maintenance for one year. The conditions for the Reggio-Eboli line are similar.

FOUR track roads common in England but a novelty in America bid fair to be no novelty much longer. The great New York Central stretch from Albany to Buffalo, 298 miles, will doubtless long continue the longest in the country or in the world, but the Pennsylvania has a quadruple track between Jersey City and Philadelphia, 91 miles, nearly completed, and the New York, New Haven and Hartford is rapidly pushing work on the 73 miles between New York and New Haven. With the 10 miles now under way, 23 miles will be already provided for, and work on the remaining fifty will then be pushed continuously and rapidly. "These three," the American *Engineering News* says, "are the first of such lines, but we may be sure they will not be the last."

AN important change in the method of charging for the use of freight cars on foreign lines has been adopted by the Pennsylvania and several other leading companies, and seems to be in a fair way to come into general use. Heretofore the settlements between the companies have been made entirely on the basis of the mileage travelled by a car, the usual rate for some years past having been three-quarters of a cent per mile. This plan has the defects that under it a car earns nothing unless it is in motion, and also that a company has no inducement to hasten the return of a car belonging to another line, but can hold it in a yard or at a way station as long as it pleases, without incurring extra charges. Under the new system a mixed charge of one-half cent a mile and 15 cents a day is substituted for the simple charge of three-quarters of a cent per mile. By this arrangement a car which is sidetracked will at least be earning the 15 cents a day for its owner, and this time charge, which will rise in the aggregate to a considerable amount for companies handling many foreign cars, will be a substantial inducement to hasten the loading and unloading of cars, and their return to their owners. A subordinate feature of the change is that the *per diem* rate will be charged on cars sent to shop for repairs, and on cars destroyed until date of notice to owners, thus enforcing the necessity of prompt notification in the case of cars damaged or destroyed, a matter which the *Railroad and Engineering Journal* says is now too often neglected.

LORD HENNIKER has just been speaking upon the railway rates question in a manner which calls for careful consideration. The chairman of the Railway Freighters' Association offers uncompromising opposition to the character of the bill which Lord Stanley of Preston announces is to be reintroduced into Parliament next session. And Lord Henniker advises that in this same spirit the bill should be received by the whole trading community. Except that it is to receive an addition providing for complaints by traders to the Board of Trade of unreasonable charges, the Government measure of next session is to be the same as that which was sacrificed to the pressure of business last session. In contradistinction to the provisions of this measure, Lord Henniker—addressing the Wolverhampton Chamber of Commerce last week—declared that traders must strenuously oppose any propositions for the perpetuation of terminal charges, and preference charges, which created a Court of Commissioners which was not easy of access to all traders, and from whose decisions too many appeals were allowable. Rather than give way on these points, Lord Henniker considers that the traders would be better without any bill at all. The Mining Association of Great Britain and the British Iron Trade Association are, we need hardly remark, both also greatly opposed to terminal and preference charges. They bear in mind the foreign competition which they have to meet, and which was illustrated by a prominent steelmaster at the gathering at which Lord Henniker spoke. The Belgians, whose iron-producing centres are about 105 miles from the sea, are, it was mentioned, carrying their iron to the sea for 2s. per ton, while ironmasters in the centre of England have to pay 15s. for the carriage to the ports. Traders should see to it that the commercial members in Parliament do their utmost to remove the objectionable features of the forthcoming bill.

NOTES AND MEMORANDA.

IT is stated that good coal has been discovered in Cashmere.

BY the recent census the population of Madrid is shown to be 475,300, which is an increase of 77,500 inhabitants in ten years.

IN London 2715 births and 1816 deaths were registered during last week. The births were 148, and the deaths 177, below the average numbers in the corresponding weeks of the last ten years.

THE deaths registered during the week ending January 21st in twenty-eight great towns of England and Wales corresponded to an annual rate of 23·0 per 1000 of their aggregate population, which is estimated at 9,398,273 persons in the middle of this year. The five healthiest places were Brighton, Hull, Bristol, Oldham, and Preston. In London 2688 births and 2000 deaths were registered.

THE steamer Essex, of the United States Navy, has been making a series of soundings between Cape Guardafui and Ceylon. In the Indian Ocean, between 60 deg. and 70 deg. E. long., a uniform depth of about 2000 fathoms is almost constantly met with, gradually deceasing as the coast is approached. The greatest depth met with was 2705 fathoms, off the coast of Africa, 160 miles from Cape Guardafui. To the east of this maximum, the sea bed rises very suddenly to a depth of only 857 fathoms below the surface.

THE *Bulletin Medical* gives the following as the death rate of thirty great cities, excluding London:—"Brussels, 15 per 1000; Amsterdam, the Hague, and Philadelphia, 16; Stockholm and Baltimore, 17; Dresden, 18; Vienna and Turin, 19; Berlin, New York, and Brooklyn, 20; Paris, 21; Christiania, 22; St. Petersburg, 23; Venice, 24; Budapest, Bombay, and Calcutta, 25; Rotterdam, Breslau, and Prague, 26; Munich, 27; Hamburg, 29; Trieste, 30; Copenhagen, 31; Alexandria, 35; Rome, 37; Madras, 43; and Cairo, 51.

PEPPYS made use of electricity for the combustion of the diamond, but it is only in the last two or three years that the application of powerful electric currents has been made for smelting. The Cowles process for producing aluminium, and welding, as proposed by Elihu Thompson, are making rapid progress. The use of enormous dynamos for the deposition of pure copper from impure ores seems certain now to remain a commercial success. Messrs. Bolton, at Widnes, and Messrs. Vivian, as well as Messrs. Lambert at Swansea, are each depositing from 40 to 50 tons of copper per week by currents of from 5000 to 10,000 ampères.

AT the present time the P. and O. Company owns 53 steamers, with an aggregate registered tonnage of 204,183 tons and 198,500-horse power, built at a cost of some £6,000,000. Their largest steamers are of 6500 tons register, and the smallest 2000 tons. In the course of the coming year no fewer than 200 of their steamers, of an aggregate tonnage of nearly 1,000,000 tons, will enter and leave the port of London alone. The steamers traverse 2,500,000 miles in the course of a year. The company gives employment to 800 officers (commanders, officers, engineers, surgeons, &c.) of the mercantile marine holding certificates from the Board of Trade, and a large proportion have her Majesty's commission in the Royal Naval Reserve. It has also in its service an army of nearly 15,000 people afloat and ashore. Great as are its resources and operations, the competition of the cheap class of cargo steamers with limited passenger accommodation which have lately been built, has forced the company to extend its branches, and of late it has established a network of agencies throughout the country.

THE report of Mr. William Crookes, F.R.S., Dr. William Odling, F.R.S., and Dr. C. Meymott Tidy, on the water supplied to London during December, states that the uniformly excellent character of the water supplied to the metropolis for a long while past has been satisfactorily maintained during the month of December. In respect to its degree of freedom from tint of colour and excess of organic matter, the numerical results obtained were found to differ but little from those taken note of for some time back. The mean proportion of organic carbon in the Thames-derived supplies, or ·160 part, and the maximum proportion in any sample, or ·188 part in 100,000 parts of the water, although, indeed, slightly in excess of the respective means and maximums of previous months, are quite exceptionally low for the period of the year, as are also the numbers expressing the degree of freedom of the water from colour tint. The mean proportion of organic carbon for the last six months of the year, or, ·143 part in 100,000 parts of the water, corresponds, as nearly as may be, to one-quarter of a grain of organic matter per gallon.

AT a recent meeting of the Royal Society a paper was read on "Heat Dilatation of Metals from Low Temperatures," by Thos. Andrews, F.R.S.E. The experiments of this paper were made to determine approximately the coefficients of heat dilatation of modern steels from low temperatures. The metals employed were wrought iron, "soft" Bessemer steel, "hard" Bessemer steel, "soft" Siemens-Martin steel, "hard" Siemens-Martin steel, "soft" cast steel, "hard" cast steel, &c., of known composition, specific gravity, &c., given in detail in the paper. The terms "soft" and "hard" relate only to difference of percentage of combined carbon. The ranges of temperature chosen for the observations were from —45 deg. C. to 300 deg. C. The experiments were made on rolled bars of the various steels and also on large hammered forgings 5in. diameter. The coefficients of dilatation were found generally to decrease with the reduced temperature. The author also found such to be the case in his recent observations on the heat dilatation of pure ice from low temperatures. There seemed to be a slightly greater dilatation in the direction of the length of the forged metallic cylinders than when measured across the diameter. It was also noticed that the coefficients of dilatation were greater in the case of steels having a lower percentage of combined carbon than in those containing a higher percentage.

"THE Elgin sandstone, so unique and so prolific in the domain of palæontology, has just yielded," a correspondent of the *Times* says, "Two other fossils, one of which, if possible, deepens the mystery which hangs around this formation. The discovery was made at Cutties Hillock quarry, the spot which was the immediate cause of the great discussion at the meeting of the British Association at Aberdeen in 1885. Since then a number of specimens have been found which have aroused the keenest interest among scientific men both in England and in Scotland, and indeed wherever geology and palæontology are practically taught. Hitherto the upper beds have yielded purely reptilian remains, the most remarkable of which has been dicynodon, a fossil which, as far as is yet known, has been found only in African strata. One of the fossils just discovered appears to be another specimen of that creature, but until parts of the sandstone are cleared away which at present hide considerable portions of the remains it would be impossible definitely to say what the fossil is. The other is more extraordinary, and may turn out to be as rare in the British Islands as dicynodon. Had it occurred in a different horizon or in strata admitted by all to be of old red age, what appears to be a large fish plate would have been without much hesitation described as belonging to Pterichthys. As it is, those most opposed to the theory that the upper beds are of Triassic age would scarcely dare to expect to find the remains of so characteristic an old red fish associated with reptilian remains. Whatever the fossil may turn out to be, it is a fresh link in the wonderful chain of palæontological evidence which the Elgin sandstones have afforded and which enrich the museums of London, Edinburgh, and Elgin."

MISCELLANEA.

THE opening of the Engineers' Instrument Exhibition, organised by the Belgian Society of Engineers in the Brussels Bourse, has been postponed to March 2nd.

WE understand the Admiralty have placed the order for the twenty 150-ton steel coaling lighters, for which tenders were recently invited, with Messrs. Edward Finch and Company, engineers and shipbuilders, Chepstow.

FIFTEEN THOUSAND POUNDS, which does not include engineering charges, is proposed to be spent in the construction of an intermittent downward filtration system of sewerage for the township of Willenhall, near Wolverhampton, the chief seat of the ock trade in the kingdom.

AN extensive machinery plant has been destroyed by the burning of Messrs. Finney and Sons' flour mill at Bromsgrove, near Birmingham. The building and machinery were together insured for £3000. The overheating of some of the bearings is at present the only cause assigned.

THE sudden death in North Wales is announced of Mr. Isaac Jenks, who until recently was the chief proprietor of the Minerva Iron and Steel Works, Wolverhampton, which, on his retirement, he left to the management of his three sons, Messrs. Isaac, Walter, and William Jenks. The deceased was seventy-three years old.

MESSRS. W. SIMONS AND CO., of Renfrew, received an order last week from Mr. Thomas A. Walker, contractor, for a screw-propelling barge-loading dredger, which will be employed in connection with the extensive works on the Ribble below Preston. They have also received an order for one of their hopper dredgers.

WE have received from Messrs. Thomas Fleming, Son, and Co., of West Grove Mill, Halifax, a copy of the "practical and useful diary" published by them. Besides being a diary, it contains a great deal of very useful information concerning belts, their necessary size, and power-conveying capacity, strength of leather, the use of belting, and other matters of interest to those who are users of belts.

MESSRS. J. F. WADDINGTON AND CO., ship and launch builders, Seacombe, are at present constructing an "Alvarez" patent life raft, sea anchor, and jury rudder combined for the South American Government. It consists of two side and two end tanks of steel, which, when not in use, form seats on the ship's deck, while the bottom of the raft, which is of wood, forms the jury rudder. The raft will also be fitted with mast, spritsail, and jib, and is self-righting.

THE Featherstone Local Board have unanimously appointed Mr. Malcolm Paterson, M. Inst. C.E., Bradford, as engineer to design and carry out Scheme A, reported on by him in October last, the estimated cost of which is £7300. The water is to be purchased in bulk from Wakefield, and the works will consist of a line of conduit, covered service tank, and distributing mains. The local wells are now drier than has ever been known at this season of the year, and in many cases a precarious supply has to be fetched in pails from distances exceeding a quarter of a mile.

THE views of trades unionists as to their relation with capitalists have lately been set forth in a clear and forcible manner by Mr. Edward Trow, of Darlington, general secretary to the new "Iron and Steel Workers' Association of Great Britain." In a recent speech he said, "he never would believe that capital and labour in the iron and steel trades would agree together. Capital was the enemy of labour, the powerful enemy that crushed labour. The masters had long had the largest share of the profits arising from labouring toil. The men should now unite and attempt to follow the example which the masters had set. The iron and steel workers must be prepared to contribute to some strong union for the whole of the country if they wish to improve their present position."

ON January 28th some experiments were made with the Snyers "brush" clutch, recently illustrated in our columns, at the Cail-Hallot Works, Brussels. The clutch, 58 cm.—22·8in.—in diameter, was designed for 1000 revolutions, but was only run at 372 a minute. Tested with a Prony brake, the pulley it was engaged with raised a weight of 30 kilogs.—66 lb.—at a distance of one metre from the centre, which corresponds with 15-horse power. The demonstrations were witnessed by M. A. Bandsept, chief of the Electrical Section of this year's Brussels Exhibition, and M. D. Robinson, engineer on the Belgian State Railways, and chief of the Machine Hall at the Exhibition. M. Robinson's father went from England to Brussels with the first locomotive for Belgium in 1835.

AN important case under the Employers' Liability Act was heard before Judge Turner, at the Stockton County Court, on the 25th ult. The plaintiff was a stone mason, named Jerrison, and the defendant was Mr. W. C. Atkinson, a builder, and lately the employer of the plaintiff. The statement of claim set forth that on the 23rd of August last the plaintiff was directed by the defendant—who had contracted for the removal of the old Stockton bridge, and who was superintending the work himself—to make holes in certain stonework of the bridge. The latter, being in an unsafe condition, gave way, precipitating the plaintiff into the river, whereby he sustained serious injuries. He now claimed as compensation £241 16s. Defendant paid £30 into Court. The case was thoroughly argued on both sides by the solicitors to the two parties. After a patient hearing, the judge gave a verdict for the plaintiff for £45, in addition to the £30 paid into court, together with costs.

WE are requested to state that, "in view of the interests of English electrical exhibitors in the International Exhibition, Paris, 1889, the Society of Telegraph Engineers and Electricians have appointed a committee to ascertain their wishes, and to make arrangements on their account with the French authorities. The Director-General of the International Exhibition having requested the Society to take part in the matter on behalf of the official administration, it is proposed shortly to address a circular to the principal firms interested in electric lighting and kindred pursuits, and to convene a meeting of gentlemen who are likely to take part as exhibitors in the forthcoming display. It is of extreme importance to British industries that they should be well represented on the occasion referred to, as without it there is danger of continental opinion assuming that England has fallen back in the race for success in the alliance between science and commerce."

THE Sheffield Corporation Water authorities are getting alarmed at the increased consumption—or waste—of water, owing to consumers letting their taps run as a remedy against lead poisoning. They have issued a diagram showing the rise and fall of water in stock from January, 1887, to January, 1888, both inclusive. They state that during 1887 the rainfall has been deficient to an extent never before experienced within the recollection of observers, at any rate in the district. As a consequence the Water Company were obliged in October to draw upon their reserve, the Dale Dike reservoir, the heavy rains that usually characterise October not having fallen. The result is that at the present moment the reservoirs are not half full of water. Owing to the fear of lead poisoning, the consumption of water has risen in one week, approximately, by half a million gallons per day, and in the next succeeding week there was a further increase. The water was restricted in 1870 in consequence of the long-continued drought, but from October in that year until now the constant supply has been maintained without interruption. The drainage area of existing water is 15,703 acres, of works completed and authorised 22,199 acres. There are six reservoirs in the Ravelin watershed, with a capacity 901,500,000 gallons, four in the Loxley watershed of 2,786,000,000 gallons, and two in the Ewden valley not yet commenced.

FOREIGN AGENTS FOR THE SALE OF THE ENGINEER.

PARIS.—Madame BOYVEAU, *Rue de la Banque.*
BERLIN.—ASHER and Co., 5, *Unter den Linden.*
VIENNA.—Messrs. GEROLD and Co., *Booksellers.*
LEIPSIC.—A. TWIETMEYER, *Bookseller.*
NEW YORK.—THE WILLMER and ROGERS NEWS COMPANY, 31, *Beekman-street.*

PUBLISHER'S NOTICE.

*** *With this week's number is issued as a Supplement the Index to Vol. LXIV. and two Two-page Supplemental Engravings, the one of the Forth Bridge Main Cantilever Piers, and the other of Tank Locomotives, Hungarian State Railways. Every copy as issued by the Publisher contains these Supplements, and subscribers are requested to notify the fact should they not receive them.*

CONTENTS.

THE ENGINEER, February 3rd, 1888. PAGE
THE METRIC SYSTEM 83
WATER SOFTENING. No. I. 83
THE PNEUMATIC DYNAMITE GUN 84
THIRD-CLASS BOGIE CARRIAGE, SOUTH MAHRATTA RAILWAY. (Illus.) 85
ABSTRACTS OF CONSULAR AND DIPLOMATIC REPORTS 86
SIEE HO BRIDGE, CHINA RAILWAYS. (Illustrated.) 87
THE FORTH BRIDGE—THE FIFE CANTILEVER PIER. (Illustrated.) .. 87
TANK LOCOMOTIVE, HUNGARIAN STATE RAILWAYS. (Illustrated.) .. 87
LETTERS TO THE EDITOR—Collapsing Pressure of Iron Boiler Flues—Steel Projectiles—Windmills for Generating Electricity—Modern Machine Tools—The 111-ton Gun Carriage—The Explosion on Board the Elbe 88
Heat Engines—Floating Batteries—The R.A.S.E. Engine Trials .. 89
Forced Draught 99
Free Trade and No Trade—Passenger Lifts—Strength of Flues and End-plates of Lancashire Boilers 100
TIENTSIN SWING BRIDGE—CHINA RAILWAY. (Illustrated.) 89
TRIPLE EXPANSION ENGINES, S.S. CITY OF BERLIN. (Illustrated.) .. 91
RAILWAY MATTERS—NOTES AND MEMORANDA—MISCELLANEA 92
LEADING ARTICLES—Copper Steam Pipes—The Metropolitan Fire Brigade 93
Condensation in Steam Engine Cylinders—Atlantic Telegraphy—Hammersmith Bridge—The Inventor of the Needle Gun 94
The Hull and Barnsley Railway and the Midland Counties 95
LITERATURE 95
THE ROYAL INSTITUTION 95
SIXTY TON STEAM CRANE, FIRMINY STEEL WORKS. (Illustrated.) .. 96
THE ECONOMY OF HEALTH IN WORKSHOPS 97
AMERICAN ENGINEERING NEWS 97
VOLK'S ELECTRIC DOG-CART. (Illustrated.) 98
HARPER TWELVETREES' ROTARY WASHING MACHINE. (Illustrated.) 98
BRAY'S ANTI-PULSATOR. (Illustrated.) 98
LETTERS FROM THE PROVINCES, &c.—The Iron, Coal, and General Trades of Birmingham, Wolverhampton, and other Districts—Notes from Lancashire—Notes from Sheffield—Notes from the North of England 101
Notes from Scotland—Notes from Wales and Adjoining Counties—Notes from Germany 102
AMERICAN NOTES 103
NEW COMPANIES 103
THE STEEL GUN CAST AT PITTSBURG 103
THE PATENT JOURNAL 103
SELECTED AMERICAN PATENTS 104
PARAGRAPHS—Naval Engineer Appointments, 84—The Manchester Ship Canal, 89—Leeds Association of Foremen Engineers and Draughtsmen, 97—Range Finders, 98—Institution of Civil Engineers, 100—Birmingham Student's Association, 100—University College, Bristol, 100—Nitro-gelatine Shells, 103.
TWO DOUBLE-PAGE SUPPLEMENTS—THE FORTH BRIDGE CANTILEVER PIERS, AND A TANK LOCOMOTIVE, HUNGARIAN STATE RAILWAYS.

TO CORRESPONDENTS.

Registered Telegraphic Address "ENGINEER NEWSPAPER, LONDON."

P. G. W.—*Messrs. Robey and Co., Lincoln.*

MIDLAND ENGINES.—*The engine exhibited at Saltaire has not been illustrated in our pages, but an engraving of one of the same type was recently published by us.*

BELTING.—*The Rossendale Belting Company*, 20, *Rook-street, Manchester; Thos. Aitken and Son, Helmshore, near Manchester; F. S. Sandeman, Dundee.*

S. P.—*We cannot assist you without further information. Any firm will fit a boiler with an arrangement by which as the steam rises the damper will close. The idea is as old as the days of Watt; but, unless for some special purpose, the thing is not worth the extra cost.*

A. C.—*Any one who pleases may write C.E. after his name. The Institution of Civil Engineers is not an examining body. It does not grant diplomas, and it has no power to interfere. The Associate in the case you state has no ground for his contention. He is not necessarily a civil engineer because he is an Associate of the Institution.*

J. C. F.—*We must refer you to Mr. Juland Danvers' last report on the railways of India. It can be obtained through any parliamentary bookseller. Most of the lines are under construction by contractors, both European and native, and we are unaware of their addresses. We counsel your making application to the India Office respecting the employment you wish for.*

C. W. J.—*Any one who has been regularly apprenticed and educated as a mechanical engineer in any of its branches, and who has attained to a more or less responsible position. Some such qualification as is necessary to fill up such a form as the following is necessary:—"Mr. A. B. served his time for — years in the —— —— —— works of C. D. at —— —— ——; was then engaged as draughtsman in the —— —— —— works of E. F. at —— —— —— for — years; superintended the execution of —— —— —— at —— —— —— for — years; was assistant manager in the —— —— —— works of G. H. at ——.—— —— for — years; and has been — years partner in —— —— ——," &c. Satisfactory qualifications may, however, depart considerably from this. Perhaps it would be better to enter as an Associate. Write to the Secretary*, 10, *Victoria-chambers, Westminster.*

SUBSCRIPTIONS.

THE ENGINEER *can be had, by order, from any newsagent in town or country at the various railway stations; or it can, if preferred, be supplied direct from the office on the following terms (paid in advance):—*

Half-yearly (including double numbers) .. .. .. £0 14s. 6d.
Yearly (including two double numbers) .. .. .. £1 9s. 0d.

If credit occur, an extra charge of two shillings and sixpence per annum will be made. THE ENGINEER *is registered for transmission abroad.*

A complete set of THE ENGINEER *can be had on application.*

Foreign Subscriptions for Thin Paper Copies will, until further notice, be received at the rates given below:—Foreign Subscribers paying in advance at the published rates will receive THE ENGINEER *weekly and post-free. Subscriptions sent by Post-office order must be accompanied by letter of advice to the Publisher. Thick Paper Copies may be had, if preferred, at increased rates.*

Remittance by Post-office order.—Australia, Belgium, Brazil, British Columbia, British Guiana, Canada, Cape of Good Hope, Denmark, Hawaiian Islands, Egypt, France, Germany, Gibraltar, Italy, Malta, Natal, Netherlands, Mauritius, New Brunswick, Newfoundland, New South Wales, New Zealand, Portugal, Roumania, Switzerland, Tasmania, Turkey, United States, West Coast of Africa, West Indies, Cyprus, £1 16s. China, Japan, India, £2 0s. 6d.

Remittance by Bill on London.—Austria, Buenos Ayres and Algeria, Greece, Ionian Islands, Norway, Panama, Peru, Russia, Spain, Sweden, Chili, £1 16s. Borneo, Ceylon, Java, and Singapore, £2 0s. 6d. Manilla, Sandwich Isles, £2 5s.

ADVERTISEMENTS.

*** *The charge for Advertisements of four lines and under is three shillings, for every two lines afterwards one shilling and sixpence; odd lines are charged one shilling. The line averages seven words. When an advertisement measures an inch or more the charge is ten shillings per inch. All single advertisements from the country must be accompanied by a Post-office order in payment. Alternate advertisements will be inserted with all practical regularity, but regularity cannot be guaranteed in any such case. All except weekly advertisements are taken subject to this condition.*

Advertisements cannot be inserted unless delivered before Six o'clock on Thursday evening; and in consequence of the necessity for going to press early with a portion of the edition, ALTERATIONS to standing advertisements should arrive not later than Three o'clock on Wednesday afternoon in each week.

Letters relating to Advertisements and the Publishing Department of the paper are to be addressed to the Publisher, Mr. George Leopold Riche; all other letters to be addressed to the Editor of THE ENGINEER, 163, *Strand.*

MEETINGS NEXT WEEK.

THE INSTITUTION OF CIVIL ENGINEERS.—Tuesday, February 7th, at 8 p.m.: Ordinary meeting. Paper to be read, with a view to discussion:—"The Alexandra Dock, Hull," by A. C. Hurtzig, M. Inst. C.E. Friday, February 10th, at 7.30 p.m.: Students' meeting. Paper to be read:—"Arched Ribs and Voussoir Arches," by H. Medway Martin, Wh. Sc., Stud. Inst. C.E.

SOCIETY OF ENGINEERS.—Monday, February 6th, at the Town Hall, Westminster, at 7.30: Ordinary meeting. The President for the past year, Professor Henry Robinson, will present the premiums awarded for papers read during the year. The President for the year 1888, Mr. Arthur T. Walmisley, will deliver his inaugural address.

ROYAL INSTITUTION.—To-morrow (Saturday), at 3 p.m.: "Experimental Optics," by Lord Rayleigh. Monday, 6th inst., at 5 p.m.: General monthly meeting. Tuesday, 7th inst., at 3 p.m.: "Before and After Darwin," by G. J. Romanes. Thursday, 9th inst., at 3 p.m.: "Early Secular Choral Music," by Professor C. H. H. Parry. Friday, 10th inst., at 9 p.m.: "Safety Lamps in Collieries," by W. H. Preece.

SOCIETY OF ARTS.—Monday, February 6th, at 8 p.m. Cantor lectures: "Yeast: its Morphology and Culture," by A. Gordon Salamon, F.I.C., F.C.S. Lecture II.—Mode of reproduction of yeast—Ascospores—Conditions necessary to their formation—Saccharomyces and torulæ—Top and bottom yeast—Character of beer determined by species of saccharomyces employed—Fungul cellulose—Protoplasm. Tuesday, February 7th, at 8 p.m.: Foreign and Colonial Section. "British Columbia," by Henry Coppinger Beeton, Agent-General for British Columbia. Wednesday, February 8th, at 8 p.m.: Ordinary meeting. "The Continuation of Elementary Education," by W. Lant Carpenter, B.A.; the Right Hon. Sir Lyon Playfair, K.C.B., M.P., F.R.S., will preside. Thursday, February 9th, at 8 p.m.: Special lectures. "Etching and Mezzotint Engraving," by Professor Hubert Herkomer, A.R.A. Friday, February 10th, at 8 p.m.: Indian Section. "The Work of the Afghan Frontier Commission," by Captain Manifold, R.A.; J. M. Maclean, M.P., will preside. To-morrow—Saturday—a Public Conference on the Sanitary Registration of Buildings Bill will be held. Introductory address, at four o'clock, by the chairman, Sir Joseph Fayrer, K.C.S.I., M.D., F.R.S. Short papers by Mark H. Judge, A.R.I.B.A., and Sir Vincent H. Kennett-Barrington, M.A.

SOCIETY OF TELEGRAPH ENGINEERS AND ELECTRICIANS.—Thursday, February 9th, at 8 p.m.: Ordinary general meeting. "On Alternate Current Transformers, with special reference to the Best Proportion between Iron and Copper," by Gisbert Kapp, A.M. Inst. C.E., Member.

CLEVELAND INSTITUTION OF ENGINEERS.—The third meeting of the session will be held in the Lecture Room of the Institution, Cleveland Hall, Newport-road, Middlesbrough, on Monday, February 6th, at 7.30. Business: List of elections since last meeting. Paper on "The Working of the New Patent Law," by G. J. Clarkson, F.I.P.A., Stockton.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.—The sixth general meeting will be held in the Lecture Hall of the Literary and Philosophical Society, Newcastle-upon-Tyne, on Wednesday, February 8th, at 7.45 p.m. Discussion on the paper on "The Combustion of Coal, and some Evaporative Experiments with Natural and Forced Draughts," by W. G. Spence. Paper on "The Results of some Experiments made on Rowe's Double-strapped Butt Joints," by James Patterson.

THE ENGINEER.

FEBRUARY 3, 1888.

COPPER STEAM PIPES.

IN our impression for December 23rd, 1887, we published a paper by Mr. Nisbet Sinclair, "On Experiments on the Strength of Copper Pipes Made at Lancefield," read before the Institution of Engineers and Shipbuilders in Scotland. This paper was discussed with another "On Copper and Copper Castings," by Mr. George Thomson, on the 20th of last December. Mr. Sinclair read a supplementary paper giving the results of further experiments, and drew the following deductions as a result of the whole series: Copper is a very trustworthy material at all temperatures within the present limits of practice in steam machinery. It may be used indifferently with or across the grain. The copper may be blistered so long as the brazing is left, and still 70 per cent. of strength may remain. Unplanished pipes have a strength cold in the neighbourhood of brazed joints of 75 per cent. of the plate from which the pipe is made. When heated to 390 deg., the strength of the whole pipe is 80 per cent. of the cold strength. Or it has in the neighbourhood of the joint, at 390 deg., 60 per cent. of the strength of the cold copper of which the pipe is made. Planishing brings up the strength of the joint to within about 5 per cent. of the body of the pipe, so that a planished pipe should have at 390 deg. a strength of 76 per cent. of the cold unworked sheet. The weakness in the neighbourhood of flanges might still exist to the extent of 20 per cent. But we must be governed in calculating the strength of a pipe, not by the mean of such experiments, but by the weakest that would be passed by a fair tradesman as a sound job, and put thus the strength of ordinary pipes cannot be taken as more than 60 per cent. of the strength of the copper the pipe is made of.

These are, it will be seen, extremely important deductions, because it has hitherto been the custom to regard the strength of the brazed joint as practically the same as that of the metal in the pipe. The solder used consists of copper and spelter in the proportions pretty nearly of one to one. This alloy—if it be an alloy—is less strong than the copper; but from the way in which it spreads itself in a thin layer between the two thinned edges of the copper sheet it is supposed to give a joint as strong, as we have said, as the rest of the pipe. The solder is in fact in shear rather than in tension. Mr. Sinclair's experiments, it will be seen, upset this theory; but it is noteworthy that the weakened portion of the pipe is not necessarily in the joint, but in its neighbourhood. It is an interesting coincidence that the strength of a brazed copper joint bears nearly the same relation to that of the solid plate that a single rivetted seam in iron does to the solid plate. The rivetted seam has a strength of 56 per cent. of the plate. In the same way the strength of a planished copper pipe bears as nearly as possible the same relation to that of the solid plate that a double-rivetted seam does to the solid iron plate.

It has frequently been urged that copper cannot now be obtained as good as it used to be. One English locomotive superintendent has recently abandoned the use of copper stays in his fire-boxes above the level of the fuel on the grate, because they broke continually, and now uses iron instead. Various reasons have been alleged for this inferiority; one is that all copper made with gas furnaces is brittle; another is that the finest and purest ores being exhausted, much more care is required in smelting than was formerly necessary, but that competition resulting in low prices has rendered it impossible for the smelter to spend the money really required to produce sound metal. Too much weight must not be attached to any of these arguments, but that they are not wholly fallacious may perhaps be admitted. In the discussion which followed Mr. Sinclair's paper, some stress was laid on the fact that there were inferior coppers in the market. It would appear that much the same danger of uncertainty urged against steel may be urged against copper. One speaker pointed out that there are not many kinds of copper to be bought, and that there is not more than 10s. a ton difference in the prices of the various brands. It was by no means an unusual thing to find a defective sheet. The copper merchant always blamed the coppersmith, and unfortunately the copper-smith did not know why the sheets were bad. It may, we think, be taken as proved that all the copper in the market is not of superlative excellence, and the fact should not be overlooked by engineers.

Perhaps the most interesting statement made in the whole discussion was that of Mr. Clarke, of the Broughton Copper Company. Much has been said about seamless copper tubes, and doubts have been expressed as to whether it is possible or not to obtain them of sufficient size. Mr. Clarke said that his firm had been making for some years past 14in. seamless pipes, and all sizes up to that diameter, and they had recently covered hydraulic rams for the Victoria Graving Dock Company with seamless drawn copper tubes 26ft. long by 10in. diameter by $\frac{3}{16}$in. thick. He claimed for these pipes a considerable advantage over brazed copper pipes for this reason—in manufacturing these pipes they cast the original shell under a pressure of five tons per square inch, with the object of driving out all the blow holes which were apt to be present in ordinary cast copper. Sheet copper suffered from this, that if there were blow holes in the centre of the copper ingot from which the sheets were made the rolling tended to cover up all defects; but when a pipe was subjected to the severe test of drawing cold, if there were blow holes in the copper the tube would probably give way in the centre. "The difficulty of using large seamless pipes was that they could not bend them when they got to 10in. and 12in. diameter, and also because they cost 7d. or 8d. per lb. more for a 12in. tube than they had to pay for a similar pipe when brazed." Here then we have one reason why such tubes are not in favour. It is possible, however, that a reduction in thickness would be permissible, in which case the cost would be reduced. But the difficulty must remain that these seamless tubes cannot be bent. They require great power to curve them, even a little, and the outside of the bend is thinned and weakened. It would be necessary, therefore, it seems to us, to combine with the seamless tube some form of bent tube which would either be a casting or have brazed joints; and as a chain is no stronger than its weakest link, so a steam pipe built up in this way might really be very little stronger than an ordinary pipe. The discussion was adjourned. Whether further information can be elicited or not remains to be seen. To us it appears that Mr. Sinclair's results, taken with all the other experiments that have been made since the occurrence of the disaster on board the Elbe, point to the fact that in every brazed steam pipe there is an element of uncertainty introduced by what we may term the personal equation of the coppersmith, and that at the best it is not safe to reckon on a strength much over 50 per cent. of that of the solid plate. As, however, a very large margin of strength always is introduced, it follows that pipes now at sea are not unsafe. Instead of having a factor of safety of nine or ten, however, it is probable that they would not resist more than four or five times the rending stress to which they are actually submitted.

The question was not raised at the meeting, but deserves consideration, Why use copper piping at all? It is difficult to see what precise advantage it possesses over good lap-welded steel or iron tubes. It appears, moreover, that a very good pipe might be made of thin steel rivetted. Such a pipe could not be caulked steam tight, but might be brazed steam tight, its strength depending mainly on the rivets, while the brazing would be a substitute for caulking. Objections can, no doubt, be urged to such pipes. Small wrought iron pipes are largely used in the United States for carrying water under heavy pressure, a very trying condition. Now that a doubt has been cast on the merits of copper for high-pressure work, it is possible that some ingenious individual will produce something as new and as suitable for its intended purpose as the corrugated flues which rendered high pressures possible at sea.

THE METROPOLITAN FIRE BRIGADE.

CAPTAIN SHAW'S report on London fires in 1887 reverses the story of the two preceding years, in which the number of fires showed a yearly decline. The number now returned is the highest yet on record. Allowing for the increase of the population, the fires in the metropolis in 1887 were not so numerous as in 1884, 1871, or 1870, but these were the only years in which the ratio stood higher than it did last year. Than can be no doubt that as a general rule fires in London increase more rapidly than the population. If we take the returns for the last seven years, we find that the average number of fires for 100,000 of the population was nearly fifty-four, whereas in the seven years 1866-72, when the returns were kept in the same way that they are now, the average was under fifty-one. If we go further back, and take the first seven years on record, namely, from 1833 to 1839, we find the ratio as low as twenty-nine per 100,000. Granting that the earlier records may be less perfect than the later, there must unquestionably be some truth where the margin is so broad. Moreover, in the later periods, where the returns have been kept on a complete and uniform system, we find the same law of increase prevailing, though interspersed with fluctuations. The rise that goes on during a period of more than half a century cannot be disputed, and the fact is established that in London there is, upon the whole, a more rapid increase of fires than in the population. It is encouraging to know that the highest ratio of fires was in 1870, when it exceeded sixty. But this year is included in the septennial average which we have previously quoted, and which shows a lower ratio than in the last septennial period. Comparing 1866-72 with 1881-87, we see that the annual average of London fires has increased by as much as 3 per 100,000 of the population, thus bringing in during the past seven years an average of 120 fires per annum beyond what can be satisfactorily accounted for. Apart from the energies of the Brigade, property in London is not so secure from fire now as it was fifteen years ago. There may be a greater certainty of the fire being promptly extinguished, but there is a greater risk that the fire will take place. From 1866 to 1872 the average percentage of serious fires was fifteen. In the last septenniad this has dropped to eight. There is no fault to be found with the Brigade, but what is the process which appears to render London increasingly inflammable?

There was a time, namely, from 1874 to 1880, when it looked as if the fire ratio was about to decline. It fell as low as forty-six per annum on an average, thus contrasting with fifty-one in 1866-72. If we start from the close of 1880, and take the last seven years, we find the improvement entirely swallowed up, and the balance turned the other way, the annual average rising to fifty-four per 100,000 of the population Thus, on instituting a comparison between such suitable periods as the two last septenniads, we are confronted with a serious advance in the number of fires. As a further fact it should be mentioned that the London fires last year averaged one in every 229 houses, or about twenty to each square mile. This brings the question tolerably close home to each man's door. The general distribution is such that in the course of the year there is a fire in each area composed of a square measuring rather less than 400 yards on the side. Thus, a man may have his own residence on fire, and in the course of the year be witness to four other fires round about him within a radius of 400 yards, besides four more fires a little farther off. If he is more lucky than this, somebody else is less lucky. The facts before us show that the Fire Brigade does its duty, but has an increasingly difficult task to perform. The decision of the Metropolitan Board to expend a large annual sum in the adoption of hydrants has been wisely taken. With fires so thickly strewn, it pays—so to speak—to have the means of suppression made correspondingly numerous. The quantity of water used in the extinction of fires is worthy of notice. Last year it amounted to more than twenty-six million gallons, which is equal to an average of 11,000 gallons per fire. It has sometimes been more than this and sometimes less, especially in 1886, the quantity fluctuating considerably. Captain Shaw reports eleven cases in which the supply of water fell short of what was needed. On eleven occasions the turncock was late, and on six occasions this functionary never came at all. Thus there were altogether twenty-eight cases in which the water arrangements were unsatisfactory; but as there were twenty-nine such occurrences in the previous year, Captain Shaw remarks that there is "an improvement," and he has "great pleasure in recognising the successful exertions of the water companies and their officials in the matter." The absence, or late attendance, of the turncock is not a circumstance on which great stress can be laid, unless proof is forthcoming that this officer was called and failed to respond. The turncock system is in itself defective. With the extension of the constant service and the setting up of hydrants, it is to be hoped the day is not far off when the presence of the turncock may be entirely dispensed with. A new feature in Captain Shaw's report consists in the announcement that the Brigade has made 12,000 hydrant inspections during the year. This indicates a new order of things, from which the best results may be anticipated, though it is evident that men are needed as well as machinery.

There is a passage in the present report which sounds like a warning note. Having enumerated some of the multifarious and onerous duties of the Brigade, in addition to the primary function of suppressing fires, Captain Shaw says:—"This represents an amount of work for each member greater than can be shown by any other force with which I am acquainted." He then makes the significant remark:—"As the number of fires is always increasing, I venture to express a hope that it may shortly become possible to make a corresponding increase in the strength of the Brigade." The statistics we have set before our readers will help to show the reasonableness of such an appeal. Ten years ago Captain Shaw estimated that the Brigade ought to comprise 1000 men. It is still short of that number by several hundreds, although the need is greatly increased since 1877, the fires having gone up by about 50 per cent. Means and appliances, no doubt, are improved. Captain Shaw is able now to report that the substitution of telephones for telegraphs, which was commenced some years ago, has been completed, and proves a great advantage in the working of the establishment. Time is saved, and accuracy is secured, where both are of such essential value. It is a matter for regret that four members of the Brigade lost their lives during the year, while many were seriously injured. It is a perilous as well as a laborious service. On its due execution depends the safety of the metropolis, and all its countless treasures. "What a city to sack!" exclaimed Blucher. It might almost as well be sacked as burned. It is to be hoped that Parliament will in some way manage to give the subject due consideration in the coming session, so as to enable the Board to raise the revenue requisite to meet the current expenses of its force. The feud which exists between the Board and the Fire Offices has hitherto been allowed to stop the progress of the Fire Brigade Expenses Bill. This deadlock renders it impossible for the Board to pay respect to the demands of Captain Shaw, and it is only by an irregular kind of financial arrangement that the Fire Brigade is maintained at its present point of efficiency.

CONDENSATION IN STEAM ENGINE CYLINDERS.

ON the 17th of May last year Major Thomas English, R.E., read before the Institution of Mechanical Engineers a paper on "Heat Distribution in a Steam Engine." The engine was a direct-acting double-cylinder pumping engine intended for use during the late Egyptian campaign, and Major English carried out with it a series of valuable experiments, principally intended to ascertain something definite about the vexed question of the behaviour of steam in an engine cylinder. It is not our intention to consider these experiments or their results in detail. In the first place, because Major English unfortunately presented the results in such a way that it is very difficult to draw deductions from them without much labour, and in the second, because, after all was said and done, he left the question very much where he found it. Our object at present is to tell our readers something of what was said during the discussion, because the drift of that discussion in many ways supports views which hitherto we alone have put before the world. It will be well first to say a few words on the existing theory of what takes place in a cylinder. According to it, there is a continued rise and fall of temperature in a cylinder, which is attended by condensation during the first part of every stroke and re-evaporation during the latter part, and the condensation is, of course, productive of great waste of fuel. It is held to be purely a result of change of temperature in the metal of the cylinder, piston, &c., by most engineers. But Clausius and Zeuner are disposed to believe that the condensation is due more to the presence of water in the cylinder than to the metal—a conclusion vigorously combatted, as we showed last week, by M. Hirn. It will be seen in a moment that on this is based the whole heat-trap theory, which is that the amount of condensation which takes place will depend on the range of temperature in a cylinder, and that the smaller the range the less will be the condensation. Therefore, as the range in the high-pressure cylinder of a triple expansion engine is small, the condensation in such engines should also be small. Our readers know that we have disputed the accuracy of these views for years, and have pointed out that the superior economy of triple expansion engines is due to a totally different cause, which has nothing to do with reduced range of temperature; and we have also maintained that the facts which are available go to show that some unknown factor other than range of temperature in the metal of the cylinder is at work to cause condensation. Such views have, as a matter of course, been regarded as heterodox. Let us see what came out during the discussion on Major English's paper.

In the first place, Mr. Longridge suggested that a very considerable gain would be obtained by lining the cylinder cover and piston face with lead. "The specific heat of lead was less than one-fourth that of cast iron, and its conducting power being also less than one half, there ought to be with lead only one-eighth of the condensation." This is almost word for word what we suggested in THE ENGINEER about eighteen years ago; and we may add that a patent was actually secured for the use of lead in this way some five or six years ago in the United States. Professor Kennedy has experimental engines at University College, and speaking after Mr. Longridge, he stated that he had used lead, and though the condensation was less than with cast iron, it was not reduced anything like 50 per cent. Now, there can be no room to doubt that Mr. Longridge's reasoning was quite sound; and the legitimate deduction is, of course, that if lead failed to reduce condensation, then the condensation is due to some cause other than change of temperature in the cylinder walls. Mr. Willans called attention to the curious circumstance that in certain experiments made by Major English there was greater initial condensation in an engine exhausting into the atmosphere than there was when the engine exhausted into a condenser, which is precisely the opposite of what ought to take place if cylinder condensation were a result of change of temperature in the metal of a cylinder and of nothing else. Mr. Bodmer directed notice to the fact that condensation during a stroke did not necessarily represent heat abstracted by the walls of a cylinder, and he proved this from some of Major English's own diagrams. Lastly, Major English in replying to the discussion said, "That it appeared to him from these trials that the initial condensation varied directly with the density of the steam, while there did not seem to be any direct relation between the initial condensation and the varying temperature." It will, we fancy, be admitted that the sense of the meeting was that some other factor than range of temperature in the metal of a cylinder plays an important part in producing condensation. A further practical proof that such is the case is the enormous initial condensation which takes place in the high-pressure cylinders of triple expansion engines, however carefully jacketted, the whole of which is in some cases re-evaporated in the remaining cylinders, nothing but dry steam finding its way to the condenser.

To explain to what the initial condensation is due is a puzzling problem. The whole subject requires careful investigation. If it can be shown that the range of temperature in the cylinder is only one factor, then it may be possible to arrive at methods of augmenting economy by eliminating other factors. Thus, for example, Major English maintains that the proportion which the diameter of a cylinder bears to its stroke will exert a considerable influence on its economy, and no one during the discussion controverted this theory. In fact, it appeared that no view advanced by any one speaker was regarded as fallacious by the rest. It seemed indeed as though it was generally admitted that anything was possible about a steam engine. Such a conclusion can only be the result of ignorance, and the truth is that very little is really known about the action of that extremely unstable fluid steam. That certain results must ensue from certain causes may be laid down by the physicist; but no one can tell whether these causes operate in a steam engine or not. It is known that if steam expands isothermally one set of results will follow—if adiabatically, another set of results. But who can say whether the steam in a triple expansion engine is expanding isothermally or adiabatically, or both, or neither? We suppose that a large number of engineers, if asked what takes place in a steam cylinder when the pressure falls, will answer that water present in the cylinder will begin to re-evaporate; yet nothing of the kind may take place. If the conditions happen to be such that the outside of the cylinder is just of the same temperature as the steam, then no heat is allowed to escape, and an increase of pressure would cause re-evaporation, while a fall in pressure will cause condensation. Again, under conditions similar to those which constantly obtain in steam engines, it is impossible to augment pressure by compression if water be present, as shown by the straight horizontal line found in many diagrams just at the top of the compression curve. Compression only converts the steam into water. It is quite well known that the presence of a little water in a cylinder at the beginning of a stroke is fatal to economy. May not this be in part because, as the pressure rises in the cylinder when the steam port opens, liquefaction takes place? Whatever may be the answer given to these or questions similar in character, the fact seems to be undeniable that condensation in steam cylinders is due in part to causes other than range of temperature in the metal of the cylinder; and it is with some pleasure we find that the members of the Institution of Mechanical Engineers are apparently prepared to admit that the views hitherto held on the subject require revision and examination in the light of recent experience. There is no room, we think, to doubt that the process which goes on inside an engine cylinder is really extremely complex, and the sudden falls and rises of pressure, so often attributed to defects in an indicator, may, under some conditions, really represent what is taking place. This much is certain, the curve drawn by an indicator never is, save by accident, either isothermal or adiabatic, and no amount of reasoning based on the conclusion that it is either one or the other can help us much to a true theory of the steam engine.

ATLANTIC TELEGRAPHY.

THERE seems at last a change for the better in the position, actual and relative, of the Atlantic cable companies; and in the case of the largest of these, the small dividends have been increased. The low tariff is beginning to yield a larger traffic, and not only that, but an increased revenue also. In the case of the Anglo-American Telegraph Company, the receipts for the last half of 1887 were £94,710, which is £9460 above that of the corresponding preceding period. Alike, therefore, in increase and in the total, the results of the working show an enormous traffic across the company's cables in the six months. If all the traffic were fully paid—and it is known that press messages are cheaply carried—there were 3,788,400 words telegraphed in the half-year by this one of the five Atlantic cable companies. The increase in the traffic is officially stated at 162 per cent. over that for the same period of 1885, when the rate was 1s. 8d. per word. It has yielded, however, to the proprietors of these cables only a very small dividend—the ordinary stock of the Anglo-American having received for the last year £1 7s. 6d. per cent.—a very inadequate return for an investment which has its risk. That this is so is proved by the fact that several breakages of cable took place last year. In one case 220 miles of new cable were used in repairing damages. But the yield has been better in the later part of last year, and it seems now to be tolerably certain that the war of cable companies is about at an end. Its effect has been seen in the reduction of the dividends of all the companies, or in the postponement of payment of dividends altogether for a time, but it has also allowed a very remarkable growth of the traffic. This is in accordance with the experience of past cable wars—low rates of charge increase the volume of the traffic greatly; and at the termination of the struggles, when the rates charged are increased, there is a slight fall in the volume, and a check to the rapidity of the increase afterwards. It is doubtful whether a sixpenny word-rate is as yet remunerative, because though dividends have been paid during its continuance, they have been largely contributed to by the interest derived from the reserve fund which the two English companies have accumulated. That of the Anglo-American, for instance, is now as high as £909,981 in investments, which yield an income of about £31,257 annually; so that whilst that sum was accumulated in times of high or comparatively high tariff, it must be looked upon as a very great help either in effecting repairs and renewals of cables or—as in some other companies—assisting to pay a dividend. But beyond the mere question of profit to the shareholders, there is room for gratification in the fact that the use of the Atlantic cables is growing, and that though a moderate increase in the word-rate may now soon take place, yet in the end the rate will gravitate downwards to lower level, until there is the ability to pay the owners a fair return on their investments out of the continually enlarging telegraph traffic. As yet the traffic is only in its infancy, as regards popular use, but it will expand with every tentative attempt at low rates of traffic.

HAMMERSMITH BRIDGE.

WE desire to call attention by the authorities to the state of incompleteness in which this bridge, so recently opened with all the *éclat* due to the presence of royalty, remains. It may not be deemed an important omission that a purely ornamental feature should be left incomplete; but it is scarcely creditable to those responsible for this fine structure that its lighting arrangements should have been left for months in their present very crude and elementary state. Of course, as much light is given by a gas jet from the top of wooden posts, albeit those posts be, as they are on this bridge, merely pieces of rough builders' scantling, as would be given from the summit of a post of the most ornamental design and costly material. But a fitness in all things should certainly be observed with respect to our great public works, and we hear daily loud complaints as to the incongruity of the appearance of the temporary lighting standards with the elegance of the design of the new bridge. Surely it evidences neglect somewhere that such an incongruity should be permitted to exist for several months after the opening of the bridge with the imposing ceremonial above referred to. Not only are the present rough standards exceedingly unsightly, but our examination of the means adopted to support them has convinced us that these are inadequate to bear the strain of a high gale of wind. The leverage brought upon them would in such a case be far too great for the attachment-iron to bear, and serious accidents might result from gas escaping from an overthrown standard.

THE INVENTOR OF THE NEEDLE GUN.

NICHOLAS DREYSE, the inventor of the celebrated needle gun, was born a hundred years ago, on the 20th of November, 1787, the son of a poor locksmith, of Sommerda, in Thuringia. At twenty-six years of age he had travelled all over his own and many foreign countries, and returned to his native town in 1814, from which time he occupied himself exclusively with experiments for transforming infantry fire-arms on a new principle. He was in a position to start a gun factory with his own means, but the Prussian Government having been made acquainted with the intelligence and experience of the man, assisted his enterprise so materially that, in the decade 1830 to 1840, Dreyse saw his efforts crowned with success. In 1841 a commencement was made to furnish the Prussian Army with the needle gun. Foreign countries at first exclaimed against the new murderous weapon, and English journals ridiculed Dreyse as "the obscure inventor of a new kind of infernal machine." Nevertheless, the gun manufactory was constantly growing until in a short time 1500 men were employed in it; and Dreyse received the title of a Privy Commissions Rath, and later on, in 1865, was created a noble of the land. The former journeyman locksmith died on the 9th December, 1867, at the ripe age of eighty years, wealthy and greatly esteemed. His son, Franz Von Dreyse, born 1822, follows him in the management of the now extensive establishment.

THE HULL AND BARNSLEY RAILWAY AND THE MIDLAND COMPANIES.

BARNSLEY, as the capital of the coal country of South Yorkshire, is up in arms against the union of the Hull and Barnsley line with the Midland Railway. The opposition is clear enough. The people of Barnsley believe that union would mean an end of what they regard as "the present wholesome competition" to Hull and the other Humber ports. It is understood that the South Yorkshire coalowners have unanimously agreed to oppose the proposed amalgamation, and now the Barnsley Chamber of Commerce follows suit. When the line was laid down it was understood that it would not be fettered by the action of the other companies, and on that account the railway received very general and cordial support from the coal-mining community. Up to the making of the line, the coalowners complained of being practically handicapped in the race for business at the eastern ports. Since its construction, the charges for carriage have been considerably reduced, and trade has largely increased in consequence. Their fear is that the suggested amalgamation means a return to the old state of affairs. The coalowners contend that in the present aspect of the coal trade it is most important that they should not be thrown back to their old position. Though they claim that in South Yorkshire districts they have the best steam coal in England, they have not been able during 1887 to get more than 5s. 9d. per ton. Under these circumstances increased railway rates would be an enormous injury to them.

LITERATURE.

Longridge on Internal Ballistics. London: Clowes and Son, Charing Cross.

THIS paper was written for the Institution of Civil Engineers but was refused by them on the ground that the writer was too "trenchant upon the authorities." With this objection we have no sympathy. The censors of the Institution of Civil Engineers do not march with the times. Have they not learned that papers are much more interesting and popular that are of the character they describe than those of a purely abstract scientific value? A society that proclaimed that all scientific papers read would terminate by a "trenchant" application of the points brought out to our authorities, would draw crowded audiences. Seriously, however, we think that the expression is unfortunate. "The authorities" may fairly resent being taken under the wing of the council of the Civil Engineers. Authorities "should be made of sterner stuff." Mr. Longridge may fairly complain of the objection, seeing that he asked to have the passages thus alluded to pointed out to him without success; and, lastly, readers may feel that they are enticed on through a desert of severely stiff matter, by the mirage set before them of oases of trenchant passages which are never reached.

The writer, it is true, quotes Captain Noble, Sir F. Abel, and General Maitland at considerable length, and quotes them to disagree with their conclusions; but the treatment is fair, there is not a trace of personal animosity. We do not concur in all the writer's conclusions by any means, but it is a profoundly difficult and important question; the investigations of a man of Mr. Longridge's calibre and reputation are of special value. It is impossible here to trace out the course of his reasoning; but it may be said, briefly, that he objects to the lessons drawn by our officers from diagrams of pressures in the bores of guns. He points out that the question of quantity of charge has been mixed up with rate of burning. Thus, when it has been put forward that a high muzzle pressure and useful effect has been obtained from slow-burning powder, it has been overlooked that had an equally large charge of quick-burning powder been used the pressure would not have dropped, as shown in the diagram given, by a small charge. The relative influence of temperature and pressure in the erosion of a bore are discussed, and it is a point of real interest. Mr. Longridge finally concludes that we have been too hasty in our adoption of cocoa powder. He considers that slowness of burning due to the physical condition of the powder and that due to size of grain have been confused; and he thinks that M. Sarrau, in France, has perfected the investigation of the question far more completely than has been done in this country, and he discusses his formulæ. We are not prepared, as we say, to accept this conclusion, based upon imperfect information as to a very small number of rounds. We admit, and we believe that our best artillerists do so, that the low pressure given by cocoa powder is obtained at the price of waste of powder; but under present circumstances this is our best course to take. The fact that we cannot follow Mr. Longridge in all his conclusions does not prevent our recognition of the value of his paper, and our regret that it should have been rejected.

RENEWED efforts are being made in Germany and elsewhere to utilise slag for cement. The German chemists have been busy on this point.

THE S.S. CITY OF BERLIN.

THE Inman and International Steamship Company's steamer City of Berlin has been renovated and supplied with new machinery by Messrs. Laird Brothers, Birkenhead. Her dimensions are:—Length over all, 510ft. 6in.; breadth, moulded, 44ft.; depth from spar deck, 36ft. 3½in.; gross tonnage, 5000 tons. The alterations made on the vessel by Messrs. Laird are of an extensive character. She has been fitted with new engines of the triple expansion type, the cylinders being 41in., 65in., and 101in., by 66in. stroke, and capable of developing 5500 indicated horse-power. The total space occupied by these engines is no more than that taken up by the old engines, although the power is now about 20 per cent. greater. Steam is supplied by eight boilers of the cylindrical return tubular type, each having three furnaces. Grate surface is 324 square feet and total heating surface 14,600 square feet. The boilers are made of steel, carry a working pressure of 150 lb. per inch, and have been tested to the Board of Trade requirement of 300 lb. per inch. These boilers are worked under Howden's system of forced draught, the air being supplied by four centrifugal fans driven by independent engines. Two of the fans are driven direct and two are belt driven. The space occupied by these boilers is so much less than was occupied by the old boilers that a gain of six first-class state rooms on the main deck and officers' cabins on the upper deck, beside an addition of cargo space, has been obtained, and the consumption of fuel and space required for coal is greatly reduced. Circulating water for the condensers is supplied by two Tangye pumps, each worked by a separate pair of engines, and there are also Worthington engines and pumps for the main and auxiliary feed, and for fire and sanitary purposes. The crank shaft is of the built type; it and the propeller shaft are of Whitworth compressed steel. An evaporator is fitted in the engine-room capable of making 15 tons of fresh water in twenty-four hours to provide for waste, and an auxiliary condenser, to which the exhaust steam is carried from all the auxiliary engines, winches, heating pipes, steering engine, &c., and the water thus saved put back into the boilers. The electric light has been fitted throughout the ship, the electricity being supplied by duplicate sets of Clarke, Chapman, and Parsons' engines and dynamos, capable of supplying the whole lighting required, so that there is now no possibility of failure. The ship's hull has been thoroughly overhauled, the upper and main decks have been completely plated with steel or iron, and additional sub-divisional watertight bulkheads have been introduced. She has new decks and deck houses, the promenade deck being extended to 180ft. in length. The rig has been altered from the old ship rig of the Inman Company to that of the three-masted schooner, giving her a much lighter appearance afloat. The entire accommodation has been re-arranged. The saloon has been re-decorated, about forty first-class state-rooms have been fitted amidships forward of engines and boilers, and new companion ways giving access to the promenade deck are fitted. In addition to the complement of boats required by the Board of Trade, three collapsible lifeboats are provided—two on Berthon's and one on Chambers' patent—each capable of accommodating eighty to 100 passengers. Fire-extinguishing apparatus by means of steam jets and water is supplied throughout the ship.

On page 91 we illustrate the engines of the City of Berlin from a photograph.

The trials of the ship were made outside the port of Liverpool on the 22nd and 23rd ult., with the following result:—

Steam:—	
Boilers	152 lb.
Engines	149 lb.
Inter. receiver	42 lb.
Low receiver	12½ lb.
Vacuum	25½ in
Revolutions	66·3
Mean cylinder pressures:—	
High	67·3 lb.
Inter.	25·7 lb.
Low	12·5 lb.
Indicated horse-power:—	
High	1963
Inter.	1885
Low	2177
Total	6025
Fans:—	
Air pressure at fans about	2¾in. water.
" reservoir "	1¾in. "
" ashpits "	½in. "
Temperature of air at inlet to fans	94 deg.
" " " ashpit	225 deg.
" feed-water	130 deg.
Indicated horse-power per foot of grate	18·6
Heating surface in square feet per indicated H.P.	2·42

It will be seen that the horse-power per square foot of grate is very high. In another page will be found a long letter from Mr. Howden, which renders it unnecessary that we should further refer to his system here.

The great success which has attended the alterations in the ship and her machinery reflect much credit on Messrs. Laird Brothers, and will add if possible to the high reputation of the firm.

STEAM CRANE OF FIFTY TONS FOR STEAM HAMMERS.

THE great development which has taken place of late years in the production of steel, and its application in large masses, has led to the necessity of creating especial and powerful machines for hammering, heating, handling, and transporting these masses. The necessities of the case have been met and successfully provided for at the steelworks and forges of Firminy by the 50-ton steam crane, designed by M. Guyenet, engineer and constructor, of Paris. Of this we give a description, taken from the *Revue Générale des Machines-Outils.* There are certain especial dispositions in the arrangements of the parts which are of particular interest and merit attention. This steam crane, in co-operation with a hand crane of 12 tons, is devoted to the service of a 35-ton steam hammer. It consists of a bent box girder jib A. The lower end is carried by an iron pivot B, on two discs of tempered steel, enclosed in a cast iron footstep, fixed to the bottom of the well of the crane by six bolts, bedded into the masonry of the foundations. Six suspension bolts permit the jib A to be held up and the pin B to be removed without taking the crane to pieces. The jib is guided in its rotary movement, on a level with the ground, by four sectors E E, which are affixed to it by means of bolts *g g*, as shown in the enlarged detail.

The thrust of the crane is transmitted to the foundations by a bed plate, in which the sectors E E^1 run, and by the heel plate F furnished with a packing of wood G inserted between it and the masonry to break the shocks, and bound tightly together by a band of iron H; the heel plate F, so constructed as to transmit the thrust which it receives from the crane to the masonry, is secured to the foundations by eight strong bolts I, each furnished at its lower extremity with an anchorage plate of cast iron, leaning against a block of hewn stone sunk into the bed of the masonry; it is also fastened by six bolts *h*, to the sole plate of the steam hammer; finally, two iron rings J, shrunk on, serve to secure it to the upper part of the masonry foundation. To complete the description of the lower part of the crane, we may add that a cast iron crown, L, for the purpose of guiding the jib A, is fixed by bolts to the heel plate G, and that a plate of iron M completely covers the rubbing surface, to keep out the dirt. The sectors E have been adopted in preference to the general system employed of a circular row of loose rollers, united by two iron circles interposed between the cast iron collar fixed on to the pivot and the heel plate, on account of the shocks of the hammer, which, as is well known, are very injurious to rollers.

In working the crane there are four movements brought into operation:—(1) The lifting movement, for raising or lowering the load; (2) the driving movement, for translating the block carriage which carries the load; (3) the revolving movement, or the revolution of the crane on its own axis; (4) the displacing movement, for changing the position of the piece to be forged.

The whole of the mechanism necessary for working the crane is fixed on the jib A. It is composed of a steam engine with two cylinders N, the pistons of which set in motion the shaft O, by means of connecting rods and crank discs J. The crank shaft carries a loose cog-wheel K^1, called the high-speed wheel; the cog-wheel K, called the low-speed wheel, is placed on the same shaft, but it can slide in the direction of the axis guided by a collar which is worked by a lever, permitting the wheels K and K to be kept in or out of gear at high or low speed. An intermediate shaft P carries two wheels gearing with K and K^1. On this shaft are also fixed two friction cones U U, which can set in motion singly or simultaneously the three movements, revolving, driving, or displacing. An intermediate cog-wheel Q is for the purpose of changing the progress of the lift. It is worked by a shaft, on which two loose wheels, with friction cones, are mounted, and the conical friction sleeves V V; they are keyed on to the shaft, on which they can slide under the action of the thrust collar, and which can be turned to the right or left, according to whether the load is to be raised or lowered, by means of a lever.

Having described the divers actions of the initial motor, we shall proceed to examine successively the mechanisms of the four movements enumerated above. (1) Lifting: The load is suspended to a steel sling chain, with jointed links; this chain passes over a pulley, the block of which is carried by a suspension rod, the upper part of which rests on a series of Belleville springs, the elasticity of which adds to that of the girder, thus minimising the effect of shocks and notably diminishing their reaction on the crane. This series is composed of ten couples of circular springs 28 centimetres in diameter, supported at their lower part by the block, the movable pulley of which receives the lifting chain; this chain, fixed at the extremity of the jib of the crane, passes successively over the pulley *b* of the block carriage, and the various other shafts and guides as shown, and on to the chain pinion on the upper shaft which carries at its ends the worm wheels *t* t^1, driven by the two endless screws of case-hardened iron. The load is raised or lowered, as already explained, by working the friction sleeves V V. (2) Driving: the movement for translating the load longitudinally is obtained by moving the block carriage. This is composed of four roller guides, and two lift sheaves, and its action will be easily understood from the engraving. (3) Revolving: the rotary movement of the crane round its own axis is obtained by a series of cogs L^1 midway between the toothed crown L, which serves as a fixed point, and the shaft A, terminated at its upper part by the friction cone B; this cone, under the action of hand lever *n*, may be put in contact with either of the driving cones U, according to the direction desired to be given to the crane. (4) Displacing: the movement for changing the position of the object to be acted on by the hammer is not yet completed. The whole of the movements are controlled from a small platform.

To complete this description we give some numerical details.

The maximum range of the crane's action is	6 3 m.
The run of the carriage	1·50 m.
Maximum height of the crane above the ground level	8·40 m.
Speed in raising the load of 35 tons (per sec.)	0·017 m.
Speed in translating the carriage	0·061 m.
Number of revolutions of the crane per minute	0·3
Power of the steam engine	25-h.p.
Minimum pressure of steam	3 ks.
Diameter and stroke of piston	0·280 m.
Number of revolutions of the motive shaft per minute	150

The trials of deflection of the extremity of the crane have given the most satisfactory results. The constructor was instructed to observe that under a weight of 50 tons the deflection should be between 60 and 120 mm. When tested the block carriage was placed at the extremity of its course, which gave a range of 6·30 m.; the deflection was measured at the extremity of the girder, being at a distance of 7·90 m. from the axis of the pivot. The deflection was 48 mm. under 35 tons and 76 mm. under 50 tons.

Since its installation this powerful crane has given the most complete satisfaction.

THE ROYAL INSTITUTION.

THE MANUFACTURE OF TELESCOPIC MICROMETERS.

IN the course of the series of popular lectures recently delivered at the Royal Institution by Sir R. S. Ball, LL.D., on Astronomy, the speaker said that nothing equals the thread of the spider for micrometer "wires," because they are elastic, even, and so fine as to approach more nearly than anything else to the ideal line of the mathematician. A gossamer thread will do for the purpose, but a rather better plan is to take the cocoon of the spider and to draw out thread therefrom. A piece of wire is then bent into the form of a horseshoe, the thread is laid over its two ends and fixed to each with wax, then it is gently drawn straight, and dropped into the grooves on opposite sides of the micrometer frame; next it is touched with shellac varnish where it lies in the grooves, and when fixed thereby "the thing is done." An optician, he said, might charge five guineas for the same work.

In another lecture he gave the following table of

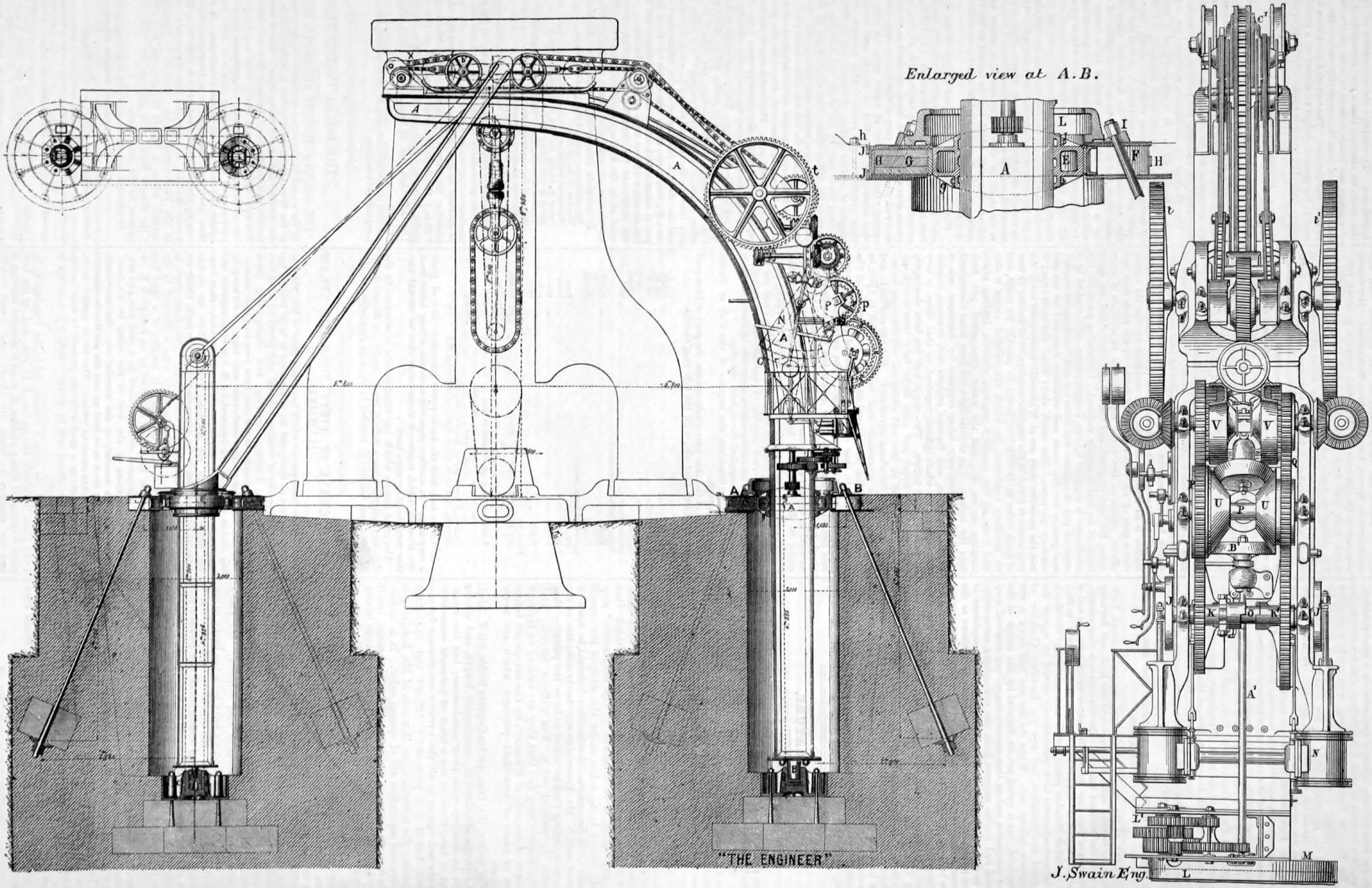
The Principal Meteoric Showers.

Name of shower.	Date of appearance.	Radiant. R.A—N.D		Remarks.
Quarantids	Jan. 2nd to 3rd.	232°	×49°	Maximum, 1863-66.
Lyraids	Apl. 19th to 20th	272°	×35°	Comet 1, 1861 (?); meteors yellow and white slightly trained.
Perseids	Aug. 9th to 11th	44°	×56°	Great shower, comet 1862.
Orionids	Oct. 19th to 20th	89°	×15°	A well marked shower.
Leonids	Nov. 12th to 13th	149°	×23°	The greatest shower; comet 1, 1866; period, 33¼ years.
Andromedes	Nov. 27th to 29th	25°	×43°	Great shower, Nov. 27th, 1872. Biela's comet.
Geminids	Dec. 9th to 12th	105°	×32°	Trained meteors, possibly aerolitic.

FIFTY-TON STEAM CRANE, FIRMINY STEEL WORKS.

M. GUYENET, PARIS, ENGINEER.

(*For description see page* 95.)



THE ECONOMY OF HEALTH IN WORKSHOPS.

AN interesting paper on this subject was read by Mr. J. Corbett before the members of the Manchester Association of Engineers at their meeting on Saturday. Starting from the basis that the responsibility for the healthiness of workshops rested rather on the employers than on the employés, and that the healthier the workman the more valuable the qualities he possessed for the proper discharge of his duties, Mr. Corbett proceeded to deal with the questions of ventilation, heating, and lighting, water supply, dining-rooms, sewering, and waste appliance, as the practical problem which had to be solved in promoting economy of health in workshops. With regard to ventilating and heating, to which the paper was chiefly devoted, Mr. Corbett observed that in engineering workshops there were comparatively few departments where the men were too overcrowded for due healthiness, but he might point out that each man should have at least 25 square feet of floor area, and at least 400 cubic feet of space for ventilation. The quantity of fresh air required per man per hour was not less than 1000 cubic feet even in cold weather, and with inactive employment, and four times to ten times this amount was required for laborious work in warm weather. In arranging for the ventilation of workshops they might, as the simplest course, make openings in the walls, windows, roofs, &c., depending on the wind and on the rise of temperature in the workshop to cause the requisite currents in and out. But the wind was utterly variable and untrustworthy, and as to the rise of temperature in the workshop, it would be highest above the open air temperature in cold weather when ventilation had to be reduced, and would be almost the same as the open air temperature in warm weather, when ventilation should be increased. So mere inlets and outlets to the open air, even when fitted with means of opening and closing them, afforded only inadequate and contradictory means of ventilation. It naturally followed from the above reasoning that all cowls and whirligigs depending on the wind for their action were most active when least wanted, and least active when most wanted. Indeed, he thought there were very few mechanical appliances by which the public was more humbugged, and more completely sold than the various wind whirligig ventilators which were successfully puffed and advertised by many so-called ventilating engineers. He only repeated the opinions of some of the most able authorities on ventilation in laying down the rule that an air inlet or air outlet, subject to the action of the wind, should not be arranged to increase its action in increased wind, but so far as practicable, should be independent of the force of the wind, so as to act evenly. For this purpose all vent shafts should be well raised above the roof, and roofed and protected from rain either by louvres on all sides, or by a flat top with side openings, or a circular double cone outlet, each of which forms allowed the wind to blow through them without materially affecting the draught. One important rule as to outlet ventilation was to have only one for each room, unless for rooms of great size, because where there were two or more outlets some of them would at times act as inlets, and thus reverse the intended currents. Air inlets, on the other hand, should be as numerous as circumstances permitted, and arranged to disperse their draughts as widely and gently as possible. Where these inlets were through the walls, they should always have deflectors to disperse the draught, but for extensive top-lighted rooms, similar to loom-sheds, it was needful to bring in the fresh air from the roof. The workshops, such as were used for smiths' work, with raised louvres along the ridge of each roof, the best means of regulating the ventilation was by light wooden doors hung so as to close, or partly close, the opening just below the raised louvres. Smithy doors were often made in two heights to aid ventilation, but a better plan was to have a second door just within the shop, formed entirely of ventilating louvres, so as to turn the draught upward, whilst a screen board might be hung over the lower part of the door when only moderate ventilation was required. Turning next to artificial means of ventilation, Mr. Corbett pointed out that heat was the most constantly available power, either by direct fire heat or by steam or hot water; but any such means were less positive and more costly than ventilation by power, as applied to fans of one form or another. Heat could be applied by placing a fire or a few gas burners below an upcast shaft; but a much safer plan was to place a coil of hot-water pipes, with a regulative valve below the upcast flue. The best of all known means for inducing and regulating the ventilation of workshops were fans driven by power. In most workshops the power could be given by shafting, or steam could be supplied to a little engine attached to the fan. In some cases it would pay well to apply a gas engine for the purpose; the power required is very small compared with the results attained. Thus one indicated horse-power will, under favourable conditions, drive 12,000 cubic feet of air per minute, or 720,000 cubic feet per hour, in and out of a workshop, affording the minimum ventilation required for 720 workmen. Even in mild weather, when tenfold ventilation is required, it would serve seventy-two men. With such a power at hand, there was now no excuse for ill-ventilated workshops, for all the risks of back draught, and the irregularities and contrarieties of wind ventilation, were overcome by the power fan, which would give as much or as little air as required by the simple regulation of its speed. The fan should be fitted to the outlet, as it was difficult to disperse its violent draught when used on the inlets, and as only one outlet was best for each room, there was the one place for the fan. An outlet shaft would be required, as the fan could not advantageously discharge through a side opening, which might meet the pressure of strong wind at times. Sometimes, where dust had to be kept down, and had to be carried away from lathes, &c., it was convenient to use the space under a boarded ground floor, as the exhaust chamber leading to the fan, each lathe, &c., having an exhaust pipe through the floor, and one or more pipes being led down from near the ceiling, to carry off the gas fumes, &c. The speed of the fan might be regulated by stepped pulleys, like a lathe, or by cone pulleys and belting, or by curved cone friction pulleys, like a potter's wheel. A readier way of checking the draught is by a valve in the discharge shaft, either a throttle valve or a return escape valve; but in these cases the fan had the wear and the power of full speed at all times, while the speed regulation economised both wear and power. This regulation of the whole room should be controlled by the foreman, but the separate air inlets might be left to the men near them. In selecting a ventilating fan, its specially light work must be remembered. The high-speed blast fan was utterly wasteful as a ventilator, and the best forms had very large airways throughout, with little frictional surface, fine cutting edges, and truly curved vanes, so as to lightly pass a great bulk of air. These principles were ignored by many makers of fans, the result being that many were in the market which showed only from 30 to 60 per cent. of the efficiency of the best designs; and though he believed we had not yet seen the best possible form, he felt warranted in saying, as the result of several experiments, that the Blackman air propeller was a long way the best fan he had yet seen for light work, but it would not do well for more than 1in. of water pressure, and so was unsuitable for blast purposes. Where blast pipes had to be laid throughout a workshop, it is sometimes convenient to use the blast pressure for ventilating, by means of a blast jet, or set of jets, in the outlet shaft, working like the blast pipe in the funnel of a locomotive. Steam jets might be similarly used, but such non-economical appliances were best suited for sudden requirements during the cleaning of fires, machines, &c., rather than for constant ventilation. Where ventilation was thus forced, it was not needful to have so large outlets as those recommended for natural ventilation, but it was well that the sizes of outlets and shafts, &c., should be arranged for an air speed not exceeding 600 lineal feet per minute. The inlets should be arranged for a speed of about 200ft. per minute, to avoid strong draughts.

On the question of lighting, Mr. Corbett said that although no rules could be given as to the extent of window or skylight area, it was good policy to give plenty of glass in any workshop, but he would urge the importance of suitable glass, which should be either thick sheet or rough plate glass. The cleaning of windows and skylights was most unwisely neglected by many engineers, and a little calculation would soon prove that the cost of frequent window cleaning would be well repaid by the comfort and gas economy resulting from it. As to artificial lighting, with regard to gas the use of good burners was most important, both from the consideration of health and economy, whilst with regard to electric lighting the large incandescent lamps seemed to be the best for nearly all purposes. A supply of good water, and of convenient facilities to enable the men to make the best of their scanty supplies of food, were essential requisites for a workshop; and when one saw men from large works loitering round the nearest public-house, or sheltering against the walls in the streets, during their meal time, it was evident that an economy of their health and strength would be effected if the employer provided them a really comfortable dining-room in the works. Indeed, he was inclined to go still further, and to venture the opinion that in every works good washing accommodation should be provided, and that a moderate outlay in engineering papers would tend to cultivate the men's power of understanding drawings, and so add to their interest in engineering work as to well repay its cost. With regard to the question of sewering and waste appliances, Mr. Corbett observed that the right policy was to encourage habits of decency and cleanliness everywhere, whilst the proper sanitary arrangement of all sewers was absolutely necessary. In conclusion, he thought the most unobservant would admit that by proper attention to health in the workshop any man now working in an uncomfortable and unhealthy shop might be made at least 1 per cent. abler, more active, and more efficient in his work. Taking an average workman to be worth £100 a year to his employer, this 1 per cent. was £1 per year, or equal to £20 of capital. All that he had suggested would not cost £20 per man; in most shops not £5 per man; so he hoped that both on the low ground of mere money value and on the high ground of duty to those dependent on employers, his paper might convince them of the true "Economy of Health in Workshops." In the discussion which followed, the president—Mr. S. Dixon—observed that if they only took a commercial view of the question dealt with in the paper, it was greatly to their advantage, and also a matter of economy, to study the health of their workmen. The question of ventilation was a very important one in engineering shops, particularly where there was a quantity of metallic dust floating in the atmosphere; the flooring was also a very important consideration, as where it was not good it greatly contributed to the quantity of dust; but he had been glad to see that in most English workshops good floors were the rule. Alderman Asquith observed that the question dealt with by Mr. Corbett had been very much neglected not only in workshops but in the construction of dwelling houses, and it was essential that they should have good dwelling houses as well as good healthy workshops. Mr. Rea thought the Municipal Corporation might do a great deal in compelling proper attention to sanitary arrangements in workshops. Mr. Nasmith did not think they would find any flagrant disregard of sanitary and ventilating arrangements in modern workshops; in many of the old shops there were no doubt serious defects, but the number of these places was yearly becoming less; time was on the side of the sanitarian, and he did not think compulsion was desirable to compel these matters to be carried out. Mr. Boswell said there was a difficulty in ventilating some shops, as they had to be built for special purposes, and architects and ventilating engineers were still so much disagreed about the most suitable methods that it was difficult to say what was the best course to be adopted. A vote of thanks was passed to Mr. Corbett, who briefly replied, and the proceedings closed.

AMERICAN ENGINEERING NEWS.

(*From a Correspondent.*)

The Hudson River Bridge at New York.—At the meeting of the American Society of Civil Engineers on January 4th, Mr. Lindenthal read a long and interesting paper on the "North River Bridge," which is the most important feature in a project to bring all the several railroads now terminating on the west shore of the North (Hudson) river, across the river into New York. In view of the extensive river traffic, river piers are inadmissible, and the structure as designed by Mr. Lindenthal has a river span of 2850ft., a shore span on each side of 1500ft., and anchorage piers 320ft. long. It is to be a suspension bridge, with wire cables, and iron towers 450ft. high; the height above high water to be 150ft. Contrary to general practice, careful attention has been paid to architectural appearance, in order to ensure an imposing structure worthy of its position and importance. There will be six railroad tracks — more would complicate terminal facilities — and trains would run through to an immense depôt in New York City, abolishing the present steam ferries. It would accommodate a traffic of 50,000 passengers per hour in one direction, which would suffice for fifty years. The terminal depôt would have loop tracks for the continuous running of local trains. On the New Jersey side there would be extensive yards and shops, and connection would be made with all the numerous railroads. The bridge would be 86ft. wide, and the floor would rise 4ft. in summer and sink 4ft. in winter, making a total vertical movement between extreme temperatures of 8ft. Each cable would consist of two cables placed vertically one over the other, and braced together with eye-bars, forming a braced arch. The towers would be of iron or steel, with flaring bases, on caissons 270ft. by 180ft., open caissons being used. The vertical cables would be 6in. wire cables. The panels would be 50ft. long. The cables would be wrapped with wire and covered with a mantle of ⅛in. steel to protect them from the weather, a space of 1in. being left between the cable and mantle. The tracks would be laid with 100 lb. rails, placed on preserved wood in trough stringers, these stringers being deep enough to protect trains in case of derailment. The anchorage piers to be of monolithic concrete masonry faced with granite, the tracks being carried through in tunnels 84ft. wide by 40ft. high. Through trusses are used, and the floor system would be supported at intermediate points by columns connected with transverse trusses resting on the upper boom. The 1500ft. shore spans have an iron tower support at mid-distance. The estimated cost of the bridge alone is 15,000,000 dols.; the total cost for the project in its entirety would probably reach 50,000,000 dols. The enterprise is very ambitious, but it is stated that it is in a fair way to be carried out.

Railroads in Mexico.—Mr. W. H. McWood, of San Francisco, Cal., has a very valuable concession from the Mexican Government for a railroad from Tepic, in the State of Jalisco, to Mazatland, through Sinaloa and Sonota to Yuma, Arizona. Work must be commenced by May and completed in three years. An engineer corps will start in January. Boston, New York, and English capital will be interested. The Mexican Central Railroad will have the Guadaljava branch completed by May. Work is in active progress from Aguas Calientes on the San Luis Potosi branch, and the line from San Luis Potosi to Tampico; both will be completed this year. The Mexican National Railroad has over 7000 men engaged on the northern and southern divisions of the gap between San Miguel de Allendo and Saltillo, and will complete this line by October, giving a direct line from the city of Mexico to St. Louis, Mo. The International Railroad from Laredo, on the Mexican Central Railroad, to Eagle Pass, is nearly completed. The Mexican Government is desirous of having a railroad built from the city of Mexico to Acapulco, of the Pacific coast, and also one across the isthmus of Tehuantepec.

American Society of Civil Engineers.—The annual meeting was held January 18th and 19th. On January 18th the meeting assembled at the house of the Society for the transaction of business, election of officers &c. The matter which aroused the most interest was a proposed amendment to the constitution, providing for a "student" grade, and the change of name from "Junior" to "Associate Member." There was a long and somewhat acrimonious discussion, both verbally and by correspondence, but there was a general opposition to the admission of young men as "students" of the Society; the conditions being different from those which obtain in the English institution. It was finally decided, however, to let the amendment relating to the creation of a "student" grade go out for a letter ballot of the whole Society, but to strike out all reference to the change of name of the "Junior" grade to that of "Associate Member." Several committees presented reports, and other business was transacted. In the evening Lieutenant C. C. Rogers, U.S.N., lectured on "The Panama Canal in 1887," being a description of what he saw on a trip over the course of the canal by order of the Navy Department. On January 19th the party went up the East and Harlem rivers by steamer to inspect the new "Manhattan" bridge over the Harlem river. There are two 510ft. spans of arched plate girder ribs—there being six ribs, 13ft. deep—these ribs are of steel; the bracing is of wrought iron. The clear height is about 135ft. The approaches are of masonry, with graceful arches, and the bridge when completed will be a very handsome structure. In the evening the usual annual reception closed the meeting.

The Railroad Commission of New York State.—The Board of Railroad Commissioners has issued its fifth annual report. The business of the railroads shows a large increase:—Gross earnings, 143,724,490 dols. 62c. and 125,160,289 dols. 48c. for 1887 and 1886 respectively; operating expenses, 92,439,974 dols. 60c. and 79,260,798 dols. 30c.; net earnings, 51,284,516 dols. ·02c. and 45,899,491 dols. 18c.; dividends, 13,822,874 dols. 10c. and 11,178,176 dols. 67c. for the two years. With regard to the Act passed providing for the abolition of the car stove after May next, it is stated that a number of roads have adopted various systems of heating by steam from the locomotive, and are now endeavouring to decide upon a uniform and standard coupling for the pipes. The Board is not yet prepared to say which method is the best, as only practical experience through several winters can decide. Proper means of ventilation are recommended. Much has been done towards the adoption of uniformity in rules and management; automatic car couplers will probably be generally adopted very soon, and continuous brakes for freight trains are an improvement for the near future. The Board recommends legislation on several subjects, as at present it has no power to compel obedience to its decisions, and thinks it ought now to have such power. Among the subjects are the abolition of grade earnings, the abolition of the centre bearing rail—⊥—for street rails, prohibiting the leasing of parallel railroads, regulating railroad construction, penalty for companies failing to make quarterly reports, providing that freight cars shall have a low railing round the roof to prevent brakemen from slipping off. During the year 532 people were killed and 1260 injured, an increase of 29 and 122 over the year 1886.

Abandoning grade crossings.—The New York and Harlem Railroad Company will lower its tracks through the 23rd and 24th wards of New York City, and has made satisfactory arrangements with the Park Department. The tracks will be lowered about 7ft. to 12ft., and twenty-eight steel bridges will have to be built. The estimated cost is 2,000,000 dols., the whole of which will be borne by the company. Work will be commenced in February. The altered line will be in an open cut, with retaining walls for about four and a-half miles.

Widening gauge.—The Cleveland and Canton Railroad—in Ohio—will be widened to standard gauge. The change is estimated to increase the receipts from 120,000 dols. to 240,000 dols. per annum. It will enable connections to be made with a large number of important lines; heavier rolling stock will increase the carrying capacity; it would avoid the public prejudice against narrow gauge roads. President Blood in his report says that a narrow gauge coal train contains 240 tons, while a standard gauge train carries 875 tons. He says that with standard gauge the road can pay on a capitalisation of 30,000 dols. per mile. The net earnings for 1887 were about 110,000 dols., or 1¾ per cent. on the stock. The line runs from Cleveland to Canton, O., 115·13 miles, with branches to Sharrodsville and Minerva, aggregating 45·46 miles; total, 160·59 miles. Gauge, 3ft., laid with steel rails of 30 lb. and 40 lb. per yard. The road runs through a coal region, and would, with standard gauge, have considerable traffic with other roads.

The Rio Grande Pacific Railroad Company has been incorporated at Salt Lake City, Utah Territory, to build 300 miles of road. The line will run from Glenwood, Col., to Salt Lake City, running by the White River cañon, and will continue to Ogden. This will be the Utah Division of the Denver and Rio Grande Railroad. Capital stock, 8,000,000 dols.

The Hudson Bay Railroad is languishing. Mr. H. S. Hoyt, who built forty miles of the road in Manitoba for a company headed by Mr. Hugh Sutherland, has had considerable trouble in securing payment; he has a judgment for 21,000 dols., and will hold possession of the road until the claims are settled, but he does not intend to operate it. The Canadian Pacific might use it as a branch road, but he does not think this likely. It may be extended to Grand Rapids, at the head of navigation on Lake Winnipeg, opening up good agricultural country, but it is not likely to be extended to Hudson Bay.

Westinghouse Air Brake Company.—The Westinghouse Air Brake Company, Pittsburg, Pa., has increased its capital stock from 3,000,000 dols. to 5,000,000 dols. Of the addition, 1,000,000 dols. will go to the stockholders as a dividend, the other 1,000,000 dols. will be available for subscription by railroad companies which have adopted the Westinghouse improved brake for freight trains.

The Nicaragua Ship Canal—At Washington, D.C., a bill has been introduced to incorporate the Maritime Canal Company of Nicaragua for the construction of a ship canal between the Atlantic and Pacific, through Nicaragua, or partly through Nicaragua and partly through Costa Rica. The capital stock to be 100,000,000 dols. in 1,000,000 shares of 100 dols. each, with power to increase the number of shares to 2,000,000. The surveying party of the Nicaragua Canal Company arrived at Greytown—San Juan del Norte—on December 9th, and is now fairly started on its duties.

The Detroit river tunnel.—A railroad tunnel is projected under the Detroit river at Detroit, Mich., to effect a connection between the Canadian Pacific Railroad and the Michigan Central Railroad. Mr. James Ross, of the Canadian Pacific, has examined the site, and believes the project to be practicable.

LEEDS ASSOCIATION OF FOREMAN ENGINEERS AND DRAUGHTSMEN.—On Thursday evening, at the ordinary monthly meeting of the above Association, Mr. J. Yates in the chair, a paper was read by Mr. J. F. Elsworth on "Modern Steam Boilers." The author dealt first with the vertical boiler pointing out its advantages and defects, and showing how these latter might be remedied, speaking favourably of the Cochran vertical boiler. The Lancashire boiler was next described, and the various points in its manufacture commented upon. The Galloway and Hopkinson forms of this boiler were also dealt with. The author next spoke of the marine boiler, and mentioned the difficulty which had been experienced in getting the furnace tubes to withstand the high pressures. A number of methods of strengthening the furnaces were then described, and their various features commented upon, including the Adamson, Bowling, Paxman, and Midgley ring-seams, and the Fox, Brown, Fenby, and Arnold flue tubes. The marine boiler itself was then dealt with, and various types described. The efficiency of boilers was next touched upon, the author showing how much of the heat generated by coal it was possible to convert into steam in a boiler, and concluding with some remarks upon the phenomenon of priming. The paper was illustrated by a number of diagrams. A useful discussion ensued, which was taken part in by Messrs. Whitehouse, Moorhouse, Atkinson, Fowler, Crier, Tempest, Horsfall, Young and Darley. After Mr. Elsworth had replied a vote of thanks was proposed by the chairman and carried unanimously.

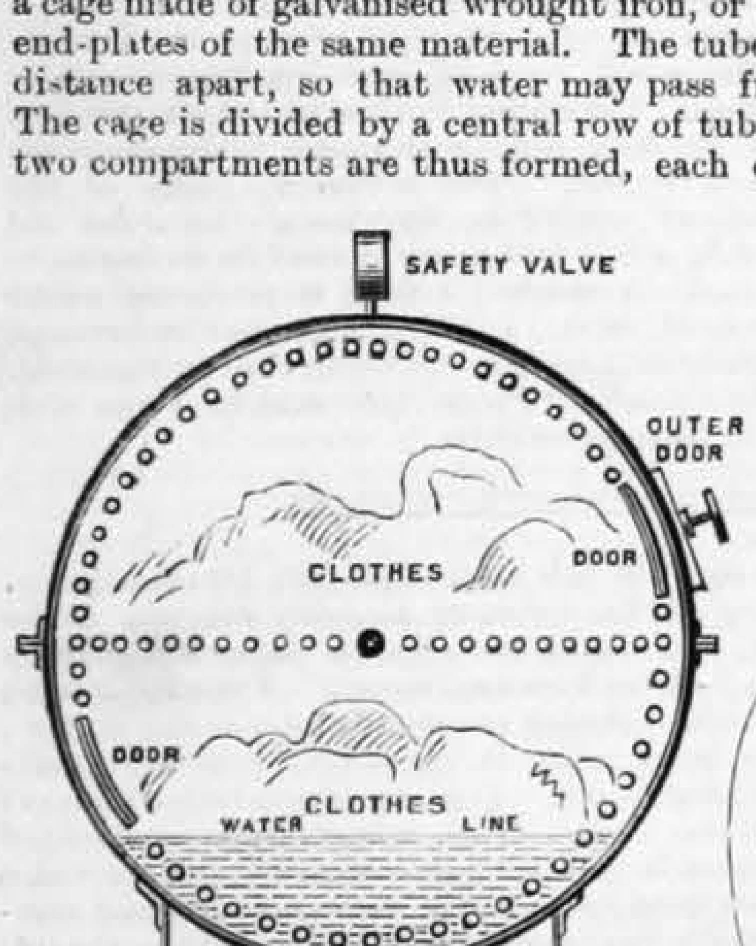
VOLK'S ELECTRICALLY PROPELLED DOG CART.

VOLK'S ELECTRIC DOG-CART.

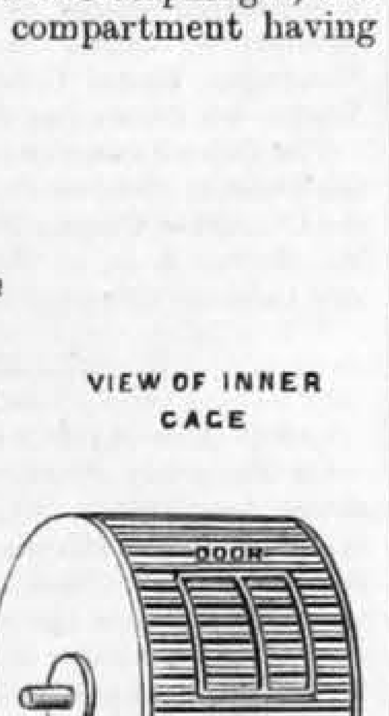
THE vehicle illustrated by the accompanying engraving is fitted with one of Immisch's motors of $\frac{1}{2}$-horse power type. The current is supplied by sixteen small E.P.S. accumulators, their normal discharge lasting six hours. The cells are placed under the seats, and the motor is placed on hangers under the body, and is connected by a chain to a counter-shaft, from which another chain leads to a toothed ring on one of the wheels, to which it is attached by a series of blocks attached about one foot apart, an arrangement which looks neater and weighs less than any pulley of similar diameter, namely, four feet. Experiments with the dog-cart show that the motor is barely large enough for the work it has to do. It only weighs 40 lb. But although not all that is required, valuable data has been obtained as to the power required to propel a vehicle on ordinary roads, and as to some details. On asphalte the tractive force is less than on a grooved rail, and a speed of nine miles an hour can be obtained, whereas on a soft macadam road only four miles an hour is found to be possible. The vehicle with two persons in it will ascend a grade of 1 in 30. Taken altogether as a first experiment, the result may be considered both interesting and satisfactory. The vehicle was made by Mr. Pack, coach builder, of Brighton, and as electrically fitted up by Mr. Volk, is the object of much attention just now in Brighton.

HARPER TWELVETREES' ROTARY WASHING-MACHINE.

THE machine we illustrate, as made by Mr. Harper Twelvetrees, consists of a stationary cylinder supported on a wrought iron stand, and made of mild steel plates $\frac{3}{8}$in. thick properly rivetted together. The cylinder is made in two parts, flanged and bolted together, so that access to the interior may be gained if required. This cylinder or casing is galvanised, made perfectly steam-tight, and tested to 120 lb. hydraulic pressure per square inch. A strong cast iron door fitted with hand-wheel screws is attached to the upper section. Inside the casing is a cage made of galvanised wrought iron, or copper tubes fixed to end-plates of the same material. The tubes are placed a short distance apart, so that water may pass freely between them. The cage is divided by a central row of tubes or diaphragm, and two compartments are thus formed, each compartment having

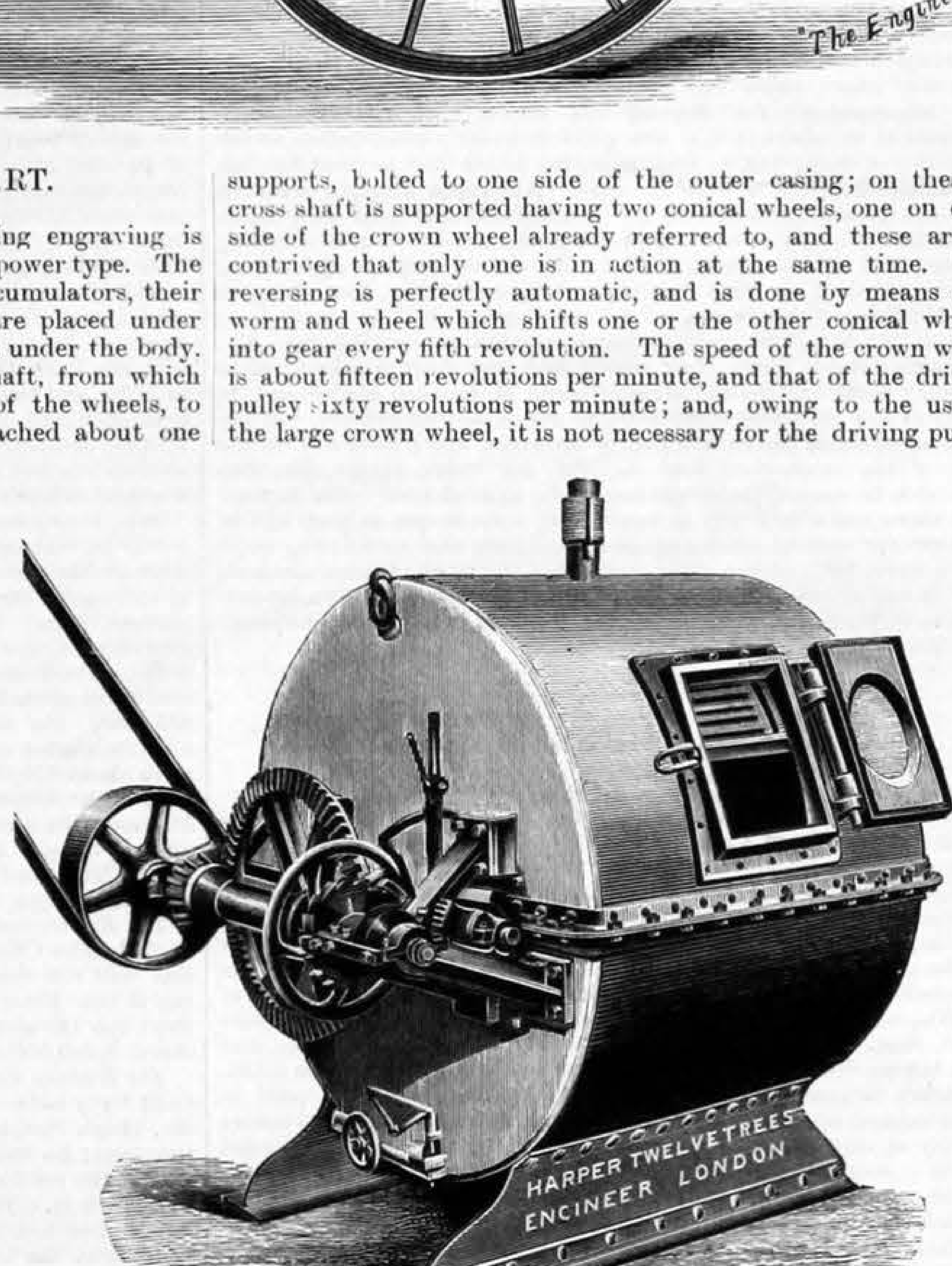


SECTION



VIEW OF INNER CAGE

a sliding door for loading and emptying. The whole of the cage and doors are galvanised. The cage is attached to a central shaft running in gun-metal steam-packed gland bearings, made in two parts like the outer casing. One end of this central shaft projects so as to receive a large crown wheel, which is actuated by the driving gear. The two main features about the driving-gear are its compactness, and the automatic reversal at every fifth revolution. The gear is supported on two massive supports, bolted to one side of the outer casing; on these a cross shaft is supported having two conical wheels, one on each side of the crown wheel already referred to, and these are so contrived that only one is in action at the same time. The reversing is perfectly automatic, and is done by means of a worm and wheel which shifts one or the other conical wheels into gear every fifth revolution. The speed of the crown wheel is about fifteen revolutions per minute, and that of the driving pulley sixty revolutions per minute; and, owing to the use of the large crown wheel, it is not necessary for the driving pulley



to be more than 17in. diameter, thus saving space. The motion is readily stopped by means of a lever provided for the purpose, and for bringing the mouth of the cage exactly opposite the outer door a hand wheel with toothed wheel and pawl are provided, ensuring perfect safety to the operator. The machine has a dead-weight safety valve, hot water, cold water, and steam pipes laid on; also waste water outlet, and two steam-tight hand holes at the bottom for clearing out sediment, these latter hinged and fitted with hand wheel and screw fastenings.

For a description of the operation of the machine we may quote a report by Mr. P. Miles, engineer to the Whitechapel Infirmary, which is as follows:—"In the infirmary we have about 800 inmates, and the number of pieces washed weekly amounts to 18,000, of which Harper Twelvetrees' rotary washer does 6000 of the heaviest articles. The machine holds 400 pillow slips, 150 shirts, 130 sheets or 35 large quilts at once. The time occupied by either of the above loads for washing is twenty minutes, the water required being only forty gallons. No packing is wanted, the clothes being thrown in anyhow. In addition to washing we rinse, boil, and blue all the clothes in the machine without removing them, thus:—(1) The clothes are thrown in loosely; (2) warm water is let in by the proper valve and liquid soap introduced, the door closed and the machine set in motion, the water being gradually raised in temperature by the admission of steam; (3) in twenty minutes the soapy water is run off, and clean cold water introduced whilst the machine is in motion; (4) being thus rinsed, the water is run off and warm water let in, which is boiled by steam; (5) the clothes are then blued in a similar way, and are ready for removal to the wringing machine. Four operations are thus done in one machine, four waters used of 40 gallons each, total 160 gallons; time occupied, 90 minutes." Mr. Miles further states the machine works very well in every way, and that since its adoption, six months ago, several hands have been dispensed with. The steam is confined to the machine, thus keeping the atmosphere clearer than when the boiling was done in open coppers. The diaphragm increases the washing-power and capacity, because the clothes are alternately drawn out of and rolled into the water, thus penetrating the fabric better. The water also treats two lots of clothes alternately, whereas in the ordinary revolving machines the clothes are always in the water. The reversing gear prevents any twisting or entanglement, and ensures both sides of the articles being rolled down the corrugated sides and diaphragm of the cage. Disinfecting may be done in the machine by subjecting the clothes to the action of steam under high pressure.

BRAY'S ANTIPULSATOR.

To prevent the pulsations and variations in the pressure of gas supplied to gas engines, Messrs. George Bray and Co. are making the antipulsator illustrated by the accompanying engravings. From Fig. 2, which is a vertical section of the apparatus, it will be seen that the gas, entering by the upper pipe, finds its way into an annular chamber, formed by a space between the outer casting and an inserted tube, both seen in section. In this inner tube is a long, narrow slot, as seen by

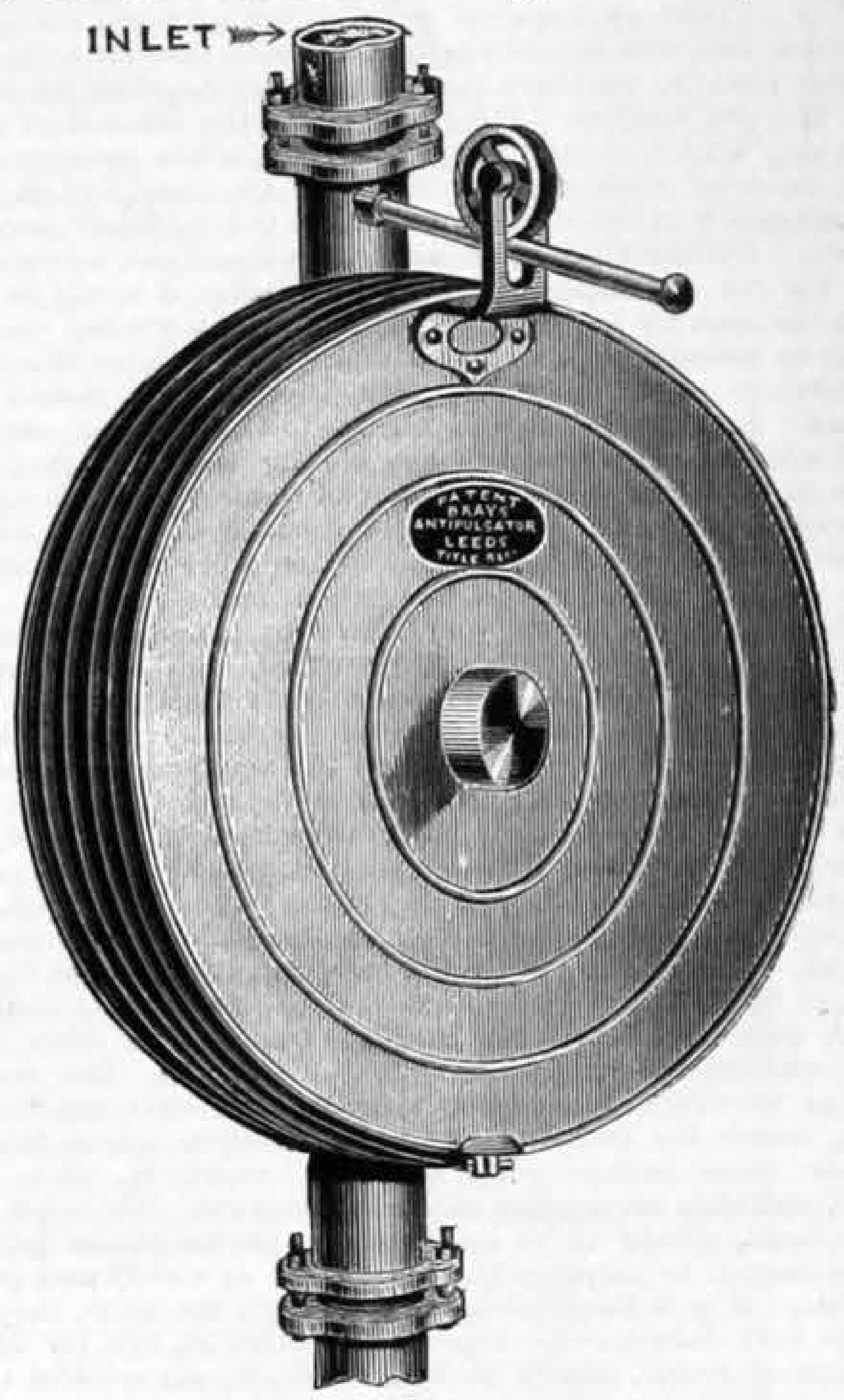


Fig. 1

dotted lines behind the little piston. When the piston is in the position shown, the gas freely enters the bellows through this slot, passing in front of the piston. As the gas fills the bellows the piston is pulled forward, and the slot is more or less covered, and the ingress of the gas restricted. When the bellows are quite full, and the pressure slightly exceeds that of the atmosphere, the piston completely covers the inner end of the slot, and the gas is cut off entirely.

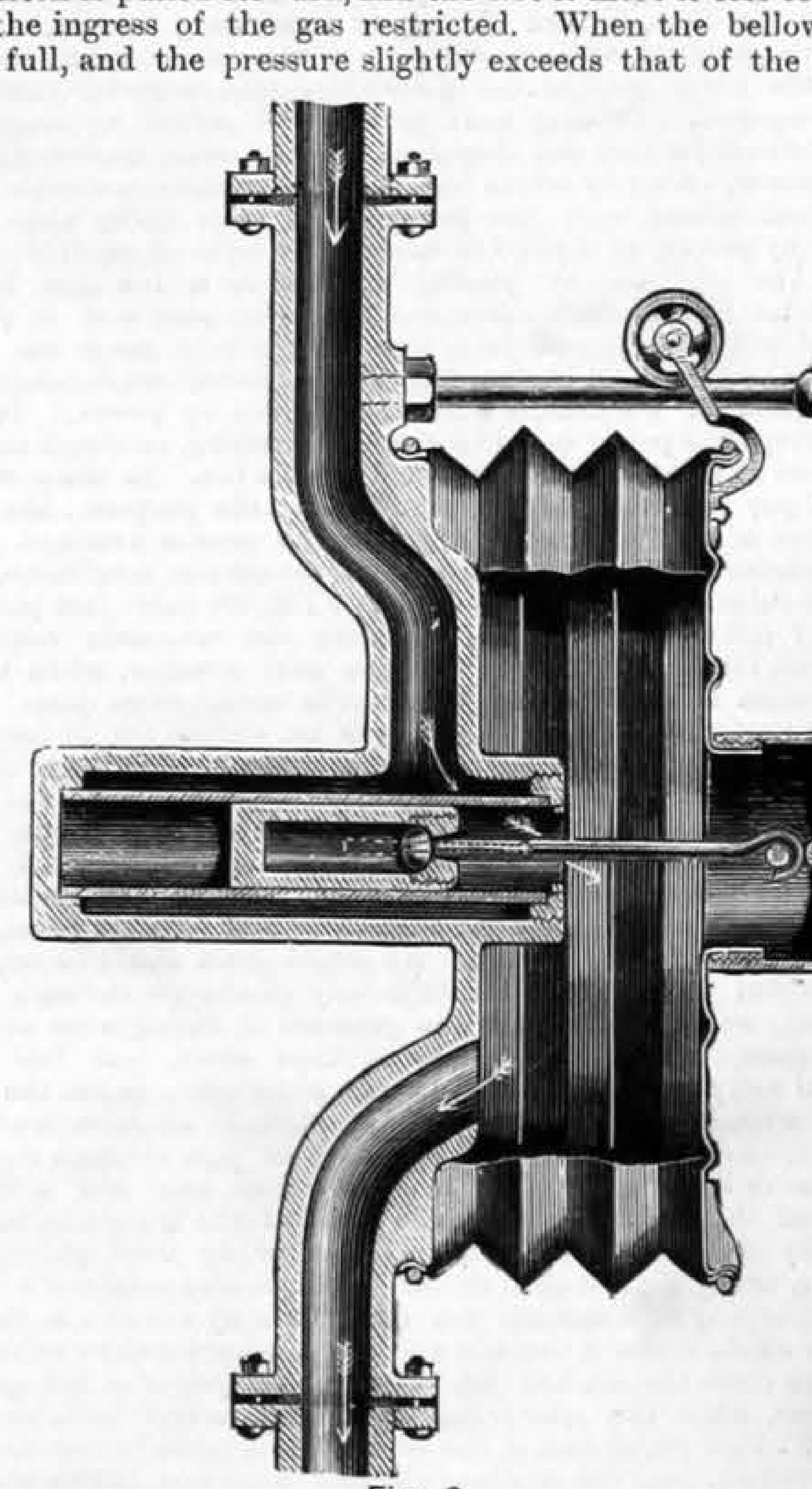


Fig. 2

The action of the apparatus is found to be effective in entirely preventing the jumping and oscillation of gas lights on the same supply as the engine, and the uniformity of the pressure supply to the engine prevents that variation in the strength of the charge taken into the cylinder. The working of the engine is thus improved, and a saving in gas is secured.

RANGE FINDERS.—Major A. W. White, R.A., has contributed an admirable paper to the United Service Institution "Proceedings," contained in vol. xxxi., No. 141, which may be commended to artillerists of all branches of the service. Major White is the head of instruction in this department. The accuracy obtainable by the service range finders is carefully and clearly investigated and the mathematics are not high or difficult. The Weldon is a favourite with many on account of its simplicity, but is liable to larger error than the Watkin. Major White works out the error due to holding the instrument over the foot instead of directly over a cap placed between his feet as the actual point taken. In 500 yards range this comes to 44 yards, or 8·8 per cent. The average errors taken from a series of trials with the Weldon were 11 per cent. by the so-called "first method" for ranges under 1000 yards, and 5·84 per cent. by the "second method" for ranges between 1000 to 2000 yards. Practice shows that the error with the Watkin is only about 1 per cent.

LETTERS TO THE EDITOR.

(*Continued from page 89.*)

FORCED DRAUGHT.

SIR,—In your yearly summary of engineering progress, published in your issue of the 6th inst., the references to my system of forced draught hardly do it justice, and in one particular they do it very considerable injustice, though this was doubtless occasioned by want of information. You say forced draught "has been fitted to a good many small steamers on Howden's system with benefit." This statement is scarcely applicable to such steamers as the City of Venice, of Messrs. Geo. Smith and Son's Calcutta Line; the Celtic, of the White Star Mail Line; the Ohio, of the Inman and International Steamship Company's Mail Line; the City of Berlin, mail steamer, of the same company; or the Tasso and Ariosto, of Messrs. Robert MacAndrew and Co.'s South American Line, sister steamers, each carrying 4000 tons deadweight cargo and coal on a comparatively light draught: all which have been fitted with my system during 1887. The smallest steamer to which my system was fitted last year in this country is the twin screw steamer Rescue, of Liverpool, of 1500 indicated horse-power. Several steamers of less power were, however, fitted abroad in 1887 with my system, the whole aggregating for the year 20,000 indicated horse-power. In the next sentence you state: "Ferrando's system is being tried by MacAndrews, and more are to be fitted." As the three steamers Messrs. MacAndrews have working with forced draught are all on my system, such a statement as you make is scarcely in keeping with the fairness, or, at least, accuracy which should characterise a journal of the standing of THE ENGINEER.

Having made these corrections on your review, which in justice to myself I could not avoid, and which for the same reason you will doubtless publish in your next issue, I will take this opportunity of briefly reviewing the history of the forced draught movement up to this date, both in the Navy and mercantile marine, and I will also give some particulars of results obtained with my system in some of those steamers previously mentioned.

As stated in the paper I read at the Institution of Naval Architects in 1884, it was in the beginning of 1880 that the reading of the trials of torpedo boats with closed stokeholds and an air-pressure considerably above the atmospherere recalled to my mind the experiments I had made with forced draught so far back as 1862, when I built a boiler to discover the effects of forced draught by maintaining an air-pressure in a closed ashpit by means of a fan. Though the results were not satisfactory in several important features, and I abandoned the idea, at the time, of continuing to prosecute the matter further, yet the causes which prevented the attainment of a high success had impressed themselves distinctly on my mind. It was therefore with considerable interest that I read the accounts of the torpedo boat trials; but it appeared to me obvious that such a mode of working a steam boiler with cold air was radically wrong, both in principle and practice, and highly unsafe, especially for sea-going steamers. This conclusion led me back to my experimental trials of 1862, and after considering the whole subject again with revived interest, I designed my present arrangement to effectually overcome all the practical and theoretical deficiencies discovered by my experimental trials with a closed ashpit in 1862, and adding thereto features insuring the highest possible economy in steam boilers, and which at same time combined unequalled power with perfect safety in working.

It was not, however, until June, 1882, that I had the opportunity of applying my system to a small marine boiler with two furnaces, which I purchased for the purpose, and finding that my anticipations of having solved the problem of a correct system of combustion were confirmed, I shortly thereafter built a larger boiler for the purpose of establishing the proper proportions and relations of areas, air pressures, quantities, &c. These experiments with the new boiler were carried out in 1883 and 1884 down to the time of reading my paper at the Institute of Naval Architects in the latter year. By that time I had established all proportions with exactitude and had proved the ease and certainty with which any desired power, within the capability of the boiler, could be attained. Since that time the experiments I have made have been chiefly to ascertain the proper mode of treating in the furnace several peculiar qualities of coal, and to establish more particularly the ratios of exit areas, and air pressures which govern the higher rates of combustion. When I read my paper in 1884 I was therefore in a position to speak with some confidence of the capabilities of the system I had worked out. It happened that the steamship Oregon was the latest and highest powered Atlantic steamship of the day, developing 12,000 indicated horse-power from boilers having seventy-two furnaces and 1512 square feet of grate surface, and I then stated that from data I had obtained, by actual trials in my experimental boiler, I could produce the same from thirty-six furnaces and 641 square feet of grate. I well remember the general incredulity with which my statement was then received.

In that paper I also called attention to the danger of working boilers on the closed stokehold system at a high power, this system being then largely introduced into our war ships. Though the reasons I gave appear obvious enough to anyone who will give the subject a little consideration, my warnings of disaster when this system should come to be really proved, were unheeded. The only trials that had taken place with this closed stokehold system had been limited to runs of from two to three hours' duration with clean boilers and fresh water, and even these trials gave indications of serious damage to the boilers.

Up to this period I had been content to thoroughly work out data with my experimental boiler, without seeking to apply my system to a sea-going steamer, but having now made quite sure of my ground, I contracted immediately after the reading of my 1884 paper to reboiler and fit with my system of forced draught the New York City, of Messrs. Scrutton, Sons, and Co.'s, West India Line. This steamer was refitted a few months thereafter, and, after a satisfactory trial, sailed direct from the Clyde for Trinidad on 13th October, 1884. The proportions of all the apparatus, the quantities and air pressures used, based on the results obtained from my experimental boiler, proved to be exactly suited for the required combustion and power, so that all details remain in this steamer without alteration to this day. This steamer, with ordinary compound engines working on 80 lb. pressure, now running in her fourth year, has run continuously since starting entirely with forced draught without the loss of an hour's time, making her long voyages at a rate of combustion giving from 17 to 18 indicated horse-power per square foot of fire grate. One noticeable feature in this case is that the boiler has worked all those years entirely with salt water, except when sailing from London once every three to four months. All waste is made up from the sea, and when the density becomes too great, the boiler is blown down, and made up afresh from the sea. Notwithstanding this severe treatment during these years, the boiler is at this day almost as good as new, and without a tube ever having been touched. In the words of the chief engineer of the ship, which I find in the December number of a monthly contemporary, "the boiler, including fan engine and fan, has not cost five pounds since it left the makers' hands, and is now in first-class condition." The importance of these facts can scarcely be over estimated by the heads of our naval department, and by steamship companies, who are seeking for increased power in reduced space, combined with the highest economy in fuel and durability of boilers. In my paper of 1884 I directed attention to the important feature of my system, which prevents the great variations of temperature of the interior, and injury therefrom to which other boilers are subject. The correctness of this claim, which in 1884 was based chiefly on inferential grounds, has been remarkably confirmed and proved by the severe practical tests of these years. The other important advantages which I claimed for my system were great evaporative power combined with high economy in fuel, complete control in working at any desired power, and capability of being worked in the ordinary way without trouble. All these claims have been amply sustained by the test of continuous work at sea. One further noticeable feature is, that whatever can be obtained in power and economy on a full-speed trial, can always be sustained, and, at least as regards power, exceeded, in ordinary working at sea. This is owing to the fact that my arrangements have never been made with a view to the delusive results of a few hours' trial, but for daily work at sea, and also to the circumstance that the trials have hitherto been made with raw hands. The results necessarily improve when the staff on board become familiar with the mode of working, and especially when they follow strictly the few and simple instructions I give as to the proper course of working.

What has actually been attained, as regards power and economy, will be better understood by the study of the results obtained in several of the steamers mentioned in this letter. The New York City, as already mentioned, with 80 lb. steam pressure and ordinary compound engines, has during all these years developed from 17 to 18 indicated horse-power from each square foot of grate on a consumption of coal averaging about 1·4 lb. per indicated horse-power per hour, though there have been voyages with the consumption as low as 1·337 lb. per indicated horse-power per hour. The City of Venice, owing to certain circumstances, has only lately been fully worked in the manner I designed, and I am therefore unable, at the moment, to give accurate ratios of consumption and power in terms of indicated horse-power, but I can state certain facts, which, probably, are as conclusive. Her performances are more than ever effective and satisfactory. She made her last voyage to Calcutta at an average speed of 11½ knots on a consumption of 25 tons Scotch coal per day, which, her owners inform me, is 40 per cent. less than would have been required for the same speed with her compound engines, though supplied with steam from boilers having double the number of furnaces, and considerably more than twice the area of fire-grate than in the forced draught boilers now fitted in this steamer.

The comparative effects of my system in regard to economy and power are still further illustrated in the case of the City of Venice by the circumstance, that the owners in order to test the effect of my system against triple expansion engines of the same power supplied by steam from boilers worked with natural draught, had another of their steamers of same tonnage refitted at the same time with triple expansion engines on three cranks and two double-ended boilers, having twelve furnaces and maximum steam pressure of 150 lb.; the steam pressure in the two single-ended boilers of the City of Venice being 145 lb. The working of these two steamers has shown that the City of Venice with half the number of furnaces worked on my system has proved herself much more economical in fuel and more powerful, as she is maintaining a fully higher speed and has a more amply supply of steam. As the refitting of this other steamer with her new machinery was executed by an eminent firm here, who would do full justice to the work, it was by no fault of theirs that the larger natural draught boilers did not compete successfully with the smaller ones worked on my system.

The Ohio, which has now been running continuously for upwards of six months, has been thoroughly tested. With nine furnaces and 111 square feet of grate surface, her boilers—on my system—produce considerably higher power than was formerly obtained from her boilers with eighteen furnaces and 300 square feet of grate. The maximum indicated horse-power contracted for was 2100, and the consumption guaranteed 1·25 lb. per indicated horse-power per hour, and on the official trial, when testing consumption, the mean indicated horse-power was 2124 and the consumption 1·23 lb. On her voyages it is more difficult to obtain the accurate consumption of the main engines only, owing to so much steam being used from the main boilers for auxiliary engines and ship's purposes. I have given elsewhere full particulars of the last special tests of consumption made during a voyage, which I believe show that in ordinary conditions of working at sea the boilers supply the propelling engines with steam on a consumption of not more than 1·25 lb. of South Welsh coal per indicated horse-power per hour.

As regards power, the engines of the steamer have—on her ordinary voyages across the Atlantic—continued to maintain a higher power than on the official trial, while there has been a greater drain of steam from her boilers for auxiliary engines, heating and other ship's purposes than on the official trial, the average total being at least equal to 2250 indicated horse-power of the main engines. The boilers have, however, never yet been worked up to the highest power of which they are capable, even with the present forced draught appliances, which were designed and proportioned to maintain 2100 indicated horse-power at sea, as the size and pitch of the propellor do not permit of the main engines being worked to a much higher speed and power with advantage, the cylinders receiving at this power nearly as much steam as they can properly use. The engines have, however, been run for a sufficient period at sea to show that with the usual staff of one fireman to three fires, a total indicated horse-power of 2500 could, with present appliances, be maintained without trouble across the Atlantic. I have diagrams taken during the day on which the engines were running above average power, showing 2425 indicated horse-power, and, as the steam then used for auxiliaries and other purposes would be equal at least to another 125 indicated horse-power, the boilers would then be supplying steam for a total of 2550 indicated horse-power, being at the rate of 23 indicated horse-power per square feet of fire-grate, the coal used being entirely American. I wish to call particular attention to these and the following facts established by the working of this steamer, the importance of which will excuse the length of detail. During every voyage across the Atlantic the boilers have made up waste from the sea, and on some voyages the amount of salt water used has been sufficient to leave a considerable scale in the boilers. Though I do not recommend so much salt water in boilers worked at this pressure, it has as a fact, been used without any detriment to these boilers even at the high rate of combustion stated. Another point to which I wish to direct special attention is, that the whole air of combustion for these boilers is obtained from one fan 5ft. 6in. in diameter, running at about 320 revolutions per minute for a total of 2250 indicated horse-power, and about 350 revolutions for 2500 indicated horse-power. In my paper read at the Institution of Naval Architects in 1884, I made a special claim of being able to give a high rate of combustion with my system with much less than the usual quantity of air. This has also been amply confirmed by the working of these steamers, hence their high economy combined with high power.

These results have been quite sustained, so far as a trial can show, in the trial of my system in the City of Berlin last month, after being re-engined and re-boilered by Messrs. Laird Brothers. The fire-grate of the boilers of this steamer, on being measured before trial, was found to be 270 square feet. On running down the Irish Channel, with the propelling engines taking all the steam they could use, and indicating 6025 indicated horse-power, the boilers all the time receiving a cold feed, the safety valves were lifted, and steam blown off hard without a poker or slice being used in the fires, though, besides the supply of the main engines, all the steam for the auxiliary engines, of which there are sixteen or seventeen, with the electric light engines and heating of the entire ship in full operation, was supplied from the main boilers. If the whole supply of steam from the boilers for auxiliary and other purposes be taken as equal to 300 indicated horse-power of the main engines, an estimate which I believe Messrs. Laird Brothers would support me in saying is not overstated, the total indicated horse-power from the 270 square feet of grate is 6325, or 23·4 indicated horse-power per square foot of fire-grate.

If these real trials at sea, during which all the ordinary and necessary work of the stokehold is at the same time carried on by the stokers, be compared with the two or three hours' forced draught trials of the Admiralty with closed stokeholds, some light may be thrown on the comparative effects of the two systems. The Admiralty trial is made with engines expressly designed for racing and recording the highest possible indicated horse-power, with probably one stoker to each furnace, and all such necessary processes for a seagoing steamer, as cleaning of fires, hoisting of ashes, &c., during such a trial are utterly unknown. Though these short, forced draught Admiralty trials with the closed stokehold thus no more compare with what could be maintained continuously at sea for twenty-four hours than the pace of the Derby winner during the seconds of the race compares with what it could sustain, without damage, during a two hours' run, I do not find that even during these few hours of supreme effort any record of so much as 22 to 23 indicated horse-power per square foot of grate having been obtained on Admiralty trials, a rate attained in the Ohio without effort on her ordinary voyages.

The case of the Celtic, of the White Star line, is one on different lines. The boilers to which my system is applied are the original boilers of the ship, over fourteen years old, and by no means so well adapted for the use of forced draught as new boilers, specially designed, would be. The arrangement of the boilers in the ship, not designed, of course, for such a mode of working, also made the application of my system more than usually difficult, and a case which under less competent management could easily have been made a mess of. In the able hands of Messrs. Harland and Wolff, by whom the work was executed, and under the judicious supervision of the superintendent and the engineering staff of the company, the Celtic, with two boilers less since the refit, has maintained a considerably higher power than before, making the voyage in considerably less time with no greater consumption of coal; thus showing, even under unfavourable conditions, the valuable advantages that can be derived from the application of my system. Now that it has become a matter of very general publicity, no confidence is violated in stating that the managers of the company, and their naval advisers, Messrs. Harland and Wolff, have been so satisfied with the working of my system in the Celtic, that they have adopted it for their two new large steamers building at Belfast, to which you referred in your summary, and which will probably surpass in power and speed all competitors on the Atlantic.

I trust I have given sufficient examples to prove that my system of combustion has—as I claimed for it in my paper read before the Institution of Naval Architects in 1884—a combined power and economy surpassing any other mode of supplying steam, and further, that it is as easily worked as natural draught, and has the important features of rendering the boilers thoroughly under control as to the generation of steam, so that no blowing-off need take place with sudden stopping of the engines; also, that it reduces the wear and tear of the boilers and enables them to be worked at a high power and pressure with salt water; and besides, prevents any high heat in the chimney even when working at the greatest possible power.

That the limits of power and economy of which my system is capable have not yet been reached, I have proved by special experiments. In my I. N. A. paper of 1884, the 12,000 indicated horse-power which I said I could maintain in ordinary work at sea, from 641 square feet of fire-grate, or 18·7 indicated horse-power per square foot, in such a steamer as the Oregon, I accomplished easily in my first sea-going steamer—the New York City—with 80 lb. pressure; and I have—as I have shown—far exceeded this, since, in the Ohio and other steamers. In my I. N. A. paper of 1886, I stated that 25 to 30 indicated horse-power per square foot of grate could be obtained at sea with ease and safety from my system. This, as I have proved, is within safe working limits. At the present moment I have undertaken to supply engines of the same power as those of the Ohio, to be worked with two single-ended boilers and six furnaces having 100 square feet of grate. These boilers may be worked continuously at 2500 indicated horse-power. The limit of safe and economical working is, however, much beyond this, but I recommend that the higher powers be reached by very gradual steps.

You mention that the progress of forced draught has been slow during the past year, and many who have seen some of the performances of my system have enquired with some surprise why it has not been more widely adopted? There are sufficient reasons, no doubt, for this. Some inventions of very doubtful merit, but catching appearance, often seem to be borne on their way to commercial success by favouring gales and almost universal applause from their first appearance, though after enriching their possessors they eventually sink into oblivion; while others of real value have to struggle for years against ignorant opposition and detraction until their merits can be no longer ignored, and eventually they take their rightful place. The history of engineering progress records many instances of the latter, the present day exhibits some notable cases of the former in various stages of progression.

There are, no doubt, other causes to account for the hitherto comparatively slow progress of the adoption of my invention. If a personal reference may be excused, I fear I am not so capable as most of placing the merits of my invention before steamship owners and others. In several cases also it has been worked for a time contrary to my instructions, and consequently failed for the while to produce the proper results. In two cases of its application from my plans by other firms to old boilers, not quite suitable, and not worked under my control, the reports were, for reasons I have not ascertained, more or less unfavourable, and in two cases at least considerable trouble was experienced through driving the fans direct at a higher speed than the purchased engines could endure without breaking down after a short term of work. Though the merits or demerits of my system had as little connection with these unfavourable circumstances as the propeller of the ship had, yet they served the purpose well of raising and propagating reports of the most absurd and deprecatory character regarding my system, and which I find in many parts in active circulation to this day. Though annoyed frequently by the vexatious delays caused by such circumstances, I felt I could "bide my time," as I knew I was working on the only true lines in this matter. The laws of nature by which we are surrounded and ruled, though inexorable, are not capricious; and when we work in harmony with them they become our faithful and controllable servants. Having ascertained by careful and repeated trials what could be realised by this mode of combustion in one boiler, I knew absolutely that the same could be reproduced under the same circumstances in every other boiler. This I have, of course, never failed to realise, and I find that the more nearly any boiler is fitted with the proportions I have established, and worked in the manner I direct, so much the better will the results be.

The delay has also not been without its compensations. It has caused my invention to be tested all the more severely, with the effect of confirming its merits all the more thoroughly. It has also given opportunity for investigating and settling satisfactorily the following points of detail in working:—The proper mode of durable and efficient fan-driving; the proper mode of arranging and preserving the fire-bars under the highest rates of combustion yet attempted; the method of keeping the tubes clean during the longest voyages, so that the last day of a forty days' run would be as good as the first, and the prevention of dust or ashes being thrown on deck from the chimney.

The unequalled excellence of my system of forced draught having been proved under difficulty and opposition, especially during the last six months, it is now overcoming all the opposition it has had to encounter, as well as the *vis inertia* which inventions requiring considerable changes in practice must overcome before users move and adopt it in a mass. There are now many indications which show the turn of the tide. Several of the engineers who advise steamship owners and companies who formerly were quite opposed to my system, and prophesied for it an early death, have now, from examination of actual facts, discovered and admit their mistake, and are now recommending its adoption. There are, no doubt, still opponents, but they are so chiefly because they as yet do not know my system except probably from some prejudiced report. I find also that it is those who know least of the processes of combustion who most confidently give their opinion against my system. It will therefore be only for a very short time that such advisers can hinder its progress, as the weight of facts will soon discredit their opinion. It will serve to show how far the tide has already turned when I mention that my system is at the present moment being applied to the boilers of new steamers of upwards of 60,000 indicated horse-power, the greater part being for steamship owners and companies who have already my system in use.

I may be asked, what about the other systems of forced draught, now being offered in some quarters to steamship owners, and the effect of their competition? I reply, that with the exception of the closed stokehold system, I have no competitors in forced draught, properly so called, and I know no specific system of forced draught, other than my own, to which anyone can legitimately attach his name. As already explained, before reading my paper at the Institution of Naval Architects in 1884, I had, during the two preceding years, carefully worked out my system practically in all details, without ever seeing or knowing of any example of forced draught other than that of the locomotive, and what I had read of the closed stokehold system. At the date of that paper the use of forced draught in a mercantile steamer was quite unknown. Some attempts had been made at artificial supply of air to boilers of steamers, which had only extended sufficiently long to prove their futility. The New York City, which I fitted and dispatched a few months after, and which has continued to run with the greatest success to this day, was the first steamer ever worked at sea with forced draught. Her advent, after refitting, marked the era of the introduction of forced draught as a practical fact in the working of steamships.

In my paper of 1884 I described the various forms in which combustion in steam boilers by artificial supply of air had previously been attempted, pointing out their several defects. Among others I described that of blowing air from a fan into a closed ashpit, as I had done myself so far back as 1862, and of which I discovered the defects when I attempted a rate of combustion much above that of natural draught; I described also that of accelerating the draught by driving a fan in or at the base of the chimney, a very old plan and one which only requires to be used on a sufficiently large scale to prove its inutility. Other methods of urging the fires by currents of air induced by jets of steam into the chimney or ashpit, or directly into the fires, I described and commented on. Since the reading my papers at the Institution of Naval Architects in 1884 and 1886, quite a number of operators in what they term "forced draught" have sprung up, most of whom have seized hold of these old discarded plans, and by attaching their names thereto pose as the original inventors, and offer them to the bewildered steamship owner, who, tickled by the now popular words "forced draught," supposes he has met with something very beneficial.

If the operator be sufficiently astute to confine his application to boilers of full natural draught power, and to limit the amount of air supplied to about the quantity which would give the same combustion by natural draught, it is possible he may enjoy for a time the satisfaction of being looked upon as a successful operator in forced draught, even though an equal if not greater power and better results might be obtained from the same boilers by a proper use of natural draught. But this mode of working is not "forced draught," though the air of combustion may be supplied by artificial means. Even the closed stokehold system could be worked at sea in this manner without much trouble. When such operators, however, have attempted combustion rather beyond natural draught power, the inherent defects of their plans become so apparent that the apparatus is soon discarded. Some parties have also attempted to use in conjunction with some of these plans partsof my patent, but further than this, being dangerous to themselves and their clients from a legal point of view, the mongrel devices which they have attempted are not otherwise to be much regarded. Some of the most conspicuous failures have been of this mongrel character, and have brought neither profit nor honour to their adaptors. As soon as steamship owners come to distinguish between forced draught proper and merely the semblance of the thing, and between legitimate and bastard applications, all these inferior modes will disappear.

Some may suppose from these remarks that I claim an entire monopoly of all dealings with forced draught. Very far from that; but I claim to be the sole designer of the only known system of forced draught, which fulfils, at a high rate of power, every condition of proper combustion in the boilers of steamships theoretically, and with the highest efficiency, economy, and safety, practically. I also claim to be the first that ever used forced draught successfully, and as a normal condition of working in a sea-going steamer.

Though this letter has lengthened much beyond my original intention, I cannot conclude without further reference to the present condition of our Navy in regard to this, for it, all important subject. The lives of the brave men who man our fleets, and our country's safety are, I truly believe, seriously jeopardised by the present forced draught arrangement in our cruisers and warships. In my papers of 1884 and 1886—especially the latter—I directed special attention to the dangerous and helpless condition to which the steamers of our Navy fitted with the closed stokehold system of forced draught would be reduced if ever called upon to go to sea and steam at full speed with forced draught for a short period. I showed that their difficulties would begin, if not before, as soon as they began to clean fires with the forced draught in operation, and after a short period of working at sea the boilers would be so injured by the action of the draught as to become leaky and helpless. I also called attention to the fact that not one of the steamers of the Navy had ever been tried at sea with this forced draught under the conditions which would obtain if they required to engage in actual warfare. Instead of my advice being received with the consideration which its *prima facie* correctness and the practical proofs with which it was supported should have insured it, it was received with evident incredulity and consequent neglect, and our Navy has to this day continued to be fitted with this dangerous system without any testing of its actual capabilities at sea.

The autumn manœuvres of last year, however, gave sufficient proofs that the dangers I have called attention to from the use of this system are not imaginary, but all too real. It is difficult to discover from the published statements how far the forced draught was used on the occasion referred to. The slow speed, ten to eleven knots, maintained both by the attacking and defending squadrons in chasing and running, could not certainly require the use of forced draught in the ironclads. On one occasion, however, we find one of them, the Impérieuse, had used her forced draught for probably an hour or two in the attempt to chase the swift unarmoured vessel Mercury, which has boilers worked by natural draught only. Your contemporary, *Engineering*, on the 6th inst., in an article on "Naval Manœuvres," refers to this incident as follows:—"The 17-knot armoured Impérieuse was sent in chase of the 18½-knot despatch vessel, and by the help of her forced draught the pursuer just kept up with the pursued. That, at least, is what the Impérieuse herself claimed, and it is so stated in the report. But the Mercurials claim that their ship gained on the armour-clad at the rate of 1½ knots, in spite of her being one boiler short. Moreover, it is stated that the effect of the forced draught was to render useless two of the armoured vessel's boilers. This fact we have on good authority, but there is no mention of the leaky boilers in the official list of casualties, although like incidents are referred to in connection with other vessels." In the same article reference is made to the Curlew, a torpedo gunboat of 1886, becoming *hors de combat* in the following significant words:—"But that vessel had apparently broken down—her boiler tubes were re-ferruled on the following day," &c. A further corroboration of the evil effects of the forced draught on the boilers of the fleet during these manœuvres is given by a writer on "Forced Draught" in your monthly contemporary, the *Marine Engineer* of October last. The object of this writer, very strange to say, is to depreciate my system and to laud the closed-stokehold system, and from the articles themselves one can gather that the writer must have some relationship with the Admiralty. Yet this writer makes the following admissions of the defects of the system which he advocates:—"A great drawback with the closed-stokehold arrangement is that when working under ordinary natural conditions the temperature of the boiler rooms is very great. This is particularly the case in warships, where the down draughts are very few in number, and even these are so choked with armour gratings, &c., that no flow of air can be obtained through them by natural means, and the only up-draughts are through the furnaces, which are too low to carry off the heated air in the higher parts of the boiler rooms. It can be urged, however, that the fans can be always kept going, even with the hatches open, and under certain conditions they are beneficial; but for very easy steaming, such as is done when a fleet is cruising, and when many of the watches have to be kept with the dampers on the first notch, the use of the fans would have to be greatly restricted. For the fans to be of any use for ventilating purposes they must be driven to exert a small pressure, and it would therefore be very difficult to keep the steam from blowing off if the fans were running. The practical experience with forced draught has so far not been a very happy one, as, with scarcely a single exception, marine boilers have not been able to work many hours consecutively without requiring either their tubes rolled or seams caulked. In the recent naval operations round the coast, it was found that for making long passages at full speed the modern ships could not compare favourably with those vessels that have not got compound engines or forced draught, simply because the boilers of the former required so much doctoring up to keep them tight." There is surely some infatuation in holding on to a system of which such can be said by a partisan, and more especially when my system puts an end to all these points of difficulty and danger.

With a few armour-clads having engines to work safely, even at sixteen to seventeen knots speed, and boilers fitted with my system, it is evident that the whole British fleet could be destroyed or captured with ease if found a few hundred miles from land. Steamers fitted with my system could maintain the same speed as on trial for weeks together, and would only require to keep the closed stokehold vessels in play for a short time until they were disabled, when they could dispose of them at their leisure. If the present forced draught system in our armour-clads and cruisers is likely to produce such a catastrophe as I have pictured, our navy is in a sorry position indeed. The important point is to discover, beyond doubt, whether the picture is not too likely to become a sad reality under the circumstances postulated? JAMES HOWDEN.

Glasgow, January 24th.

FREE TRADE AND NO TRADE.

SIR,—The distinction between gross income and net income is, it seems, new and occult to "A Heathen." I fail to see how the argument is advanced by such travesties of the point at issue as those he indulges in. Mr. Scott, on the other hand, puts a definite and intelligible issue. Of course home produce is income in the same sense that imported produce is, but surely national outlay is required to secure the one as well as the other. The cost of production is equally outlay, whether it goes to the production of commodities for home consumption or of commodities to send abroad in exchange for other commodities which will be consumed here.

It is pretty generally agreed now that it is not to the good of the country to make the production of goods for home consumption more costly by reason of artificial impediments, such, for instance, as opposing the use of machines—in short, that the true interest of the labourer lies in applying his labour in the most efficient manner. Your columns are witness how eagerly the whole army of inventors and manufacturers pursue this end.

The wealth of the country depends in the long run on the efficiency of its labour; that wages are higher here than on the Continent is simply due to the greater efficiency of English labour, applied under the conditions existing in England. If this be lost, no fiscal measures can maintain a superiority.

Kensington, January 25th. W. A. S. B.

SIR,—Your correspondent, "Heathen" replies to my letter with a question, but omits to answer mine asking if he admits that the £4 paid to his butcher is expenditure. Before replying to his inquiry, permit me to remind him that he attacked the theory that imports are income by an argument that depended upon the confusion of an individual's profits with a nation's returns from foreign trade. He bracketted both under the term "income," as if the meaning were the same in each case; and this in the same sentence in which he says, "What is true of a nation is true of a man."

Having been shown this error, he now asks if I can admit a third and different meaning for the word "income." Certainly; and probably several others. But what then? We are not discussing the number of meanings which "income" will bear, but whether imports are income; or, if "Heathen" prefers it, whether a surplus of imports over exports is an accession to national wealth or otherwise.

Perhaps "Heathen" will object that he does not suggest a third meaning. Let us gauge his new question by his first letter. He asks what are "our products, coal, iron, steel, corn, and such like?" The farmer does not pay income tax on the whole of the corn he grows, nor does the ironmaster upon the iron or steel he produces; so they cannot be "income" in that sense. As certainly they are not returns from foreign trade, which was the second sense in which "Heathen" used the term. But they are still income, inasmuch as they are the products of our own labour, and as such represent an accession to national wealth.

Now, having obtained this definition, "Heathen" is of course waiting to say, "Coal, iron, &c., are income; we export these materials, and therefore exports are income;" just as he gazes lovingly at the £4 paid to his butcher, firmly convinced that it is his income still, though possibly the butcher would take a different view. But this theory of once income always income, will not stand the test "Heathen" himself applies, viz., "what is true of a nation is true of a man."

A merchant at the end of a year's trading finds he has made £3000 profit, and that he has drawn for personal use £2000. He decides to leave the other £1000 in the business. Now, though on the 31st of December the £1000 was income, on the 1st of January it undoubtedly became capital. So with a nation. The moment it puts its surplus products into foreign trade—*i.e.*, the only trade which a nation can do—that portion of its income becomes capital.

But perhaps all this is waste of argument. Possibly, "Heathen" intends to admit that imports are income, but wishes, together with Mr. G. D. Scott, to argue that to import at a low price what we could otherwise produce ourselves at a higher price, is simply to increase one source of wealth at the expense of another. But will they excuse me for saying this is begging the entire question? The Free Trader is convinced that the opposite is the truth. Take an instance of a type with which most business men must be familiar.

Suppose "Heathen" and his supporter, Mr. Scott, are engaged in a business for which there is an excellent foreign market, just out of their reach in the matter of price. A reduction of 5 per cent. in their costs will place the market within reach. A portion of their raw material is, say, sugar, obtainable either at home or abroad. A sudden change in the conditions surrounding the foreign product enables them to make the requisite reduction in cost by purchasing foreign sugar. Would not these good gentlemen fall before this temptation, and put their factory in full swing, employing additional hands, increasing their purchase of the ingredients other than sugar, and adding to their own wealth and the tale of the national exports?

Of course, they would be consistent with their principles; they would energetically assist the English sugar manufacturers in their agitation for a tax on foreign sugar, and presently having succeeded in their object, raised the price of all obtainable sugar, and removed the temptation from their own path, they would now buy English sugar as being slightly cheaper than the imported.

It is true that, having artificially raised their cost to the original figure, they might soon be relieved of all necessity for troubling the English manufacturer with any orders for sugar or anything else, that they might find it necessary to close or reduce their works, and to throw many operatives out of employment; but our "Fair-Trading" friends would not complain for they would have the satisfaction of knowing that they had been "fostering our home industries"—"protecting" them, some people term it.

This wish to reduce the amount of imports is surely one of the most suicidal which could be imagined. The object to be aimed at is the increase of exports—actual increase, not relative. For the latter we need not concern ourselves, as the exports must be paid for either with imports or gold, and the form which the payment will take will without doubt be that most suited to our needs. It will probably be imports, and in any case the greater the value the better is the net result for the nation. In the endeavour to increase the export trade, it will be necessary to avail ourselves of all possible means, including even that of buying in the cheapest market. C. G. MAJOR.

34, Freke-road, Lavender-hill, S.W.,
January 25th.

SIR,—May I have space to point out that Mr. Brett now asserts that in consequence of foreign protectionist duties we receive less value in return for our exports than we otherwise should—that is to say, on his showing, the procuring our present amount of imported commodities creates more employment here than it would if the removal of adverse duties caused our exports to fetch better prices. Is this what Mr. Brett means? I do not ask now whether it is advantageous thus to provide employment. In your articles on technical education you have asked how that could be a remedy for depression in England which in Germany has not availed to relieve artisans from long hours and low wages. May I not ask the same question in regard to Protection? and will Mr. Brett tell us why we should expect it to do for Englishmen what it has failed to do for Germans? He has supplied us abundantly with caricatures of current economical writings—has he any practical philosophy to put in their place? One theorem he has given us—that Protection abroad creates employment in England. Is the converse true, and if so, how would Protection help our workers, even on no-trade principles? W. A. S. BENSON.

January 31st.

PASSENGER LIFTS.

SIR,—I notice your paragraph about the American lifts, or "elevators," as they are called in the States. The interests of the company you allude to are well represented here by my friend Mr. Gibson. You ask what the English manufacturers are about. I happen to be able to give you some information on this matter. The impetus which has recently been given to the use of lifts in England has not come from America, but has been mainly due, apart from natural causes, to the operations of the hydraulic power companies. You will no doubt be surprised to hear that during the past four years about four hundred and fifty lifts have been erected in London along the London Hydraulic Power Company's twenty-five miles of mains, in which a pressure of 700 lb. on the square inch is constantly maintained for use as motive power; 99 per cent. of these lifts have been constructed by English makers. Probably the best lift service in London is that at the Hotel Metropole, the largest hotel in England. There are seventeen hydraulic lifts in the hotel worked from the hydraulic proper mains without the use of pumping machinery on the premises. These lifts are of English design and manufacture, and there are numerous other good examples elsewhere by various makers.

America knows nothing of the advantages of high pressure hydraulic power and hydraulic rams for lift service, except through English experience; she has concerned herself principally with the suspended principle of construction and the use of water at a low pressure. The safest lifts cannot be made on the suspended principle, and from a mechanical standpoint low pressure may be said to be defunct. I greatly admire, however, the skill with which the Americans have produced such a serviceable machine with such unserviceable materials. Under some circumstances, of course, suspended lifts must be used, and the American competition in this class of lift has, I am glad to say, stimulated us to improve these machines. English lifts of this kind equal to the American can now be obtained.

In connection with the London Hydraulic Power Company, I have had exceptional opportunities of studying the mechanical arrangements and working of lifts of all classes by nearly every maker of note, and am of opinion that whether considered from the point of view of safety, simplicity, efficiency, economy, or mechanical perfection, the typical English lift will continue to take the first place. E. B. ELLINGTON.

Palace-chambers, Bridge-street, Westminster,
January 30th.

STRENGTH OF FLUES AND END-PLATES OF LANCASHIRE BOILERS.

SIR,—Referring to the letter by Mr. Ellis, of Manchester, in your last issue, on "Collapsing Pressure of Iron Boiler Flues," it seems to me that he has opened a subject which ought to be thoroughly discussed in your columns. Pressures carried by Lancashire boilers have risen in recent years—120 lb. per square inch being now sometimes employed—and will certainly rise still further if the triple-expansion engine is to be used on shore. The literature on the subject is decidedly meagre, and any that exists is so time-worn as to be of little use to the engineer of to-day. Under the above circumstances I should say that any trustworthy formulæ which would give a correct estimate of the strength added to flues by Adamson flanged seams, Bowling hoops, or Galloway tubes, or any experimental results connected with above joints or tubes, would be of great service to those engaged in the design of high-pressure boilers.

As regards the end-plates, there also seems to be a want of sound formulæ and experimental data, and a difference of opinion on the comparative merits of plate gusset stays and bolt stays, tying both end-plates together. Does the load borne by these bolt stays not have a serious local straining effect on the end-plates?

The calculations necessary for the strength of the shell are of so simple a character that no difficulty is presented in making a change to higher pressures.

Another question arises as to the limit of pressure which can be suitably carried by boilers of the Lancashire type, and after that limit is passed, what form of tubular boiler would be best adapted for use at manufactories. ST. PANCRAS.

January 25th.

INSTITUTION OF CIVIL ENGINEERS—BIRMINGHAM STUDENTS' ASSOCIATION.—The first meeting of the current session of the Association of the Birmingham Students of the Institution of Civil Engineers was held on Monday at the Colonnade Hotel, under the presidency of Mr. E. Pritchard, C.E. Mr. C. Hunt, M. Inst. C.E., delivered a lecture upon "Gas Manufacture."

UNIVERSITY COLLEGE, BRISTOL.—On Thursday evening, the 26th ult., Professor Ryan delivered a lecture on "Steam Engineering" in the Athenæum Hall, Bristol. The lecturer sketched briefly the history of his subject, noting the various improvements which formed the most important stepping-stones in its course of development. He emphasised the part which Bristol had taken in the development of the applications of steam. Near Bristol, Hornblower's compound engine was first set up. The patents for the use of the crank and fly-wheel were held by Wasborough, a Bristol engineer; in Bristol the Newcomen engine was first applied for mill purposes; and from Bristol the Great Western started on its celebrated first journey across the Atlantic. The modern steam engine in its multiplicity of types and adaptations was then discussed, characteristic examples being described and illustrated by transparencies. The part played by science in the evolution of the steam engine was dwelt upon, and an appeal on behalf of technical education concluded the lecture.

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

(*From our own Correspondent.*)

THERE is a little revival this week from the quietude which came over the market subsequent to the quarterly meetings, and orders are coming to hand with rather more freedom. Buyers who, in some directions, had been limiting their accounts, are, now that we have started upon another month, more disposed to enter the market. Finished iron makers enter upon February with good anticipations.

Sufficient work is in hand at the mills and forges to allow of almost full employment. Speculative business, however, is checked by the firm quotations, and while this necessarily limits the extent of iron changing hands, it yet imparts to the Staffordshire market a substantial character which in many other centres is wanting. The production of finished iron for the month just closed is expected to be considerably above the average of any January for some years past.

Marked iron of best qualities is in good request at the former prices, especially the best known brands of horseshoe and rivet iron. But the enhanced values of medium and common qualities have checked business to some extent. Prices of the last-mentioned qualities are not so well maintained as makers expected, and some giving way from the best prices of quarter-day is reported. Good medium bars are quoted £6 2s. 6d. to £5 17s. 6d., at which figures considerable business is being done, and common bars are £5 to £5 5s.

The prices of sheets, alike common and best sorts, keep in better condition than they have been for a long time past, and makers are now putting money together. This is inducing the preparation for a re-start of mills long idle. There is some danger that this policy may adversely affect prices, but it is thought that demand will be sufficiently large to take the increased production without influencing quotations to much extent. A portion of the Bromford Ironworks, West Bromwich, formerly occupied by Messrs. John Dawes and Sons, will probably re-start in the course of a few days under the style of the Bromford Iron Company, and the new proprietary have already secured agents for the London, Liverpool, and other markets.

Common 20-gauge sheets are £6 5s. to £6 10s; 24-gauge, £6 15s. to £7; and 27-gauge, 20s. additional. Galvanised sheets maintain the Association quotation of £12 10s. to £13 f.o.b. London, but underselling is occurring in a few directions. The advance of 10s. per ton, advised this week by cable from Melbourne, was received by the galvanised sheet makers here with much satisfaction.

Morewood and Co.'s quotations for galvanised corrugated sheets, Red Star brand, are: 18 and 20 B.G., £11 15s.; 24 B.G., £12 5s.; 26 B.G., £13 15s.; 28 B.G., £14 15s.; and 30 B.G., £16 15s. per ton. Galvanised tinned corrugated sheets, Lion or Anchor brand, are: 18 and 20 B.G., £12 5s.; 24 B.G., £12 15s.; 26 B.G., £14 5s.; 28 B.G., £15 5s.; 30 B.G., £17 5s. per ton. Close annealed galvanised flat sheets, Wheatsheaf brand, are: 18 and 20 B.G., £13 10s.; 24 B.G., £14; 26 B.G., £16; 28 B.G., £17 per ton. Close annealed and cold rolled, Woodford brand, are: £15 10s., £16, £17, and £19; and double best ditto, Lion brand, £22, £23, £25, and £26 for the respective gauges.

A large bulk of corrugated sheets was sent away last week for the West Indies and other markets. Good orders for plain, as well as corrugated sheets, are coming in from Australian buyers.

The better demand for plates keeps up, and the mills are doing better than for many months past. Prices for tank sorts keep at £6 10s., and for boiler qualities £7 10s. to £9 10s.

A good deal is heard at the present time of the competition of iron and steel making districts on the coast with inland iron and steel districts. A striking instance has just occurred in the steel trade of this part of the kingdom, as showing that it is possible sometimes to tell another tale. The Staffordshire Steel and Ingot Iron Company has just taken a large order for flat bars 12in. wide for delivery to Middlesbrough, and also an order for round bars 6½in. diameter for Glasgow. Such a circumstance as this is highly creditable to the Staffordshire Steel Company, and the solution of the secret is to be found in the splendid machine facilities which the company possess for rolling steel bars of large sizes.

For steel wire rods there is a steady demand, and representatives of Warrington makers on 'Change in Birmingham to-day quoted mild steel sorts, No. 5, of ten to twenty carbon, £6 10s. per ton, and best spring steel rods, No. 5, £7 10s. per ton, both delivered f.o.b. Liverpool.

Pig iron consumers sought this afternoon to secure supplies at less rates than they have hitherto been paying, on account of what they are pleased to regard as the quieter condition of the market and the lessened strength in the North of England. Native makers, however, had but one reply to such buyers, and agents of imported brands were in many cases equally firm. They reported themselves in receipt of communications from principals expressing the belief that though the market is for the moment quieter, prices will recover themselves, and reach fully quarter-day rates. Native makers are so excellently situated as regards the business in hand, that they refuse to give any ear to buyers' appeals for easier quotations. Prices are maintained at 52s. 6d. to 55s. for hot blast all-mine pigs; 42s. for best part mines; and 32s. 6d. to 35s. given for cinder pigs. Imported sorts are an average of 41s. to 42s., delivered. Hematites keep very strong at 55s. 6d. for good west coast forge brands, delivered free, and supplies are short. From South Wales, too, it is quite a difficult matter to get deliveries of hematites at date.

There is no feature which is more encouraging in the state of trade than that the local mineral and goods traffic returns keep up remarkably well. Traffic has now recovered the interruption occasioned by the holidays, and the returns, alike as regards incoming and outgoing traffic, are much larger than this time a year ago.

The demand for manufactured iron in North Staffordshire is scarcely so brisk this week. It is supposed, in explanation of this circumstance, that merchants have placed nearly all their current contracts. However, makers have been supplied during the past few months with sufficient to keep them closely occupied for a considerable time to come. At the moment the mills have numerous specifications in hand. Sheets—quoted nominally at £6 15s. f.o.b. Liverpool—are less brisk than some other classes of iron. Hoops are in fairly satisfactory demand. Plates are dull at £6 5s. per ton. Pig iron is well called for at improved prices.

The revival in the shipbuilding trade is proving a good thing for the district. The chain, cable, and anchor trades are wearing a more promising appearance than for a very long time. Numerous and important inquiries are to hand, which point to much activity amongst the shipbuilders. Some of these inquiries are being accepted, and makers of chains and anchors in the Tipton and Dudley districts, who have long been very quiet, are becoming busy again. More orders might be booked if makers were willing to accept all the prices offered, but they are not. One of the largest firms in the Dudley district is reported to have lately booked orders for half-a-dozen complete ships' outfits of cables, anchors, rigging, and drawing chains, &c. The work is of much value. The prospects of this important industry for 1888 are very gratifying.

The engineering trades of Birmingham have hardly sustained this year the expectations which were formed of them during the closing couple of months of 1887. There is not so much activity in the matter of new orders, though the works mostly keep well occupied, and certain of them are running relays of men night and day to execute contracts within the prescribed periods. The country demand is well seconded by orders from Australia, India, the Cape and South America, for varied classes of machine tools, steam engines, air-compressors, lifting tackle, and general machinery. Steam and other pumps for irrigation purposes, and mining machinery, are also going away well to South Africa and the Indian Empire. Our own Government have of late placed some good orders for marine engines, torpedo machinery, air-compressors, &c. Certain of these contracts I have noted in this report at the time of their receipt.

Messrs. Tangye are steadily engaged, and one of their most recently completed contracts is for the horizontal engines for driving the cable of the Birmingham cable tramway. Another big order which they are now finishing off is for centrifugal pumps for Australia.

Messrs. Ralph Heaton and Sons, the Mint, Birmingham, are busy upon the valuable orders which they possess in connection with the Chinese Mint contract.

Messrs. G. G. Bellis and Co. have recently been particularly successful in the matter of Government contracts for gunboat and torpedo boat machinery, and they are also building torpedo boat machinery for the Government of India. When at the works of this firm a few days ago, I found them completing large extensions which will more than double their previous capacity.

Messrs. James Archdale and Co., Birmingham, are turning out some splendid machine tools at date, and gunmaking and cartridge drawing machinery is a specialty with them. Government contracts of this sort are just now under execution. Wire netting machinery is in large outturn at the works of Mr. E. S. Bond, and Australian orders are plentiful. Among specialty engines a demand is being expressed for petroleum engines of increased power. Messrs. A. Shirlaw, Birmingham, are building a 13-horse power engine of this description for the Italian Government. For fog-horn signalling the engines answer admirably. The competition in the trade in stocks, dies, ratchet braces, and similar tools continues severe, but makers are steadily engaged on home, Indian, and colonial orders.

The Birmingham works of the Credenda Seamless Steel Tube Company are just now the subject of a scheme for an extension to treble their present capacity, in consequence of the conversion of the company into a limited liability concern, with a capital of £100,000. Sir Joseph Whitworth and Co., Manchester, where the other works of the same company exist, are the originators of the new company, and it is matter for satisfaction in this district that a scheme suggested some while ago of removing the business wholly to Lancashire has been abandoned. The Birmingham works are very busy, and engineers at home and abroad are increasingly demanding these seamless steel tubes.

NOTES FROM LANCASHIRE.

(*From our own Correspondent.*)

Manchester.—A generally quiet tone has again come over the iron trade of this district, and although it is exceptional where makers show any anxiety to press sales, there is a good deal of iron, bought at prices under the recent full advance, held in second hands, some of which finds its way into the market at under what may be termed the current rates. This of necessity gives a weaker tone to the market, especially as regards pig iron, in which there is very little buying just now going on, and except where consumers are compelled to take some special brand, there are generally cheap second-hand lots offering in the market sufficient to meet the present limited requirements of buyers. Makers who hold for the full prices which have been ruling recently find themselves just now practically out of the market, and sales of any weight are only possible at very low prices. Much the same may be said with regard to hematite qualities of pig iron, which can be bought at considerably under the full prices quoted by makers. Manufactured iron is in a much stronger position than the raw material, but here there is also underselling, and makers are finding new business rather difficult at the recent advance.

The Manchester iron market on Tuesday brought together the usual average attendance, but there was only a slow business doing. For local and district brands of pig iron prices were generally maintained at about late rates, but outside brands offering in this market are decidedly easier. Lancashire makers who have only a very small quantity of iron to offer are firm at 39s. 6d. to 40s. 6d., less 2½, for forge and foundry qualities, delivered equal to Manchester, and on small sales they are able to get these figures. For Lincolnshire iron 37s. 6d. to 38s. 6d., less 2½, represent about the average selling prices for forge and foundry qualities, delivered equal to Manchester, but 1s. per ton above these figures is still being quoted in some instances. Good foundry brands of Middlesbrough can now be bought readily at 40s. 4d., net cash, delivered equal to Manchester, although this is 1s. 6d. to 2s. per ton under what is being quoted for some of the special brands, and Scotch iron is offering at under the prices which makers have recently been quoting.

For hematites some makers are still quoting nominally 55s., less 2½, delivered in the Manchester district, but where there is any business doing, considerably under this figure has to be taken, and occasional sales are made at about 53s. 6d. to 54s., less 2½, delivered.

In manufactured iron, although the recent advance has tended to restrict buying of any weight, there is still a fair business doing, and as makers are mostly well supplied with orders for the present, they are very firm at £5 5s. for bars, £5 10s. for hoops, and £6 15s. to £7 per ton for local and North Staffordshire sheets delivered in the Manchester district. For steel boiler plates quotations remain firm at £8 5s., delivered equal to Manchester.

As an item which may possibly be of interest in connection with the present inflated condition of the metal market, I may mention that arrangements have been made for offering very shortly for sale by auction in Manchester about eighty tons of copper.

Ironfounders report more work coming forward, but they are still not in a position to hold out for any material advance in prices, and work has to be taken at excessively low rates.

The improvement which is so very generally talked of in the engineering branches of industry is slow in making itself very appreciably felt, but there is certainly a steady progress towards better trade. In nearly all departments inquiries are more numerous, and are certainly an indication that there is a fair amount of work coming forward. Cotton machinists almost without exception are full of work for some time forward; boiler-makers are kept well employed; locomotive builders have recently secured a fair amount of work, and makers of carriage, wagon, and general railway plant have received some fairly large orders. Machine tool makers, stationary engine builders and general engineers, as a rule, are still only moderately employed, but in these branches there are also encouraging prospects of an improved trade.

A company, with a limited number of shareholders who have fully subscribed all the capital required, has taken over the business recently carried on by Mr. Hy. Fourness for the manufacture of the patent Fourness lamp, and will carry on the works both in Manchester and Brussels.

In the coal trade business moves on about steadily, with prices unchanged from last week. There is no pressure of demand for any description of fuel, and with collieries only in very exceptional cases working more than five days a week, supplies are ample to meet requirements. Common round coals for steam and forge purposes continue rather a drug, and for these and engine classes of fuel the prices that are being taken are practically no higher than those ruling during the summer months. The average prices at the pit mouth remain at about 9s. for best house fire coals; 7s. to 7s. 6d. seconds; and 5s. 6d. to 6s., common house coals; 5s. to 5s. 6d., steam and forge coals; 4s. 6d. to 4s. 9d., burgy; and 2s. 6d. for common up to 3s. 6d. and 4s. per ton for the best qualities of slack.

For shipment there has been a rather better demand, and for good qualities of steam coal delivered at the high level, Liverpool, or the Garston Docks, about 7s. to 7s. 3d. per ton has been got, but ordinary descriptions can still be bought at 6s. 6d. to 6s. 9d. per ton.

Barrow.—There is a better demand for all qualities of hematite pig iron this week, and business has been on a rather fuller scale, although, as a matter of fact, makers are not disposed to enter into large transactions at present rates, which are somewhat lower on the week. Mixed Bessemer numbers are quoted at from 44s. to 44s. 6d. per ton net, f.o.b., and ordinary forge and foundry iron 43s. 6d. to 43s. 9d. There is more enquiry from consumers for forward deliveries, as their immediate requirements are well provided for in the deliveries already arranged with makers. Some steelmakers who do not use their own iron have lately been buying more largely, while prices are down. This position, however, does not affect Barrow, where steelmakers use the iron they make themselves, and convert it into steel at one fusion. Stocks of iron are large, generally speaking, although makers do not hold much. The steel trade is in a much better condition by reason of the fact that the only dull department during the past few weeks has been the rail branch, which is now recovering, and a better inquiry is springing up; but prices are unchanged, and £4 per ton is still the quotation for ordinary heavy sections net, f.o.b., with lighter sections at £4 5s. per ton. There is still a full enquiry for steel shipbuilding material, and plates and angles have been largely ordered, while enquiries are to hand from all sources. Prices are rather easier, plates being down to £7 per ton net, f.o.b., and angles at £6 5s. Makers in this district, however, are not in a position to accept many new orders, as their hands are full for some time to come. There is likely to be a large increase in the output of Siemens-Martin steel, now that so large a demand is made on this department by shipbuilders. No new orders have been placed by shipbuilders, but it is probable that the next few weeks will see a renewal of the activity which formerly characterised this trade in Barrow. Engineers are better employed, both in the general and marine departments, and they have better prospects. No change can be noted in the iron ore trade, which remains brisk and steady, at prices varying from 9s. 6d. to 12s. 6d. per ton at mines. In coal and coke there is a steady trade, and the demand is improving. Shipping is much better employed than is usual at this time of the year.

THE SHEFFIELD DISTRICT.

(*From our own Correspondent.*)

STEAM coal is in fair demand throughout South Yorkshire, though prices keep very low. Excellent coal for locomotive purposes is not making 6s. per ton at several of the pits. In house coal there is again rather colder weather, and there is no class of fuel so susceptible to climatic changes. House coal ranges from 6s. 6d. to 8s. 6d. at the pits. No change is reported in iron, though the advances recently secured are maintained. Steel, except to the United States, is in brisk demand. All qualities required for railway material are in request on account of foreign orders for railway material, chiefly from South America. Colonial work is heavy in nearly all specialities of railway stock, India and South Africa showing the greatest improvement.

Exceptional interest attaches to the expedition against the predatory Yonnie tribe on the West Coast of Africa, owing to the employment there of the new Maxim gun, which is being manufactured by Messrs. Vickers, Sons, and Co., River Don Works, Sheffield. I have attended several trials of this weapon of precision, which, it will be remembered, Mr. H. M. Stanley has taken with him to the Congo. The last experiments were on account of the Chinese Government, and were witnessed by Lord Li, of the Chinese Legation, and his secretary. Governor Hay, at Sierra Leone, despatched General Sir Francis de Winton with orders to advance through the dense jungle to the fortified villages and bombard and destroy them. The General had only one Maxim gun, ·45in. calibre, and a small 7-pounder. The Maxim gun was carried by two coolies, and its tripod by two more, while a few others followed in single file, bearing the boxes of ammunition. At the fort a commanding position was assumed for the Maxim gun and 7-pounder rifled gun, at a range of 450 yards. The enemy—I quote from the London *Telegraph*—were in swarms on the wooden towers on the walls. The 7-pounder opened fire, but the shells stuck in the mud walls, and were of little use. Then the "Maxim," worked by Sir Francis himself, poured a tremendous volley into the nearest tower. The bullets rained in through the portholes and in between the planks, killing numbers of the enemy. The breastwork and other towers were similarly treated, and such was the consternation created by the rapid and accurate shooting of the gun, that the Ching Wad tower was evacuated, as well as the other villages of the same nature, and the chiefs surrendered, and are now in prison. This success of the Maxim gun is no more than would be anticipated by anyone who, like myself, has seen it at work and, indeed, fired it. The little rifle bore is a veritable spitfire, and it requires an expert at touch to let off a single shot, the volleys coming readily. In the larger 3in. size the Chinese will be the first Power to possess examples of a weapon which is bound to be singularly destructive both on sea and land.

The president of the Sheffield Chamber of Commerce, Mr. Charles Belk, J.P., at the annual meeting on the 26th January, expressed the opinion that we were on the threshold of a period of moderate prosperity and steady progress. The question of a canal between Goole and Sheffield—as recently referred to in THE ENGINEER—was brought before the Chamber. Alderman W. H. Brittain, J.P., said he had made inquiries into the matter, and he was assured there were no great engineering difficulties in the way of a canal between the two places. The undertaking was one of such immense advantage, and could be done with such little outlay of capital, that at the earliest opportunity they should consider the scheme at the meetings of the Council of the Chamber. Mr. G. F. Lockwood—the ex-Master-Cutler—who succeeded Mr. Belk in the presidential chair, thoroughly agreed with Alderman Brittain's remarks as to the proposed canal. The Manchester Canal, he said, was now started, and if it was a success—and he hoped it would be—he did not think there would be any difficulty in pressing forward and getting other canals in the country. He thought it was very short-sighted policy that the railway companies were permitted to buy up the canals in the past, and regarded it as an important step that in the bill which was abandoned last session a stop was put to the railway companies buying up any more canals.

Mr. Ritchie—the President of the Local Government Board—speaking at Sheffield on the 30th January, gave much satisfaction by his announcement that the Government intended to make 1888 an English and Scotch session. Special gratification was expressed in commercial circles here, that the question of railway rates and limited liability were to be a part of the Ministerial programme. No town in England has suffered more from the present application of the law of limited liability than Sheffield. At the end of last year the result of inquiries into limited liability companies in which this district is interested was to bring out a net loss in depreciated capital of nearly £4,000,000. This simply represented the difference between the called-up amount and the market price of the shares, and was altogether exclusive of the losses sustained by those who bought their shares at a premium, and of companies which have altogether disappeared in liquidation.

THE NORTH OF ENGLAND.

(*From our own Correspondent.*)

NOTWITHSTANDING fluctuations at Glasgow, the prices of Cleveland pig iron are fairly well maintained. There was but a moderate attendance at the market held at Middlesbrough on Tuesday last, and owing, no doubt, to the circumstance that it was the last day of the month, sales were neither numerous nor large. No. 3 g.m.b., for prompt delivery, has been maintained at 32s. per ton for about three weeks, and there is a prevalent feeling that the lowest has been reached, and that higher prices will be realised as the spring advances. There are not many inquiries for deferred supplies at present. Buyers are willing to give 32s. for delivery to the end of the quarter, but sellers are holding back in the hope of doing better when shipments to the Continent recommence. There is a steady demand for forge iron, the price ranging from 31s. to 31s. 6d. per ton.

Stevenson, Jaques, and Co.'s current quotations: "Acklam Hematite," Mixed Nos., 45s. per ton; "Acklam Yorkshire," Cleveland, No. 3, 35s.; "Acklam Basic," 35s.; "Refined Iron," hematite and Cleveland, 65s. to 55s.; "Chilling Iron," 55s. to 60s. net cash, at furnaces.

Warrants are greatly influenced by the frequent changes at Glasgow. The price on Tuesday last was 31s. 10d. per ton, as against 32s. 7½d., which figure was reached on the previous Tuesday. At Middlesbrough holders ask 32s. to 32s. 3d., but little or no business is being done.

The stock of pig iron in Messrs. Connall and Co.'s Middlesbrough store increased 647 tons during the week ending the 30th ult., the quantity held on that day being 347,724 tons.

Shipments since the commencement of the year have been so far very good. The exports of pig iron between the 1st and 30th ult. amounted to 57,464 tons, and of finished iron and steel to 54,310 tons.

The demand for manufactured iron is good, and makers continue to book orders at the prices which have ruled since the middle of December.

The report of the accountants to the Durham Mineowners' and Miners' Associations for the quarter ending December 31st shows an increase in the price of coal sufficient to warrant a rise to the extent of 1¼ per cent. in miners' wages.

The usual bi-monthly report of the accountant to the North of England Board of Conciliation and Arbitration has just been issued. It sets forth that during the two months ending December 31st, 1887, the average net selling price of manufactured iron was £4 12s. 0·87d. per ton. The average during the previous two months was £4 12s. 6·4d. It therefore appears that the price realised by the finished iron makers was on the decrease up to the end of last year. The output, however, seems to have increased, as during the period under consideration 6333 tons more iron were manufactured and sold than during the preceding period. Inasmuch as prices have distinctly risen from 10s. to 15s. per ton of late, it is clear that the above unexpected result as regards price must be due to the books of makers being overladen with old low-priced contracts. This adds one more proof to the oft-stated declaration that months must always intervene between a rise of quotations and any benefit being received by the manufacturers therefrom.

The annual meeting of the Board of Arbitration was held at Darlington on the 20th ult., and was largely attended. The report of the Standing Committee is a somewhat important document. It shows that the number of operatives subscribing to the Board is now 3712, being an increase of 272 on the number on the books in July last. The balance in hand is £644 12s. 10d. The expenditure during last year amounted to £970 5s. 3d., a fact that shows that conciliation and arbitration are luxuries which cannot be had without paying somewhat heavily for them. A great many disputes were settled during the year, including several relating to the manufacture of steel. This raised an important point. Hitherto the Board had existed for the benefit of the manufactured iron trade, as indeed its title implies. Latterly, however, as the manufactured iron trade has been on the decrease and the steel trade on the increase, its services have been in considerable request for the adjustment of disputes arising in the last-named industry. But only when both employers and employed have been willing to abide by its decision has it been able to deal with these cases; it has had no compulsory power. It was announced at the meeting of the 30th ult., that the standing committee recommends that as soon as may be the title of the Board shall be altered, so as to include the finished steel as well as the finished iron trade. The operatives generally and the employers, with a single exception, are of opinion that the time has arrived when this should be done. Effect will be given to the resolution, by means of a new bye-law, during the present year, and in January next the title and the rules will be permanently altered to suit. The Board of Arbitration has now entered the twentieth year of its existence, and though its operation has been somewhat costly, it has, in the language of the chairman, been an "untold blessing" to the great industry for which it exists.

The dispute between Messrs. Bolckow, Vaughan, and Co. and Lloyd's Committee has been settled. The manufacture of steel for shipbuilding purposes has been resumed at Eston, and Lloyd's inspectors are again permitted to visit the works, and inspect and test as heretofore. The settlement has been the result of Mr. Dale's investigation and report, followed by certain changes made by the company, and which have been pronounced satisfactory by Lloyd's Committee.

NOTES FROM SCOTLAND.

(From our own Correspondent.)

THERE has been a want of animation in the Glasgow pig iron market this week. Very little speculative business, comparatively speaking, has been done; but prices have, on the whole, been fairly steady. The ironmasters are agreed that while the exports are not quite up to the mark, the home consumption is larger than usual, a fact which is also apparent from the coastwise shipments of pigs to date, showing an increase of 6000 tons over those of January last year. The constant activity in the malleable works accounts for this improvement, which there is reason to believe will continue during the greater part, if not the whole, of the current year. The past week's shipments amounted to 6669 tons against 7988 in the corresponding week of 1887. Our best customer for pigs is still the United States, and it is noticeable that the export trade to Australia has begun well, the shipments there showing a considerable increase. A small quantity of iron is now being added to the stock in Messrs. Connal and Co.'s Glasgow stores. Since last report an additional furnace has been put in blast at Glengarnock Ironworks, and there are eighty-three blowing against seventy-six twelve months ago.

The current values of makers' pigs are again somewhat easier. Coltness, f.o.b. at Glasgow, No. 1, is quoted at 50s.; No. 3, 44s.; Langloan, 49s. and 44s.; Calder, 48s. 6d. and 42s. 3d.; Summerlee, 50s. 6d. and 44s.; Gartsherrie, 46s. 9d. and 43s. 3d.; Carnbroe, 43s. and 41s.; Clyde, 45s. 6d. and 41s. 6d.; Govan, 42s. 6d. and 40s. 6d.; Monkland, 42s. 6d. and 40s. 6d.; Glengarnock, at Ardrossan, 47s. 6d. and 42s.; Dalmellington, 43s. 6d. and 41s.; Eglinton, 43s. and 40s. 6d.; Shotts, at Leith, 48s. and 45s.; Carron, at Grangemouth, 47s. 6d. and 43s. 6d.

There is a steady and good business in Scotch hematite pigs, which is being consumed in large quantity for the purposes of the steel manufacture.

The iron and steel manufactured trades both keep very busy, and while the amount of new work being placed at the moment is admitted on all hands to be small, there is no quotable change in the prices.

The past week's shipments of iron and steel goods from Glasgow embraced locomotives to the value of £4400 to Bombay; machinery, £9441; sewing machines, £1815; and general iron manufactures, £29,000, a hopper steamer with machinery being in addition sent out to Egypt. She is valued at £7300, and she steams out to her destination.

The coal trade is fairly active, there being a good demand for manufacturing purposes, while the cold weather has quickened the demand for domestic use. There was dispatched from Glasgow 26,781 tons, Greenock 150, Ayr 8051, Irvine 2956, Troon 5500, Ardrossan 1885, Burntisland 7938, Methil 3630, Leith 672, Grangemouth 9264, Bo'ness 4946, Granton 660, and Port Glasgow 80—total 72,517 tons, as compared with 54,592 tons in the same week of 1887. There is practically no change in the quotations for the different sorts of coals.

There is considerable unrest among the colliers in the different mining districts. Resolutions have been passed by Lanarkshire miners to the effect that "in view of the improved trade of the country, and the enhanced value of coal, a vigorous agitation should be forwarded to improve wages and to promote union." The secretary of the Shale Miners' Union has been instructed to communicate with the Mineral Oil Association and the various oil companies, asking back the remaining part of the reduction, so that the wages may be restored to what they were in July last year. At many of the collieries in Fife, notices were lodged with the employers on Saturday last that fifteen days from that date the men would finish present contracts. This action of the men meant to resist a curtailment of 10 per cent. in their wages.

During the past month twelve vessels, with an aggregate of 13,056 tons, were launched from the Clyde shipyards, as compared with ten of 15,980 tons in the first month of last year. All the launches were steamers, with the exception of one sailing vessel and a lifeboat, and the greater part of the tonnage was of steel. Contracts for new vessels aggregating about 15,000 tons have been booked during the month.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

THE steady improvement that is going on in the coal trade is bringing into the market a few decent properties that will soon be caught up. One of these, in the Mynyddyslwyn parish, Newport, is certain to tempt, the character of the coal being of high value and scarce. I see that Rhondda No. 3 is, as forecast, going steadily up. It is now quoted at 8s. 3d., showing an advance of 1s. from what it was a few months ago. This class of coal, like the 4ft. smokeless, is far below the price it should be, considering how small its area is getting. Best steam coal is not so much advanced as most expected. Cardiff quotations were only 9s. to 9s. 3d. on Monday, and since prices have remained the same, though firm at that. Good kinds can yet be bought for 6s. at pit, 8s. to 8s. 3d. at port. Small steam is quoted from 4s. 3d., and as the demand is improving, will very likely be advanced. One of the most scarce of coals is small house coal; for this 6s. 9d. is given readily. Its coking properties are good, and the works on the Hills, especially Cyfarthfa and Dowlais, are large consumers.

I recorded last week the loading of the Asama at Cardiff. It steamed away with the enormous cargo of 5000 tons of coal—the largest yet cleared from this port. Some idea of the large Rhondda collieries will be given by noting that several of them are able to load two such vessels weekly.

Last week's coal trade at all the ports was a good one. Cardiff cleared over 170,000 tons. Many of the cargoes were fine. For instance, five vessels cleared 11,500 tons, and nine others took between them 10,560 tons.

Swansea suffered from a deficiency of tonnage, but, as it was, sent away a good average, and Newport continues easy.

The Aberdare colliers continue to exercise themselves in "federation" movements. On Monday there was a meeting of fifty-nine delegates representing over 35,000 colliers, and an executive committee was formed with president and secretary. Local committees are also to be appointed, and addresses given. The first is to be an organisation. It is to be hoped that the society will support all good movements, and aim especially at nourishing the Miner's Provident Institution.

The coaling cranes invented by Sir W. T. Lewis and Mr. Hunter are doing excellent work. They were especial objects of interest when the Roath Dock was opened, and were fresh then from the hands of that well-known firm, Walker and Co., Leeds. Since then they have come up to fullest expectations, and for rapid shipment are unsurpassed. A few instances of this may be given. One day last week the steamship John Dixon was put under the cranes at 8.40 a.m., and by twelve 1101 tons had been put on board. This was at the rate of 340 tons per hour. Even this was eclipsed next day, when the Ambient was loaded. In this case 200 tons were put in twenty-eight minutes, or at the rate of 428 tons per hour. In former times rapid shipments have been accomplished under high pressure, but only to the damage of cargo, the coal suffering in a serious manner. In the working of these cranes the coal is shipped in very much the same state as when the collier placed it in his tram. Certainly it may be said to be as good as when it left the screens.

What with great outputs that come up well to demands, and rapid despatches by the Taff and Rhymney lines from the collieries, and these exceptional feats of shipment, substantial benefit is being reaped by the coalowner, as a steamer delayed at port is a costly infliction.

The Taff Vale dividend is to be 13 per cent. Rhymney, 8 per cent. Barry shares are going up.

The Taff Vale and Bute Dock amalgamation is still keenly discussed, and I hear from many quarters confidence expressed in its passing. The Barry, which is to be completed by the autumn, is expected to take away from the Taff more than two-thirds of its Rhondda coal. In the face of this, the working of the new line to Newport from Pontypridd, and the opening of the Rhondda and Swansea, amalgamation would seem to be practical wisdom.

Swansea means to have a good slice yet of the Rhondda coals. They are the only things needed to make the port a more formidable rival to Cardiff. With Rhondda coal, and a day and a-half nearer France, she will lessen Cardiff exports.

No less than 300 applications have been received for the position as superintendent of Swansea Harbour. Mr. Capper's remarkable ability and energy have made his successor's task a great one. He must be a good man to fill the vacancy.

Sir John Jones Jenkins, at a bank meeting at Swansea this week, referred to the tin-plate market, and as he is largely interested, his remarks were listened to with attention. He states that a proposal had been made for a combination between the tin-plate trade and the French syndicate, but it had fallen through. In his opinion they would soon see tin down again to its normal value. With regard to the combination in tin-plate alone, that is going on steadily, and one of the first results is that there will soon be a limitation to make. It was proposed at the Exchange this week to stop make at 6 p.m. every Friday. This will reduce the make one-sixth—that is 1½ million boxes per annum. Nothing is yet decided, though the leading makers have quite made up their minds to lessen make in one way or the other. I have all along looked upon this step as unnatural, and not likely to be effective. It has been tried several times.

The exports of tin-plates continue about the average. Quotations are unaltered; buyers slightly backward, but makers have good orders and are not disposed to entertain any falling off in price.

In steel, rails are not quite so firm, and the 2s. 6d. advance in price has been taken off. Bars and blooms are unchanged, and works, on the whole, continue a busy trade. At present I imagine that Cyfarthfa is taking the lead, especially with its tin bar. Care in selection of ores and in the make has resulted in the production of a bar which now stands A1 in the market, and the demand, I hear, is excessive.

A formidable competition to most of the new works is coming into the field—the Treforest Works. Their position, twelve miles nearer to Cardiff, and on the side of the line to Newport and to Barry, as well as convenient for Swansea, will make these works a powerful rival.

NOTES FROM GERMANY.

(From our own Correspondent.)

THE tendency of these markets continues firm, although it would appear as if the convention period had arrived at its zenith, for if the news from certain quarters be correct, some of the covenanted groups have already exceeded the limitations fixed, so if this were to be repeated the days of the grand convention would be numbered. Again, the case of boycotting on the part of the crude iron convention, mentioned last week, is also calling up a voice in some of the press organs, insinuating that if such practices continue to the detriment of the wrought iron industry, the Government may be induced to interfere, which, of course, would give a death blow to all similar combinations, but it is hardly likely Government would meddle in the matter, though who can say to what lengths paternal Governments will or will not go? Be this as it may, there is nothing but the slight duty to prevent the importation of pig iron, if the convention acts unreasonably. The demand generally is brisk, especially for forge and basic pig iron, which are only procurable with difficulty from the smelters, and which accounts for prices suddenly jumping up as they do; but most other articles have a decided ascending tendency, and have been well maintained, so it cannot now be long before all manufactured goods take a flight upwards, in accordance with the actual rise in raw materials.

From Silesia the reports are most satisfactory. The wire-rod mills are quite deluged with specifications for present and spring delivery; all factories dependent upon this material are also very busy. The steel works are compelled to work night turns to complete orders, and works are being enlarged. The iron forges and rolling mills have as much to do as they can accomplish, and the whole of the works are in operation. Plates are in so much request that customers are with difficulty promptly served, and as to the blast furnace proprietors, they are satisfied too, as what pig iron is not contracted for goes off as quickly as made, and all the prices are satisfactory, as they are mostly regulated by the conventions on a paying footing. From February 1st the Breslau iron merchants have announced that they shall advance present list prices of plates.

As regards the Rheinland and Westphalia, the demand for iron ores keeps up and has, indeed, somewhat increased, which is only a natural consequence of the blast furnaces being so busy. Roasted steel-stone costs up to M. 13·20, while Spanish ore is noted 16 at the wharf on the Rhine at Duisburg or Ruhrort, equal to nearly M. 20 at the furnaces. The prices of pig iron, with the exception of Spiegel, have remained nearly unchanged, but have a rising inclination, which is likely soon to lead to higher rates, in consequence of all the limestone quarries of the district having been bought up by a single company, which will now enjoy a perfect monopoly of the limestone requisite for the blast furnaces. A rise of 1½ to 2 M. has taken place since this was written, and the convention at the enhanced prices has contracted for the output of most furnaces for the first half of the year, and in some cases beyond. Spiegel iron has made a jump from M. 54 to 58 for 10 to 12 p.c. Mn.; while 20 p.c. is noted up to 74 p.t., and this without any apparent cause to outsiders, as neither for export nor inland has the demand increased. Forge pig cannot be brisker, and many works have closed contracts for all their output up to June. Prices range from M. 50 to 52, and even 53 for best sorts. Luxemburg has gone up 4f., and is now selling at M. 39 to 40, whilst the sales office declines to make any new sales just at present. Foundry pig goes off well at old convention list prices as lately given. Bessemer is noted 53 to 54, basic at 45 p.t., and is in much request.

The pig iron production, including Luxemburg, has been for December last 359,867t.; forge and spiegel, 175,569; Bessemer, 34,330; basic, 106,901; and foundry, 43,067. From January 1st to December 31st, 1887, 3,907,364 against 3,339,803t. for the like period 1886. If the average production for the last three months be taken 350,000 t., this would equal an output of 4,200,000 t. per annum, but the production is increasing at a rate which would make it quite equal to 4,400,000 t., to say nothing of the 160,000 t. imported each year. This exceeds very much indeed all requirements, besides the Russian market, which formerly took large parcels, being now closed against the country, so a little sooner or a little later in the year a point will arrive when either prices must come down or output be decreased. The finished iron trade is announced to be in a healthy state of development, as prices are firm and paying; nevertheless, the rolling mills complain of the inequality between their prices and those of the raw materials becoming more and more pronounced, which diminishes their profits. For the interior orders for merchant iron come in sufficient numbers to keep the works employed for the present, but there is little doing for export, and these prices are very low. It is in contemplation to fix a higher list price soon. Just the same may be said of hoops, only that the works have inland orders assured for a greater length of time, the price remaining M. 137·50 to 140 p.t. There is a little more doing in boiler and heavy plates, December showing an increase over November of 5000 t., and many more orders are expected this month than last, yet this branch is not brisk. Nevertheless a rise of M. 15 to 20 is talked about, but which is not to be thought of yet awhile. For the season the sheet mills are running briskly, the price being still M. 184, but which was to have been raised last meeting of the convention. To keep step with forge pig, the rise has, however, been postponed to see what Silesia does in this respect. Anyhow, a rise must soon take place. The wire rod branch is not quite so flourishing as it was, inasmuch as the export business is not brisk at all. The inland trade is good as far as orders are concerned, but the price is low, so much so, indeed, that it is nearly M. 20 below bar iron, and for that reason the mills are endeavouring to get rods of, say, 10mm. classed as bars. There is a great over-production. It is too early after its formation to say what the new convention has already done or will accomplish. Well-informed authorities are not inclined to give it a long lease of existence, one reason for which being that some of the largest works have not joined, about which there is much tribulation, and they are accused of having little regard for the German iron industry by not so doing, the other reason is that the question of quality will probably cause the convention to be wrecked. It seems almost an impossibility to get the prices up, and the only means then left is to decrease the output 5 to 7½ per cent. The same depression and arguments were observable because only one-fourth of the wire nail factories have joined their convention, but the wire spring and light chain factories have formed one now, so it is hoped wire rods for domestic consumption will be kept in good request and no more lowering of prices take place. There is nothing new to say regarding the machine shops and foundries, except that the latter in Silesia, where, amongst other things, a great deal of pottery and light castings are cast direct from the blast furnaces, have formed a common sales-office at Gleiwitz. The constructive works in iron, as roofing, &c., are busy still, and the boiler shops have more work in hand. The wagon factories have now got work for a length of time, and driblets are still coming to them from the State directions all over the country, also locomotives are being given out, but the prices received for them are by no means extravagant. The brass foundries are full of orders, and a much needed rise in price has taken place, so that bronze castings are now quoted M. 2·20, phospor bronze 2·30, red brass, 2·20, and smithed copper tuyeres 3·60 p. ko.

The coke trade has become especially active; what with forcing the old to a higher output, and the starting of fresh blast furnaces in Westphalia, Rheinland, the Saar district, and Belgium. In fact, more furnaces would be blown in if coke could be immediately procured for them.

In Belgium pig iron continues very scarce; the rolling mills are not as busy as they were, because export buyers refuse to give the advanced prices, and the export of girders is slack, except to England. In fact, the whole trade seems just now to be existing on complaints, for the coke makers grumble at the coalowners about the price of dust coal for coking; the blast furnaces at the coke makers and the rolling mills at the high price of pigs and coals; and at the buyers for not coming forward with more orders. Forge pig cost 46f.; foundry, 48 to 49; merchant bars, 120. Coal is exceedingly firm.

The French iron trade has taken a marked turn for the better in an upward tendency all round. Pig iron has gone up to 46f. for forge and 56 to 60 for foundry, while merchant iron has kept pace, and is now 130 at works and 145 at Paris, and girders are 120 and 135 p.t. respectively.

AMERICAN NOTES.

(From our own Correspondent.)

NEW YORK, Jan. 18th, 1888.

THE blizzard throughout the North-West, especially in the territory of Dakota, has been exceptionally severe. Entire families have been lost, live stock has been frozen by the hundreds in stalls, railroads are blockaded, and trains are from fifty to one hundred hours late. The snow ploughs are hard at work, and in a few days will have the trans-continental lines once more open. The winter has been the most severe for years. The most important matter in financial and industrial circles to-day is the attitude of the Reading Railroad and miners' strike. They have combined, and will appeal to organised labour throughout the country for funds to maintain them in their strike against the Reading Company for the next six months. The impression is gaining ground that the Reading Company is making a mistake; but the officials still insist that they are able to bring their rebellious workmen to terms. Several hundred establishments will be out of coal in ten days. Bituminous coal will be used in place; but the supply of bituminous mines within reach of the Atlantic Coast is not regarded as sufficient for the extraordinary requirements that will be presented.

The iron trade is quiet. In metals there is a moderate degree of activity. The market in tinplates closes strong. Tin is in quite active demand in a retail way. Large lots are seldom sold. The copper market has been irregular. The copper syndicate has closed a contract with the Rio Tinto Company for its entire product for three years. The same syndicate has made contracts with two or three other heavy producers in the North-West. The exports of copper since the first of the year have been 1,893,805 lb., against 272,500 lb. same time last year; and of copper matte and ore, 1,983,530 lb., against no exports last year to this date. Lead is offered freely at 4·90, sales at 4·80. Spelter is in active demand at 5½c. Sheet zinc is sold at 6¾c. Steel rails are quoted dull at 32 dols. to 33 dols.; wire rods, 40 to 41; old tee rails, 22 dols. Double-head rails would find buyers at 22·50 dols., but the asking price is 23 dols., and stocks are light. The general situation in the iron trade is satisfactory, although business is moderate. Advices from the interior show a general curtailment of demand, owing to cold weather. The exports of tin to the United States from Holland for 1886 were 473 tons, against 916 tons for 1885; for nine months of 1887 the exports from Holland were 204 tons, against 360 tons for nine months of 1886. The production of pig iron last year was 6,433,851 tons, against 5,684,542 gross tons for 1886. The production is being increased, particularly in the Southern States. At this time 143 bituminous furnaces are in blast, producing 83,101 tons per week; 110 charcoal furnaces, producing 9166 tons per week; 118 anthracite furnaces, producing 38,206 tons per week.

NEW COMPANIES.

THE following companies have just been registered:—

Cwm Irfon Slate Quarry Company, Limited.

This company was registered on the 21st ult., with a capital of £5000, in £10 shares, with power to increase, to lease from Mr. Parry Lloyd the Cwm Slate Quarries, parish of Llanwrfyd, county of Brecon. The subscribers are:—

	Shares.
P. Lloyd, Glasbury, Radnor	10
J. Davies, Builth, Brecon, wine merchant	10
Hugh Bennett, Builth, Brecon, surgeon	10
R. W. E. Owen, Builth, Brecon	10
M. Vaughan, jun., The Skvens, Radnor	10
R. B. James, Llanwrfyd, Brecon, merchant	1
B. Jones, Llanwrfyd, Brecon, hotel keeper	10

Registered without special articles.

The Discoveries Company, Limited.

This company was registered on the 19th ult., with a capital of £20,000, in £10 shares, to deal in all kinds of novelties and to manufacture and trade in goods of every description. The subscribers are:—

	Shares.
A. Barrett, 28, High-street, Sydenham, shorthand writer	1
J. B. Purchase, 11, Queen Victoria-street, solicitor	1
E. K. Purchase, 11, Queen Victoria-street, architect	1
T. G. Davis, Richmond Lodge, Hornsey	1
W. S. Oliver, 15, George-street, E.C., engineer	1
W. S. Simpson, C.E., Battersea Park-road	1
P. Brown, Friern Park, North Finchley	1

Most of the regulations of Table A apply.

Folding Gate and Shutter Company, Limited.

This company was registered on the 20th ult., with a capital of £60,000, in £1 shares, to acquire the letters patent No. 2189, dated February 17th, 1885, granted for "Folding steel gates and shutters," and for such purposes will adopt an agreement of the 12th ult., entered into with W. W. Bodwick. The subscribers are:—

	Shares.
J. W. Morris, Thorners-chambers, Fenchurch-street, architect	1
C. H. Driver, 5, Victoria-street West, architect	1
Colonel J. H. Smith, Wallington, Surrey	1
F. Warburton Stent, C.E., Gracechurch-buildings	1
J. M. Gottrell, Cambridge Park, Twickenham	1
Ernest Baker, 7, John-street, Bedford-row, valuer	1
R. J. Drinkwater, 14, Hill-street, Knightsbridge	1

The number of directors is not to be less than three, nor more than seven; qualification, £200 in shares; the subscribers are to nominate the first; remuneration, £750 per annum, and a sum equal to one-tenth of the net profits remaining after payment of 10 per cent. dividend.

Manila Railway Company, Limited.

This company was registered on the 25th ult., with a capital of £500,000, in £10 shares, to acquire the concessions, rights, and privileges relating to a railway from Manila to Dagupau, in the Isle of Luzon, with power to maintain the said railway, and any other railways or public works authorised by concession of the Spanish Government, or of the Philippine Islands. The subscribers are:—

	Shares.
F. J. Irwin, 41, Sistova-road, Balham	1
A. B. Curtis, 1, Honeywell-road, Wandsworth Common, clerk	1
W. F. Wayte, 92, Godolphin-road, clerk	1
M. Elvysohn, 20, Pall Mall	1
G. Bell, 30, Wildash-road, S.E., engineer	1
R. L. McLaren, C.E., 10, South Vale, Blackheath	1
C. R. Leighton, 13, Croftdown-road, Highgate, clerk	1

The number of directors is not to be less than three, nor more than ten; the subscribers are to appoint the first, and act *ad interim;* qualification, £500 in shares or stock; remuneration, £3000 per annum. £30,000 of the shares are to be 7 per cent. cumulative preference shares.

General Cycle Supply Company, Limited.

This company was registered on the 24th ult., with a capital of £5000, in £1 shares, to trade as cycle manufacturers, general merchants, machinists, millwrights, machine and engineering tool makers. The subscribers are:—

	Shares.
W. Forbes, 79, Cambridge-street, S.W.	1
H. B. Ironside, Foots Cray, Kent	1
C. M. Roberts, 33, Milton-road, Acton, clerk	1
D. Wheeler, Bromley-road, Beckenham	1
J. Fisher, Lewisham, builder	1
T. W. Gowen, Walthamstow, clerk	1
H. W. Murray, Stoke Newington, clerk	1

The number of directors is not to be less than two, nor more than seven; the subscribers are to appoint the first two; qualification, fifty ordinary or two founders' shares. The remuneration of the board will be £50 per annum on each issue of 500 shares. Mr. W. J. Endersley is appointed managing director at a salary of £200 per annum, to be increased at the discretion of the board.

J. F. Blyth and Company, Limited.

This is the conversion to a company of the business of ironfounders and engineers carried on by J. F. Blyth and Co. It was registered on the 18th ult., with a capital of £10,000, in £1 shares. The subscribers are:—

	Shares.
*H. Rogers, Clifton, Bristol, manufacturer	1
*J. F. Blyth, 91, Queen Victoria-street, engineer	1
J. W. Newall, Manor Park, Essex, engineer	1
R. T. Strangman, 101, Leadenhall-street, secretary to a company	1
*R. Raffety, Lee, Kent, manufacturer	1
Alex. Kerl, 14, Great Winchester-street, solicitor	1
H. C. Murchison, 8, Austin Friars, secretary to a company	1

The subscribers denoted by an asterisk are the first directors; qualification for subsequent directors, 100 shares; remuneration, £300 per annum to the managing director—Mr. J. F. Blyth—£100 per annum to the chairman, and £50 to each other director.

Patent Hydraulic Freestone Company, Limited.

This company was registered on the 23rd ult., with a capital of £10,000, in £1 shares, to acquire and work the letters patent No. 4927, dated 10th November, 1881, relating to the manufacture of artificial stone. The subscribers are:—

	Shares.
J. R. Smith, 17, Lowfield-road, West Hampstead, glass manufacturer	1
T. Farrow, 5, Selby-road, Leytonstone	1
W. R. Woolston, 34, Mark-lane	1
W. H. Sharpe, 84, Waddon New-road, West Croydon, clerk	1
J. Roberts, 14, Union-court, E.C.	1
T. R. Pyrke, 242, Romford-road, E., traveller	1
C. H. Kirk, 9, Lamb-lane, Hackney, accountant	1

The number of directors is not to be less than three, nor more than seven, every member being eligible. The subscribers are to appoint the first directors, and the company in general meeting will determine remuneration.

Patent Improved Sea Bathing Machine Company, Limited.

This company proposes to trade as proprietors of bathing machines and bathing establishments in the United Kingdom or abroad, and for such purposes to purchase the letters patent No. 12,411, dated September 30th, 1886. It was registered on the 25th ult., with a capital of £15,000, in £1 shares, with the following as first subscribers:—

	Shares.
O. McCrea, Brixton, clerk	1
D. Brown, 2, Cambridge-terrace, Fulham, clerk	1
E. E. Allen, Chelsea, engineer	1
T. Pittman, 7, Humphrey-street, Old Kent-road, merchant	1
W. Walmisley, 3, 4, and 5, Queen-street, E.C., engineer	1
F. Birkenshaw, 26, Hillfield-road, West Hampstead, secretary	1
J. Mitchell, 62, Howard's-buildings, Mile End, brewer	1

The subscribers are to appoint the first directors. The number of directors is not to be less than three, nor more than six; qualification, fifty shares; remuneration, £50 per annum, with £10 additional for the chairman. Mr. Oliver Pitts, of 56, Gladstone-street, S.E., and Mr. D. G. Deacon, of 1, Holland-road, Brixton, are respectively appointed manager and secretary.

Public Streets Lighting Company, Limited.

This company was registered on the 20th ult., with a capital of £10,000, in £1 shares, to carry on in all branches the business of a public and private lighting company, and to produce and trade in all apparatus, appliances, and things used in connection therewith. The subscribers are:—

	Shares.
J. Cawdy, 40, Queen-street, merchant	1
H. S. King, St. Swithin's-lane, engineer	1
H. B. Bartlett, Bow, contractor	1
J. P. Cawdy, Sidcup, iron merchant	1
T. J. Davies, Dulwich, iron merchant	1
H. O. Mellor, Marquis-road, N., solicitor	1
W. E. Breakspear, Tottenham, accountant	1

The number of directors is not to be less than three, nor more than five; the first are Messrs. Hubert Barrow Doo, Frederick Hill, and Edmund Herbert Stevenson; remuneration, 25 per cent. of the net profits after 10 per cent. dividend has been paid.

Skytmyr Copper Mines, Limited.

This company proposes to acquire certain copper mines, buildings, and appurtenances, situate in the county of Nedenæs, Norway, upon terms of an agreement of 19th ult. between the Nedenæs Copper Company, Limited, and Henry Charles Murchison. It was incorporated on the 21st ult., with a capital of £120,000, in £1 shares, the whole of which will be allotted, credited as paid up to the extent of 15s. per share.

	Shares.
A. G. Thiselton, 20, Queen's-terrace, Peckham, clerk	1
J. H. Murchison, 8, Austin Friars, director	1
A. B. Wymond, Imperial Club, E.C.	1
H. C. Murchison, 8, Austin Friars, secretary to a company	1
Henry Verden, 14, Great Winchester-street, solicitor	1
A. Kerly, 14, Great Winchester-street, solicitor	1
A. W. Kerly, 14, Great Winchester-street, solicitor	1

The number of directors is not to be less than two, nor more than five; the first are Messrs. C. Macdona, David Macfie, Alexander C. Macfie, and Sidney Sharp; qualification for subsequent directors, 500 shares. The remuneration of the directors will be at the rate of £100 per annum each.

Stannaries Company, Limited.

This company was registered on the 18th ult., with a capital of £10,000, in £1 shares, to carry on the business of miners, potters, brickmakers, quarrymen, engineers, and contractors. The subscribers are:—

	Shares
J. Fraser, M.E., Carnarvon	1
W. J. Antram, 268, Shirland-road, W., shorthand writer	1
W. E. Bacon, 17, Ironmonger-lane, clerk	1
S. J. Chisholm, 12, Pancras-lane	1
H. E. Edmunds, 57 and 58, Chancery-lane	1
A. H. Gobey, 104, Ashmore-road, N., clerk	1
R. Rodgers, 52, New Broad-street, secretary to a company	1

The subscribers are to appoint the first directors; qualification, 100 "A" shares, or one founder's share. The minimum remuneration is to be at the rate of £200 per annum in respect of each director.

THE STEEL GUN CAST AT PITTSBURG.

THE Pittsburg *Despatch* of January 17th says:—"The big steel gun was drawn from its mould at the Pittsburg Casting Company's works early yesterday morning. Although it is nearly five days since the metal was poured into the mould, when taken out the steel was too hot to be touched. The huge casting, after it was released from the chains, lay prone upon the earthy floor, where it was critically and silently inspected by Mr. Hainsworth, the master mechanic of the foundry, and Lieuts. Fletcher and Force, United States Steel Inspectors. Flaming lights were flashed upon every part of the crude cannon, as the almost breathless examination continued. Powerful glasses were also used; but after fifteen minutes, during which not a syllable had been uttered, the quartette of experts stood up and instinctively grasped and shook each other's hands. The action was more expressive than words, and was readily understood by the workmen. With a loud cheer they sprang for the steam whistles, and, for the next fifteen minutes, those instruments of torture shrieked a mighty pæan of victory. The casting is smooth and free from either depressions or excrescences. Mr. Hainsworth is confident, unless some mishap should occur during the delicate process of 'rough boring,' that it will fully meet the requirements of the Ordnance Department. It will still be several days before the casting is sufficiently cool to permit the sawing off of the superfluous steel at breech and muzzle. This will be the first step toward getting it into something like the form of a cannon. These pieces will be used to make a test of the tensile strength of the steel. The gigantic lathe which will be used for boring is already nearly completed in the finishing department; but this work will probably not be commenced ere the middle of February. It will require at least four weeks to do the work. The cannon will, therefore, not be ready for shipment to Washington before March, or perhaps later. The ability to make heavy steel cannon at a single cast means that such guns can be made at a reduction of one-sixth the cost of the present heavy artillery of the world. If Pittsburg can produce great guns of this sort, there is every reason to expect that she may become the centre of cannon manufacture for the world. It would be no slight addition to Pittsburg's magnificent industries if yesterday's experiment should develope a rival to Krupp's and Armstrong's establishments right in our midst. Since the United States Government would not give us a gun foundry here, Pittsburg is in a fair way of starting one on her own account."

NITRO-GELATINE SHELLS.—The Constantinople *Stamboul* of December 13th says that experiments have been made there lately with the purpose of proving that the Snyder projectile, charged with nitro-gelatine, can be thrown from an ordinary cannon without bursting in the gun. The experiments were made under the orders of General Asif Pacha, Inspector-General of Fortifications. The gun employed was a 15-centimetre breech-loading field howitzer. The shell was loaded with ten pounds of nitro-gelatine composed of 94 per cent. of nitro-glycerine and 6 per cent. of collodion amalgam, gun-cotton, camphor, and ether. Ten shots were fired without the slightest accident to the howitzer. A target, at a distance of 200 metres from the howitzer and composed of twelve plates an inch thick bolted together, with a support of oak beams 14in. thick, was completely demolished by one shell. The other shells did not explode, because the ground did not offer them sufficient resistance. Eight photographic views of the experiments were taken, and those of the target as seen before and after the explosion. The report made by Asif Pacha has been laid before the Turkish Minister of War.

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.

20th January, 1888.

876. FLOWER POTS, W. Allen, Benthall.
877. ADJUSTING the AXES of CYLINDERS, G. and E. Ashworth, Manchester.
878. CUTTING, &c., MACHINE TOOLS, S. Matthews, Newcastle-on-Tyne.
879. GAS BURNERS, W. H. Blakeney, Nethergate.
880. TWINE FORMED into BALLS, J. Howard, Liverpool.
881. SAFETY APPARATUS for TRAMCARS, P. P. Ayres, Birmingham.
882. MULES, H. H. Sinkinson, Manchester.
883. VENTILATING SEWERS, &c., S. H. Adams, Monkbridge.
884. WEIGHING MACHINES, C. P. Skipworth.
885. CRANE, J. Otter, Brightside.
886. REGULATING BYE-PASS COCKS, E. B. Whatley, Cheltenham.
887. COLLIER'S PICKS, R. T. Howard, Kearsley, near Bolton.
888. DRAUGHT PREVENTERS for DOORS, H. Waddington, Accrington.
889. STOVES for HEATING AIR, A. E. Fletcher, Liverpool.
890. VENTILATING APPARATUS, E. P. Brett, York.
891. READING DESKS, &c., M. A. Boyde, Manchester.
892. FLY SPINNING MACHINERY, A. H. Briggs, Bradford.
893. LATCH BOLTS, J. Cadbury and J. G. Rollason, Birmingham.
894. TICKET HOLDER D. Larmer, West Derby.
895. SAFETY WINDOW CATCH, C. Jones, Bury.
896. RECOVERY of SULPHUR, &c., H. Kenyon, Clayton, near Manchester.
897. DYEING COTTON CORDS, J. Marshall, Wallesden, near Todmorden.
898. GIRTHS for SADDLES, F. H. Peat, London.
899. CHAIRS for PERMANENT WAYS, F. S. Morris, London.
900. LIQUID INK ERASER, R. N. Hobart, Liverpool.
901. ADVERTISING, W. Brownlie, Glasgow.
902 CARPETS, W. C. Gray and W. Tannahill, Glasgow.
903. COMPOUND MATERIAL, F. R. Putz, London.
904. WORKING COAL, W. T. Goolden and L. B. Atkinson, London.
905. FIRE LIGHTERS, J. A. Coldewey, London.
906. SAFETY TARGET, F. L. Stephenson and B. Hardcastle, Woolwich.
907. CAMERA STANDS, F. Barr, Walthamstow.
908. PUNCHING JACQUARD CARDS, P. A. C. de Sparre, London.
909. GAS MOTOR ENGINES, J. Southall, London.
910. WIRE WORK STRUCTURE, A. Schunck, London.
911. GAS LAMPS, T. Gordon, London.
912. BOILER PLATES, D. Purves, A. L. Jones, and W. J. Darling, London.
913. SPLITTING MACHINE BELTING, G. B. Mallinson and W. Speight, London.
914. CENTRIFUGAL BLADES, &c., R. H. Fisher, Liverpool.
915. SCRAPER for POTATOES, &c., C. F. Wilmot, London.
916. SLIDE VALVES, T. Lockerbie, London.
917. BICYCLES, A. Easthope, London.
918. VELOCIPEDES, A. Easthope, London.
919. TENTS, S. M. Johnson, London.
920. ALKALINE METALS, G. Baron de Overbeck, London.—(*F. Hornung and F. W. Kasmuyer, Germany.*)
921. PLOUGH SHARES, J. E. Ransome, London.
922. LOTION and POWDER for FOOT-AND-MOUTH DISEASE, G. Jeanes, London.
923. FOG SIGNALLING, C. Tighe, London.
924. MEASURING, &c., J. G. Lorrain, London.
925. MEASURING, &c., J. G. Lorrain, London.
926. FREEZING MACHINES, W. H. Tomson, London.

21st January, 1888.

927. JAW for WRENCHES, H. W. Atwater, London.
928. BUFFERS, A. Spencer, London.
929. FORCING LIQUIDS, G. H. Fish, London,
930. DROP BOX MOTIONS for LOOMS, T. L. Daltry, Manchester.
931. ROLLERS of WASHING MACHINES, &c., J. Hudson, Birmingham.
932. PRIMARY BATTERIES, R. H. Thomas and B. W. Warwick, London.
933. CONTACT REGULATORS, F. Bosshardt, London.—(*L. Bouchet, France.*)
934. LINEAL MEASURING, &c., BLOCKING MACHINES, J. C. Clegg, Lancashire.
935. ROOF TILE, S. Turner, Hull.
936. CURLING IRONS, W. Lamb, London.
937. BRAKE, L. Pourri, Great Grimsby.
938. RIDING SADDLES, F. V. Nicholls, London.
939. BUCKLES for BRIDLES, F. V. Nicholls, London.
940. COLOUR BLOCKS, D. D. Muter, London.
941. HANDLES for PERAMBULATORS, L. G. Russell, Birmingham.
942. MOTIVE-POWER APPARATUS, M. Blumrich, Philadelphia.
943. BLOWERS, EXHAUSTERS, &c., J. T. H. Ashbury, Birmingham.
944. REFLECTING LAMP, O. Y. Rhodes, F. Mori, and S. S. Skipton, Halifax.
945. BEDSTEADS, M. Weightman, Newcastle-on-Tyne.
946. VALVES, W. Haythornthwaite, Manchester.
947. GOVERNORS for ENGINES, S. Buckley and J. Taylor, London.
948. NOZZLES of CARBOYS, J. Bullen, Manchester.
949. FLASH LIGHTS, J. E. Thornton, Manchester.
950. AUTOMATIC DOORS, E. B. Andrews, Birmingham.
951. LIQUID COOLING PURPOSES, W. H. Richards, Staffordshire.
952. SECURING CARDS to FLATS, R. Tatham, Manchester.
953. GAS BURNERS, G. J. O'Reilly, London.
954. SCREWDRIVERS, D. R. Hart, London.
955. BOBBINS, C. Rainey, London.
956. COPYING LETTERS, G. A. Sweetser, London.
957. CLOSING HOLES in CASKS, T. Walker, London.
958. RAILWAY CHAIRS, R. Armstrong, Glasgow.
959. LOCK BAR, R. S. Moncaster, London.
960. THREAD-SPOOLING MACHINES, W. McGee and D. McGee, Glasgow.
961. STRAINER and STEAMER, G. Beal, Liverpool.
962. POTS for EXTRACTING DECOCTIONS, H. Salkeld, Birmingham.
963. UMBRELLAS, A. J. Boult, London.—(*S. Martin, Spain.*)
964. GAS BURNERS, A. M. Craig, London.
965. HAND GUARDS, H. Hayley, London.
966. SACKS, BASKETS, &c., A. J. Boult, London.—(*F. A. y Portillo, Spain.*)
967. RUBBER COMPOSITIONS, A. M. Wood, London.
968. SAFETY HARNESS, A. H. N. Brandt, London.
969. BOXES for BOTTLES, W. Pett, London.
970. ZITHERS, F. Kühmayer, London.
971. DRAWING AERATED LIQUID from FONTS, O. Imray, London.—(*E. Rowland, Victoria.*)
972. TRUSSED GIRDERS, J. Goüin, London.
973. INTERNAL FLUED STEAM BOILERS, C. J. Galloway and J. H. Beckwith, London.
974. FLOWER STANDS, J. Nichols, Birmingham.
975. CONVEYING CASH, &c., R. T. Smith, Glasgow.
976. TOY WHISTLING LOCOMOTIVE, G. F. Lutticke, London.
977. SIGNALLING, J. Ashton, London.
978. LIFEBOATS, H. Benjamin, London.
979. MATERIALS for SOLING BOOTS, &c., T. Cowburn, London.
980. ELECTRIC BATTERY CELLS for LIGHTING, W. Balch, London.
981. ELECTRIC "CALL" SIGNAL APPARATUS, C. Spratt, London.

982. LENSES, T. R. Dallmeyer, London.
983. AUTOMATIC DELIVERING MACHINES, S. S. Allin, London.
984. CONTROLLING RAILWAY SIGNAL LEVER, W. F. Burleigh, London.
985. RAILWAY INTERLOCKING APPARATUS, W. F. Burleigh, London.

23rd January, 1888.

986. ROCKING-BOAT for CHILDREN, C. R. Illingworth, Halifax.
987. SHIRT COLLAR BRACE, A. Savage, London.
988. BLEACHING, &c., TEXTILE FABRICS, A. McNab, Glasgow.
989. ROLLING BOARDS for PIECE GOODS, C. H. Priestley, Bradford.
990. FOUNDATIONS for PIECE GOODS, C. H. Priestley, Bradford.
991. FOUNDATIONS for PIECE GOODS, C. H. Priestley, Bradford.
992. FOUNDATIONS for PIECE GOODS, C. H. Priestley, Bradford.
993. CHARGING BOTTLES, &c., with SYRUP and AERATED WATER, H. W. Carter, E. M. Wright, and W. Edney, Bristol.
994. CIGARETTE PAPER, &c., C. Davies, South Liverpool.
995. SHIPS' BERTHS, W. P. Hoskins, Birmingham.
996. NEEDLES, A. R. Allwood, Alcester.
997. PARASOLS, W. Ross, Glasgow.
998. STOKERS, A. Thomson, Glasgow.
999. CALICO-PRINTING MACHINES, &c., E. J. Jones, Glasgow.
1000. TROLLEYS for TRANSPORTING COAL, A. C. Hart, London.
1001. WARMING RAILWAY CARRIAGES, &c., J. Milnes, Huddersfield.
1002. SANITARY SUSPENSORY BRACE, P. G. Harris, Tenby.
1003. STOPPERING BOTTLES, W. T. Cook, Sheffield.
1004. BRICKS, G. A. Wright, London.
1005. VELOCIPEDES, A. Hunnable, London.
1006. CARTRIDGES, A. Barker and H. Andrews, London.
1007. WATER-FITTINGS for HOSE PIPES, J. H. Stone, London.
1008. ADJUSTABLE COMBINATION FOLDING CHAIR, D. Lowe, London.
1009. DYNAMO-ELECTRIC MACHINES, J. H. Davies, London.
1010. DIFFERENTIAL SCREWS for PRESSES, C. and W. Junge, London.
1011. SEWING MACHINES, J. B. Bailly, London.
1012. TINDER-BOX, L. Foix, London.
1013. PROJECTILES, C. A. McEvoy, London.
1014. COAL, &c., W. T. Goolden and L. B. Atkinson, London.
1015. PUMPING ENGINES, E. Barnes and Tangyes Limited, London.
1016. ELECTRICAL TRANSFORMING APPARATUS, A. M. Taylor, London.
1017. IMITATION OIL PAINTINGS, H. A. Bogaerts, London.
1018. APPARATUS for CARBURETTING AIR, C. Herzog, London.
1019. SEWING MACHINES, J. J. Robinson and E. Hanff, London.
1020. WOOD WOOL, H. T. Anthon, London.
1021. LOCK, A. Davies, London.
1022. PREPARING SLIVERS of COTTON, &c., R. Tatham, Manchester.
1023. REVOLVING AXLETREES for VEHICLES, C. P. Holliss, London.
1024. ELECTRIC COILS, L. S. M. Pyke and H. T. Barnett, London.
1025. AUTOMATIC EXHAUST VALVE, G. Fincham, London.
1026. PICTURES, W. P. Thompson.—(*J. W. C. C. Schirm, Germany.*)
1027. PERMUTATION LOCKS, H. H. Lake.—(*T. Kromer, Germany.*)
1028. CABLE GRIPS, &c., W. J. E. and J. E. Carr, London.
1029. ROTARY GALVANIC BATTERIES, A. Wunderlich, London.
1030. DISINFECTANTS, H. G. Armstrong and J. E. Waller, London.
1031. SIGNAL LIGHTS, &c., J. Pain and A. A. Craig, London.
1032. APPARATUS for INDICATING HEIGHT, J. A. Bryce, London.
1033. APPARATUS for INDICATING PRESSURES, J. A. Bryce, London.
1034. MOUNTING HOBBY-HORSES, &c., T. Hurst, London.
1035. COMBINED SPEED and PRESSURE INDICATOR, T. Thorpe, Whitefield.
1036. CLEMENTS DRIVER, J. S. Lyon, Cambridge.
1037. HATS, &c., J. Ashworth, Manchester.
1038. CLEANING and PRESERVING BOILER FURNACES, J. Rankine and J. P. Hall, Jarrow.
1039. SPRING CARD EASEL and SUSPENDER, J. Appleby, Birmingham.
1040. EXAMINING the UNDERSIDE of CLOTH when being WOVEN, J. Irving, Barnsley.
1041. WASH or RUBBING BOARDS, J. Watling and W. W. Smith, Barnsley.
1042. HORSESHOE PROTECTOR, J. Birrell, Manchester, and A. Blackburn, Stretford.
1043. DOBBY APPARATUS, J. Irving, Barnsley.
1044. COMPOSITION for CLEANING GLASS, &c., D. S. Roberts and A. Peters, Bristol.
1045. LAMPS for BURNING OLEAGINOUS VAPOUR of GAS and AIR, G. Rose, Glasgow.
1046. FIRE-GRATES, W. B. Redish, Liverpool.
1047. EUREKA PERFORATED, &c., SOCK, J. Bigford, Birmingham.
1048. KEEPING a BUOYANT BODY at a CONSTANT DEPTH BELOW the SURFACE of WATER, F. M. Sims and W. C. Nicholls, Manchester.
1049. BROOMS, J. I. Ryder, Derbyshire.
1050. ADVERTISING REFLECTORS, G. Whitehead, Birmingham.
1051. STANDS for BICYCLES, &c., J. Parr, Leicester.
1052. INTERIOR and EXTERIOR of SILK, &c., HATS, S. J. Barber and J. Challinor, Stockport.
1053. WRINGING and MANGLING FABRICS, W. H. Beal, Halifax.
1054. PREVENTING the COLLAPSING of FURNACES in MARINE, &c., BOILERS, J. Rankine, North Shields.
1055. ELECTRIC SAFETY APPARATUS, R. J. Jones and A. Wright, London.
1056. DETECTOR SOUND SIGNAL, H. J. Peddie, Edinburgh.
1057. OPEN BACK SHEAR SPRING BICYCLE SADDLE, L. von Lübbe, London.
1058. DESTRUCTION of VERMIN, G. Rodger and W. J. Cordner, London.
1059. TAPS, &c., C. and C. W. East, London.
1060. BOOKS, W. P. Thompson.—(*J. M. Beers, United States.*)
1061. VALVES, W. P. Thompson.—(*The Barnett Brass Company, United States.*)
1062. CHIMNEY POTS, G. F. Verini, Liverpool.
1063. VELOCIPEDES, J. Cottrell, Liverpool.
1064. BALE BAND FASTENINGS, H. Lindon, Liverpool.
1065. OIL LAMPS, C. Halliday, Manchester.
1066. SWITCHES for FIELD RAILWAYS, R. Dölberg, Berlin.
1067. MEAT CHOPPING MACHINES, P. Müller and A. A. Schöler, Berlin.
1068. JOINTS of RAILS for FIELD RAILWAYS, A. Dölberg, Berlin.
1069. JOINTS of RAILS for FIELD RAILWAYS, R. Dölberg, Berlin.
1070. MUSICAL BOXES, W. Brierley.—(———, *Germany.*)
1071. CLUTCH, A. S. Bowley, London.
1072. TRAVELLING CIRCULAR SAW BENCHES, E. Cory, F. W. Reynolds, and G. W. C. Catford, London.
1073. SAFETY STIRRUP IRONS, A. Vickery, London.
1074. WARP MACHINES, B. J. B. Mills.—(*Messrs. Beer and Co., Germany.*)
1075. FELT HOODS and FELT HATS, W. Morgan, London.
1076. DRAWING PENS, G. M. Asher, London.
1077. RECEPTION of COIN, W. Pearse, London.
1078. SWITCHES for MAKING ELECTRICAL CIRCUITS, S. Bergmann and J. T. Dempster, London.
1079. CABINET for INSURING or ASSURING the PUBLIC, A. E. Adlard, London.
1080. STOP MOTION for SPINNING, &c., MACHINES, H. H. Lake.—(*W. C. Sanford, United States.*)
1081. CRUSHING MACHINES, A. P. Granger, London.
1082. ABSORPTION TOWERS, H. P. Weidig and R. C. Remmey, London.
1083. PREVENTION of SMOKE in STEAM BOILERS, &c., FURNACES, A. Don, London.
1084. STAMPING, &c., in COLOURS, C. N. Bintcliffe and H. N. Parkins, London.
1085. CHAIN BOLTS for DOORS, H. E. Newton.—(*C. Cleveland, United States.*)
1086. AUTOMATIC MUSICAL INSTRUMENTS, F. E. P. Ehrlich, London.
1087. STEAM BOILERS or GENERATORS, S. Orlando, London.
1088. BRACES or SUSPENDERS, J. Healey, London.
1089. WEIGHING SCALES or BALANCES, G. F. Redfern.—(*W. C. Thomson, United States.*)
1090. CUTTING, &c., VEGETABLES, G. F. Redfern.—(*P. J. Carmien, France.*)
1091. RECORDING MECHANISM and ELECTRICITY, A. Aird, London.
1092. SIGHTING from TORPEDO BOATS, W. S. Simpson, London.
1093. BAKING, &c., POTTERY, J. Edwards, London.
1094. VELOCIPEDES, P. Purnell, London.
1095. HORSE RAKES, J. E. Ransome and F. W. Garrard, London.
1096. KITCHENERS, H. Hunt, London.
1097. ADAPTATION of COINS, L. Courlander, London.
1098. VELOCIPEDE, D. Albone, London.
1099. CONVEYING CASH, &c., H. H. Lake, London.—(*G. B. Kelly and W. A. Webber, United States.*)
1100. ELECTRICAL BRAZING and SOLDERING, G. Downing, London.
1101. ANTI-CORROSIVE COMPOSITIONS, J. O. Wallace and W. Ward, London.
1102. TUNING STRINGED INSTRUMENTS, C. G. Schuster, jun., London.
1103. COMMUNICATING SIGNALS, P. Dalley, London.
1104. CORKS, F. C. Roberts, London.
1105. TREATING SEWAGE, W. Webster, jun., London.
1106. MACHINERY for CRUSHING, &c., R. Stone, London.
1107. ROLLER MILLS, P. Tafel, London.

25th January, 1888.

1108. TICKET ISSUING, A. Légé and C. A. Remané, London.
1109. LIGHT GIVING APPARATUS, G. Prescott and J. Farrar, Dublin.
1110. RING SPINNING, E. Leak and T. B. Wilson, Manchester.
1111. SPOOL FINISHER, M. H. White and T. White and Sons, Glasgow.
1112. THREADS in SPINNING FRAMES, J. Barbour and J. Berkeley, Belfast.
1113. CORKING BOTTLES, W. Thomson, Glasgow.
1114. DIGGING TOOL, B. G. Hall, County Cork.
1115. MANGLES, G. C. Douglas, Dundee.
1116. WEIGHING MACHINES, C. E. Payne, Birmingham.
1117. WIRE BRUSHES, J. Masters, London.
1118. PACKING for CYLINDERS, &c., J. J. Galloway, Glasgow.
1119. CARTRIDGES, G. Quick, London.
1120. GIG MILLS, E. Michaelis, A. Smethurst, and C. Wood, Manchester.
1121. FLATS and FASTENERS, E. Tweedale, Halifax.
1122. WOVEN GLOVES, W. A. Campbell and G. G. Pomphrey, Glasgow.
1123. GRINDING NEEDLES, J. Moseley, Manchester.
1124. BARREL BOLTS, G. Moore, sen., A. L. Moore, jun., and S. Bott, Birmingham.
1125. RUBBER SHEETS, S. A. Rogers, Manchester.
1126. REGULATING GAS HEATING, J. E. Carter, Halifax.—(*O. Böhm, Germany.*)
1127. LADIES' JACKETS, G. W. Hunt, London.
1128. GALVANIC BATTERIES, A. A. Fortin, London.
1129. REGULATING GAS HEATING, J. E. Carter, Halifax.—(*W. Böhm, Germany.*)
1130. ALARUMS, G. Freeman and A. Bunn, Birmingham.
1131. TEACHING CLEFS, J. Roeckel, London.
1132. HANSOM CABS, S. Betjemann, London.
1133. PHOTOGRAPHIC SHUTTERS, J. C. Asten, London.
1134. GAS BURNERS, A. Kuhnt and R. Deissler, Berlin.
1135. METALLIC CEMENT, A. Clery, London.
1136. BELT FASTENER, T. C. Sargeant, Northampton.
1137. TWIN SCREW PROPELLERS, E. Hunt, Glasgow.—(*E. Henry, France.*)
1138. TOOLS for PIPE JOINTS, A. N. Rankin, London.
1139. SAFETY WATCH-POCKETS for LADIES, A. Dormitzer, London.
1140. SECURING and RELEASING DOORS, G. W. Henderson, London.
1141. ROD CLIP, E. Neale and F. Carter, Birmingham.
1142. AUTOMATIC MACHINES, H. I. Forster, London.
1143. UMBRELLA FRAMES, W. Corah, Birmingham.
1144. STANDS for UMBRELLAS, C. Deschler, London.
1145. OVENS, D. Thompson, London.
1146. WATER-MARK, F. Hawke and C. J. Ford, London.
1147. DRILLING MACHINE, A. Whitney, London.
1148. DWARF BICYCLE, S. J. Rose, London.
1149. DRYING INTERIOR of CASKS, &c., H. P. Rieth, London.
1150. FASTENING WINDOW-SASHES, J. C. Carr and F. W. C. Carr, London.
1151. VEGETABLE SOUP, C. Tacot, London.
1152. BOTTLE-STOPPERS, L. E. Sunter, London.
1153. COMPRESSION of GUNPOWDER, A. Greenwood, London.
1154. TILE ROOFINGS, A. Eggiman, London.
1155. FIRE SCREENS, &c., W. P. Thompson.—(*A. Chauffroy, France.*)
1156. SIGHT FEED LUBRICATORS, W. Grimes and C. C. Wakefield, Liverpool.
1157. CHECKING APPARATUS, R. Foulkes and W. Hutchinson, Liverpool.
1158. PURIFICATION of CRUDE ANTHRACENE, F. Lennard and S. P. Eastick, London.
1159. TOY SWEETMEAT SUPPLY BOX, G. F. Lutticke, London.
1160. STEAM BOILERS, H. Davey, London.
1161. PURIFICATION of SEWAGE, &c., A. J. Capron, London.
1162. PULVERISING ORES, E. C. Griffin, London.
1163. FILTERING BEER, &c., H. Stockheim, London.
1164. IRON BEDSTEADS, A. Wright, London.
1165. SCREWS and SCREW-NUTS, A. Schütz, E. Schultes, and R. Plücker, London.
1166. FACILITATING TARGET PRACTICE, W. Lorenz, London.
1167. CARTRIDGE CASES, W. Lorenz, London.
1168. SUPERHEATING STEAM, T. Bell.—(*J. Niven, Uitenhage.*)
1169. INTERLOCKING RAILWAY POINT and SIGNAL LEVERS, J. Saxby, J. S. Farmer, A. J. Grinling, and G. Fox, London.
1170. FELTING HAT BODIES, H. H. Lake.—(*J. T. Waring, United States.*)
1171. CASKS, &c., A. Dunbar, London.
1172. CLEANING HEADS and FEET of SLAUGHTERED ANIMALS, J. H. and J. D. Koopmann, London.
1173. ELECTRIC INDUCTION APPARATUS, B. Scheithauer, London.
1174. REMOVING TIN from TIN SCRAP, C. K. Farquharson and R. R. Gubbins, London.
1175. DISINFECTING SEWER GASES, J. Arnold, London.
1176. EQUIPMENT for CAVALRY, &c., E. T. H. Hutton, London.

26th January, 1888.

1177. SUPPORTING ELEMENTS in ELECTRIC BATTERIES, E. E. Mandeville, London.
1178. AUTOMATIC PERFORATING ATTACHMENT, R. Kennedy, London.
1179. WINDING FRAMES, E. Guest and T. Brookes, Manchester.
1180. RACK and CATCH, A. P. Jevon, Birmingham.
1181. SCREW CRAMP, T. B. and J. Anderson, Belfast.
1182. COOKING RANGES, M. Cockburn, Glasgow.
1183. BANJOS, E. A. Calvert, Chiswick.
1184. HOLDERS for CANDLES, &c., J. Monteith, Glasgow.
1185. ROTARY ENGINES, J. Monteith, Glasgow.
1186. MATCH-BOXES, J. Brown, Glasgow.
1187. MATCH-BOXES, J. and A. A. Brown, Glasgow.
1188. BOOTS and SHOES, J. Cutlan, London.
1189. SUPPORTS for COOKING UTENSILS, J. E. Pickles and J. E. Holden, Halifax.
1190. PAD for VIOLINS, W. M. Smeeton, Halifax.
1191. EJECTORS for BREECH-LOADING FIRE-ARMS, J. Coster, Edinburgh.
1192. LAMPS, J. Erskin, Halifax.
1193. CORKING BOTTLES, T. Ireland, Adenshaw.
1194. STOPPERING BOTTLES, &c., R. George, Bristol.
1195. TREATING ANTHRACITE COAL, J. T. Williams, Bristol.
1196. UTILISATION of WATER POWER, J. Rettie, F. W. E. Gruggen, and H. J. Peachey, London.
1197. SELF-ACTING CATCH for SECURING CORVES in MINES, T. Brook and E. Brook, London.
1198. AUTOMATIC BRAKE for CARTS, P. McKenzie, Glasgow.
1199. VENTILATORS, A. Brown, Glasgow.
1200. FUSIBLE PLUG for STEAM BOILERS, &c., H. Field, Southall.
1201. PHOTOGRAPHIC PLATES, A. J. Boult.—(*L. Backelandt, Belgium.*)
1202. RAILWAY SLEEPERS, W. G. Bagnall and A. H. Heath, London.
1203. SAFETY LAMPS, T. Jackson, Chiswick.
1204. RANGE-FINDING APPARATUS, H. C. Walker and H. C. Heiffer, London.
1205. WARP LACE FABRICS, J. S. Wells, London.
1206. STITCHING MACHINES, W. Birks and H. S. Cropper, London.
1207. WET GAS METERS, G. Mills, London.
1208. ACTUATING RAILWAY SWITCHES, A. J. Martins and A. C. da Rocha, London.
1209. WINDOW-BLIND ATTACHMENTS, J. Paget, London.
1210. REVERSIBLE CHLORINE BATTERIES, E. Andreoli.—(*P. A. Fichet and A. L. C. Nodon, France.*)
1211. PARCELLING TOBACCO, G. Wilcox, London.
1212. WINDING BOBBIN, J. Stevenson.—(*J. Lallemand, France.*)
1213. ELECTRICITY to SPECTACLE FRAMES, J. T. Leighton, London.
1214. GAUGE GLASSES, J. Werner, London.
1215. MANTLES for LAMPS, W. S. Simpson, London.
1216. TRICYCLES, J. M. M. Truffault, London.
1217. COMBING MACHINES, F. W. Durham, London.
1218. STOPPERING BOTTLES, A. Kempson, London.
1219. VELOCIPEDES, G. J. Stevens and J. Cuninghame, London.
1220. TRAPPING RABBITS, &c., T. Jones, London.
1221. CYCLIST'S GALOSH, E. Prudon, London.
1222. AGGLUTINANT, H. H. Lake.—(*H. F. W. Völlner, Germany.*)
1223. BUFFERS, A. B. Ibbotson, London.
1224. CIRCULAR RAILWAYS, A. H. Crockford, London.
1225. COMPOSITION for WOUNDS, H. H. Lake.—(*H. F. W. Völlner, Germany.*)
1226. SELF-EXTINGUISHING BURNERS, S. Gower, G. Thomson, and J. Bowing, London.
1227. CHURNS, S. Pond, London.
1228. LOADING COALS, F. W. Walker, London.
1229. BREECH-LOADING FIRE-ARMS, G. Baron de Overbeck.—(*F. Fortelka, Vienna.*)
1230. FURNACES for ROASTING ORES, G. de Wolf, London.
1231. METAL FRAMES for PIANOFORTES, H. J. T. Broadwood, London.
1232. ARTIFICIAL FUEL, C. H. Gosling, London.

SELECTED AMERICAN PATENTS.

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

372,487. BOILER FLUE, *D. Purves, Ferro Dene, Green Lane, North Dulwich, Surrey, England.—Filed October 23rd, 1886.*

Claim.—(1) In the manufacture of boiler flues, the herein-described method of making the same, which consists in forming the plate with thickened bands on one side and channelling it on the opposite side, and then rolling the thickened bands into stiffened ribs,

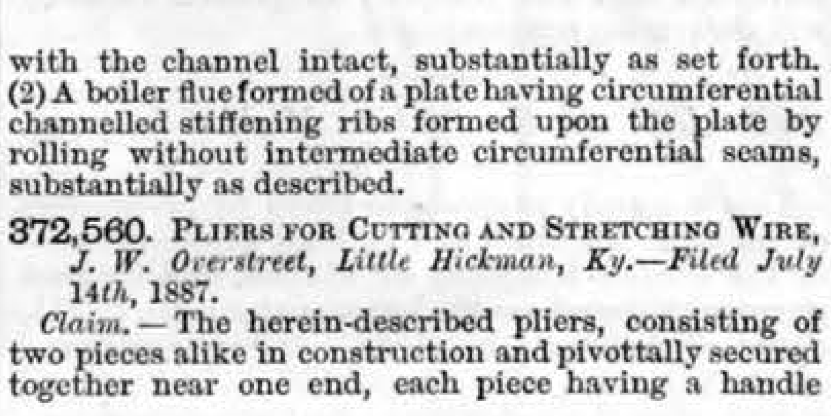
372,487.

with the channel intact, substantially as set forth. (2) A boiler flue formed of a plate having circumferential channelled stiffening ribs formed upon the plate by rolling without intermediate circumferential seams, substantially as described.

372,560. PLIERS FOR CUTTING AND STRETCHING WIRE, *J. W. Overstreet, Little Hickman, Ky.—Filed July 14th, 1887.*

Claim.—The herein-described pliers, consisting of two pieces alike in construction and pivottally secured together near one end, each piece having a handle

372,560.

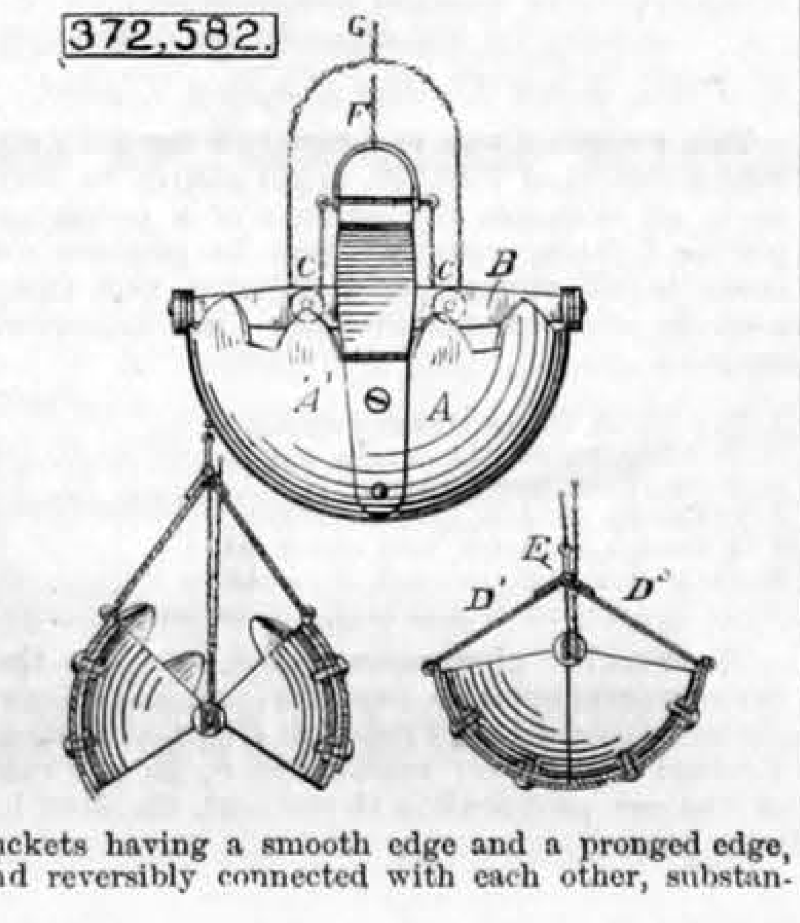


portion, C, a curved jaw portion, E, and a circular reduced portion, D, said reduced portions being provided with recesses G G, and the outer end of each jaw portion having a serrated face, H, and provided with a projection, I, upon its outer side, substantially as and for the purpose set forth.

372,582. SUBMARINE EXCAVATOR, *J. and P. Wagner, Atchison, Kans.—Filed August 16th, 1887.*

Claim.—(1) The combination, in an excavator, of

372,582.



buckets having a smooth edge and a pronged edge, and reversibly connected with each other, substantially as and for the purposes described. (2) The combination, in an excavator, of the hinged reversible buckets provided with double penetrating edges, and a straining beam connected to the said buckets by butt plates and removable fastening devices, substantially as described. (3) In an excavator, the combination, with the buckets, of a cross-bar formed of double plates and journal blocks, upon which the said buckets are hinged, sheave pulleys supported between the plates of said cross-bar, a straining beam, and chains passing from said straining beam around the pulleys, substantially as described. (4) In an excavator, in combination with the buckets A A^1, the cross-bar B, the pulleys C, the toggle plates D^1 D^2, hinged shaft E, and chains F G, combined for joint operation, substantially as described.

372,660. APPARATUS FOR MEASURING CLOTH IN BOLTS, *A. B. Cross, Salem, Mass.—Filed June 20th, 1887.*

Claim.—(1) The frame *a* and its pivot or spindle *b*, combined with the sliding carriage *e*, the index carrying frame *f* hinged to said carriage, the toothed measuring wheel G G^1, journalled in said frame *f* and the feed-piece *h*, secured to the carriage *e*, as and for

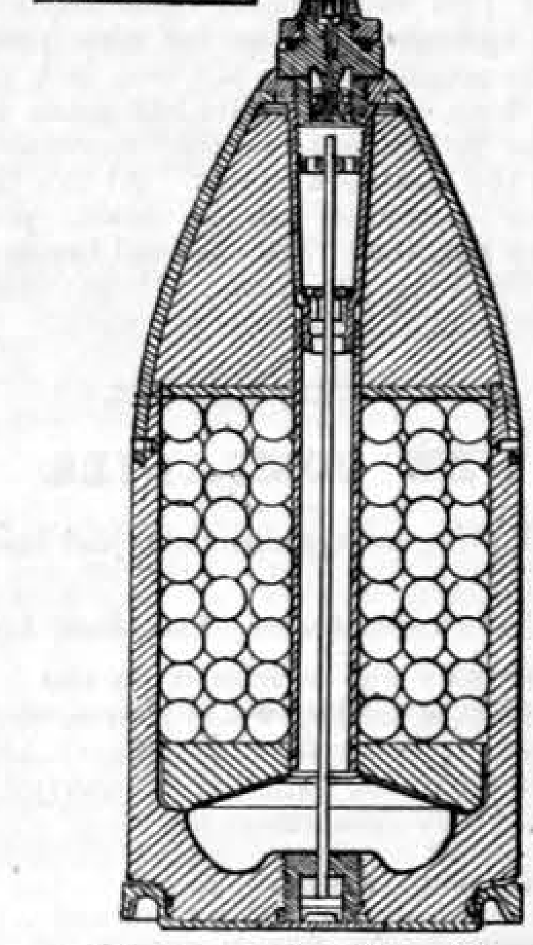
372,660.

the purpose set forth. (2) The frame *a* and its spindle or pivot *b*, and the sliding carriage *e*, having pivotted to it the frame *f*, combined with the toothed measuring disc or wheel G G^1, journalled in said frame *f*, the feed-piece *h* and spreader *i*, secured to carriage *e*, as and for the purpose set forth.

372,699. FUSE OR FIRING MECHANISM FOR PROJECTILES, *A. Noble, Newcastle-upon-Tyne, England.—Filed May 7th, 1887.*

Claim.—(1) The combination of a projectile provided with a cavity at the centre of its base, a piston in such cavity, a forwardly extending piston stem, and a time fuse at the fore end of the projectile, which is ignited by the blow of the stem when the stem is thrown violently forward, substantially as set forth. (2) The combination of a projectile provided with a cavity at the centre of its base, a piston fitting within the cavity, a forwardly extending piston stem, a time fuse at the nose of the projectile

372,699.

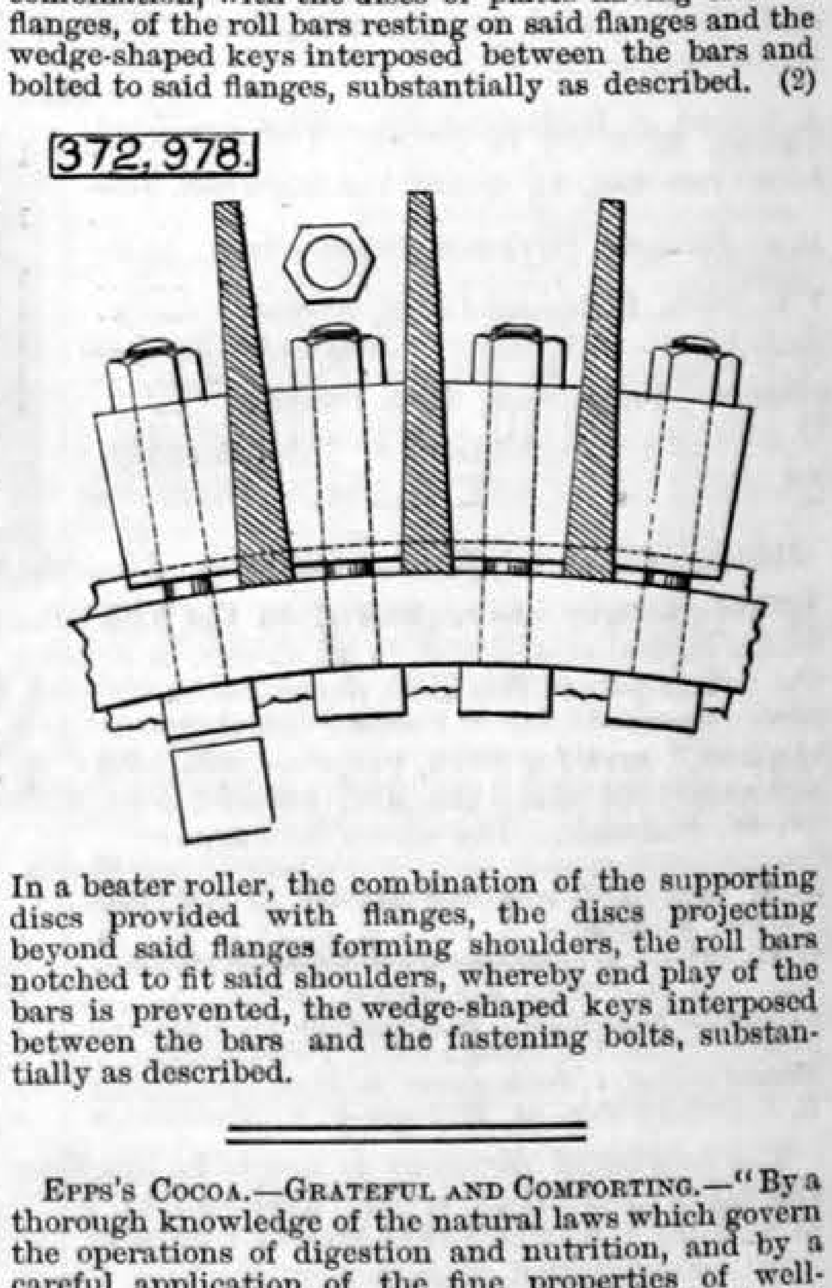


a needle carried by the fuse in a line with and a short distance in front of the piston stem, and provided with a head at its rear end, the fuse priming in advance of the needle, and a tubular guide of the fuse holding the needle back away from the priming, and which yields and allows the needle to be forced forward against the priming when the piston is thrown violently forward against the needle head, substantially as set forth.

372,978. BEATER ROLL FOR PULP ENGINES, *J. Hoyt, Manchester, N.H.—Filed May 5th, 1887.*

Claim.—(1) In a beater roll for pulp engines, the combination, with the discs or plates having circular flanges, of the roll bars resting on said flanges and the wedge-shaped keys interposed between the bars and bolted to said flanges, substantially as described. (2)

372,978.



In a beater roller, the combination of the supporting discs provided with flanges, the discs projecting beyond said flanges forming shoulders, the roll bars notched to fit said shoulders, whereby end play of the bars is prevented, the wedge-shaped keys interposed between the bars and the fastening bolts, substantially as described.