TREATMENT OF MERCURY IN NORTH CALIFORNIA.

By T. Egleston, Ph. D.

(*Continued from page* 277.)

Modified Idria Furnace.—Redington Works.

The practice of the Redington with the old Idria furnace is the best example of non-continuous work in shaft furnaces. These are the largest works in Northern California, and are likely to have no rival except, perhaps, at the Sulphur Bank Mine. As everything relating to this variety of furnace, which is destined in future years to disappear altogether, is of historical interest, I have given a few details of the New Almaden furnace of the same general type, which I visited shortly after, though it is south of San Francisco.

The most important question in the metallurgy of mercury is condensation, and it is of even more importance than the construction of the furnace. The two questions are, however, intimately connected, and are engaging the serious attention of all persons interested in the metallurgy of mercury.

The Redington Quicksilver Company own a large property or hacienda, which has been called Knoxville, and a small village connected with their works is known as the Redington Mine. They formerly had at this mine two modified Idria furnaces, which have since been reconstructed into Livermore's fine ore furnaces. These furnaces were situated within a few feet of the ore shaft. The mine produces 700 to 800 tons of cinnabar per week. It occurs in serpentine. A very large quantity of high grade ore is found, but the average yield of the mine is about 3 per cent. Cinnabar and metacinnabarite are both found crystallised in considerable quantity. Epsomite resulting from the action of iron pyrites on the serpentine is also found in very great abundance in acicular crystals over a foot long. The ore is very intimately associated with iron pyrites. About one-tenth of it comes from an opening made in the side of the hill. From the mine the ore is dumped on to screens, two of which are placed one over the other. The upper screen is made of bars $1\frac{1}{2}$ in. in diameter, 2 in. apart at the top, $2\frac{1}{4}$ in. at the bottom. The screen is 8 ft. long, 5 ft. wide at the top, and $5\frac{1}{2}$ ft. wide at the bottom. What passes over this screen only is hand picked. What passes through falls upon a wire screen of $\frac{3}{4}$ in. mesh. What passes this screen goes directly to the furnace, and is charged with hand-picked ore. What passes through it is treated as fine ore. All the large pieces are broken by hand. The fine ore was formerly made into adobes, which were used in the modified Idria furnaces exclusively. No dirt is mixed with the adobes. The ore is so filled with an easily decomposing iron pyrites that the action of the water effects a partial decomposition of the magnesian rock that binds the particles together.

Under ordinary circumstances, but for the large amount of magnesia present, the pyrites would disintegrate the rock. The adobes are made in wooden frames roughly put together by the workmen, and intended to be 9 in. by 4 in. by 4 in. When such adobes are dry they weigh about 12 lb. They are sometimes made 12 in. by 5 in. by 5 in., when they weigh about 25 lb., which is an unusually large size. The smaller size is the one most generally used. Seven men at 2 dols. per day can make 6000 adobes; each man can mould 1000, but six men require one helper. The adobes therefore cost about 2.33 dols. per thousand. The actual cost is difficult to ascertain, for adobes are not like ordinary ore which can be dumped anywhere. They are really more tender than ordinary sun-dried brick. They are generally made during the dry season only, and they must then be carefully stored in sheds until wanted. They will therefore have to be handled at least three times after being made, once in storing, once in being removed to the furnace, and once in charging, which causes many of them to break up and become entirely reduced to powder and useless; broken in two or three pieces they still can be used, but there comes a limit when the pieces are too small, which limit is reached all the more rapidly as the adobes contain less binding material. No account is usually taken of this loss; it has not been considered worth while to estimate it, and it will probably never be done, as in the future, adobes will probably not be made, as some of the best metallurgical ability in California is being expended on special furnaces for the treatment of fine ores. The cost of the adobes, delivered at the furnace ready for charging, as near as can be estimated, including making and storing them, is about 5 dols. per thousand.

The modified Idria furnaces, Fig. 2, are built on each side of the condensers E, which are at right angles to them. Each of these furnaces treats 100 tons of ore and 4000 to 5000 adobes per week. They are built of a very porous sandstone found a short distance from the works. Each furnace has a double fireplace A, 20 in. wide, 17 ft. long, and 15 ft. high. The total inside height of the fireplace compartment is 20 ft. The ore chamber B has on both ends a brick screen with fourteen openings of the size of one brick, and two bricks apart, across the furnace, and fourteen openings in height, also two bricks apart. The fireplace screen had to be rebuilt once in seven years; it is made of firebrick. The condenser screen is built of red brick. The ore chamber B is 13 ft. by 10 ft., and 20 ft. high; its walls are 4 ft. thick. It has two openings, Fig. 3, H, for discharging the ore, 32 in. by 20 in., 4 ft. above the ground on the outside. The car for discharging the furnace runs under a swinging apron of cast iron. The ore which has been treated is raked out over it. The holes in the fireplace and condenser wall are the starting-points of flues made in the charge. As the condenser side is constantly exposed to acid vapours it rapidly wears away, and is renewed about twice in five years. To secure it against pressure, it is strengthened with an abutment. From the action of the ore and vapours the inside walls of the ore chamber are worn away to a considerable depth, making it larger than it formerly was.

Fig. 2.

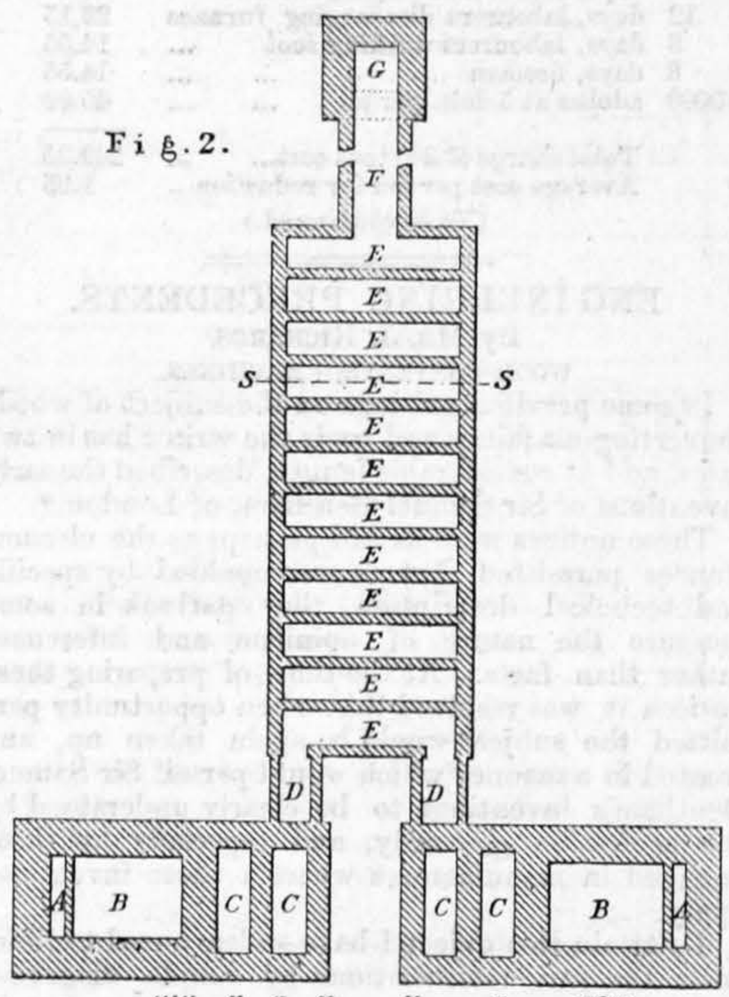
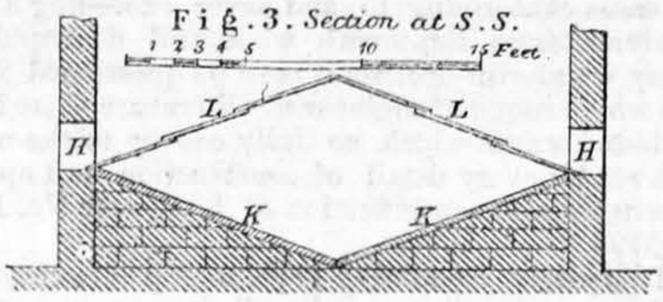


Fig. 3. *Section at S. S.*



Beyond the ore chamber each furnace has two sandstone condensers C, 4 ft. wide, 13 ft. long, and 20 ft. high. Very little mercury ever condenses in them, not more than two flasks a week. They are connected with the main condensing chambers E in the upper part by a flue D supported on arches, which enters the top of the first chamber of the main condenser. The length of this flue D is 8 ft.

The furnaces are independent, so that each may work, without reference to the other, into the condenser, the connexion being cut off at will. The total length of each furnace, including fireplace, ore chamber, and the two condensing chambers, is 36 ft. Its total width is 17 ft., and its outside height 24 ft. The main condensers E consist of a series of twelve chambers, each of which is 4 ft. wide, 20 ft. long, and 20 ft. high on the outside, common to both furnaces. Each one of these chambers has an iron door, Fig. 3, H, on each side at the bottom. The partition walls between each are 1 ft. thick; the outside walls are 18 in. They are braced by wooden beams 8 in. by 10 in. on the outside, which are tied together by $\frac{3}{8}$ in. round iron rods. These rods pass through the interior of the furnace, and must be carefully watched, as they are likely to become corroded through, and allow the wall to fall. All the walls of these chambers are very soon saturated with mercury. They rapidly become soft from the effect of the acid vapours; some of the side walls have been corroded to a depth of 6 in. only, while the partition walls, as they are exposed upon both sides, have been corroded entirely through. Wherever they have been repaired with brick it has been found to resist better than the stone. The relation of the condensing surfaces to that of the charge compartment is much too small. The ratio of the condensing volume to the volume of the furnace should be as 24 to 1. In this furnace it was not half the amount. The condensing chambers are really only large enough for one furnace. On this account the walls have become super-saturated with mercury, and after a little exposure, even after they have been thoroughly cleaned, they still exude mercury in globules. The flue F leading to the chimney G is built of cut stone, and is 250 ft. long. It is over 4 ft. in the largest diameter, with walls 2 ft. thick. It is built against the side of the hill. The chimney is also of stone, and is conical, 50 ft. high, 5 ft. in interior diameter at the base, and the walls 3 ft. thick.

The ore is charged by a windlass from above; the buckets used for charging are of iron 3 ft. in diameter and 30 in. high; the adobes are charged on platforms 3 ft. by $2\frac{1}{2}$ ft., and $2\frac{1}{2}$ ft. high, that carry 150 adobes weighing about a ton. To make the charge the ore compartment is first lined with adobes two to five thick, piled together, but not crowded close. Inside of this the ore is placed in pieces from a size not larger than 12 cubic inches, down to one-quarter of this size in layers 18 in. to 20 in. in thickness. Adobe channels are then built, communicating with the openings in the wall of the fireplace and condenser side of the furnace. Their number depends upon the size of the ore, four for coarse and five for fine ore. They are made as flues to carry the heat into contact with all parts of the ore, and also have the effect of preventing the charge from packing together. A part of the soot that either has been worked, or is too poor to work in the retorts, is charged over every layer of ore. A new layer of ore is then put in over the adobe channels, and so on until the chamber is nearly full over the top, fine ore mixed with poor soot is placed, and the whole is covered over with clay and ashes, which the heat bakes, so that it becomes hard after the furnace has been fired a short time.

When the charge is being drawn these compartments are closed on the top with cast-iron pans, which are either filled with water or covered over with ashes, in order to prevent the heat of the charge setting fire to the building above. The joints between the pans and the masonry are made tight with ashes to prevent the escape of the fumes. These pans are 5 in. deep, $4\frac{1}{2}$ ft. wide, and 10 ft. long. They are provided with two eyes on each end, so that they can be removed by a crane.

One furnace is charged Monday, and is fired Monday night, and kept burning until Thursday morning. Two cords of wood are burned during this time. The sulphur takes fire and answers for fuel for the most part, for there is always an excess of sulphur as iron pyrites in the ore. The other furnace is charged Tuesday and fired Tuesday evening, and kept burning until Friday. One furnace will thus be cooling on Saturday and Sunday, the other on Sunday and Monday. A small quantity of mercury runs in C on Tuesday, and in the first, second, and third compartments of the main condenser. It runs most freely Wednesday and Thursday. By Thursday a very small quantity of mercury is condensed in the extreme end of the condenser; 150 to 200 flasks are collected from both furnaces during the week, most of it from the fifth and sixth condensers. On Wednesday it commences in the fifth and sixth, and runs from this point until the furnace is discharged. Most of the mercury is obtained when the furnace is cooling down. When the draught is good, and the ore of moderate richness, the yield will not be less than 200 flasks per week.

The bottoms of the condensing chambers were originally built inclined towards the centre, Fig. 3, with the intention of having all the mercury in the condenser run out through a common opening made for the purpose at the bottom of the incline. The openings, however, became rapidly clogged, so that the flow of mercury was prevented, and instead of flowing to the outside of the furnace it became absorbed in the masonry. This method was abandoned; as it was not worth while to change the

construction of the furnace, iron pans were placed over this floor, sloping from the centre towards the outside, Fig. 3. These are placed 3 ft. above the old furnace bottom, so that there is a space under the bottom of the pans, which are made of three pieces overlapping each other. This construction is necessary, as when the walls get old and fall, as they frequently do, the whole pan would be liable to be broken; but by this disposition only parts of it are.

Tiles have been used to protect the surfaces of the pans, which thus protected have lasted during four years constant use. Without this covering they last only two years, at which time they were entirely corroded by the acid fumes.

On Saturday the iron doors of the condensing chambers are taken off, and a workman collects the soot on the pan and from the walls about 2 ft. above its bottom, with a long hoe. What accumulates above is left until it falls by its own weight. Seventy-five to a hundred bushels of soot are collected in this way which yields from five to twenty flasks of mercury. The soot is a mechanical mixture composed of ordinary soot, fine ore, ashes, dirt, volatilised cinnabar, and sublimated mercury in very fine globules, carried over from the ore chamber. On account of the condensation of the steam from moisture in the fuel and ore, it is usually damp when removed from the furnace. The soot buckets are 33 in. high, 30 in. in diameter at the top, and 14 in. at the bottom. Each side of the condenser will fill such a bucket twice, a foot high.

It takes two men two days to clean all the condensers and work the soot. The amount collected varies very greatly. When the furnace is stopped for repairs, it cools; a large quantity of soot becomes detached as soon as the furnace is lighted again. The amount of mercury collected from the soot will vary from five to twenty flasks a week. The flue leading to the chimney is cleaned once in three weeks, and about a bushel of soot is taken from it.

It takes ten men one day to charge each furnace, and six men one day to discharge it. These men are paid 35 dols. per month and board, which amounts to about 1.90 dols. a day. There is one foreman, and one man to clean and repair the flasks, and fill them. They work during the day only. Each shift of twelve hours has its own foreman. When the draught is not good, a fire is placed at the foot of the chimney to increase it. This chimney is 50 ft. high. The draught depends for the most part on the way the furnace has been charged. The draught furnace is oftenest used when the ore furnace is allowed to get cool, but occasionally when the direction of the wind is unfavourable. Less than a cord of wood per month is required for its use. In the fall, winter, and spring no trace of mercury is found in the flue, but when the weather is hot it collects near the chimney, and in very hot summer weather it sometimes escapes. The accident of salivation is very rare except from the carelessness of the men. It generally occurs amongst those who are in the habit of using tobacco. As soon as the workmen experience any sensitiveness about the mouth, they are instructed to go to the office, and are there furnished with a mouth wash consisting of two parts of cinchona, one part tincture of myrrh, and three parts water.

Twice a year a general clean up is made. This is done by putting into the compartment **C** pipes 24 in. in diameter, and three in the flues leading to the chimneys. This is done both to cool and to ventilate the chambers while they are being cleaned. The walls of the condensers are scraped to remove the soot. As there is a considerable quantity of dust arising from the fallen soot, it is necessary for the workmen to protect themselves with a wet sponge, which is held over the mouth and nose by a thin cloth tied behind the head. No one man is allowed to work more than fifteen minutes. After having been thoroughly scraped, the walls are carefully washed. They are so thoroughly impregnated with mercury, that after having been scraped and washed every day for a month, when exposed to the sun for a few hours only, they still show bright mercury globules all over the surface. As an illustration of the absorbing power of the masonry, the first time that the furnace was charged, the ore was picked. At the top of the charge 6 ft. to 7 ft. of rich soot was put in, but the heat did not reach it. The charge should have yielded 500 flasks of mercury; all but nine flasks were absorbed by the walls.

It takes eight men two days to wash the walls, flues, and condensers. The soot in the first condenser is often 6 in. thick, and in concretions which are sometimes hard and solid. This same concretion is sometimes found below the iron pans; it consists of soot, hardened by the acid, and mercury in globules. In all the other condensers, however, it is soft and light. On the walls it is of very variable thickness, generally from 1 in. to 2 in., but sometimes is as much as 6 in. thick, when they have had a long run without cleaning. When the soot is very rich it may accumulate to 6 in. on the bottom of the pan. The richest soot is taken from the fourth, fifth, and sixth condensers. From a general clean up, as many as 100 flasks have been collected.

The furnaces were in use eight years, during which time they were repaired three times, parts of six partition walls having fallen down at the flue end. At the furnace end the wall is good. All the stone taken out from the condensing chambers during repairs, is put on one side and treated as very rich ore. The furnaces originally cost 100,000 dols. to 125,000 dols. They are now abandoned at the Redington Mine. The masonry has been altered into Livermore's inclined continuous furnace for fine ore, the cost of the alteration being 1200 dols. The average cost per week of reducing one ton of ore in the modified Idria furnace, No. 1 and No. 2, at the Redington Mine in 1874, was:

		dols.
5½	cords of wood at 5 dols.	27.50
36	days, furnacemen, fireman and assistant	86.00
20	days, labourers charging furnace ...	38.60
12	days, labourers discharging furnace	23.15
8	days, labourers working soot ...	14.55
8	days, fireman	14.55
9000	adobes at 5 dols. per m.	45.00
	Total charge of 200 tons cost... ...	249.35
	Average cost per ton for reduction ..	1.25

(To be continued.)

ENGINEERING PRECEDENTS.

By Mr. J. Richards.

WOOD-CONVERTING MACHINES.

In some previous writings on the subject of wood-converting machines and tools the writer has in two cases, and at considerable length, described the early inventions of Sir Samuel Bentham, of London.*

These notices were as full perhaps as the circumstances permitted, but unaccompanied by specific and technical description, they partook in some measure the nature of opinions and inferences rather than facts. At the time of preparing these notices it was resolved that when opportunity permitted the subject would be again taken up, and treated in a manner which would permit Sir Samuel Bentham's inventions to be clearly understood by the profession generally, and especially by those engaged in manufactures wherein these inventions apply.

To attain this object I have endeavoured to illustrate the various inventions by simple diagrams, following in some measure modern practice, but in all cases conforming to and never exceeding a fair inference from Bentham's wonderful descriptions. I say wonderful because it is to be questioned if in the whole range of engineering literature there is to be found words which so fully convey to the mind of a reader every detail of construction and operation as does the specification of his patent No. 1951 of 1793.

This patent, containing 49 pages of printed matter, and comprehending nearly all known operations in cutting and shaping wood, was in 1848 referred to in one of the law courts in the following words: "The specification of this patent is a perfect treatise on the subject, indeed the only one worth quoting which has to this day been written on the subject." The descriptions apply mainly no doubt to machines constructed at the "works," Queen's-gate, Westminster, and operated there, because Professor Willis, who is a careful authority, said in a lecture before the Society of Arts, 1852, "There were constructed machines for all general operations in wood-working, including planing, moulding, rabeting, grooving, mortising, and sawing, both in coarse and fine work, in curved, winding, and transverse directions, shaping wood in complicated forms. Further, as an example, all the parts of a highly finished window sash were prepared, also all the parts of an ornamental carriage wheel were made so that nothing remained to be done by hand except to put the component parts together."

There is no complete copy of this paper at hand to be referred to, but my recollection is that the facts are taken from the report of a Parliamentary Commission appointed to examine into the inventions of Sir Samuel Bentham, with a view to determine their applicability to the penitentiary labour system proposed by his brother, Jeremy Bentham, the well-known author of various writings on legislation and jurisprudence.

The absence of drawings in this patent will to most persons seem a strange omission, and is, in fact, a most unfortunate one, because it is from such drawings instead of written text that patented inventions become popularly known, and if Bentham's patents had been fully illustrated by drawings, they would no doubt have formed for fifty years past the most familiar as well as the most complete reference in judging of novelty in the various contests over new discoveries in wood-cutting machines and tools.

Nothing would have been easier than for Sir Samuel Bentham to have supplied drawings, not only of the machines which he constructed, but also diagrams to illustrate modifications of inventions not reduced to actual practice; and their absence I attribute to a most natural conclusion on his part that the inventions being new, his claims would be broader and of more value if not confined to what he calls a "particular mode."

A description clearly drawn may comprehend an operation in all of its variations, while a drawing will explain but one, so that on the whole, and having in view the state of the art in 1793, Bentham's patent, in so far as it conferred rights on him, was stronger and more comprehensive than if it had contained drawings.

Referring now again to the descriptions from which ample quotations will appear in future places, no engineer or mechanic can read a single page without being impressed with a power of words unknown, I believe, in any other printed matter relating to technical operations, the more remarkable when we consider the paucity of terms and lack of formulæ at that period (1793).

These powers of describing mechanical operations with words alone was not wholly a natural gift; it was the result as well of systematic training, because in a letter written by Mr. George Bentham, of Knightsbridge, London, in 1876, he says, "The facility my father had in describing machinery without the aid of illustrations, was probably derived from a practice he had acquired in drawing up the propositions in Euclid without reference to figures, as he had, on the other hand, represented them in figures without written text; both having been exercises of his youth."

This somewhat lengthy notice of the circumstances attending on Sir Samuel Bentham's inventions, and his patent of 1793, I have thought necessary because of the possible good results which may follow from attention being directed to the power of words in describing machinery, and also in support of a claim which I will boldly advance, that Sir Samuel Bentham's inventions comprehend nearly all that is now known of wood-converting implements, and had these inventions been surrounded and aided by modern circumstances in respect to constructive tools and processess, and had the world been ready to receive them, not much would have remained for less able engineers to contend about.

There is also a further and perhaps greater reason for bringing these inventions once more to notice in the fact that Mrs. Bentham, widow of Sir Samuel Bentham, in writing his memoir, published in 1862, had not at control the required data from which to give an account of his inventions in wood-cutting machinery, which inventions were made prior to his marriage, and of which I am informed by Mr. George Bentham no complete records exist.

The material for a biography was naturally drawn mainly from Sir Samuel's public life and official acts, instead of his private engineering works, a matter not to be wondered at, even if full records existed, because of the technical character of the latter, and the fact that they could not be popularly understood. Viewing, however, the ultimate development of skilled industry as the greatest of the country's interests, and the relation which Bentham's inventions bear to that interest, there are but few who will not in the various machines and processes to be described see the greatest of his many useful works.

One more thing may be noticed in respect to the method to be followed in treating upon these old inventions. When opinions are added, such opinions will be based upon analogy to modern practice, and certainly no better measure of utility can be assumed, nor any fairer standard be set up in respect to early improvement in any of the constructive arts. An

* "A Treatise on the Construction and Operation of Wood-Working Machines." London, 1872. "Wood Conversion by Machinery." London, 1876.

THE LLANDULAS VIADUCT: DETAILS OF TEMPORARY WORKS.

(*For Description, see Page* 343.)

Viaduct washed away at 4.0 p.m. on Sunday 17th August 1879.
Diversion of Down Line commenced..... " " *4.0 a.m. on Tuesday 19th* " "
First Goods Train over " *2.0 p.m. on Sunday 24th* " "
Opened for Passenger Traffic " *4.17 p.m. on Monday 25th* " "

Fig. 1.

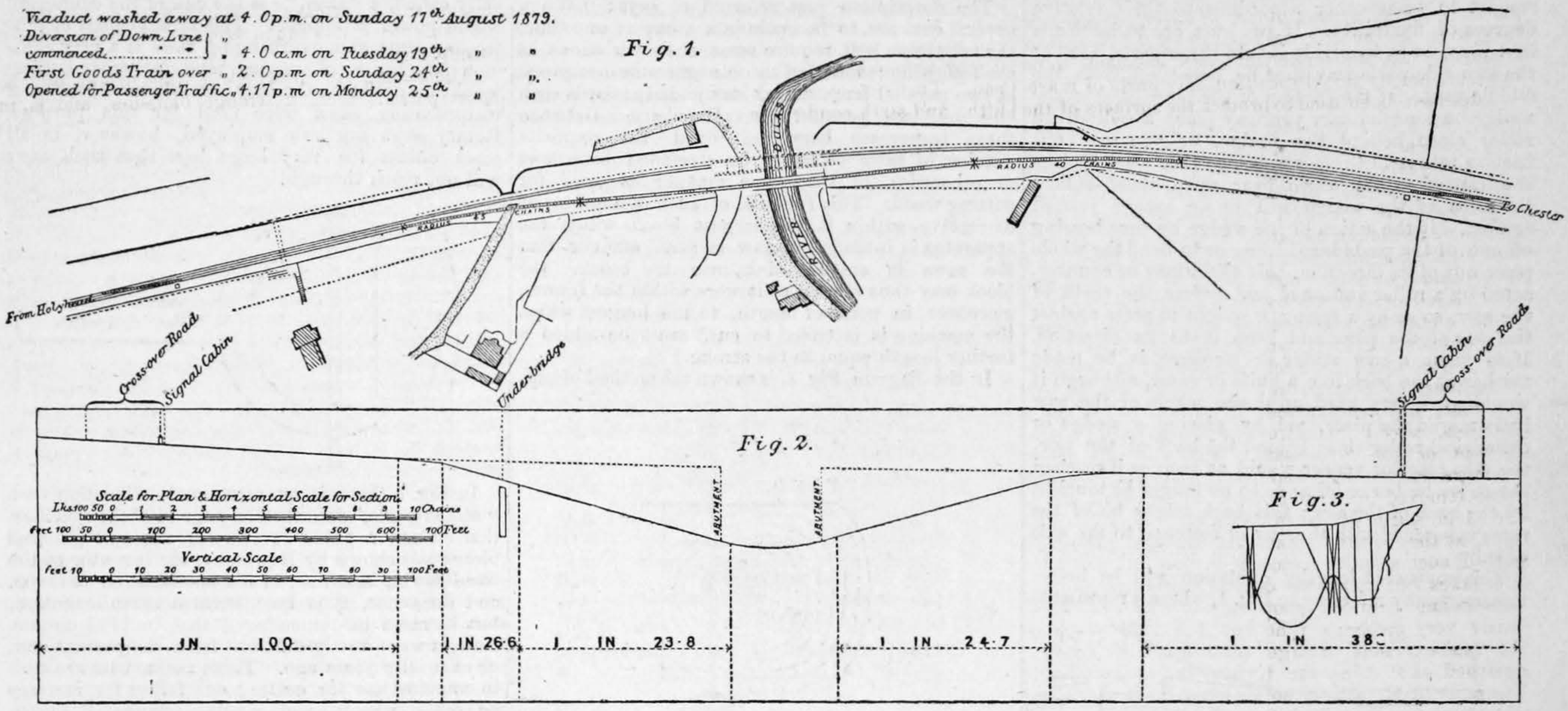


Fig. 2.

Fig. 3.

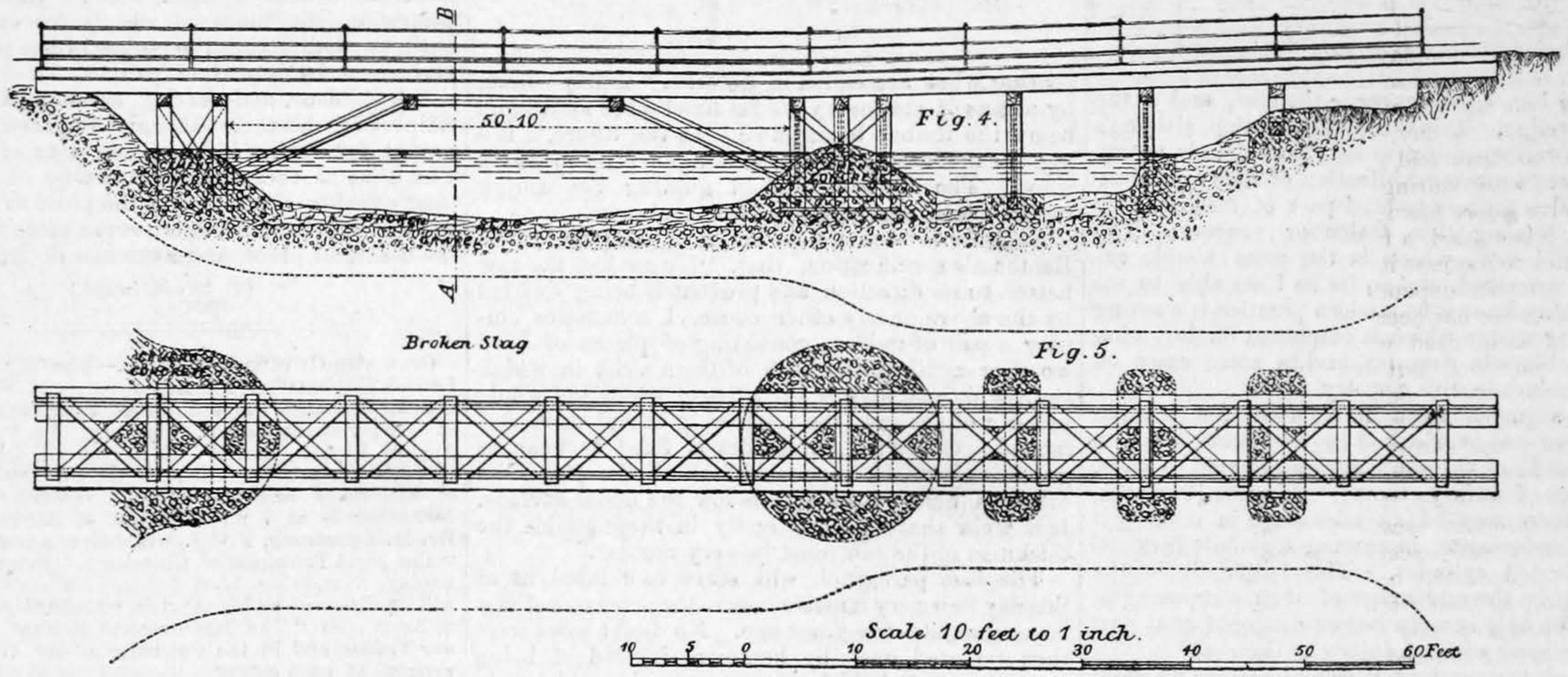
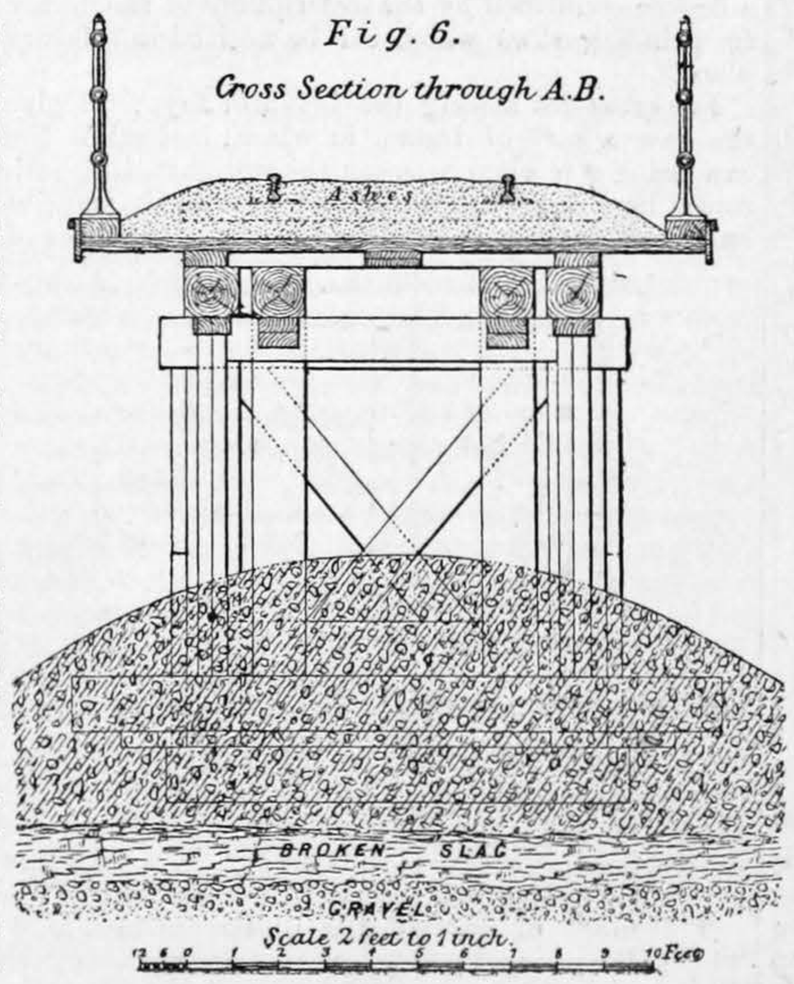


Fig. 4.

Fig. 5.

Fig. 6.

Cross Section through A.B.



invention which has come down to modern times without material alteration, and can be traced throughout common practice, was most likely conceived in a consummate knowledge of the operations to which it pertained, and when such inventions are increased to scores, all having the same practical characteristics, inference becomes certainty. This remark I feel called upon to make, because in some cases it has been claimed that Bentham was a theoretical professional man without the power of applying his inventions to useful purposes.

The test of "continuance" as a measure of merit I feel safe in assuming, not only in respect to Bentham's and other precedents in wood converting, but also in regard to metal-working machines and tools.

The first quotation to which attention will be called is in his earlier patent of 1791. In speaking of planing wood by power, he says, "Hence three capital advantages: first, the quantity of force used at one time can be increased at pleasure; second, the force of men may in this way be exerted to a greater advantage than while confined, as in present practice, to a particular mode by the necessity of care and dexterity; third, the labour of the awkward and unpractised may be used . . ." This quotation, taken from Bentham's first patent on machine tools, is given to show that mechanical scheming was made subservient to ultimate results, and that practical utility and economic effect were the objects continually had in view.

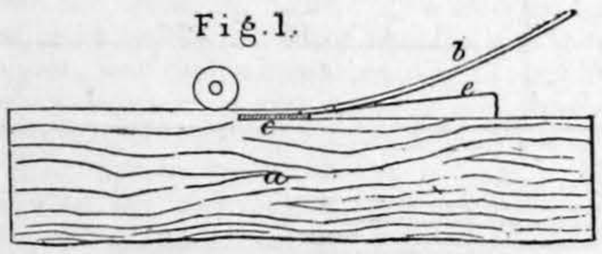
Referring now to the inventions described in Bentham's patent, No. 1951, of 1793. The first sections related to the formation of wooden tubes by rolling and glueing scales or veneers, on which subject there is a long dissertation, without much interest, however, because paper, papier-mâche, caoutchouc, and metal are now employed for such purposes, so that however complete and ingenious the various processes described, they could scarce be regarded as precedents of modern practice.

The first mechanical device to be noticed is the spreading wedge to be employed in connexion with saws, which is described as follows: "For sawing a veneer that the saw may work the easier, and the sawdust have the more room to escape, I fix to the bench or floor a wedge, the edge of which applies itself as near as possible to the back of the saw so as to enter into the saw kerf as the piece is advanced and open it more or less according to the sharpness of the wedge. If a thin piece is to be cut from a thick one, a veneer for example from a thick block or log, then one side of this wedge should stand in line with that side of the saw which is towards the thick part of the piece, so that the inclination of the wedge will bear off the thin part only. If the piece is to be cut in the middle, or nearly so, then the wedge may stand so as for the middle line of its thick-

ness to be straight with the middle thickness of the saw; thus by varying the position of this wedge, the two parts into which a piece is to be cut may be borne off from the saw, each more or less with respect to each other according to their relative degrees of flexibility. If two cuts are to be made in a piece so as to divide it into three parts, each of the two side parts may thus be borne off from the middle part. If the friction of the piece against the wedge be considerable, you may place a cylindrical roller close behind the wedge, or you may put friction rollers in these wedges, so that when a piece is advanced so far as to bear upon these rollers the sides of the wedge will be no longer rubbed against. If the action of the wedge by thus bearing off one of the parts is so strong as to bend the whole piece out of its direction, this effect may be counteracted by a roller stationed just before the teeth of the saw, so as by a spring or weight to press against the side of the piece and keep it to its direction. If to make a saw stiffer or stronger it be made thicker at the back like a knife or razor, although it would work very hard until the whole of the saw had entered the piece, yet by placing a wedge or cylindrical roller close behind the back of the saw, the thin piece or veneer would as soon as it reached the roller be borne off so as to no longer be touched by the back of the saw; this back might be of the same substance with the saw or fastened to the side of it."

This somewhat lengthy quotation will be better understood by referring to Fig. 1, where *a* represents

Fig. 1.



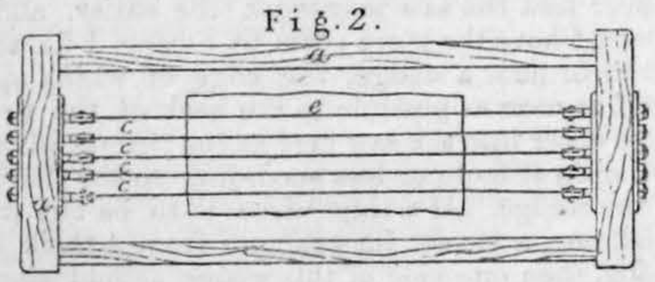
the piece or log, *b* the veneer, *c* the saw, and *e* the spreading wedge. This careful description, although confined to reciprocating saws, comprehends nearly or quite every known modification of such spreading wedges, which are an essential part of machines for cutting or sawing thin scales or veneers. The "ground off" saw, which is the most simple expedient, is described, and so far as I am able to see only one thing known to modern practice is wanting—the rolling wedge which is employed on large log sawing machines in America, and in some cases on similar machines in this country.

Rotary segment saws now used for making veneers were not overlooked by Bentham, who, on page 24 and 25 of the specification referred to, says, in speaking of rotary tools: "In some instances, however, there may be an advantage in making it in pieces, for instance, in annular segments fastened to an included cylinder. The larger it is the greater will be the advantage of thus composing it, and if a part only is worn out or damaged, that part may be replaced without injury to the rest."

After such instructions it would require no great skill to make a segmental saw, although it is doubtful if such saws were made at the time, because the reciprocating form was then almost wholly employed.

In respect to inserted teeth, which is generally considered quite a modern invention, practised in America for the large forest saws employed in reducing rough timber, Bentham says, referring still to composite rotary tools: "Another mode of composition is to make the teeth distinct from each other as well as from the cylinder from which they project; they will thus be separately bedded in the cylinder and can be taken on or off as occasion may require. This is a mode I have practised with particular advantage in the instance of the moulding cutter and the planing roller above spoken of."

Fig. 2.

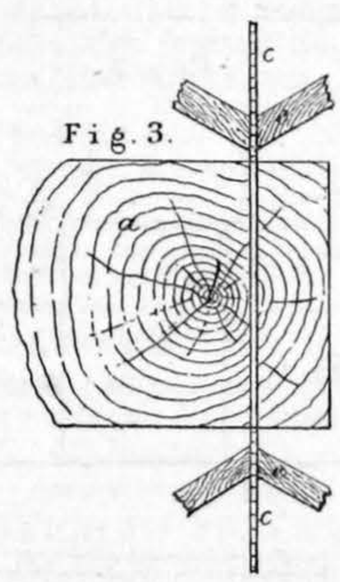


In connexion with saws and sawing there is on page 8 of the specification a description of what is at this day called a stone frame, corresponding so exactly to modern practice that its reproduction will be a matter of interest. Fig. 2 is a diagram, top view of a common frame or gang, except that key buckles are more commonly used than screws for straining; *a a* is the reciprocating frame, *c c c c* the saws, and *e* the stone to be cut or sawn.

The description just referred to says: "When several cuts are to be made in a stone at one time, the apparatus will require some such variations as the following: conceive an oblong frame composed of two parallel longitudinal bars joined towards each end by two parallel transverse bars. Between these transverse bars are fixed the requisite number of saws so as to be stretched by screws or otherwise, in the same manner as saws for cutting wood. This frame is of such dimensions as to receive within it the largest block which the apparatus is intended to saw in such manner that the saws in cutting sink into the block, the block may thus rise up as it were within the frame; moreover, in point of length, to the longest which the machine is intended to cut, must be added a further length equal to the stroke."

In the diagram, Fig. 3, is shown the method of sup-

Fig. 3.



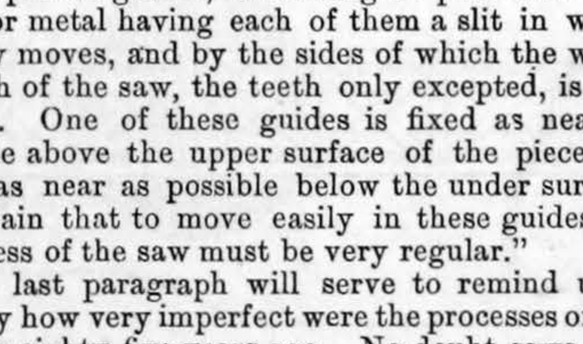
porting what are called in America "muley" saws, by means of stationary guides fixed both above and below the timber being sawn. In the figure, *a* is a log, *c c* the saw, and *e e* guides, generally made of wood. The same method of guiding has during recent years been employed for band saws.

Relating to such guides we read on page 10 of Bentham's specification, that, "To confine the saw better to its direction and prevent it being twisted by the above or any other cause, I sometimes employ a pair of guides, consisting of pieces of hard wood or metal having each of them a slit in which the saw moves, and by the sides of which the whole breadth of the saw, the teeth only excepted, is embraced. One of these guides is fixed as near as possible above the upper surface of the piece, the other as near as possible below the under surface. It is plain that to move easily in these guides the thickness of the saw must be very regular."

The last paragraph will serve to remind us at this day how very imperfect were the processes of saw making eighty-five years ago. No doubt saws were then "plated out" by hammers instead of being rolled to parallel thickness, a supposition which is in a degree confirmed by the descriptions of machinery for grinding saws which will be noticed in a future place.

For cross-cut sawing the inventor says: "I give the saw a sort of frame, in which, instead of the saw being stretched between the uprights, the horizontal bars are made to extend beyond the upright ones, and the saw is stretched at the extremities of

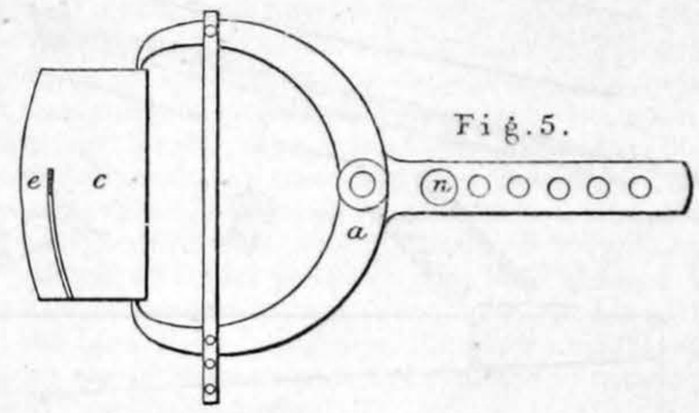
Fig. 4.



the horizontal bars, the saw being fixed in a direction which, with respect to the frame, is at right angles to that which it assumes when fixed for longitudinal cutting, that is to say, in a direction across the sliding bed instead of parallel to it."

This mode of operating is illustrated in Fig. 4, which is in every respect an embodiment of Bentham's description, and is also very similar to a machine recently designed by the writer for a special purpose. In the figure, *a* is the wood to be cut, *c c c c* the frame, or, as it is sometimes technically called, a "sash," *e* is the end of the connexion where power is applied. This arrangement of projecting arms and overhanging saws is a very common one for scroll sawing, and for cross cutting would no doubt be the best possible modification if reciprocating saws were used for this purpose. Rotary saws are now employed, however, in all cases unless for very large logs that such saws will not reach through.

Fig. 5.



In Fig. 5 there is an attempted delineation of a "radius guide," described on page 11 of the specification. Such a guide as this for sawing segmental pieces was shown by Newberry, the inventor of the band-sawing machine, in his specification of 1808, and does not, it is true, involve much invention, but it must be remembered that in 1793 circumstances were vastly different from the present day, or even fifty years ago. These radius bars are now in common use for cutting out fellies for carriage or other wheels, and similar segmental pieces. Bentham describes them thus: "In cutting circularwise, the fillies of wheels for example, the business of directing the course of the piece may be performed by a pair of calipers lying flat on the bench or floor, and moving about a centre, which calipers are at their extremity furnished with teeth proper for laying hold of the ends of the piece. The arms of these calipers must be of a length at least equal to the radius of the piece to be cut. In the figure *a* is the caliper, *c* the piece to be cut, *n* the centre or pivot, and *e* the saw in section.

(*To be continued.*)

City and Guilds Institute.—The City and Guilds of London Institute for the Advancement of Technical Education, announce the opening of their technical classes, at Cowper-street School, Finsbury. In the section of Applied Physics, Mr. W. E. Ayrton will deliver a course of twelve lectures on "Some of the Practical Applications of Electricity and Magnetism," commencing Monday, November 3, at 7 p.m. In that of Applied Chemistry, Dr. H. Armstrong, F.R.S., will deliver a similar course on "The First Principles of Chemistry," commencing Wednesday, November 5, at 8 p.m. An inaugural lecture will be delivered by Mr. Ayrton, on Saturday, November 1, at 8 p.m., on "The Improvement Science can Effect in our Trades, and in the Condition of our Workmen." A syllabus of each course of lectures can be obtained at the halls of the companies of Mercers, Clothworkers, and Drapers, or at the schools, Cowper-street. Intending students should send in their names to the demonstrator, Cowper-street Schools, Finsbury, E.C. The inaugural lecture will be free.

Metropolitan Gas Companies.—Whatever other interests may have suffered owing to the depression of trade, the gas companies seem to have been fortunately excepted. At three meetings recently held of the London companies—including the Crystal Palace, the London, and South Metropolitan, the past half-year in each case showed signs of increasing profit. The report of the latter company, for the half-year ending June 30 last, states that owing to the prevalence of dull and cold weather there had been, on the half-year, the unprecedented increase of 14 per cent. in the consumption of gas, which was now becoming extensively used, besides as an illuminating agent, for heating, cooking, and manufacturing purposes. This company is about to amalgamate with the Surrey Consumers', with the consent of the Board of Trade. The profit of the half-year enabled the directors to declare a dividend of 11½ per cent. The gas companies seem to have lost all fear of competition by the electric light, and at the same time have done very wisely in attempting to extend the use of gas in domestic and other arrangements besides that of lighting. It must be borne in mind, however, that the low price of metals and of coals which has, until recently, been in favour of the gas companies, seems likely to take a different turn, and, perhaps, from this cause the future dividends may not be so favourable to the shareholders. In reference to the amalgamation of the South Metropolitan and the Surrey Consumers' Companies, the Board of Trade very wisely insisted on the application of the sliding scale conditions, as applied to the whole of the joint capital.

LIST OF PROVISIONAL ORDERS DEPOSITED WITH THE BOARD OF TRADE UNDER THE PROVISIONS OF THE TRAMWAYS ACT, 1870, AND THE GAS AND WATER WORKS FACILITIES ACT, 1870.

SESSION 1879.—TRAMWAYS.

SUBJECT OF BILL.	Proposed Capital to be raised under Powers of Bill.	Engineer or Surveyor.	Parliamentary Agents.
	£		
1. Bristol (Extensions)	32,700	J. Kincaid	Toogood and Ball.
2. Briton Ferry and Swansea	10,700	Alfred Clayton	Rose and Fry.
3. Burnley and District	21,500	E. E. Allen	Tahourdins and Hargreaves.
4. Chesterfield, Brampton, and Whittington	15,725	Nimms and MacNay	Stevens and Co.
5. Crewe and District	6,000	F. C. Winby	Milne, Riddle, and Mellor.
6. Derby	32,800	J. Kincaid	W. Webb.
7. Dewsbury, Batley, and Birstal (Extensions)	3,880	M. Sheard	W. Webb.
8. Ipswich	17,250	Peter Bruff	Tahourdins and Hargreaves.
9. Leamington and Warwick	22,000	E. E. Allen	P. Burrowes Sharkey.
10. Liverpool (Corporation)	43,000	G. F. Deacon	J. M. Clabon.
11. Newcastle-upon-Tyne Corporation ...	50,000	A. M. Fowler	Dyson and Co.
12. North London Suburban	40,000	Russ and Minns	Hanly and Carlisle.
13. Oxford	27,675	J. and W. A. Brunton	Rose and Fry.
14. Staffordshire	18,000	J. Kincaid	W. Webb.
15. Stoke-upon-Trent, Fenton, Longton, and District	22,500	C. Lynam	W. P. Slater.
16. Sunderland (Corporation)	89,375	C. Thwaites	W. Webb.
17. Sunderland (Extension)	5,100	J. Kincaid	W. Webb.
18. Swansea (Extension)	4,400	J. Kincaid and H. Hunham	W. Webb.
19. Tynemouth and District	25,000	Menzies and Blagburn	Wyatt and Co.
20. Wigan	31,305	C. H. Beloe	Sharpe, Parkers, and Co.
21. York	13,500	J. Kincaid	Best, Webb, and Co.

GAS AND WATER.

SUBJECT OF BILL.	Proposed Capital to be raised under Powers of Bill.	Engineer or Surveyor.	Parliamentary Agents.
	£		
1. Aldershot Gas and Water	31,250	... ...	Norton, Rose, and Co.
2. Cleethorpes Gas	25,000	... ...	R. W. Cooper.
3. Dorchester Gas	25,500	... ...	Baxters and Co.
4. Dorking Water...	10,000	J. Mansergh	Rooks and Co.
5. Dronfield Gas	30,000	... ...	G. Norton.
6. Eckington Gas	6,500	... ...	J. C. Rees.
7. Enfield Gas	30,000 includes 11,625 for purchase money	Jabez Church	R. J. Pead.
8. Havant Gas	13,250	G. Garnett	R. J. Pead.
9. Herts and Essex Water	40,000	Russ and Minns	Hanly and Carlisle.
10. Longridge Gas	...	... ...	Dyson and Co.
11. Maidstone Water	20,000	... ...	Dyson and Co.
12. Margate Water	10,000	... ...	J. M. Clabon.
13. Mexbrough and District Water ...	10,000	C. Tomlison	Sherwood and Co.
14. Northfleet Gas	15,000	... ...	Baxters and Co.
15. Oystermouth Water	8,000	W. Whittington	Simson and Wakeford.
16. Rhyl District Water	15,000	... ...	Paine, Layton, and Co.
17. Saint Albans Water	25,000	... ...	Marriott and Jordan.
18. Shoreham and District	20,000	C. O. Blaber	W. Bell.
19. Stourbridge Water	25,000	... ...	Dyson and Co.
20. Thirsk District Water...	20,000	J. H. Rhodes	J. C. Rees.
21. Ventnor Gas and Water	37,500	... ...	R. J. Pead.
22. Wantage Gas	13,300	J. and E. Belcher	E. Walmisley.
23. Wellingborough Gas	21,875	... ...	Baxters and Co.
24. Ystrad Gas and Water...	50,000	... ...	W. Bell.

THE IMPROVEMENT WORKS AT ANTWERP.

(*Continued from page* 281.)

THE construction of the new quay wall is one of the most important parts of the work connected with the Antwerp harbour improvements, and the conditions under which it had to be constructed are unusual. The level of the tops of the foundations is 26 ft. 3 in. below lowest tides, the thickness of their foundations varies from 8 ft. 3 in. to 16 ft. 6 in. or even more, and the depth of the wall at the base was fixed at 29 ft. 6 in. The best mode of carrying out this extensive work, not only as regards the foundation, but also for that portion of the wall below the water level, was the object of careful study on the part of the contractors, who as usual with them found a solution at once novel and practical, and which was as follows. They resolved to divide up the whole length into sections of 82 ft. each, one section following another continuously, and to get in these lengths of foundation by means of iron caissons with compressed air, an arrangement which would permit of the excavation and subsequent refilling being carried on without interruption. Above the foundation, and up to the level of low water, that is, for a height of 26 ft. 3 in., it was determined to build the wall within a kind of iron cofferdam having the same form as the caisson, and sunk with it, to be removed after the section of wall had been completed, and attached to the next caisson for the adjoining length. Spaces of about 39 in. were to be left between each section or block of wall to accommodate the ends of the cofferdam. This space was to be afterwards filled in with béton up to low-water level, above which height the wall would be continuous and solid. So far as the works have proceeded, this plan has been carried out. The iron caissons for the foundation are constructed complete on the river bank, and launched down an inclined plane. They are being made by MM. Rollin Brothers, of Braine-le-Comte, and the Villebroeck Company. For putting these caissons in place, a floating scaffolding is employed, which also serves for handling the cofferdam secured successively to each caisson. This scaffolding, of which we recently published illustrations (see ENGINEERING for the 10th inst.) is composed of two iron hulls 85 ft. 6 in. long, and 16 ft. 5 in. wide, carrying each an iron framework or staging strongly braced, and connected together at a height of 39 ft. 6 in. above the water, by cross girders, the length of which keeps the boats separated by a distance of about 33 ft. These stages are also rigidly connected together at the ends. The dimensions of the spaces enclosed are such that there is room for the caisson and cofferdam attached, and chains and winches are distributed over the vessels for manœuvring these. The cofferdam is a large iron box 82 ft. long, 29 ft. 4 in. wide, and 39 ft. high. The length and breadth correspond to the caisson, and the height is sufficient to protect the work from ordinary tides (see Figs. 9 to 14, page 336). At the bottom there is an enclosed space where the connexions with the caisson can be made under water with the help of compressed air. Entrance to the caisson is effected by means of four shafts with air locks passing down through the cofferdam. The rigidity of this latter is secured by bracing at the upper end, and by being bolted to the caisson at the bottom. There are also within the structure a number of movable stays which are successively removed as the work advances. In the hulls, which form a base for the floating scaffolding, are placed the engines and boilers by which the winches are driven which control the cofferdam, as well as the air compressors, hoisting engines, and steam pumps for emptying the cofferdam. The form and construction of the caissons are shown by Figs. 6, 7, and 8 on page 336.

Work is commenced by dredging the site of foundations as uniformly as possible. The floating scaffolding then raises the cofferdam until its lower edge is about 3 ft. above water, the floating caisson is guided beneath, and the connecting bolts are adjusted. The compound structure is then moved with the floating staging exactly over the place where the wall section is to be built. Béton is then discharged on to the top of the caisson and the masonry is commenced, and to ballast the structure additional weights are added and water admitted to sink it, the edges of the caisson gradually penetrating into the ground as the soil is excavated from within the caisson, with the assistance of compressed air. When the water is pumped out the temporary loading is sufficient to maintain the work in its proper position. The greater part of the material excavated consists of mud and sand, and this is removed by means of a syphon; the subsequent filling consists of béton which is introduced through special locks. After the chambers of the caisson have been thus filled, the working shafts are removed, the cofferdam is pumped dry, and the masonry of the wall is continued; this part of the work being carried on in the open air is of quite an ordinary character, special care only being necessary that the faces of each section are absolutely in line. As soon as the wall is carried up to low-water level, the cofferdam is unbolted, raised, and shifted by the floating stage to be attached to another caisson.

For those parts of the wall built in a cutting of the foreshore, a similar form of construction will be adopted, but the floating scaffolding will, of course, not be required. It is proposed to excavate the ground in short lengths to low-water level, to bring the caissons into their exact position, and then to proceed with the sinking, carrying up the masonry as the subsidence goes on.

(*To be continued.*)

CENTRAL ASIAN RAILWAY.—A despatch from St. Petersburg says that Russia has completed a survey of a route for the proposed railway in Central Asia.

TORPEDO BOATS.—Messrs. Yarrow and Co., of the Isle of Dogs, have just completed two torpedo boats for the French Government, which they delivered at Brest last week. As a record of a long run for boats of this class—by far the longest that has ever been made yet—it may be mentioned that they steamed the whole distance of slightly over 500 miles, that they were under way 34 hours, and that a mean speed was maintained of 15 miles an hour. The consumption of coal was eight tons, which amount the boats are designed to carry without requiring a fresh supply. This gives 525 lb. per hour, or 35 lb. per mile. The above data are important as showing that long distances can be accomplished by small craft of the kind provided an excessive speed is not required. Should a speed of 23 statute miles an hour be wanted, the consumption of fuel would be at the rate of 17 cwt. per hour, or 83 lb. per mile. The vessels were subsequently tried on their arrival at Brest for three hours' continuous running at full speed, and were also tested for their turning powers, and in every respect they were found to exceed the best performances of any torpedo boat in the French Navy.

IMPROVEMENT WORKS AT THE PORT OF ANTWERP.

MM. HERSENT AND COUVREUX, ENGINEERS AND CONTRACTORS.

(*For Description, see preceding Page.*)

Fig 6 Section at A B.

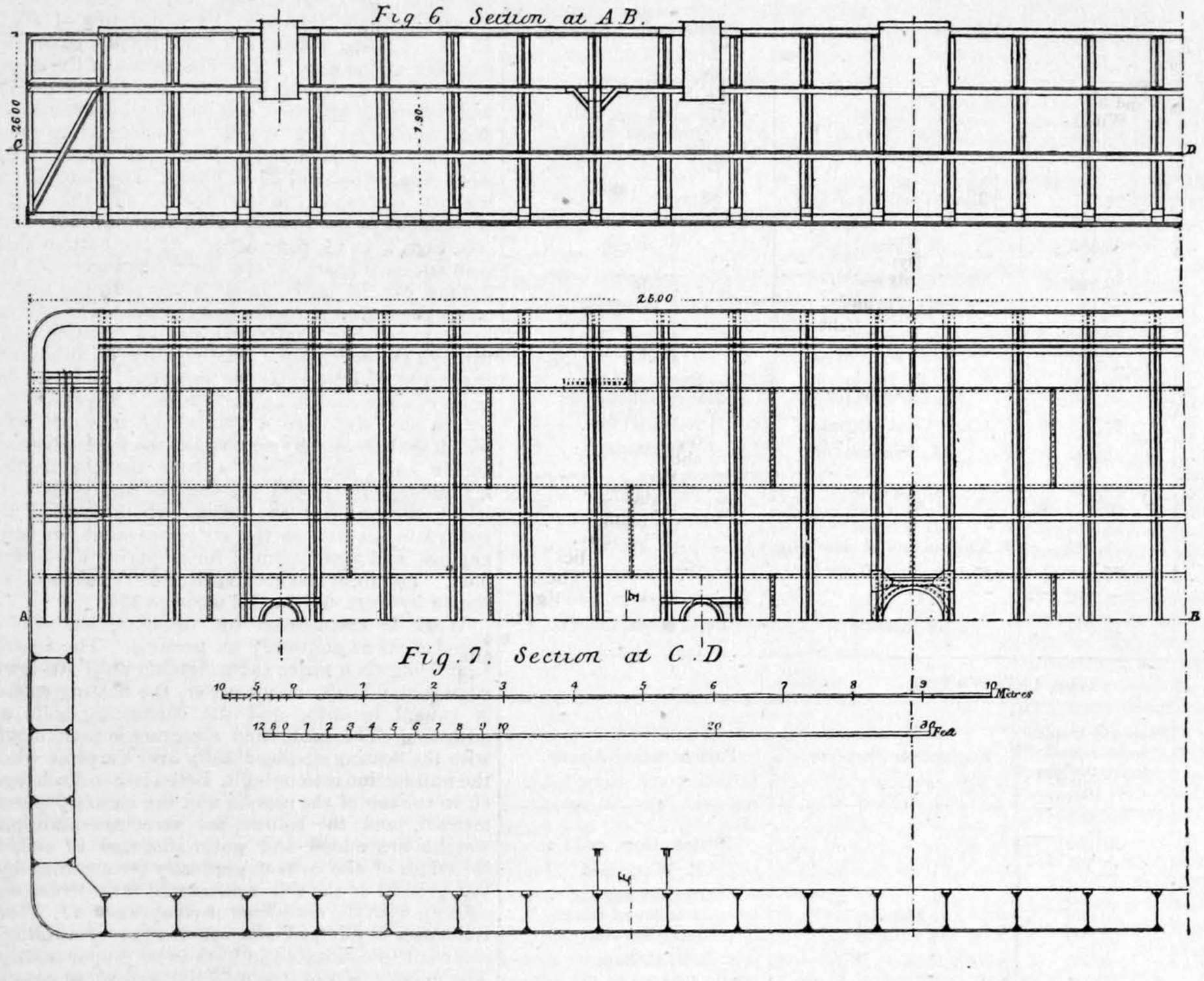


Fig. 7. Section at C D

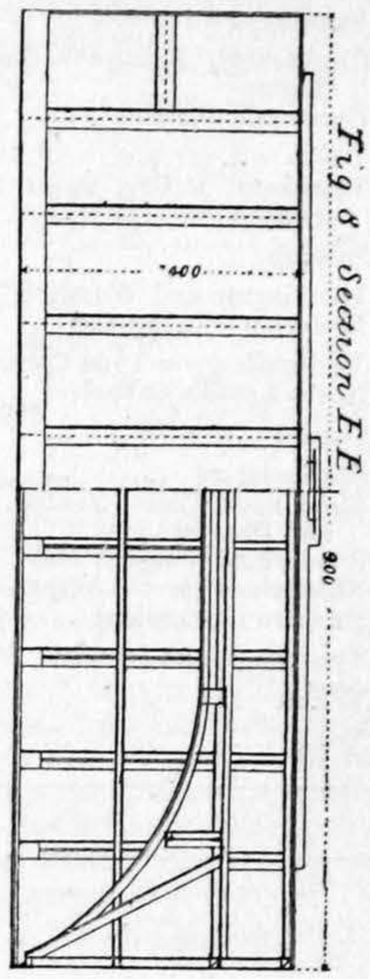


Fig 8 Section E F

Fig. 9

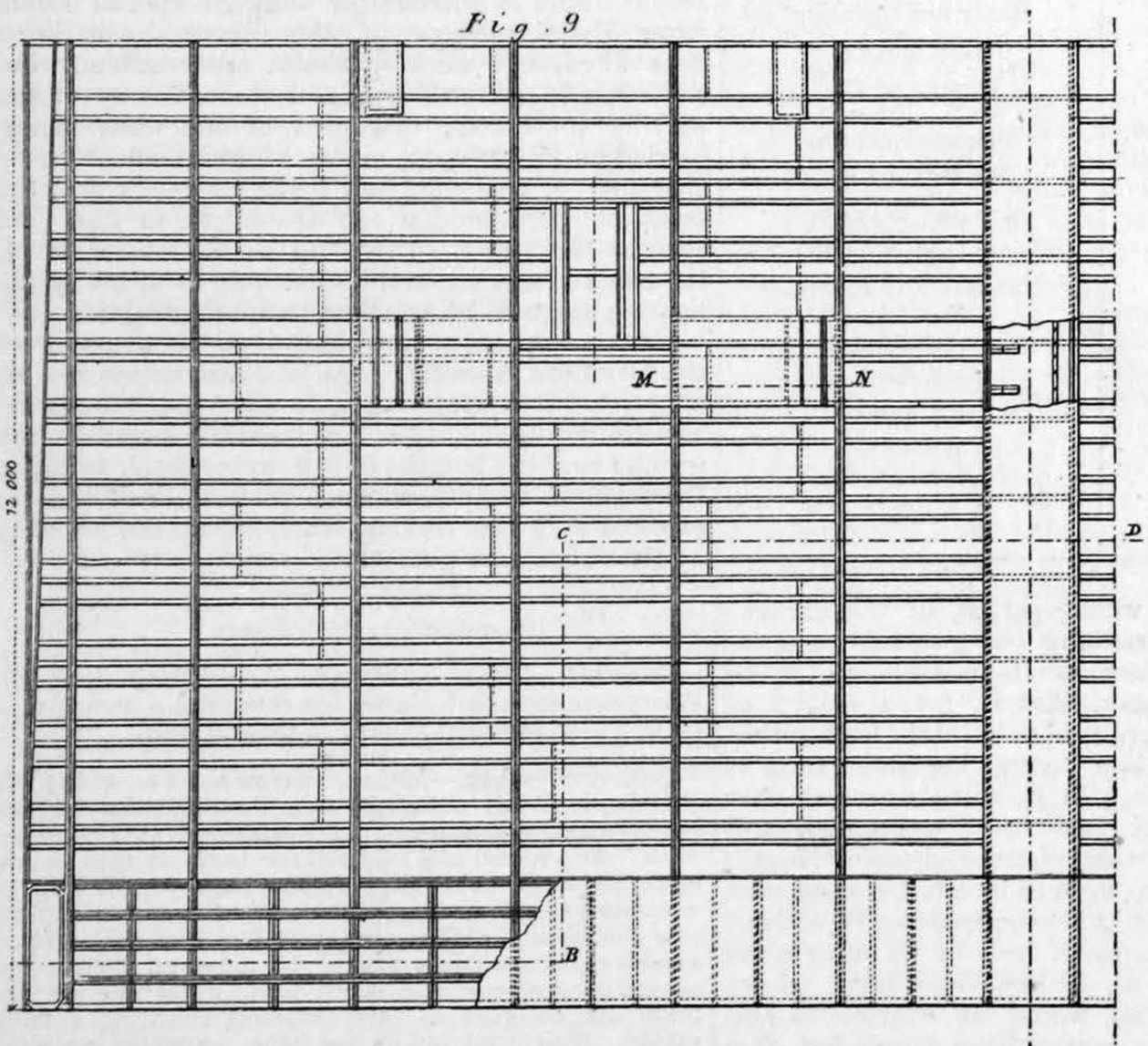


Fig 11 Section at M N.

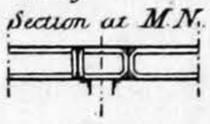


Fig. 12

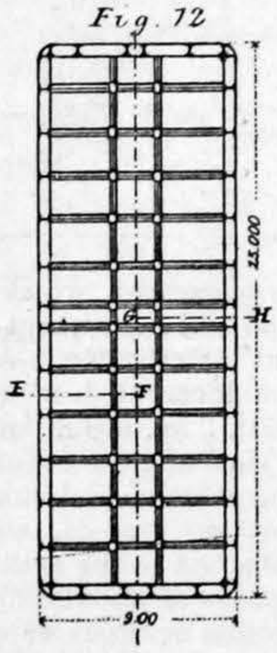


Fig. 13. Section E F G H

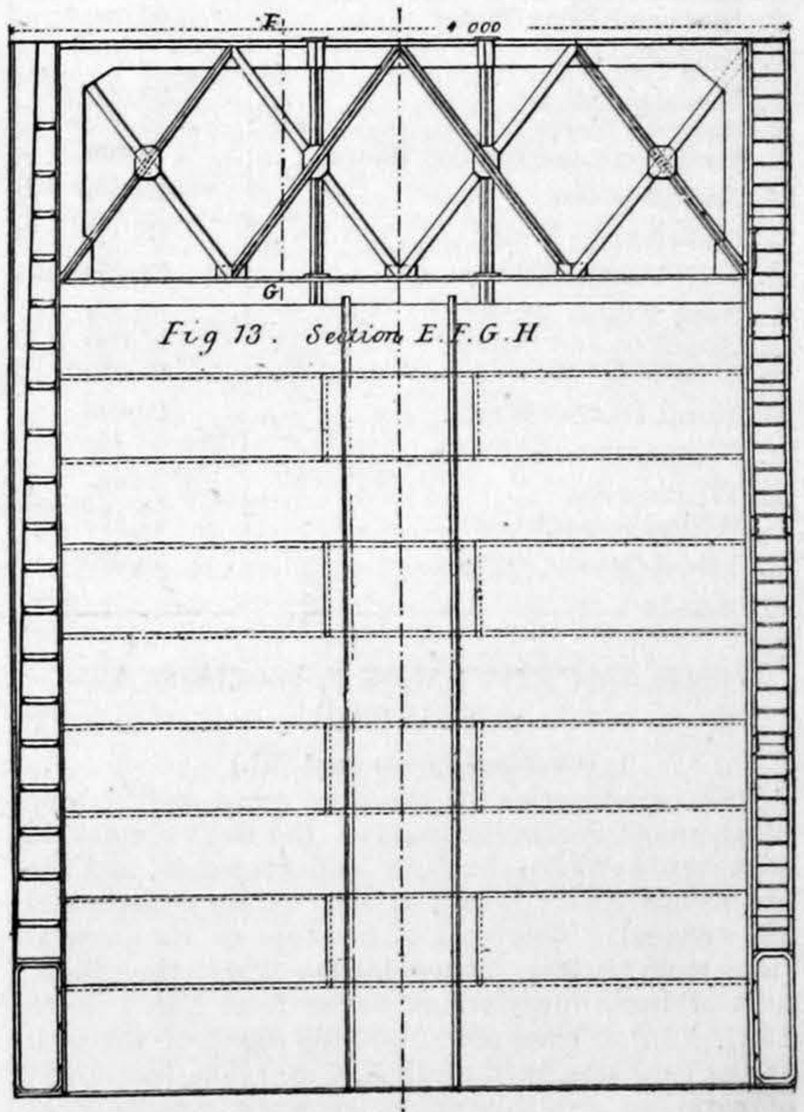
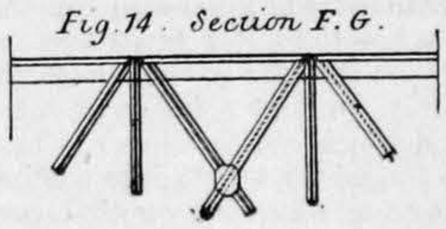
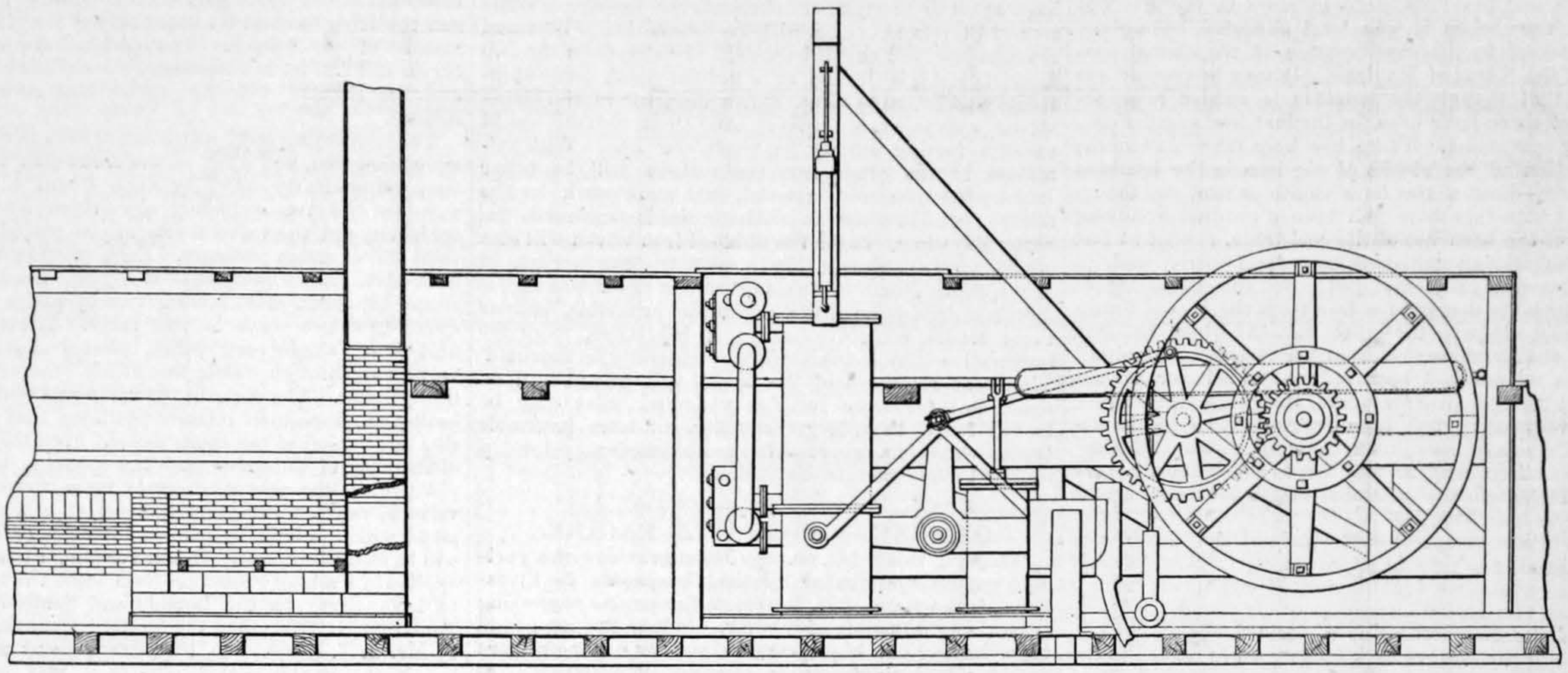


Fig. 10. Section ABCD

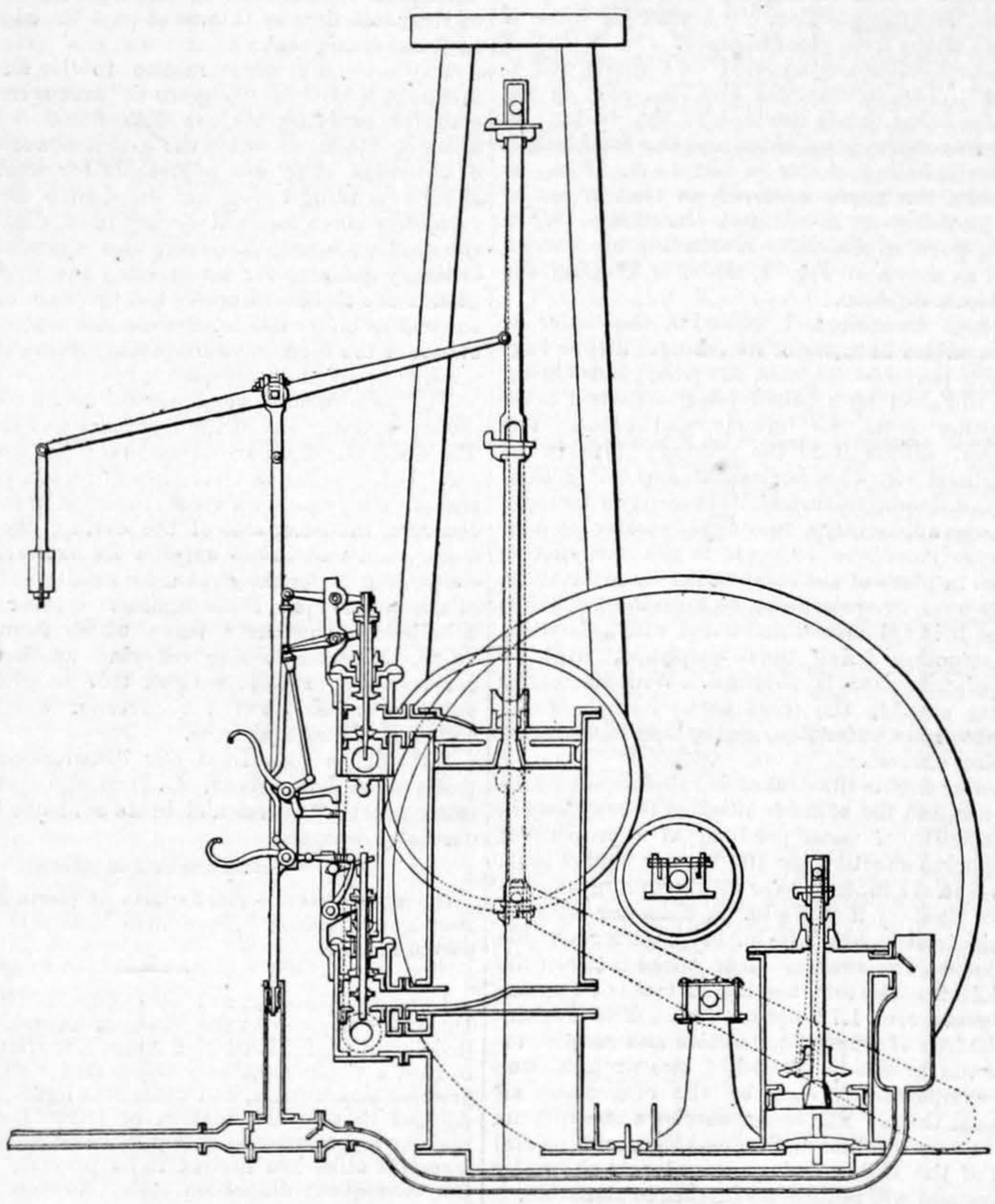
Fig. 14. Section F. G.



EARLY AMERICAN MARINE ENGINES.



ENGINE AND BOILER OF THE RIVER STEAMBOAT "CLERMONT," 1807.



ENGINE OF THE RIVER STEAMBOAT "CHANCELLOR LIVINGSTON."

Some time since (see Engineering, vol. xxv., page 72), we published drawings of an engine and boiler made by John Stevens, in 1804, for propelling a small vessel; we, this week, give illustrations of two other early American marine engines, the one being that of the Clermont, made in 1807, and the other the engine of the Chancellor Livingston, which was constructed at a somewhat later date. Both these were designed by Robert Fulton, one of the great pioneers of steam navigation. In the admirable work called "A History of the Growth of the Steam Engine," by Robert H. Thurston, the author gives some very interesting particulars, not only of these machines, but of their designer also, and of his later work. It is from this source that we obtain the information for the present notice.

Robert Fulton was born in Lancaster County, Pennsylvania, in 1765; educated as a watchmaker, he early developed both artistic and mechanical tastes, and, as a protégé of Benjamin West, he came to England to study painting about the year 1785. This profession he abandoned about eight years later for that of an engineer, especially devoting himself to the construction of torpedoes and torpedo vessels, and later to the mechanical propulsion of vessels. He found in Mr. Robert Livingston, who in 1801 was the American ambassador in France, one of his most valuable advisers and influential friends, and it was in or near Paris, that he made his first working model of a side-wheel boat, which was experimented with on the Seine in 1802. This first experiment was a failure, the vessel giving way under the weight of the machinery, and another hull, 66 ft. long and 8 ft. beam, was built, and the engines placed in it. The first experiments with this vessel were made on the Seine in July, 1803, when a speed of 4½ miles an hour was attained; the trial, however, attracted but little attention in France, and Fulton came to England in 1804, where he prepared plans for new engines that were constructed by Boulton and Watt, being completed in 1806, when Fulton returned to the United States, taking the machine with him Arrived there, he, in connexion with Mr. Livingston, who had also returned to America, built a boat 133 ft. long, 18 ft. beam, and 9 ft. in depth; the machinery was placed on board, and the first trial trip was made in August, 1807, between New York and Albany, the distance of 150 miles being made in 32 hours by steam alone. The illustration above shows the engines fitted to this vessel, and made, as already stated, by Boulton and Watt; they had vertical cylinders 24 in. in diameter and 4 ft. stroke, the crossheads of the piston rods being connected to side levers attached to bell-cranks, which transmitted the motion, through gearing, to the paddle-wheels, which had floats 4 ft. long, and were immersed 2 ft. The illustration, as well as that of the engines of the Chancellor Livingston, are copied from Fulton's own drawings. This was the inauguration of steam river navigation in the United States, and immediately after the trial trip just referred to, the Clermont plied regularly between New York and Albany as a passenger boat. In the winter of 1808 she was enlarged and repaired, and two other vessels were added to the service. In 1812, Fulton built the first steam ferry boat between New York and Jersey City, and the next year two more were constructed for running between New York and Brooklyn. They were twin boats with parallel hulls decked over, and could each carry eight vehicles, thirty horses, and 300 or 400 passengers. They made the journey between New York and Jersey City in fifteen minutes, or only five minutes longer than the same journey requires to-day. Fulton's most interesting work, however, was commenced in 1812, when he designed a steam-propelled war vessel to have a speed of four miles an hour and to carry heavy guns, some of which were to be discharged below the water line. The time taken in the building of this vessel was remarkably short; her construction was authorised by Congress in March, 1814, she was commenced the 20th of June following, and launched on the 29th of October of the same year. This vessel was called Fulton the First, and the following are some of her particulars: She was 156 ft. long, 56 ft. wide, and 20 ft. deep, and she measured 2475 tons. She was composed of two hulls placed parallel to each other about 15 ft. apart, the space between being decked over. Her engine had a cylinder 40 in. in diameter and 5 ft. stroke, and steam was supplied from a copper boiler 22 ft. long, 12 ft. wide, and 8 ft. high; the engine drove a wheel 14 ft. wide and 16 ft. in diameter, and having an immersion of 4 ft. The engine was placed in one of the hulls and the boiler in the other; the vessel was practically armour-clad, for the sides were 4 ft. 10 in. thick, and the spar deck was protected by musket-proof bulwarks; she was armed with thirty 32-pounders and designed for firing red-hot shot. The trial trip of this, for that time, truly formidable vessel took place in July 1815, when she ran from New York to Sandy Hook and back, a distance of 53 miles in eight hours, and at a subsequent trial, when the vessel was thoroughly equipped, her measured speed was 5½ miles an hour. Robert Fulton did not live to see this triumphant conclusion to his important work, since he died on February 24, 1815.

Newfoundland.—We understand that the Government of Newfoundland have instructed Messrs. Kinipple and Morris, engineers of Westminster and Greenock, to report on the drainage, and prepare a scheme of sewerage for the town of St. John's; this firm some time ago was engaged in carrying out an extension of the water works of St. John's.

NORTHERN TRADE PROSPECTS.

The sudden display of animation in the iron trade of the North, and the very large increase in the prices of iron at a time when it was least expected, have given great interest to the consideration of the trading prospects of the North of England. It may be pointed out at first that though the increase is sudden in its activity, yet there have been for the last few months premonitory symptoms. There has been for some months a fluctuation in the stocks of pig iron in the hands of the makers—first a rise for a month or two, and then a fall; and with this there has been a gradual briskness in some of the branches of the coal trade, so that at last the Northumbrian collieries have been fairly, and, in some instances, fully employed. But the circumstances under which the demand for iron from the United States developed itself gave the great impetus which the iron trade of the North has received, for it became manifest, when the output had been reduced to a lower amount than had been known for years, and when the stocks, though very heavy, had been brought down by the demand, that has now been reduced, from Germany. There was from such an addition to the demand a very large effect, and the stimulus which was thus given has not yet been lost.

If the future prospects of the trade of the North were to be judged from present appearances, it may be said that these prospects would be judged of as only having the tokens of a partial improvement. In the coal and coke trades of the North there is a decided change for the better; and the same remark holds good in regard to the crude iron trade and to its dependent industries; but there are not as yet the same full tokens in regard to the manufactured iron trade, nor to the iron shipbuilding industries. There is a growth of the output at the iron and coal mines, and also at the blast furnaces, but there is not such a growth at the mills and forges nor in the iron shipyards. At the latter, indeed, dulness is now very marked; at Stockton for instance, at the time of writing, there is not one vessel on the builders' stocks—the usual number thus in course of erection being from six to ten. And it is a matter of notoriety that a very large amount of capital is idle in the closed rolling mills—an amount of capital which is not over-estimated at 1,400,000*l.*, whilst a portion of the remainder of the capital invested in rolling mills is only partially productive.

But we have to look beyond present appearances in estimating prospects. It is certain that the stocks of pig iron are being reduced further—the rate of shipment from the Tees ports of pig iron being nearly equal to the whole output of Cleveland at the present time. This large shipment is likely to continue at least for some time, and hence we may assume that there will be for the fuller output of crude iron in the North, a fair demand. In the fuller output there is bespoken an enlarged production of ironstone, limestone, and coal, and it is more than possible that there will be with larger production of these, higher wages to the miners—though probably not to any very great extent. As to the manufactured iron trade, there are orders placed which will give more employment to the works still in operation, for some time to come, and some large works are quite full; but it does not appear probable at present that there will be any considerable addition to the puddling furnaces in operation. There is little or no present probability of the fulfilment of the prophecy of one of the old pioneers of the northern manufactured iron trade—to the effect that before the close of the present year all the now cold furnaces would be lighted up, though the tendency is in that direction, rather than in that of a further contraction of the output. As to the shipbuilding trades, the difficulty in regard to wages is the cause of the present extreme dulness, but this is answering the end of lessening the overproduction of vessels which has forced down the freight market. With the removal of the labour difficulty, though work will not be so full as it was a year ago on the northern rivers, yet it seems clear that there will be recovery from the present extreme dulness, and in that recovery the marine engine factories and foundries will participate.

In the subsidiary industries of the North there is less fluctuation, though the iron trades have suffered from the general dulness that has been known in constructive trades. Any improvement in these will be preceded by one in the great controlling industries of the North, and we have seen that this is to be expected, though slowly and gradually. The bounds which have been known in prices have here no justification, such as that which is a partial apology for the greater rise prices in the iron trade in the United States have taken. These great fluctuations necessarily impede revival when the full effect is known, for it is clear that with pig iron at, say, 2*l.* a ton a profit might be made on its shipment to America, which is not likely when prices have risen to 2*l.* 10s. per ton, and when a part of the demand for iron in the United States has been gratified. There is nothing to give ground for the belief that we shall have such "leaps and bounds" in prices. We can largely increase our output—nearly double it indeed; and in the largeness of the available resources we have a guarantee against such an effect of over speculation. But it may be pointed out that there is a probability that that capacity of production will possibly be more fully drawn upon in the future. Germany will in all probability have again to increase its demands for the cheap crude iron of Cleveland, and whilst the production of Scotland remains low, and the difference in price between the two districts lasts, with iron at a normal price, large shipments will be made there. Our home trade in iron shows strong symptons of revival, and that revival would cause a further inquiry for cheap pig iron. With animation in the crude iron trade there will be fuller inquiry for the raw material, and more work for the miners; whilst so far as northern coal is concerned, the better days in store for the finished iron works will also contribute to briskness. In a sentence, the increase of prices in the North of England for both crude and manufactured iron have made the trade profitable, and as these trades control other great industries, more remunerative work in the North may generally be expected. The great resources of the North will be more drawn upon, but far from fully as yet, and what may be looked for is, then, larger, steadier, and more profitable trade, which in a future a little more remote may develop into still more enlarged dimensions.

DEMENGE'S PORTABLE ENGINE.

We give, this week, on page 340 engravings of a portable engine constructed by the Compagnie de Fives-Lille, on the plans of M. Demenge, this engine possessing several special points of interest. It is of the compound type, having one high-pressure and one low-pressure cylinder, both single-acting, as will be seen from Fig. 1, which also shows how the engine proper is mounted on the top of a boiler which is slightly inclined when the engine is in its working position, but horizontal when it is being moved about from place to place.

The engine and boiler are mounted on a single pair of iron wheels 4 ft. 7 in. in diameter and 7 in. wide on the rim, their axles being firmly rivetted to the boiler. A pair of removable shafts is provided and the total length of the engine including shafts is but 13 ft. 11 in., or 6 ft. 6¾ in. with the shafts removed, so that it can be very readily moved about in confined situations. When in its working position the boiler is steadied by wooden blocks placed as shown in Fig. 1, tie-bolts keeping the front wedge block in place.

As will be seen from Figs. 1, 2, and 3, the boiler at first sight resembles in many of its features a type long used on French portable engines, the front plate being connected to the shell by a bolted joint so that it is removable together with the furnace and tubes. The boiler, however, differs from the ordinary type in its axis being inclined instead of horizontal, and this inclination—which is a special feature of M. Demenge's arrangements—although apparently a very slight matter, enables important improvements to be made in the constructive details. Thus in place of the combustion chamber at the rear having to be of irregular form, to keep the top below the water line, it is cylindrical and fitted with a spherical end, its construction being thus simplified, while a greater area of tubeplate is obtained. With the boiler in its working position the front part of some of the tubes comes above the water line, giving a certain amount of superheating surface.

The particular engine illustrated is rated as six effective horse power, and the boiler is intended to evaporate in regular work 220 lb. of water per hour at a pressure of seven atmospheres effective, or 103 lb. per square inch. The boiler is 5 ft. 11 in. long over all (including smokebox) and the shell is 2 ft. 7½ in. in diameter outside. There are nineteen tubes 2.76 in. in diameter outside and 2.52 in. inside, the average clear space between the tubes being 1.18 in. The total heating surface is 70 square feet and the grate area 1.72 square feet. The firebars are of wrought iron of trapezoidal section and coupled together, while the bridge is formed of two wrought-iron plates kept comparatively cool by the current of air passing between them. The boiler carries a steam dome as shown. The construction of the smokebox and general arrangement of the boiler fittings are clearly shown by our engravings and will require no further explanation.

The engine proper is shown in longitudinal section by Fig. 1, and in sectional plan by Fig. 4, and from these views it will be seen that the two single-acting cylinders are placed facing each other with the crankshaft between them. The engine only measures 3 ft. 3 in. over all, so that notwithstanding the shortness of the boiler, there is room for it clear of the steam dome. The frame which connects the two cylinders is of a cylindrical form cut away at the upper part to give access to the crankshaft bearings which it carries. The frame is also continued downwards to form a base for the attachment of the engine to the boiler.

The form of the pistons, to which the connecting rods are directly jointed, is clearly shown by Figs. 1 and 4, and we need only point out that the pins of which the connecting rods take hold are so fixed as not to allow of any steam leakage along them. The pistons are very deep, their depth exceeding their stroke, so that no part of either cylinder which comes into direct contact with the steam is brought into contact with the atmosphere. The piston and cover of the low-pressure cylinder have formed in their inner surfaces dovetailed recesses, in which lead plates are fixed with a view of reducing the internal condensation. Each cylinder is fitted with two lubricators, one a simple syphon lubricator delivering the lubricant at the upper part of the mouth of the cylinder, and the other fixed on the upper side of the cylinder at the middle of its length. The pistons are respectively 5.9 in. and 7.87 in. in diameter, while the stroke is 4.72 in., and the regular working speed 300 revolutions per minute.

The connecting rods, which are always in compression, are of cast iron, and abut on the crank-pin, the arrangement being clearly shown by Figs. 1 and 4. The slide valves of the two cylinders are driven from a single eccentric, and the valve chests are so placed as to get short direct steam passages. Each valve is fitted with a back-plate forced up against it by the pressure of the steam, this back-plate having two openings in it corresponding to two ports in the valve. These two ports unite into a single port, which pierces the face of the valve, and through which the steam enters the port in the cylinder. The ports in the valve and openings in the back-plate have such relative positions that the admission and cut-off of the steam depend upon the movement of the back of the valve past the openings in the back-plate, while the exhaust depends upon the face of the valve as usual. This arrangement of valve and back-plate, which practically gives a double-ported admission, will be familiar to many of our readers, as having been applied in a slightly different form some thirty years ago to locomotives on the London and South-Western and the Great Eastern (then the Eastern Counties) railways by Mr. J. V. Gooch. In the arrangement used by Mr. Gooch the double-ported admission was obtained by allowing the steam to enter through one opening in the back-plate communicating with a port through the valve, at the same time as it entered past the edge of the valve in the ordinary way.

The eccentric gives motion to the slide valves by means of a kind of "dog-crank" arrangement, the valve spindles carrying a cross slide fitted with cast-steel shoes or blocks in which the eccentric works. The parts of the cross slide are adjustable for wear. The valve spindle stuffing-boxes are fitted with metallic packing formed of rings made of a very hard alloy of antimony, the stuffing-boxes, however, also containing some soft ordinary packing for maintaining the lubrication. The glands are tightened up by the pressure of springs. In the engine under notice the steam is cut off at 0.6 of the stroke of the high-pressure piston, giving an effective expansion of about threefold.

The governor is very neatly arranged in a casing mounted at one end of the crankshaft as shown in Fig. 4. The weights, which are of peculiar form, are hinged to one side of this casing and have levers cast in one with them, and abutting against a steel pin which passes through the centre of the outer side of the casing, the arrangement being such that as the weights fly outwards radially the centre pin is forced outwards axially. The outer end of the centre pin bears against a lever fixed on the spindle of a butterfly valve which forms the throttle valve, this spindle also carrying another lever which carries an adjustable weight, this weight opposing the outward movement of the governor weights under the action of centrifugal force.

As will be seen from our illustrations, and the particulars we have given, M. Demenge's engine includes many special features and bears evidence of having been carefully designed.

German Coal.—The exports of German coal are constantly increasing. More than 5,000,000 tons were exported in 1878.

London Association of Foremen Engineers and Draughtsmen.—At the sitting of Saturday, November 1 (to-morrow), Mr. Frederick Alma Hamilton has consented to read a paper (copiously illustrated with diagrams, and prismoidal, sectional, and other lens lights), on "Optics as Applied to the Illumination of Dark Localities." The reading will commence at 8 p.m., and members and non-members alike are invited to be present, and to share in the subsequent discussion. Mr. Newton will preside on the occasion.

The Manchester Tidal Navigation.—A meeting has been held in Manchester for the purpose of considering the expediency of the proposal for the construction of a tidal navigation for sea-going steamers between Manchester and Liverpool. At this meeting Mr. Hamilton Fulton, the engineer, explained the nature of the proposal, and stated that the length of the channel between Manchester and Liverpool would be about 36 miles. The minimum width of the navigation would be 200 ft. and the minimum depth at low water spring tides would be 10 ft., or about 2 ft. more water than exists at low water over the bar at the mouth of the Mersey. A basin would be provided at the Manchester end of 81 acres with 16,000 lineal feet of well-constructed wharves, and all requistes for shipping accommodation on a large scale. The estimated cost of the undertaking is 3,500,000*l.* Mr. George Hicks, of Manchester, presented a statement as to the probable revenue which, if realised, would give a large return upon the proposed outlay. Owing to the inability of several members of Parliament and others to attend, the further consideration of the subject was adjourned.—*Warrington Guardian.*

NOTES FROM THE NORTH.

GLASGOW, Wednesday.

Glasgow Pig-Iron Market.—There was no market last Thursday on account of the occurrence of the Autumn Sacramental Fast Day. On the following morning the market opened firm at 3d. over Wednesday's close, and improved 7½d. further. Towards the close, however, a weakness set in, and the final price was the same as at the opening. The week closed 1s. 9d. per ton under the previous week's close, but 2s. 3d. above the lowest figure accepted during the week. Business was done during the forenoon at 55s. to 55s. 6d. cash, and at 55s. 3d. to 55s. 9d. one month, closing sellers at the highest figures and buyers 1½d. less. In the afternoon prices touched 55s. 7½d., but thence receded to 55s. cash, and from 56s. to 55s. 6d. one month, closing buyers 55s. cash and 55s. 4½d. one month, and sellers 1½d. per ton over. Monday's market was a little firmer during the forenoon, but prices gradually gave way, and the close was at the weakest point 9d. under last week's final quotation. Business opened at 55s. 1½d., or an advance of 1½d., and thence improved to 55s. 6d., but returned to 54s. 11d. cash, and from 55s. 9d. to 55s. 4½d. one month, closing sellers at 54s. 11d. cash and 55s. 7½d., and buyers near. In the afternoon there was a further reduction, from 54s. 10½d. to 54s. 3d. cash, and the market closed with sellers at 54s. 4½d. cash and 54s. 9d. one month, with buyers at 54s. 1½d. cash and 54s. 6d. one month. The warrant market was again backward yesterday, and prices had a further decline in consequence of unfavourable reports from America regarding pig iron. The close of the day's transactions was not at the lowest point, but still the final price was 1s. 9d. under that of the day previous, and 2s. 6d. under last week's close. During the forenoon there were transactions at from 54s. 3d. cash and fourteen days to 52s. 9d. cash, and the market closed with buyers at 53s. cash and 53s. 4½d. one month, and sellers 1½d. over. Prices went down in the afternoon from 53s. to 52s. 3d., recovering to 52s. 6d. cash, and from 53s. 6d. to 52s. 9d. one month, closing buyers at 52s. 4½d. cash and 52s. 9d. one month, and sellers asking 1½d. per ton higher. On Tuesday of last week prices got down to 52s. 9d., but there was an immediate recovery to 54s. It was stated yesterday that in consequence of the continued decline in prices, and the final quotation being 5s. below the sum fixed for the second advance of 6d. upon the wages of the miners employed by the ironmasters, that the latter were to meet to-day to consider a proposal to reduce the men's wages by 1s. per day, thus leaving the men with the first advance of 6d. per day. The market opened flat this forenoon when business was done at 52s. 3d. cash, but the price quickly advanced to 54s. cash, closing with sellers asking 53s. 10½d., cash and 54s 4½d. one month, buyers offering 3d. per ton less. The afternoon market was also flat, and business was done at 53s. 9d. to 54s. 4½d. cash, and at 54s. 7½d. one month. The feeling now prevailing in the pig-iron market is a very restless and uneasy one, and it is quite evident that a prejudicial effect has been produced upon the trade by the recent erratic movements of speculators in warrants. For the present consumers are very generally holding off. The demand from America has fallen off to small parcels of certain brands, and out there prices have come tumbling down in Yankee fashion, just as the shipments from this country have been arriving. It is stated that there are still somewhere about 30,000 tons of pig iron at Glasgow under contract for shipment to America, and that it is questionable if all that quantity goes out within even the next two months. The Continental demand for pig iron is quiet, the home trade, however, though only creeping as yet, shows visible signs of improvement. Last week's shipments from all Scotch ports amounted to 22,945 tons, as compared with 8923 tons in the corresponding week of last year. There are now 93 blast furnaces in actual operation, as against 90 at the same time last year. The deliveries of pig iron into the public warrant stores were again large last week, and the total stock with Messrs. Connal and Co. up till Friday night amounted to 348,434 tons, thus showing an increase for the week of 8769 tons.

Institution of Engineers and Shipbuilders.—The first general meeting of the twenty-third session of the Institution of Engineers and Shipbuilders in Scotland was held in the Hall of the Institution, Corporation Buildings, Dalhousie-street, last night. There was a large attendance, and Mr. Robert Mansel, the president, occupied the chair. Mr. R. S. Newall, F.R.S., F.R.A.S., &c., Gateshead-on-Tyne; Mr. James Tait, civil engineer, Wishaw; and Mr. John Young, ironfounder, Glasgow, were elected members; and Mr. Jonathan L. Dean, pupil civil engineer, Glasgow; Mr. Donald M'Taggart, foreman engineer, Glasgow; and Mr. Wm. Willox, M.A., pupil civil engineer, were elected graduates. The Institution Medal, awarded to Mr. Charles C. Lindsay for his paper on "The Design and Construction of Partick Bridge," read during session 1877-78, and the Marine Engineering Medal, awarded to Mr. James Howden for his paper on "The Action of the Screw Propeller," read during session 1877-78, were presented. The president delivered his introductory address, in the course of which he spoke in feeling terms of several eminent members of the Institution whose deaths had been recorded during the past year, including Mr. Charles Randolph, Mr. William Froude, F.R.S.; Mr. Robert Curle, shipbuilder; Mr. Alexander Whitelaw, M.P., of the firm of William Baird and Co., Gartsherrie; and Mr. Robert Steele, shipbuilder, Greenock. He also discussed at some length, and in continuation of the remarks in his first presidential address, the question of Force and Energy, and endeavoured to show the true meanings which those terms should convey to the mind. A paper was afterwards read by Mr. John Turnbull, Jun., on "A New and Perfect Compound Action Piston Packing," which excited an interesting discussion.

Dock Extension at Burntisland.—With the view of providing further dock accommodation, the Harbour Committee of the Burntisland Town Council have agreed to recommend that borrowing powers for a further sum of 30,000*l.* be applied for in the ensuing session of Parliament.

The New Dock Works at Grangemouth.—Since January last excavations have been carried on at the Grangemouth dock works by day and night, with the result that above the entrance lock a large portion of the ground to be hollowed out for the new docks has been removed. The wall which is to bound the dock on the south stands completed, with the exception that the granite coping has yet to be placed on it. The foundations of the north wall are laid, and the erection of the north wall itself is rapidly going on. A good deal of time and labour have been expended in the formation of the dock entrance, but under careful supervision this part of the work has also been successfully grappled with. Regarding the timber basin, it is to be situated at the extremity of the new docks, which will have a depth of 8 ft., will be connected with the canal, whose waters will run through a part of it and give an additional depth to the basin of 7 in. in the channel through which they will flow. A complete network of railroad covers the entire area, and several locomotives are kept in continual activity. Steam navvies, steam hammers, and stationary engines, together with various other kinds of machinery, are seen at work on all sides, while manual labour is represented by several hundreds of workmen, masons, joiners, and labourers. A handsome stone and brick structure, in which will be placed the powerful hydraulic machinery for working the locks, has been erected, and is all but in a state of completion.

The James Watt Dock, Greenock.—On Friday of last week, Mr. John Waddell, Edinburgh, the contractor for the great undertaking which is to be called the James Watt Dock, at Garvel Park, Greenock, took a very large party of gentlemen over the new works in which he has now for several months been actively engaged. In addition to the harbour and municipal authorities of Greenock, and the leading officials, there were also present a very large number of the most eminent contractors in Scotland. The object was to inspect the works generally, and more specially to witness the manner in which the excavations are being conducted by the aid of four steam navvies. The visitors generally were very much surprised and delighted with what they saw, and they heartily complimented Mr. Waddell on the success which was attending his great skill and enterprise. A luncheon was given by that gentleman in Garvel Park Mansion House, at which several interesting speeches were made, particularly one by Mr. Kinipple, the engineer for the works.

The Railway Works at Oban.—These works are progressing apace. On the Dalmally and Taynuilt section a considerable portion of the permanent way has already been completed. Although the Taynuilt and Oban section is not quite so far advanced, all the heavy work has been got through, and before many months are over something like completeness will have been attained. The branch line and harbour works in the hands of the Messrs. Watson are being pushed vigorously forward. The jetty and quay wall are getting into form. The sub-contractor for the erection of the station buildings has also got his men busily at work.

NOTES FROM SOUTH YORKSHIRE.

SHEFFIELD, Wednesday.

Opening of Firth College.—On Monday last the Firth College, Sheffield, was formally opened by Prince Leopold in the presence of a brilliant assemblage. The college has been built at the expense of Mr. Mark Firth, of Sheffield, at a cost of 20,000*l.*, and by him handed over to trustees for the benefit of the town. It forms a portion of a large group consisting of the college, the School Board offices, and the great central school, all of which buildings are after the plans of Messrs. Flockton and Gibbs, of Sheffield, and Mr. E. R. Robson, F.S.A., of London. The style of building was suggested by the Clare College, Cambridge. The principal apartment is the great lecture hall, in which the opening ceremony took place. It is a plain hall, with low side galleries and well lighted from the ceiling. Throughout the work there is an absence of lavish ornament, and the whole style is one of substantial neatness. In the spandrels over the principal doorway are figures, symbolising science and art, from the chisel of Mr. Onslow Ford, of Blackheath. It is proposed to form an endowment fund amounting to 25,000*l.* Of this some 15,500*l.* has been subscribed already, Mr. Firth contributing 5000*l.*

South Yorkshire Colliery Owners and the New Railway.—A meeting of the principal colliery owners of South Yorkshire was held yesterday at Barnsley to consider the Hull and Barnsley Railway scheme. Nearly a score of the largest collieries in the district were represented. Colonel Smith after describing the project said they proposed to provide new dock accommodation at Hull and appliances for shipping 14,000 tons of coal per day. The meeting resolved that the new line, with its dock and shipping appliances, so as to place the South Yorkshire coalfield on an equality with the ports of the Tyne, was a pressing necessity, and pledged itself to support this scheme.

Profits of Lead Buying.—A meeting of lead miners has been held at Bradwell for the purpose of considering their position and inviting "buyers" to come amongst them. It was stated that with lead at only 17*l.* per ton the present monopolists made a handsome profit. Thus, 26 cwt. of lead ore would yield one ton of lead; one ton of lead at present price of ore 10*l.* 19s.; cost of coal to smelt it, 10s.; wages, 6s.; carting of ore, 5s.; carriage of lead to Manchester, 10s.; sundry expenses, 5s.; total cost of one ton of lead, 12*l.* 15s.; which at 17*l.* per ton would leave a profit of 4*l.* 5s. per ton.

Proposed Diversion of the River Hull.—A very curious scheme is before the Hull authorities in connexion with the Beverley and Barnston drainage. It is to divert the River Hull about a quarter of a mile above Stoneferry, and make a navigable cut of sufficient breadth and depth to carry vessels such as at present navigate the river; what is called the Old Harbour is to be constructed into a floating dock. The estimated cost of the scheme is 230,000*l.* exclusive of the land required.

Trade.—The improvement recently noted in the iron trade is maintained. Hematite pig is quoted 82s. 6d. to 83s. per ton. The blast furnaces in the district are fully employed. Bessemer steel manufacturers fully engaged on all classes of railway material, both for home and colonial consumption.

NOTES FROM THE SOUTH-WEST.

The Severn Tunnel Works.—A new shaft is being sunk on the Sudbrook Farm, near Portskewet, in order to facilitate the pumping out of the water which has flooded the works of the Severn Tunnel. The task will be one of no ordinary difficulty.

The Forest of Dean.—The improvement in the coal trade in this district is maintained, and mention is made of a probable advance in quotations on the 1st prox. At the present time summer prices prevail; and, inasmuch as in many instances these reached a minimum not within remembrance, an advance will be acceptable and necessary. The better condition of the iron trade in other districts is making but little perceptible difference here in the output of iron, the prospect of re-blowing in at Parkend or Sewdley being still apparently remote and doubtful. For tin plates the demand continues good, and the manufactories are once again in full operation.

The Marshfield Works, Llanelly.—These works, which have been a long time idle, have been purchased by Mr. R. Nevill, Mr. B. Morris (son of Sir John Morris, Bart.), Mr. J. Jenkins, and Messrs. Harrison, Smith, and Forster, of Barrow-in-Furness. Two of the mills will be put in operation at once, and it is expected that the whole of the works will be in action before the close of December.

Cyfarthfa.—The Cyfarthfa Iron Works, Merthyr, which have been closed for five years in consequence of the depression in trade, were reopened on Monday. The occasion was one of general rejoicing, and is looked upon as the dawn of prosperity to this district. It may be interesting to known that the first rail order to be worked off is a short rail about 460 tons per mile. The conveyance of the iron will be, as in past times, by canal, and for the better passage of the heavily laden canal boats, the canal is being cleared out. The proprietary have a fine range of coke ovens which will also be put into work, the coal used being supplied by Messrs. Baddoe, of Llancaiach. The first furnaces put into blast will be those near the office.

Iron Shipments from Cardiff.—The exports of iron from Cardiff last week were: Rails, to Baltimore, 1400 tons, by Messrs. Ropner and Company; to New York, 500 tons, by Mr. E. J. Howard; to Port Adelaide, 693 tons, by Messrs. E. Jones and Company; to Yatsdad, 650 tons, and to Genoa, 500 tons, both by the Dowlais Iron Company. Pig, to Amsterdam, 250 tons, by Messrs. Guest and Company; total, 3993 tons.

Trade Prospects at Fleur-de-Lis.—A new trial pit is being sunk by the Wingfield Colliery Company in the wood near Glan Ramney Drift, not far from the Herrgoed Station, in search of coal. The Old Place Colliery, at Pengram, which was closed a few years since by the owners, the Messrs. Prothero's trust, is being reopened by Messrs. Price and Evans, who, it is rumoured, will commence shortly to sink a pit below the Gilfach Colliery for the coal under the "fault."

Coal Contract.—The London and South Wales Coal Company have secured a contract for the supply of Risca coal to the Royal Mail Steam Packet Company.

The Welsh Coal Trade.—We learn on the authority of one of the leading coalowners of South Wales and Monmouthshire that an order has been secured at an advance of 6d. per ton. This amount, though small, indicates clearly the course of affairs, and shows that the long-expected turn in the Welsh coal trade has at length taken place. Coke, best brands, has advanced 1s. per ton. Extensive building is forthwith to be carried out at Harris's Navigation, and 400 houses are to be built at once at Penrhiwceiber, near Mountain Ash.

Gas at Bristol.—The new works erected by the Bristol Gas Light Company at Stapleton are now finished, and in fact gas is being manufactured at them, operations having commenced on Monday. Bristol has grown so rapidly that these new works were simply a matter of necessity. The old works in Canon's Marsh and St. Philip's were found quite insufficient to meet the growing demand for gas, and the consequence was that the directors had to take immediate steps for supplying a demand which was becoming more and more pressing. Fortunately they were able to secure about 40 acres of land at Stapleton, and this has enabled them to lay out and build new works. At present only a sixth part of the plan has been completed, but it is so arranged that if the demand arises the other sections can be added. The plan of the works was prepared by Mr. Walter Fiddes, C.E., the engineer of the company.

Rhymney Iron Company (Limited).—No. 6 blast furnace at the Rhymney Iron Works, has been blown in, and will employ a large number of men. Preparations are also being made for blowing in No. 5 furnace at once.

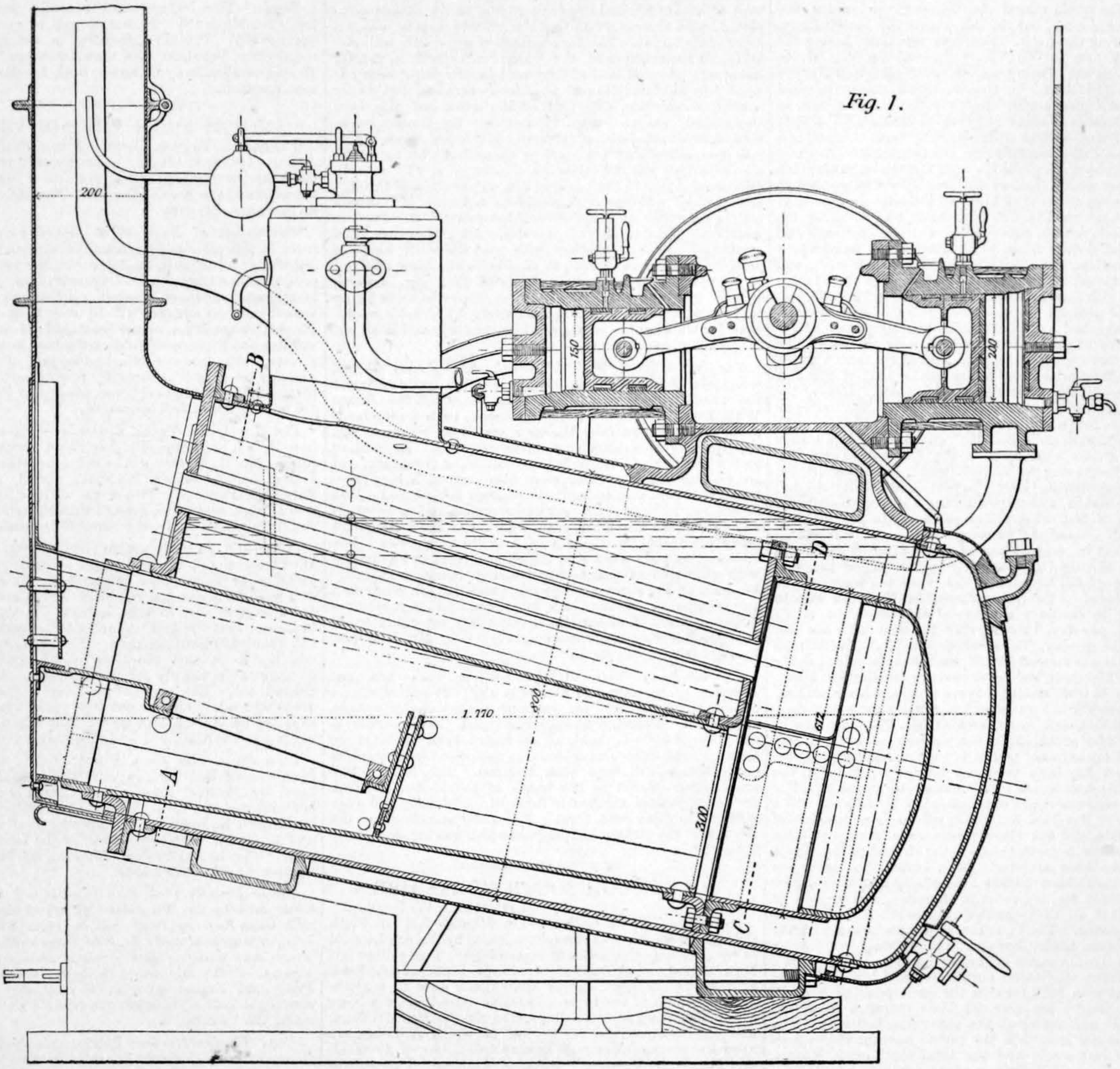
ROLLING STOCK IN ITALY.—MM. Galopin, Sue, Jacob, and Co., of Savona, have obtained a contract for 200 covered trucks of 12 tons each, for the Upper Italy Railway. The contract price is 152*l.* per truck.

DEMENGE'S PORTABLE ENGINE.

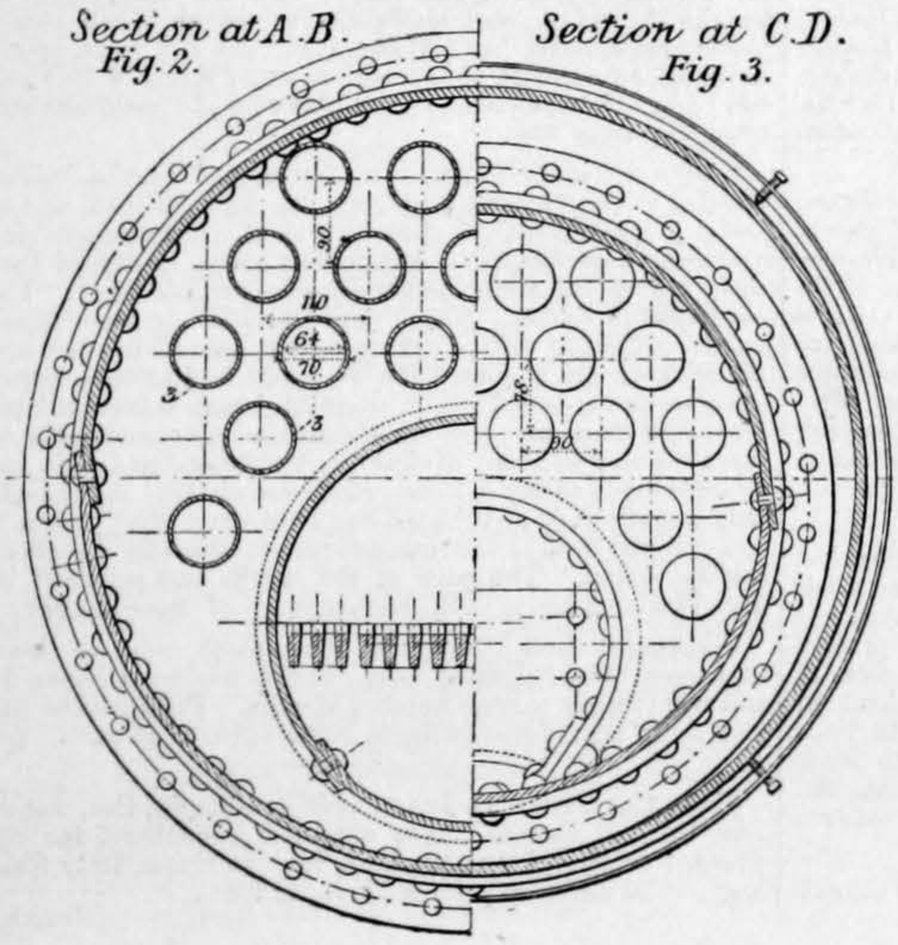
CONSTRUCTED BY THE COMPAGNIE DE FIVES-LILLE, FROM THE PLANS OF M. DEMENGE.

(*For Description, see Page* 338.)

Fig. 1.

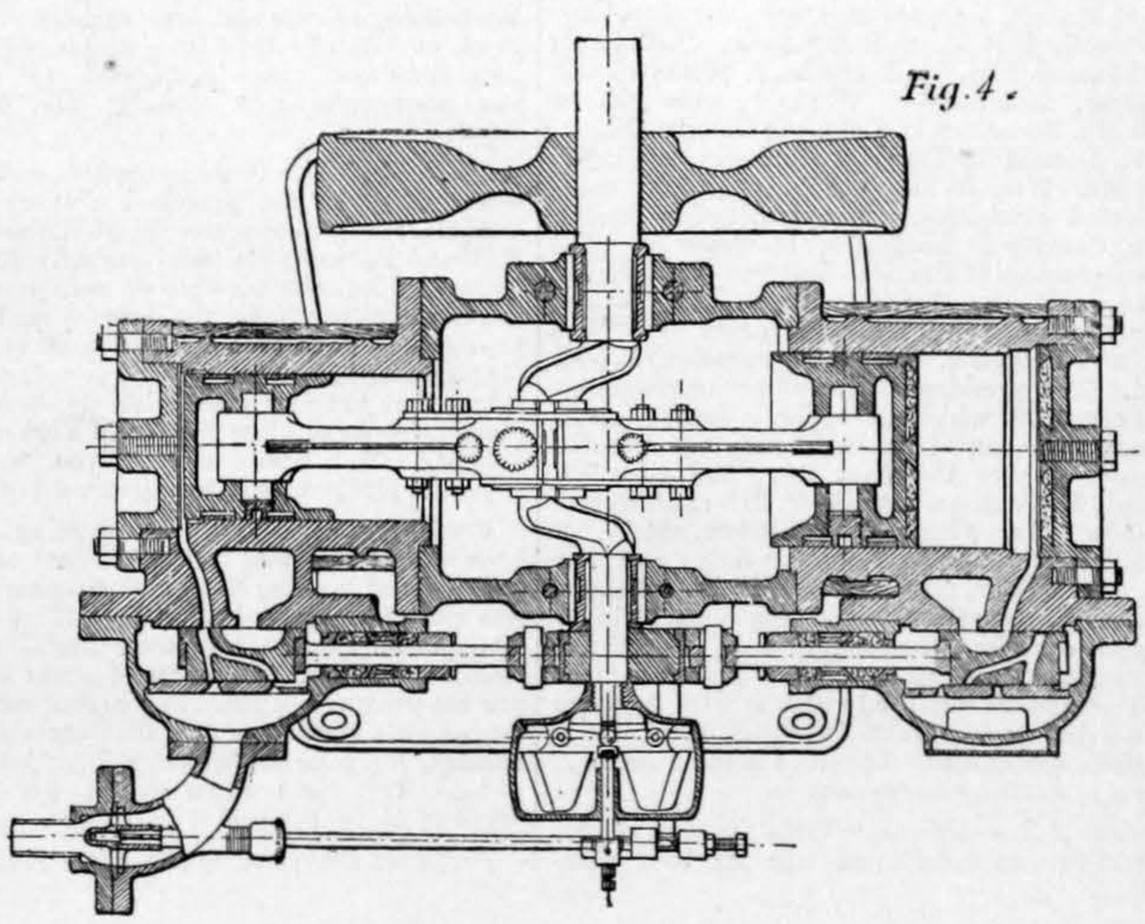


Section at A.B.
Fig. 2.



Section at C.D.
Fig. 3.

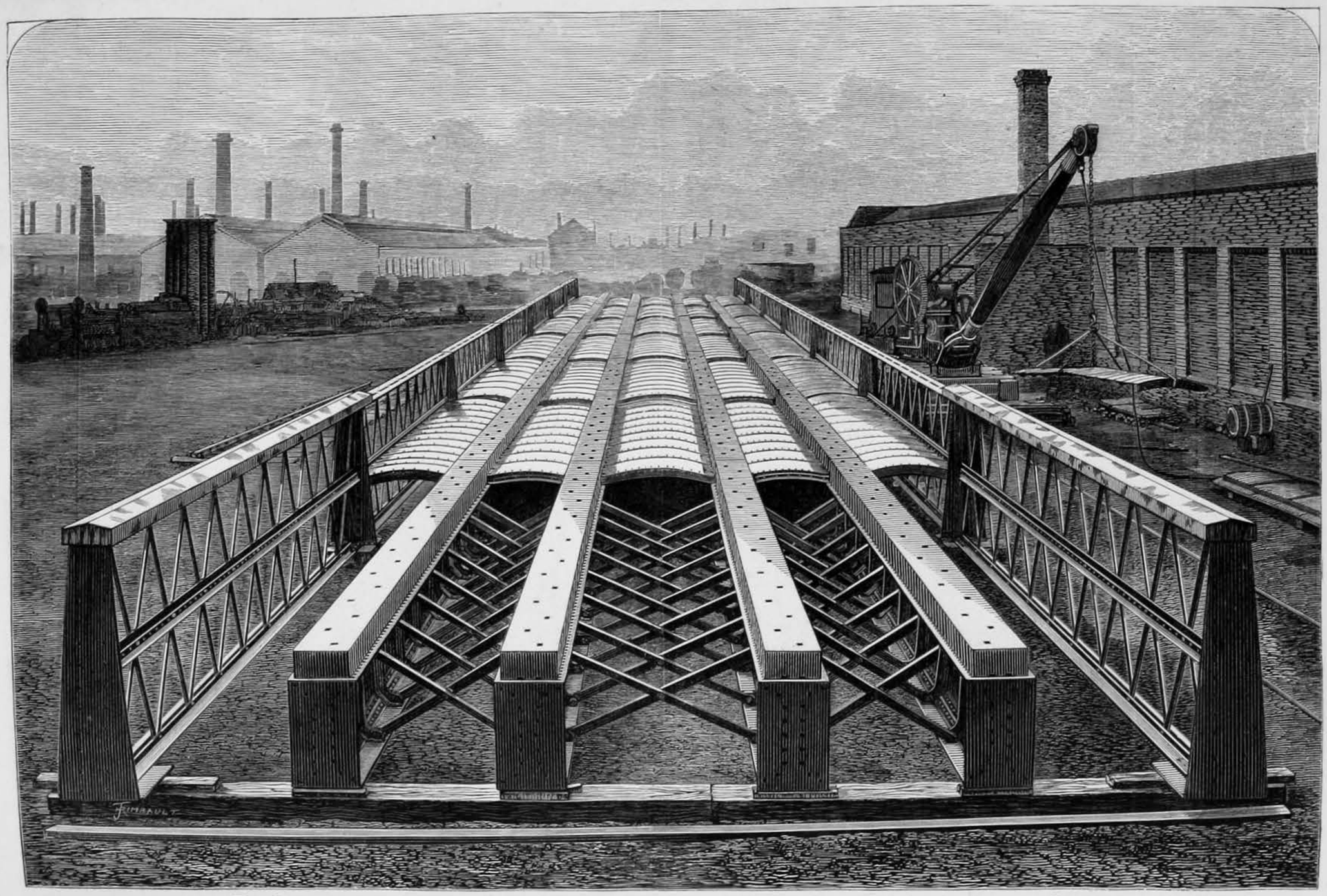
Fig. 4.



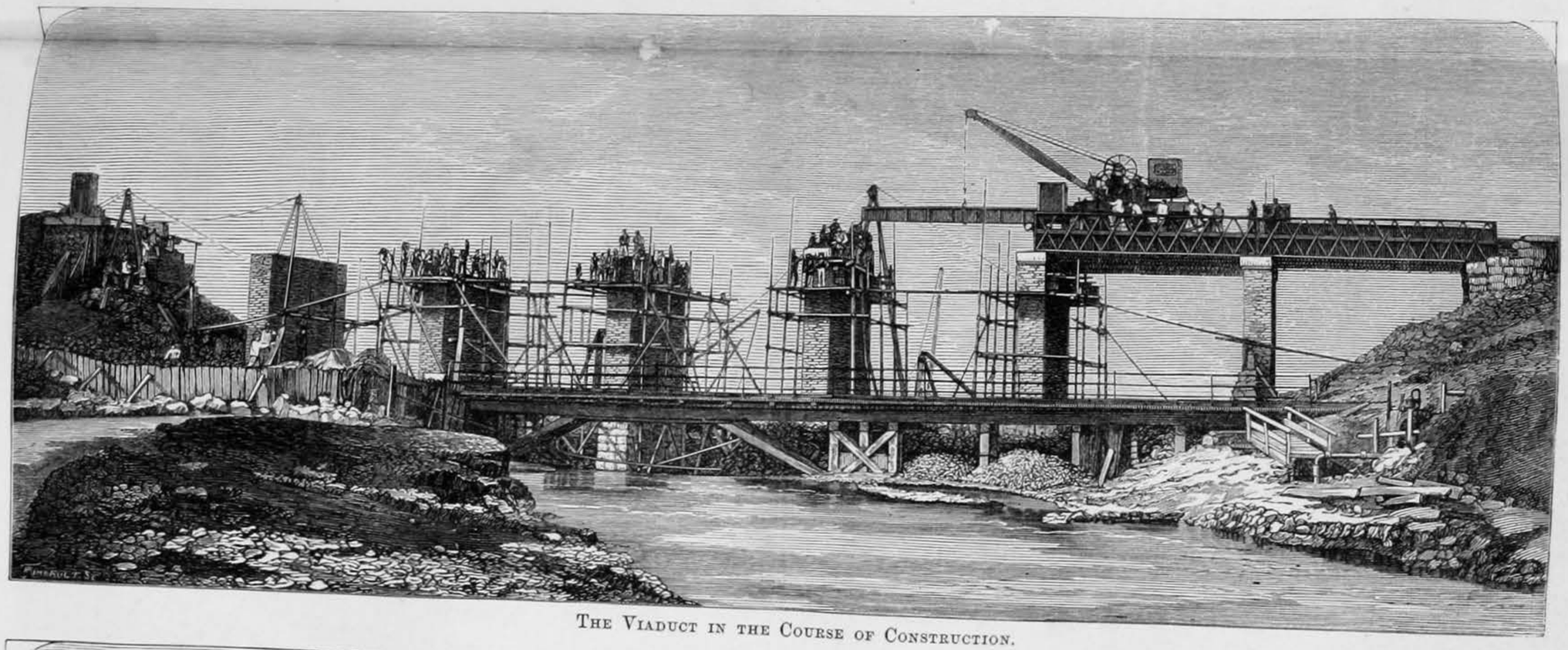
THE NEW VIADUCT AT LLANDULAS: LONDON AND NORTH-WESTERN RAILWAY.

CONSTRUCTED BY MR. F. W. WEBB, CHIEF MECHANICAL ENGINEER TO THE LONDON AND NORTH-WESTERN RAILWAY CO.

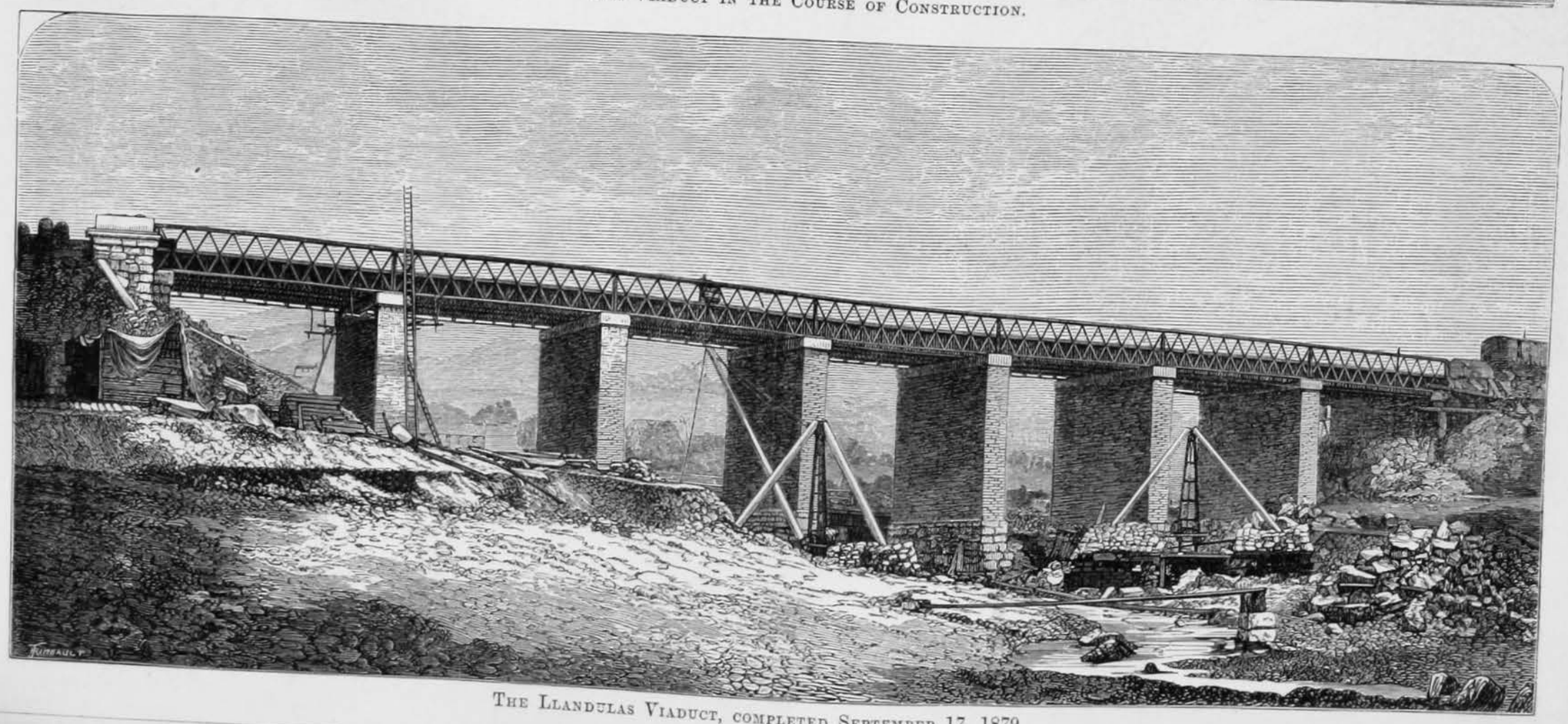
(*For Description, see Page* 343.)



The Superstructure Erected at the Works of the London and North-Western Railway Company, Crewe.



The Viaduct in the Course of Construction.



The Llandulas Viaduct, completed September 17, 1879.

AGENTS FOR "ENGINEERING."

MANCHESTER: John Heywood, 143, Deansgate.
GLASGOW: William Love.
EDINBURGH: John Menzies and Co., 12, Hanover-street.
FRANCE: Lacroix, 54, Rue des Saints Pères.
BELGIUM: P. Bailly, 12, Rue du Parchemin, Brussels.
Kirkland and Cope, Ostend.
UNITED STATES: Lenox Smith, 46 Pine-street, New York.
VIENNA: Lehmann and Wenzel, Kärntnerstrass
Gerold and Co.
LEIPZIG: Alphons Dürr.
F. A. Brockhaus.
BERLIN: Messrs. A. Asher and Co., 5, Unter den Linden.
CALCUTTA: G. C. Hay and Co.

Advertisements cannot be received for insertion in the current week later than 5 P.M. on Thursday. The charge for advertisements is three shillings for the first four lines or under, and eightpence for each additional line. The line averages eight words Payment must accompany all orders for single advertisements, otherwise their insertion cannot be guaranteed. Terms for displayed advertisements on the wrapper and on the inside pages may be obtained on application.

The price of ENGINEERING to annual subscribers in the United Kingdom receiving copies by post is 1*l.* 9s. 2d. per annum, this including two double numbers. If credit be taken, the charge is 2s. 6d. extra, the subscriptions being payable in advance.

FOREIGN SUBSCRIPTIONS.

The rates for subscriptions to ENGINEERING from abroad are:

1*l.* 15s. 8d. For Australia (*via* Southampton), Austria, Belgium, Brazil, Canada, China (*via* Southampton), Denmark, Egypt (*via* Brindisi), France, Germany, Greece, India (*via* Southampton), Italy, Netherlands, Natal, New Zealand (*via* Southampton), Norway, Portugal, Russia, Spain, Sweden, Switzerland, and United States of America.

2*l.* 4s. For Australia (*via* Brindisi), China (*via* Brindisi), India (*via* Brindisi), and New Zealand (*via* Brindisi).

All accounts are payable to the publisher, Mr. CHARLES GILBERT, 37, Bedford-street. Cheques should be crossed "Union Bank, Charing Cross Branch." Post Office Orders to be made payable at 407, Strand, London, W.C.

Office for Publication and Advertisements, No. 37, Bedford-street, Strand, W.C.

ENGINEERING is registered for transmission abroad.

READING CASES.—Reading cases for containing twenty-six Numbers of ENGINEERING may be had of the publisher or of any newsagent. Price 6s. each.

NOTICE TO AMERICAN SUBSCRIBERS.

We beg to announce that we have appointed Mr. Lenox Smith, 46, Pine-street, New York, the sole agent for ENGINEERING in the United States, and all subscriptions for the United States will in future be payable to him. Mr. Lenox Smith is also prepared to receive advertisements for ENGINEERING, and will afford full information as to terms, &c., on application. The annual subscription for ENGINEERING delivered post free in the United States is 10 dols. U.S. currency payable in advance.

NOTICE OF MEETING.

PHYSICAL SOCIETY.—Saturday, November 8th, at 3 p.m. "On a Standard Cell," by Captain Armstrong, R.E.

ENGINEERING.

FRIDAY, OCTOBER 31, 1879.

THE ART OF REFERENCING.

THIS being the witching time of year when engineers bring forth and place upon a practicable footing the various schemes requiring Parliamentary sanction with which their brains have long been teeming, the present may not be an inappropriate opportunity for making a few observations upon the above vocation and those who practise it, the brain of the engineer being the source from which they derive vitality.

Gloomy November has its historical and traditional associations, such as Guido Fawkes, the Lord Mayor's banquet, and the intensest fogs which this eminently foggy country is capable of producing, but to the referencer it possesses a great redeeming brightness, it in fact comprises the entire term of his existence, in it he lives and moves and has his being, and on the 30th of the month he (in a business point of view) expires.

Our professional readers are well acquainted with referencing in all its phases, but to the uninitiated both the calling and its followers are probably alike mysterious and require explanation, which may be briefly furnished as follows.

When the applications to Parliament for railway Bills became numerous and every deposited plan required a corresponding book of reference, the call for people competent to supply the latter became so great as to create what may in compliment to those who practise it be styled a new profession under the title of referencing.

The railway mania (1844 to 1847) is the period at which referencing may be said to have culminated into an art. Up to that time a knowledge of the work had probably been confined to surveyors and estate agents, but the kind of life it involved and the emolument it yielded appeared then so enticing that the old adage "with the occasion comes the man," was amply verified in this instance, and idlers from every calling to which reading and writing are essential flocked to the referencing works. Much of the glory then attending it arose, however, from novelty, and has now departed, although the occupation still contains enough of the Bohemian element to render it attractive to some spirits, but the £ s. d. portion of it has assumed the same decorous and economical aspect as characterises other English pecuniary matters. Referencing as regards Parliamentary Bills consists in compiling a book containing a description of the property within the limits of deviation shown upon the plan of the work proposed to be authorised, together with the names of the owners, lessees, and occupiers of it. The most important branch is that relating to Railway Bills, with which we intend exclusively to deal, but it may be noted in passing that all reference for Parliamentary Bills is similar in character, though sometimes differing slightly in detail.

As a rule the work is undertaken in couples, that is one man takes the plan the other the book, but some old stagers prefer to do it single-handed. Country reference to be thoroughly sifted and accurately completed, seldom averages more than a mile a day throughout to one set of hands, but the details and intricacies attaching to London work defy all limits of that kind, and must be estimated by the locality in which it is situated; for instance, that portion of the Inner Circle Completion Line of last year which is to extend from the Mansion House to Aldgate was only one mile one furlong in length, but it passed through twenty-three different parishes, and included 526 separate houses or other properties.

The inquiries necessary to be made about every particular property constitute the hardest part of referencing. In country work a journey of five miles is sometimes requisite to procure a piece of intelligence which can be compressed into half a dozen words, and even then numerous slips between the cup and the lip often occur before the information is ultimately obtained.

But in London these difficulties are enormously multiplied, for to one house in such a thoroughfare as Cannon-street there may be half a dozen owners, three times as many lessees, and thirty occupiers. In order to substantiate the reference before the Standing Order Committees of both Houses of Parliament (if the Bill is opposed on technical objections) and prove that due diligence was used in endeavouring to obtain the particulars required, the promoters of the Bill must be able to show that separate inquiry was made of these 54 people, and the agent or solicitor, any one among them, might refer to multiply that labour by the 526 properties mentioned as scheduled for the Inner Circle Line, and a notion may be formed of what preparing a book of reference for a London railway sometimes involves.

Three prominent impediments to locomotion in country work are parish boundaries, wide streams, and large woods; the boundaries are best checked by the parochial rates levied upon the particular property through which they run, which is the surest index to the parish the land belongs to, but the streams and woods must be passed somehow. The time occupied in achieving this, unless provided for beforehand, is often tantamount to a mile of straightforward work. When the referencer sees these rocks ahead upon his plan he will do well to make arrangements for meeting them before leaving his inn in the morning.

There are, however, many minor difficulties to be encountered, conspicuous among them being a strict prohibition not to enter certain land upon the route of the line, the owner of which is determined to oppose the proposed railway by every means in his power, and whose feudal proclivities impel him to adopt this course as one of them.

It is stated before Parliamentary Committees regularly every year that nothing improves property so much as bringing a railway into proximity with it. The last person capable of appreciating this view of the case appears to be the landowner himself. The consequence is that he is often up in arms against the engineers, who thus voluntarily interest themselves in his behalf, and summarily orders them and the referencers off his land. This clever proceeding defeats its own object in two ways; in the first place, it would most probably be a sufficient excuse to the Standing Order Committees for any error that might arise in consequence of it, but principally because, so far at the referencer is concerned, the fact of being ordered off shows the referencer that the property belongs to the individual from whom the prohibition emanates, and enables him to schedule it accordingly.

Simplicity of style in describing property is of paramount importance, the opposite course being highly calculated to bring the work to grief; for instance, such a description as "grass field, stone quarry, and cowshed," might involve three errors if the titles mentioned were inaccurate, whereas "field, pit, and building," would cover all that is requisite. Again, "house and garden" is quite enough for all that could be included in "dwelling-house, shop, outbuildings, yard, garden, and premises." The point which the referencer should keep in mind is that so long as the number on the plan covers the space he is describing that is all he has to deal with. Lastly, upon this head we would bid the referencer remember there are two kinds of allegations in a memorial before the examiner, one being public, for which anybody may sign, the other private, and requiring the signature of the party affected. Descriptions of property are included in the first class.

Another evil to which the work is exposed is the short time generally allowed for completing it. Nobody works harder or faster than railway engineers when they can get work to do, but even their powers are limited, and thus it frequently happens that what might have been effected by one set of referencers, if time had permitted, has to be divided between three or four, so as to insure its completion. It is decidedly preferable to confine the work as much as possible to a few hands, because in the event of opposition on Standing Orders, the expenses of witnesses to substantiate the reference are a great consideration.

The omnipotent point, however, in referencing calculations, before which all others pale, is the weather; a fine frosty morning puts life and spirit into the work, but an umbrella forms no part of either an engineer's or a referencer's equipment, rain consequently prostrates both of them. Fog is equally bad, so in making arrangements and calculations for completing work this element requires to be prominently borne in mind.

Having now dealt with what is included in referencing, we will devote a few words to the class of persons who follow it as a vocation. There are, of course, degrees of proficiency among these as in every other calling, but for the present purpose they may be divided into two classes, the spry artist and the plodder; the first is he who takes the plan and, in fact, directs the whole affair, while the second takes the book and notes down what his superior dictates.

One advantage in adopting referencing as a profession is that it requires no capital to start with, the stock in trade is supplied by the employer, and consists of a book and a blacklead pencil; thus equipped the referencer is ready to commence business with equal indifference as to whether his work is located in the parish of Bloomsbury or the confines of Scotland or Ireland.

Shortlived as the referencer's existence is, it brings him into contact with all sorts of people, and affords ample opportunity for the study of his fellow man if he chooses to avail himself of it. As regards country work the first object is to provide himself with a guide acquainted with the district, and with the names of the tenants occupying the land he is about to traverse; the choice of this individual ranges between agricultural labourers out of employment, professional mole-catchers, rat-catchers, and poachers, the guiding star to their whereabouts being the village inn, while their capabilities are purely matters of speculation; it may, however, invariably be taken for granted that to them the world ends at their parish boundary; the district beyond that is as foreign to their intelligence as if it were on the other side of the English Channel.

These humble individuals undoubtedly require management to properly develop their faculties, but skilfully handled may be useful and amusing companions, and as the referencer has mainly to depend upon them for his primary information, as well as to enliven the tedium of his work, it is his interest to make the most of them. The professionals are decidedly preferable, business requiring them to practice a sort of *sauviter in modo*, which removes them out of the labourer's groove; their anecdotes turn principally upon the instincts of animals, but the poacher has ever an eye to business; those furtive glances of his are big with the subject of game, he is, in fact, seeking an opportunity to ask whether his patron would like to invest in that line.

The best way of avoiding complicity in a breach of the commandment is to suggest his dealing with the landlady of the inn; failing that, it becomes a question of conscience *versus* lust.

The guide in each parish furnishes first the names of the occupiers of the land, and then takes the referencer to them, which brings him into contact with a set of beings differing according to the locality in which they are found.

Some farmers are hospitable by nature, but many are so perforce, or upon the reciprocity system of payment for what is supplied; this latter practice arises from the farmers' aversion to public-houses as a snare to their labourers; and in districts where the custom prevails strangers are invited to partake of the meal which happens for the time being to be pending, but in the course of doing so receive a pretty broad hint as to the basis upon which it is supplied.

The referencer, in the course of his perambulations, is doomed to hear much wisdom and receive many valuable hints in connexion with the work he is engaged upon, it being the inflexible opinion of every owner and occupier he comes into contact with, that although the proposed line is admirable as a connecting link between the two termini, it has taken a wrong direction in passing through his land. Information of this description may have its value if some one would take the trouble to analyse it; but it certainly, to the impartial observer, presents this drawback, that if acted upon early in the railway history of this country, the present system would be a perfect blank.

In all parts of the country allotments of land to poor people are to be found, and as the referencer approaches a town or large village he will find much land let out in small patches. These kinds of property are difficult to obtain information about, but they introduce him to the agricultural labourer, a being who is, and has now for some time past been, occupying a considerable share of public attention. If taken in his normal condition, he is harmless and civil enough, but viewed in his popular character of legal inheritor of the soil, he is a fish out of water, and acts as such.

The referencer also, when he enters great trading localities, makes acquaintance with that other political enigma, the working man as defined by his admirers. It is a noticeable fact in passing from rural to manufacturing districts that the poorer classes of the former are more cleanly and better behaved than the latter. There can be little doubt but that the thrifty farmers' argument as to public-houses before alluded to is at the bottom of this. The noble savage of whom it has somewhere been said that nature made him a man, but civilisation turned him into a beast, is largely represented in the manufacturing districts of this kingdom.

At the bottom of the social grade the referencer encounters the miner with his grim aspect and uncouth demeanour, but who still induces sympathy by his dangerous and unwholesome means of earning a livelihood, and who taken for all in all is nothing like so black as he is often painted.

Every one coming into contact with these three latter sections of the *genus homo* upon the familiar terms which the referencer does, will probably admit that the maxim of "Heaven preserve us from our friends and we will protect ourselves against our enemies," can scarcely receive better illustration than in their respective cases.

The final though not least consideration to the referencer is the selection of quarters; in continuous work two nights are about the utmost he can devote to one inn, and it, therefore, behoves him to choose it at the most convenient place available.

The house should never be at the commencement of the work, but if practicable about three miles ahead; this enables him to clear up casual inquiries on his road out and home and to make arrangements overnight as to guides in the intervening parishes. As regards comfort there are many little boxes strewed about the country frequented by huntsmen and shooting parties, which may be safely relied upon, the inns, too, where magistrates meet or farmers' local clubs are held generally provide good larders, but under any circumstances the referencer must banish fastidiousness and make up his mind to rough it in this respect, and once settled in this happy frame of mind he will soon become used to his fare and well pleased with it.

Collaterally with inns naturally comes the subject of vehicles, although the referencer's experience under this head is not always confined to licensed carriages, but ranges through every description of conveyance on wheels that the ingenuity of man has invented, and he must accommodate himself to a farm cart without springs, and thank his stars that Providence has vouchsafed even that rickety machine to him in a district where it is the only alternative to travelling from fifteen to twenty miles on foot.

And now, trusting that some of our remarks upon this humble branch of Parliamentary private business may prove useful to those whom they concern, we take our leave of the subject.

THE TEMPERATURE OF THE CARBON POINTS IN THE ELECTRIC LAMP.

Early in the development of the electric light a difference was observed in the appearance of the two carbon terminals. The positive was blunt and hollowed out in the centre; the negative was conical, pointed, and covered with the particles disintegrated from the positive. This, together with the difference of brilliancy noticed when the image of the carbons was projected on a screen, led to the same conclusion, viz., a difference of temperature between the incandescent points.

In 1844, Foucault and Fizeau wrote a paper upon this subject in which they described the general phenomena, but gave no data from which the heat condition of the two poles could be inferred. It was not until 1862 that any careful measurements were made. In that year, the late M. Becquerel made a series of experiments on the temperature of the positive carbon. The current was supplied by a battery of 80 middle-size Bunsen cells, and the temperature was taken at the moment the light flashed forth. M. Becquerel concluded that this temperature was not constant, but that it varied between the limits of 2070 deg. C. and 2100 deg. C. Unfortunately an assumption was made by the French physicist which has since been disproved, and hence the above figures have not been generally accepted.

It may be remarked that this determination is beset with considerable practical difficulties. The radiating surface must be small, a mere slice of the glowing carbons, and yet it must be measured with great accuracy. M. Rosetti, an Italian physicist, who has been following up the work begun by the late Professor Henry and Father Secchi on the temperature of the various parts of the solar disc, has recently applied his method to this electric problem. He has found that the temperature of the incandescent carbons, at the moment of ignition, is not the same throughout and is effected by a variety of circumstances, *e.g.*, the thickness of the terminals, the number of cells in the battery, the way in which they are coupled together, and the time they have been charged.

Thus in one series of experiments, the temperature of the positive terminal was found to be 2980 deg. C. By using a thinner terminal, it rose to 3065 deg. C.; and by changing this for a third of still smaller dimension, it reached 3136 deg. C.

The effect of the number of cells in the battery on the temperature is shown in the following Table:

Number of Cells.	Temperature.
80	2784 deg. C.
70	2536 ,,
60	2334 ,,
50	2190 ,,

Foucault showed photometrically that the light produced by a battery of 80 Bunsen cells lost one-third of its intensity in less than three hours. Hence M. Rosetti was obliged to make a large number of determinations including all the varying conditions above mentioned before he could arrive at any very definite conclusion. In every case, however, he found the temperature of the positive pole higher than that of the negative; and, summing up his experiments, he concludes that the temperature of the positive carbon point cannot be less than 3200 deg. C. whilst that of the negative is at least 2500 deg. C.

THE HALIFAX BOILER EXPLOSION.

On Thursday, October the 9th, a serious and very fatal boiler explosion occurred at Halifax, under circumstances which call for some comment. The accident took place at the work of Messrs. Balme and Pritchard, stuff finishers, the exploded boiler being the end one of a group of four, all of similar construction. The general arrangement of these generators will be understood from the somewhat imperfect sketches on page 348. The exploded boiler (and to all four the same description applies) was 30 ft. 4 in. long, and 7 ft. in diameter inside. It contained an internal flue consisting of two tubes each 2 ft. 7½ in. in diameter, which were connected by a U-shaped section near the front end. The ends of the tubes passed through the back plate, one of them serving as an inlet for the heated gases, which passed along the whole length of the flue, returning along the other tube which opened into the uptake. The boiler was externally fired, and was not set in the brickwork, but was suspended from girders laid on the top of the setting. The plates of the shell were specified to be ½ in. thick, and those for the end to be ⅝ in., and there appears no reason for supposing that in this respect, nor in regard to quality or workmanship, any deficiency existed. The arrangement for internal staying will be gathered from the sketches above alluded to. The upper part of the end plates was secured to the shell by six angle-iron and gusset stays, and a little below the centre line, by two similar stays marked 1 and 4. The lower part of the plate was not stayed at all to the shell. There were however, certain attachments between the U end of the flue tubes and the end plates as follows: underneath the flues there were the stays marked 2 and 3, consisting of a horizontal plate extending across, and rivetted to the two flues, double angle irons were rivetted to the plate, and a web extended from each pair to the end plate, where they were rivetted up to angle irons as shown. Stay 5 was made up of angle irons and a plate, between the end of the U and the end plate of the boiler. Similar angle irons for a similar stay 6 were also on the U tube, but the stay does not appear to have ever been put in. Finally, there was a hanging stay from the top of the U tube to the boiler shell. It will thus be seen that while the upper part of the end plate was well supported, the lower half was not only unstayed but was exposed to the constant strains arising from the expansion and contraction of the flues through the connexions 2, 3, and 5. One of these (3) had been apparently harmless for some time, as it had yielded prior to the explosion, but doubtless it had already helped to place the boiler in its highly dangerous condition. This and the other boilers were made in 1871 by Messrs. Savage and Norton, of Halifax, to conform with a general specification supplied by Mr. J. W. Balme, one of the partners of the firm owning the works when the accident occurred. From the time of their installation they had been insured for 100*l.* each with the Manchester Boiler Insurance and Steam Power Company, by whom an external examination had been made only a few days before the accident; this report was satisfactory, though how it could have been so it is difficult to understand, since the boiler was covered with non-conducting coating.

The explosion occurred, as already stated, on the morning of Thursday, October 9, when there was a pressure of about 45 lb. of steam in the boiler. The lower and unstayed half of the front end plate was rent away, tearing the stays 1 and 4 and partially some of the upper stays, as well as the connexion between the plate and the U end of the flue. The force of the explosion projected the boiler from its setting for a distance of 102 ft., and after passing through one of the workshops it was stopped by striking the angle of a house. The works were converted instantly into a ruin, not only the boiler-house but some of the principal shops and machinery being entirely destroyed, and unfortunately six lives were also sacrificed, including those of Mr. J. Pritchard, the senior partner of the firm, and the manager of the works.

The official inquiry into this catastrophe was not by any means a difficult one. The cause of the explosion, so far from being obscure, was obviously due to the absence of staying in the lower part of the end plate, which was still further weakened by the strains set up in it by the connexions with the flue. But one fact of exceptional importance was elicited at the inquest, namely, that the last internal inspection of this group of dangerously constructed boilers was made on June 17, 1875, nearly 4½ years ago, although they were under the charge of a responsible company, whose obvious duty and apparent interest it is to properly inspect all boilers under their charge. Such a neglect as this merited even more than the strictures passed both on the owners and on the insurance company by the jury, and it is clear that the reason urged—that the owners always raised difficulties in the way of internal inspection—could not justify such neglect. It must, or should, have been obvious to the engineer of the Manchester Insurance Company that the boilers were structurally weak, and that if they accepted

them at all, they were bound to exercise especial watchfulness over them; and, in the event of opposition to proper inspection on the part of the owners, to decline further risk.

This is another illustration that insurance and efficient inspection do not harmonise. We are very far from supposing that any boiler insurance company would deliberately prefer the risk of possible explosions to the cost of frequent inspections, but in an association of this nature, established to make money, the criminal folly of an owner in placing obstacles in the way of inspection, is more easily accepted as an excuse, than if its object were that of securing life. That the Halifax jury fully appreciated this is shown by the concluding sentence of their verdict. "They are further of opinion that some efficient action should be taken by Government to compel the various insurance companies who undertake the insurance of steam boilers to insist on a periodical and thorough inspection of all boilers and their fittings under their care, and that in all cases each boiler should have a separate and independent steam valve."

THE LLANDULAS VIADUCT.

No more striking example of rapid bridge construction exists than that afforded by the restoration of the Llandulas Viaduct on the main line of the London and North-Western Railway between Chester and Holyhead, and not far from Rhyl. The disastrous floods which occurred during August last, destroyed the old viaduct which carried the railway over the River Dulas, severing one of the main arteries of the London and North-Western Railway system, and interruping one of its most important branches of traffic. The old viaduct was a heavy masonry structure consisting of seven arches about 28 ft. span, and of six piers, the approaches on either side being formed of embankments. The accident occurred on Sunday, the 17th of August last, at four o'clock in the afternoon, and only a quarter of an hour after a train had passed over the bridge; the flood water, which converted the Dulas for a time into an overwhelming torrent, swept away the viaduct, throwing piers and arches into one mass of ruin. It was not until the early morning of Tuesday, the 19th of August, that it was possible to commence the temporary works which had to be constructed pending the permanent restoration of the viaduct; these temporary works consisted of a timber trestle bridge and a diversion of the line on each side. The nature and extent of this diversion are shown on the plan, Fig. 1, which we publish on page 333; from this plan it will be seen that the diversion commenced about 12 chains on each side of the river, and the temporary line descended with steep gradients of about 1 in 24 to meet the trestle bridge. This latter is shown in Figs. 4, 5, and 6, and will be seen to consist in one main span 50 ft. 10 in. long, and of four smaller ones. The roadway was supported by four longitudinal timbers stiffened by struts in the main span, and carrying transverse bearers to which the close planking forming the floor was secured. Fig. 6 shows this construction clearly. These temporary works were completed by the end of the week, and on Sunday the 24th of August, at 2 P.M., the first goods train passed over, followed the next day by passenger trains; the interruption to the traffic, therefore, lasted only a week, during which time passengers and luggage were transferred by road from the station at Abergele to that of Llandulas; these temporary works were carried out by Mr. Footner, one of the officers of the company, in three hours less than seven days, including two days of enforced inactivity while the flood was subsiding.

Meanwhile the preparations for the permanent restoration of the viaduct were being actively pushed forward, and at the same time the débris of the old bridge was removed, a work of no small difficulty. The distance to be spanned is 224 ft., and it was decided that the superstructure should consist entirely of steel, the girders resting upon masonry piers. The total distance was divided into seven openings, each of 32 ft. in length, and the height of the tallest of the six piers is 50 ft.; the lower part of these piers, which are about 4 ft. in thickness, are of masonry, and the upper part of brickwork, and they are connected together near their foundations by masonry inverts, which are protected up and down stream by aprons; the whole of the work is set in Portland cement. The two lower illustrations of the two-page plate which we publish this week, give a good idea of this portion of the work. As soon as the general plan of the bridge was decided upon, Mr. F. W. Webb, the chief mechanical engineer for the London and North-Western Railway Company, commenced the manufacture of the steel plates for the superstructure. There were in all 42 girders, each 32 ft. long, besides transverse girders, flooring plates, &c.; but the work was simplified by adopting the bold device of rolling all the plates and angle irons for the top and bottom girders of each span in single lengths; the upper figure of our two-page engraving, which shows one of the spans erected in the yard at Crewe, will convey a good idea of the character and design of the bridge. In the incredibly short space of seven days the whole of the material was turned out ready for erection, the steel having been manufactured, rolled, and worked up at Crewe; as rapidly as possible the material was despatched to Llandulas, so that no time should be lost in the erection, which was indeed completed seven days after the last of the steelwork had been delivered at the site. One of our illustrations shows the manner adopted for erection, and from this it will be seen that the work was carried forward from one end of the viaduct, each span as it was completed serving as a platform for the erection of the next; some slight delay was incurred during construction, from the fact of the piers not being completed as soon as the superstructure. In somewhat less than a month from the time of the accident, the traffic was diverted on to the re-established line, and the temporary works became useless. The official inspection of the Board of Trade took place on Monday, September 22, when it was found that the deflection in the centre of the spans under a passing load was only $\frac{1}{16}$ in. In recording this feat of rapid bridge construction, we must not omit to mention the names of the officers of the company who carried out the work. These were Mr. F. W. Webb, the chief mechanical engineer and locomotive superintendent, Mr. Frank Stevenson, the chief civil engineer, Mr. Smith, the district engineer, and Mr. Footner; it must not be forgotten either that an additional interest is attached to the viaduct, from the fact that it is built wholly of steel, and that there are no cover or joint plates used in it throughout.

It is almost unnecessary to state that the work was carried on continuously, night and day, the portable electric light apparatus, devised by Mr. R. E. Crompton, and illustrated on page 364 of our twenty-seventh volume, being employed.

THE SANITARY CONGRESS.

The Sanitary Institute of Great Britain commenced its congress on the 21st inst. at Croydon. After the formal opening of the Exhibition, the general business of the Institute was commenced in the evening by an address by the President, Dr. Richardson, who, in a kind of scientific romance, endeavoured to impress on his audience his ideal of a happy people supposed to reside in a "Salutland." Leaving this idealistic picture, we select the following among the many really valuable, because practical, addresses, or papers read before the congress.

Dr. Carpenter took as his subject, "The First Principle of Sanitary Work." He pointed out that the first principles of sanitary law were frequently at variance with private interests, and this, with other causes, had long prevented the progress of sanitary improvement. He dealt with the varieties of diseases resulting from blood poisoning, showing that however they might differ in external symptoms, their cause was frequently identical. He urged that the present system of the registration of the causes of death was generally of no scientific value. He referred to the disease of animals used by us as food, and stated that he was not surprised when he heard it remarked on oath by an inspector from the Metropolitan Meat Market that 80 per cent. of the meat sent to London was the subject of tubercular disease. To this cause he assigned the occurrence of many diseases among us. Dr. Carpenter's conclusions, in reference to the general conditions of sanitation in towns, were to the following effect: 1. That sewers are necessities for crowded population. 2. That such sewers might safely be used as water carriers for human excreta, &c. 3. That sewage smells and gases are not a necessary consequent of the system. 4. That sewage should be judiciously applied to the land, by which the spread of enthetic disease would be impossible. 5. That the effluent of such use of the sewage might be safely sent into any watercourse. But the most important part of Dr. Carpenter's conclusions, as bearing on the last questions, involves a serious qualification, for he remarks (6), that the application of sewage to land must be conducted on scientific principles, otherwise failure, financial and sanitary, must be the result; and (7) a local board is the worst possible body to manage a sewage farm—the manager of a sewage farm must be an autocrat. Does not Dr. Carpenter remember that even with such scientific autocrats, sewage farms have become failures, equally with those governed, managed, or mismanaged by local boards?

Passing over a variety of papers dealing with the subject of drinking water, water analysis, alcoholic drinking, &c., we turn to an address delivered by Captain Douglas Galton. He remarked that there were few subjects in which so many professions of progress had been made during the last few years as in the theoretical knowledge of how to provide a healthy dwelling. Yet, in spite of all efforts, there were few houses, and very few towns, where sanitary blunders could not be easily detected. General ignorance of sanitary science prevailed, for it had never yet been brought to a system. From this and other causes, much money that had been advanced under Government sanction had been literally wasted. He thought that the Government should have limited its action—first, to the enactment of laws requiring the removal of existing sanitary defects; secondly, to the promotion and diffusion of sanitary knowledge among the people, instead of attempting to dictate exactly the measures to be adopted in each individual case. He pointed out the evils resulting from houses being built on foundations composed of refuse of all kinds, instead of the virgin soil. He urged that the health of every building depended on the free access of air to and through it. He entered into the general question of the water supply, and contended that it was the duty of Government to take the question up in a national point of view, in place of leaving it in the hands of local authorities. He stated that abundant statistics were already in the hands of various departments to enable such a scheme to be at least originated, but he thought that the responsibility of the matter should devolve on the Local Government Board. As to the question of sewage, he observed that this must always remain a problem for the sanitary engineer to solve. He strongly urged that a systematic course of instruction should be given to all who were to attempt officially to undertake sanitary construction, and that no person should be appointed to the office of surveyor without he possessed a certificate of his competency given by some duly qualified institution. We will add one more suggestion as supplementary to Captain Douglas's remarks. Let every medical officer undergo a similar examination before he receives an appointment. Our experience teaches us that there are at least as many medical officers as surveyors who are deficient in the necessary qualification for their sanitary duties.

Interesting papers were read by Mr. J. Bailey Denton on certain points in sanitary engineering; by Major General Scott on the effects of long continued application of sewage to the same land, &c. Dr. Corfield delivered a lecture on "Sanitary Fallacies," which dealt with the history of some portion of sanitary science. He exposed the various fallacies of the faculty in regard to the science and art of medicine. In dealing with modern sanitary science he showed the errors we laboured under, in regard to the communication of infectious diseases, to the removal of refuse matters from the vicinity of habitations, to the nature, quantity, quality, and other conditions of water supply, sewers, &c. This address had the advantage of at least showing how little had really been done, despite the great supposed advances which modern sanitary science claims to have made.

We have only room to select a few remarks on the address of Mr. G. J. Symons on meteorology, geology, and sanitary practice. He pointed out the errors prevalent as regards the ventilation of private houses, and the waste of money which occurred by the bursting of mains and pipes during frost, and the terribly unhealthy character of our churches, theatres, &c. He described some simple arrangements by which, at little cost, large buildings might be effectually ventilated. He drew attention to local impurities of the air and their causes, and to the effects of mists, miasma, and rainfall on the general health. In regard to the geology of sanitary questions he did not think that a clay soil was necessarily more unhealthy than a gravel soil. In conclusion, he strongly urged a better system of

registration in regard to deaths caused by zymotic diseases.

We have been compelled thus only briefly to notice some out of the forty papers and addresses that formed the business of the congress. It appears to us as one of the most valuable because most practical that has yet been held on sanitary subjects. We are glad to find that the Institute is not only making moral but material progress. In a future article we shall notice in detail some of the most interesting features of the Exhibition of Sanitary Appliances at Croydon, which will be kept open until, and inclusive of, the 8th of November. It is well worthy of a careful inspection, not only by those who may be connected with various professions, but also by private individuals who may there gather many hints for the sanitary improvement of their households.

SPEED CURVES.

Since the introduction of progressive steam trials for ships by Mr. W. Denny, and the investigations by Mr. Froude of the results obtained therefrom, it has been becoming more and more evident from year to year that this is a direction in which naval architects must look for valuable information on the resistance of ships and on marine propulsion. By his discovery of the important part played at low speeds by the constant initial friction of the engines Mr. Froude considerably advanced people's knowledge in a direction that had previously been very cloudy. He had previously demonstrated his law for the corresponding speeds of ships and models.

Following in the same direction Mr. J. Inglis, Jun., shipbuilder, of Glasgow, who had been one of the earliest to adopt progressive trials, read an interesting paper before the Institution of Naval Architects in 1877 "On a Method of Recording and Comparing the Performances of Steam Ships." The object of Mr. Inglis's paper was to afford a means of comparing the performances of vessels of similar form, but greatly differing in size, thus showing the effect of alteration in size of a particular type, and its scope may be briefly stated as follows:

The Admiralty system of estimating speeds up to that time had been to compare the proposed new vessel with the nearest one to hand, whose performances were known, and, having fixed upon the probable value of the "constants," the speed was obtained by the Admiralty formulæ which were based on the supposition that the resistance varied as the square of the speed and the area of midship section, and a certain power of the displacement. Now, Mr. Denny and Mr. Inglis both discarded this system and obtained for each ship a complete curve of resistance, or curve of indicated thrust from slow speeds to high ones.

Combining this system of progressive speed trials with Mr. Froude's law for corresponding speeds, Mr. Inglis in the paper referred to, advanced an important step on the ladder. The process may be again described briefly: He gets from the speed trials of a particular ship the curve which shows the relation between indicated horse power and speed. He next gets the curve of "indicated thrust" in terms of the speed, and this indicated thrust minus a constant quantity due to the initial friction of the engines is proportional to the resistance of the ship at the different speeds. From these results a curve is obtained showing a varying coefficient of performance from the equation

$$\frac{\text{Augmented surface} \times V^3}{\text{I.H.P.}} = C.$$

Instead of this latter might be taken equally well the Admiralty formula $\frac{D^{\frac{2}{3}} \times V^3}{\text{I.H.P.}} = C.$ Mr. Inglis's system of comparison rests on the assumption which appears quite a reasonable one, "that for vessels similar in form and similarly propelled, but dissimilar in size, at corresponding speeds, a coefficient of performance such as the Admiralty so-called 'constant' is really constant." The same curve of coefficients or "constants," therefore, applies to all size vessels of the particular type by taking them at the corresponding speeds. Having got the constants for any particular sized ship at the different speeds, a curve of indicated horse power can be formed for this sized vessel. Similarly an indicated horse power curve can be got out for any number of ships of the type differing in size.

From this brief description the speed diagrams shown on Figs. 1 to 12 will be easily followed. They are for vessels of the following dimensions: Figs. 1, 2, and 3 pertain to the screw steamer Flinders of 947 tons, dimensions 227 ft. by 28 ft. by 20 ft., mean draught of water 11 ft. 6½ in., and displacement 1243 tons, tried January 16, 1879. Fig. 1 shows the form of the line at the water surface, and at a parallel water plane at half the vessel's draught of water. It also shows the greatest angle of entrance and run. Fig. 2 shows the area and position of the propeller disc in reference to the area of midship section. Fig. 3 shows the results of the trials. The actual spots on the curves are very nearly at 6, 9¾, 11, and 13 knots' speeds, and through these the curves are drawn, being continued beyond the spots at either end in dotted lines, so as to form a fair curve. By the help of the scales attached, it will be easy to read off the particulars. It will be seen at once, for instance, that to drive this vessel at a speed of 13 knots required 75 revolutions per minute, and an indicated horse power of 1360, with a slip of 3 per cent. It also shows that the coefficient of performance is highest at 9 knots, from which point upwards also a marked difference takes place in the slip curve. Probably beyond this speed and power the propeller begins to lose some of its efficiency. The propeller of the Flinders was 13 ft. diameter and 20 ft. pitch, with 60 ft. area, four blades. The engines were inverted cylinder, direct-acting compound, with cylinders 37 in. and 66 in. diameter and 42 in. stroke.

Figs. 4, 5, and 6 show similar curves for the

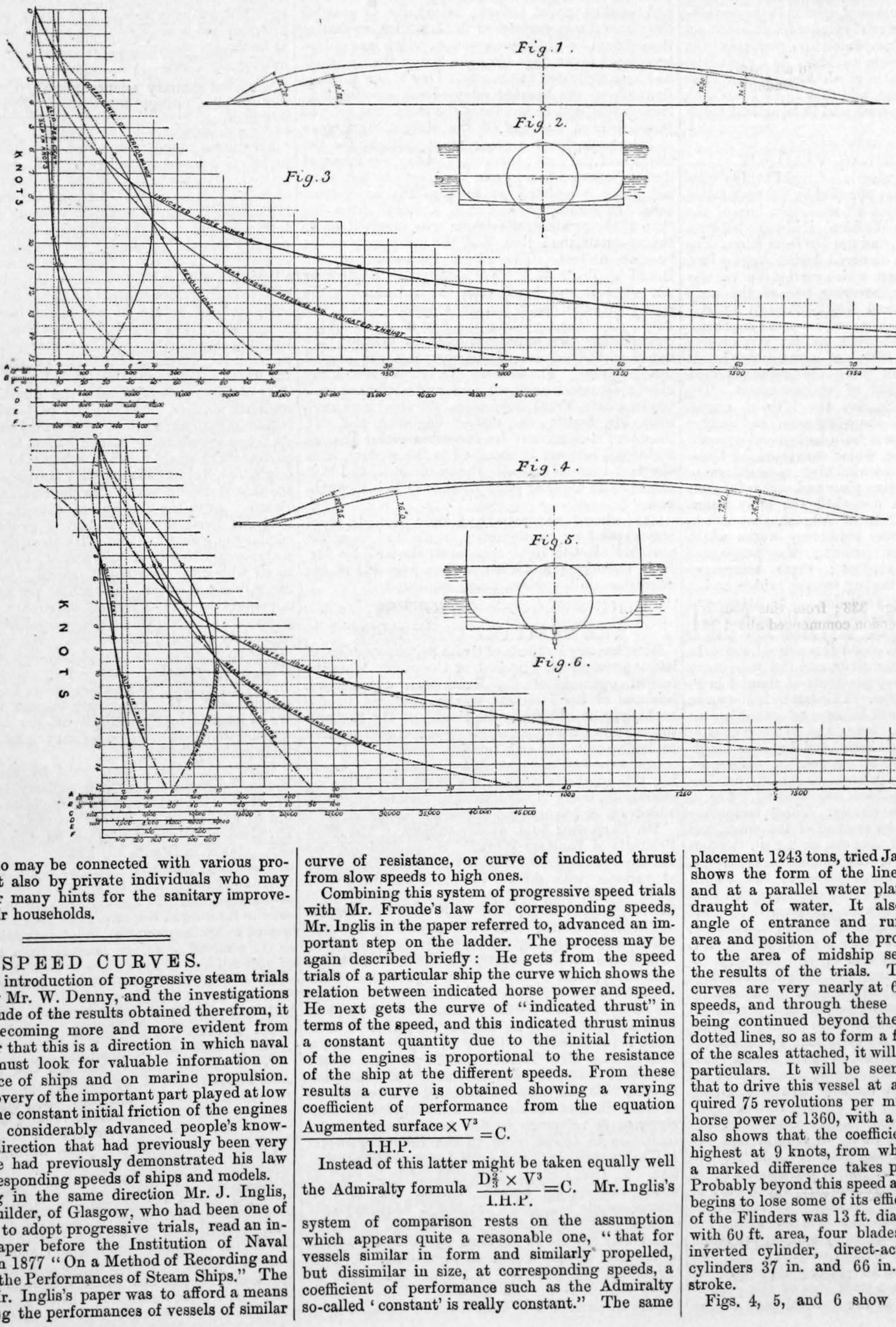


Fig. 1.

Fig. 2.

Fig. 3

Fig. 4.

Fig. 5.

Fig. 6.

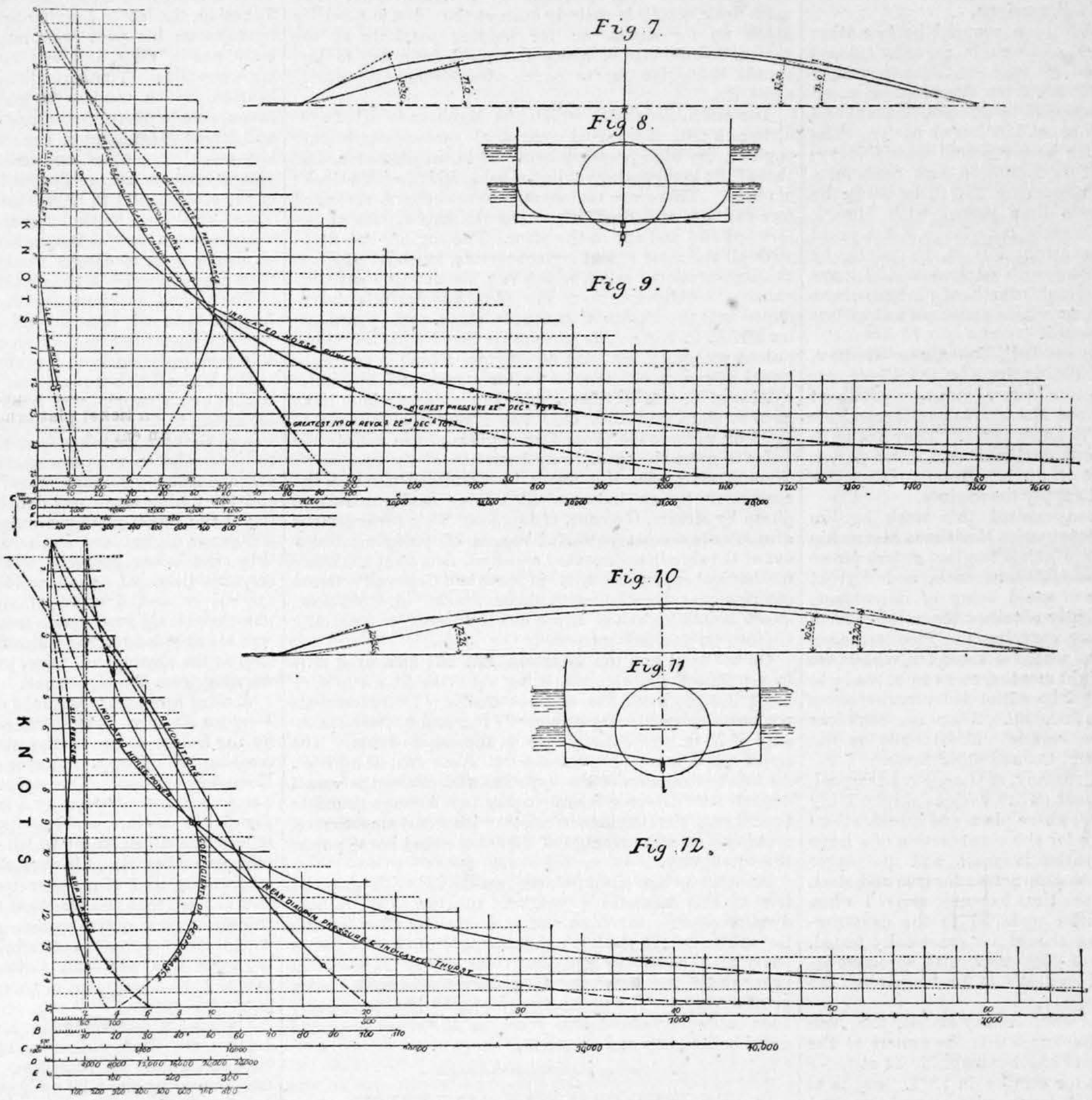
Azalea, a screw steamer of 706 tons gross register; dimensions 217.6 by 30.2 by 15.1, built in 1878, and tried September 28, 1878. The draught of water on trial was 11 ft. 7 in., and the displacement 1165. The diameter of screw propeller 13 ft., pitch 20 ft. and area 60 ft., four blades. Here also there are trials at four different speeds, viz., 5½, 8½, 11, and 13 knots. At this latter speed the propeller made 75 revolutions per minute, with 1325 indicated horse power, and 2¼ per cent. slip. In this vessel the coefficient of performance is a maximum at from 9½ to 10 knots, and a decided change takes place in the slip curve from the same cause probably as in the foregoing vessel. The engines were the same type as those of the Flinders' described above, the cylinders being 36 in. and 67 in. diameter, and 42. in stroke.

Figs. 7, 8, and 9 apply to the Bessbrook, a vessel of 511 tons gross register, and dimensions 182.0 by 27.2 by 14.0, built in 1877, and tried December 21, 1877. This vessel made 12¼ knots with 71 revolutions, 640 indicated horse power, and 1 per cent. of slip. The curve of coefficients in this case has its maximum between 9 and 9½ knots, from which point the slip curves also begin to rise more rapidly. The propeller was four-bladed, having 11 ft. 9 in. diameter, 18 ft. pitch, and 48½ square feet area. The engines were of the same type as those of the Azalea and Flinders, but the Bessbrook and Azalea had pumps worked direct from crosshead, whereas the Flinders and the Kinlock, mentioned below, had their pumps worked by levers. The cylinders of the Bessbrook were 32 in. and 58 in. diameter and 36 in. stroke.

Figs. 10, 11, and 12 refer to the Kinloch, a screw steamer of 425 tons gross register, and dimensions 205.0 by 24.1 by 12.7, built in 1878, and tested under steam July 4, 1878. The draught of water on trial was 9 ft. 11¾ in., and the displacement 668. The highest speed given is 13¾ knots, which was done with 87 revolutions per minute, and indicated horse power of 960, with a slip of 2 per cent. Here the curve of coefficients has its maximum at about 10 knots, and the curve of slip begins to rise rapidly. The propeller, as in the case of the Bessbrook, was four-bladed, with 11 ft. 9 in. diameter and 18 ft. stroke, and 48½ square feet area. The cylinders 29 in. and 54 in. diameter and 42 in. stroke.

The results of these trials taken together are most instructive, and afford valuable data for future vessels of nearly similar size and type, beyond their use for scientific purposes. The trial draught was, we believe, in each case nearly what the vessel was intended to work at.

In spite of the views expressed by Mr. Harland at the last meetings of the Institution of Naval Architects against measured mile trials, and the scientific and practically useful data derived therefrom, we fail to see how any sea trials can give us the measure of a ship's resistance, and the relation of power to speed so accurately, as trials like those we have described above. We go further, and say that without such trials a naval architect who has to design many ships of varying types is bound to work to a great extent in the dark, and must trust greatly to his luck, or allow a large margin on the safe side to cover eventualities. When ships follow each other in succession pretty much alike, of course certainty is easy enough, but this is no adequate reason for neglecting data which give a wider range of professional knowledge and safety.



CLYDE SHIPBUILDING CONTRACTS.

WE are glad to say that since the appearance of our former article on this subject three weeks ago there has been a very marked degree of activity in placing orders for the building of additional vessels, practically the whole of which are to be steamships, and ranging from 1000 tons or so upwards to about 4000 tons. The contract for the vessel formerly referred to as being tendered for on account of the State Line Steamship Company of Glasgow, has been placed with the London and Glasgow Shipbuilding and Engineering Company (Limited), the builders of all the other vessels in the company's fleet. She will be a full-powered vessel of about 4000 tons gross, measuring 385 ft. by 43 ft. by 34 ft., and having engines of 500 horse power nominal. Like the other vessels of the fleet, she is intended for the Glasgow and New York trade *viâ* Larne.

Messrs. John Elder and Co. have booked an order for two screw steamers, each 1500 tons, for the British and African Steam Navigation Company, of Glasgow and Liverpool. These vessels will each measure 290 ft. by 36 ft. by 18.3 ft., and they are to be built of steel.

At least two new steamers have recently been ordered for service in the passenger trade on the Clyde. One of them is being built by Messrs. D. and W. Henderson and Co., who have also laid down two new steamers for the Anchor Line, similar in all essential particulars to the Britannia which was recently completed by the same firm, and which has already done excellent service as a cargo steamer. The other river passenger steamer is to be a splendid saloon vessel measuring 206 ft. by 21 ft. by 8 ft., with engines of about 600 horse power, and having, it is expected, a speed of about 20 miles an hour. Like the Columba, she is to be built of steel, and is to run on the Helensburgh and Arrochar route in connexion with the North British Railway, and the famous circular tour established by the Loch Lomond and Loch Long Steamboat Company. This vessel is to be built by Mr. Robert Chambers, Jun., Dumbarton, and Messrs. M. Paul and Co., of the same town, are to supply the engines, the principal parts of which are also to be of steel.

The Clyde Shipping Company have just closed a contract with Messrs. William Simons and Co., London Works, Renfrew, for an iron steamer of 1000 tons, for their Glasgow, Irish, and South of England services. There was very keen competition for this contract, the tenders for which are said to have ranged from about 21,500*l.* to nearly 28,000*l.* In fitting out the vessel there will be an extraordinary variety of the newest machinery and other appliances for economising fuel and labour.

Messrs. Blackwood and Gordon, Port-Glasgow, have secured orders for three steamers of considerable size, one of which is a vessel of 1600 tons, and measuring 245 ft. by 32 ft. 6 in. by 18 ft., with engines of 140 horse power nominal supplied by the builders. She is intended for the copper ore trade, and her owners are Messrs. Henderson, of Belfast, and Moffat, of Androssan. The other two are to be built to the order of the Adriatic Steamship Company (Messrs. Burrell and Sons), Glasgow, their dimensions being 245 ft. by 32 ft. 6 in. by 18 ft. One of them will be built of iron, and will have a carrying capacity of 1600 tons, and steel will be the material of construction in the other, which will, it is expected, be able to carry 100 tons more than her sister ship. The owners are very much to be commended for thus attempt-

ing to solve the question of Iron *versus* Steel, so far as economy is concerned. Their experiment will be anxiously watched by other shipowners. Powerful compound engines will be employed in both cases.

Contracts for two new steamers of 2200 tons each, and measuring 320 ft. by 34 ft. by 26 ft., have just been placed with Messrs. Scott and Co., Cartsdyke, Greenock, by an eminent shipowning firm in Liverpool, namely, Messrs. Alfred Holt and Co. The vessels are intended for service in the Liverpool and China trade. We may here mention that in the shipbuilding yard formerly occupied by Mr. J. E. Scott, at Greenock, and lately taken over by Messrs. Russell and Co., Port-Glasgow, there are already two new vessels in progress; and Messrs. John Reid and Co., of the same town, have lately commenced to build a steel vessel of considerable dimensions.

New contracts have also been secured by two other Port-Glasgow firms. One of them is an order placed with Messrs. Murdoch and Murray by Glasgow owners for a steamer of 800 or 900 tons, for the Mediterranean trade, the engines to be supplied by Messrs. Kincaid and Donald, Greenock, and to be of 120 horse power. The other is an order which has been received from a Maryport firm by Messrs. William Hamilton and Sons for a barque of 900 tons, and measuring 210 ft. by 30 ft. by 16 ft. An order has also been placed with Messrs. Robert Steele and Co., Greenock, for a large steam yacht of about 600 tons, measuring 180 ft. by 26 ft. by 15 ft. 6 in., and to be fitted with engines of 120 horse power. She is for Mr. Houldsworth, of Coltness, who has done well to go to a firm whose eminence as builders of steam yachts in undisputed.

Messrs. Napier, Shanks, and Bell, Yoker, near Glasgow, one of the youngest shipbuilding firms on the Clyde, are about to lay down two iron screw steamers of about 900 tons each, to the order of Messrs. Robert Macandrew and Co., London, for the Spanish trade. They are to be fitted with engines of about 600 indicated horse power, working up to a pressure of 80 lb. Messrs. Dunsmuir and Jackson, Govan, will supply the engines.

Much interest has been excited this week by the announcement that the Messageries Maritimes Steamship Company, of Marseilles, are about to place orders for no fewer than ten steamers of 1600 tons each, and of great engine power, a high rate of speed being of importance, as the company have recently obtained the subsidy from the French Government for carrying the Mediterranean mails. It is stated that the whole of these ten vessels are to be delivered in about eight months, so as to be ready to begin the mail contract. The estimated contract price is understood to be about 500,000*l.* There is a confident expectation that all these vessels will be built on the Clyde, by Messrs. Elder and Co. and other firms.

The Allan Steamship Company, of Glasgow, Liverpool, and Montreal, have just sent out to various shipbuilding firms on the Clyde and elsewhere plans and specifications on which to invite tenders for the construction of a large steamer for their Transatlantic mail and passenger service. Tenders are to be alternative for iron and steel, it being considered that the time has now arrived when the applicability of the latter material to the construction of merchant steamers should be practically tested. The new steamer will be of 5500 tons, with accommodation for 200 passengers, and she is to be named the Parisian.

In confirmation of what we formerly stated, the *New York Nautical Gazette* announces that the owners of the Guion Line are about to add another magnificent steamer to their fleet, to be ready for service in 1881. She is to be 16 ft. longer than the Arizona, with more beam, and 37 ft. depth of hold, and is to be fitted with very powerful machinery. The order will doubtless be placed with Messrs. Elder and Co.

Various other vessels are being spoken of which will doubtless be contracted for very soon. The recent heavy rise in the price of iron, and the more recent advance of 2*l.* per ton for steel, have put shipowners on the alert who have been hesitating for some months. Four firms are already supplied with as much work as will keep them going busily till next summer; unfortunately, however, there are still several other yards that are almost empty. It is not too much to say that within the past four or five weeks orders have been placed on the Clyde for upwards of 40,000 tons of shipping.

TRIAL TRIP OF THE "MENDOZA."

On Friday last, the handsome screw steamer Mendoza, the latest addition to the magnificent fleet owned by the Pacific Steam Navigation Company, went on an experimental cruise down the Firth of Clyde, prior to being delivered over to the company at Liverpool. The Mendoza, a sister ship to the Pizarro, which was also handed over to the company a few weeks ago by the builders, Messrs. Robert Napier and Sons, Glasgow, is a vessel 340 ft. long by 40 ft. broad, and 21 ft. deep, with a load displacement of 3400 tons, and of 2519 tons builders' measurement. Her hull is constructed of mild steel, having an average tensile strain of 29 tons per square inch, and manufactured on the Siemens system by the Steel Company of Scotland. By the adoption of this superior material, the owners have not only got a vessel much stronger than an iron one, but one whose carrying capacity for coal and cargo is increased by nearly 200 tons. Being intended specially for the company's trade along the west coast of South America, between Callao and Valparaiso, the Mendoza has been constructed with an awning deck right fore and aft, on the top of which there is a range of deck-houses capable of affording most complete and comfortable accommodation for one hundred first-class passengers. Her saloon is a splendid and most spacious apartment, extending almost the whole breadth of the ship, and the tables and chairs are so fitted that passengers can be served at meals without the usual difficulty of passing dishes, &c., across to those who may be sitting at the sides of the saloon. The ladies' boudoir, state rooms, &c., are also roomy, and elegantly and comfortably furnished, while they are well adapted for a hot climate. The main deck, which is entirely open at the sides, is specially fitted up for cattle, or for holding markets at the various towns visited along the coast from day to day, stands being let out to parties travelling with provisions, &c.

The machinery with which the Mendoza is fitted consists of a pair of inverted compound surface condensing engines, the high pressure being 42 in. in diameter, and that of the low-pressure cylinder being 80 in., with a stroke of 48 in. There are two double-ended boilers, arranged fore and aft, and fired from two stokeholes, one at the forward end and one at the after. The engines are fitted with all the most recent improvements, amongst which is the high-pressure valve, which is a piston valve with expansion arrangement on the plan successfully introduced into the Pacific Company's ships some years ago by Mr. A. C. Kirk. The pistons are fitted with Buckley's patent packing; the starting engine, which is of exceptional power, is constructed on the steam and hydraulic system of Brown Brothers, and the arrangements have been so simplified that only two levers are required to start or reverse the propelling engines of the vessel. In order to meet the special requirements of the company's West Coast trade, the water is circulated through the condenser by an independent engine and centrifugal pump by Messrs. Gwynne, of London. This arrangement also affords a most powerful means of pumping water out of the ship in the event of accident. Amongst the other mechanical appliances there is Muir and Caldwell's steam steering gear, together with steam winches and windlass, steam hoists for ashes, and a large number of pumping engines for sanitary purposes.

On her trial trip the Mendoza ran the measured mile in 4 minutes 13½ seconds, being equal to 14.2 knots, or 16¼ miles per hour, the engines making 78 revolutions per minute, with a vacuum of 27 in., and a steam pressure of 70 lb. per square inch in the engine-room. The mean speed attained over several runs was 13.9 knots. At the termination of the experimental cruise the vessel departed for Liverpool, and during the passage round to the Mersey the engines worked with great smoothness, making a steady average of 2300 indicated horse power the whole way.

An interesting circumstance connected with the trial trip of this splendid vessel, was the use of a Gramme dynamo-electric machine and a Serrin for illuminating the saloon by the electric light during dinner, to which a party of about forty gentlemen sat down, all of whom pronounced the very novel experiment to have been a great success. The apparatus employed had previously been in use for about two years in Messrs. Napier and Sons' boiler-shop at Lancefield, Glasgow.

RECENT RAILWAY ACCIDENTS.

The Board of Trade has recently issued reports on several railway accidents. The first, we may notice, occurred on the 26th of July last on the Lancashire and Yorkshire Railway at Wigan. The nature of the accident was as follows: The 2.55 p.m. passenger train from Bolton to Rainford was standing at the down platform of the Wigan Station, when it was run into from behind by the 3.5 p.m. train of the London and North-Western Railway from Warrington to Southport. Thirteen passengers were injured, eleven being in the Lancashire and Yorkshire train, and two in the London and North-Western train. The rolling stock sustained very little damage. The junction between the two railways is at a point about 660 yards south of the Wigan Station, and to a distance of about 187 yards from the station there are four lines of rails, two up and two down, and the points of the junction are worked from the goods yard signal-box, about midway between the Wigan Junction signal-box and the centre of the station. The points at the north end of the junction and the up station signals are worked from the Southport Junction cabin which commands a view of the station, while the goods yard box does not. The down home signals are 322 yards south of the centre of the platform, and after passing them a train has to run about 150 yards before coming in view of the station, while at the time of the accident the presence of struts and shores supporting the station roof still further obscured the view, so that the driver of the London and North-Western train could not see the tail of the standing train till he was within 50 yards of it. The tender of the North-Western train was fitted with a hand brake, and the driver controlled a chain brake on the two front vehicles, while the guard operated a second chain brake applied to his van, and the two adjacent carriages in front. The line between the goods yard and the Southport cabins is worked on the block system with this modification, that when the latter has not given the former the signal "line clear," and it is desired to admit a second train into the station, this second train must be warned at the home signal to stop, or advance with caution. The Lancashire and Yorkshire train, which is timed to stop at Wigan for 20 minutes, is usually shunted to allow the other to pass, but on the occasion in question this was neglected, owing to the temporary absence of the station master, while the Southport Junction and the goods yard signalmen made, one or both, a mistake in working the telegraph, the former asserting that he allowed the North-Western train to pass, having received "line clear" from the Southport Junction, the latter denying this, and urging that such a mistake on his part was impossible, as the standing train was in view, and was not due to quit the station for some time. The unfortunate position of the Wigan Station, which renders it invisible from the south, is favourable to the occurrence of such accidents as this, and Major Marindin, in reporting on the case, suggests the establishment of an additional down signal to be placed between the goods yard cabin and the south end of the station, and to be worked from the Southport box. These would not be stop signals, but would intimate that a train was ahead at the station, and approaching trains on seeing them at danger would pull up under them, and then draw forward to the station.

The second accident, which occurred on the 15th of August upon the London and North-Western Railway, was of a somewhat similar character. In this case the 4.40 p.m. up train from Rugeley to Walsall was standing at the Walsall ticket platform, when it was run into from behind by an engine and tender, running tender first, belonging to the Midland Railway Company, and which was at the time running from the engine shed at Walsall to be coupled on to a passenger train. Sixteen passengers and one railway servant were injured by the collision, and the rolling stock was damaged. As the trains standing at the ticket platform are protected by a home signal 200 yards distant, and as there appeared no doubt that this signal was properly worked on the occasion, the responsibility of the accident rested entirely on the driver and fireman of the Midland engine. The passenger train was visible from the home signal, which was set at "danger," an intimation that the engine should stop at the signal, and then proceed cautiously after a warning from the signalman.

A third accident took place on the London and South-Western Railway on the 20th of August, and was caused by the failure of one of the approaches to a footbridge crossing the railway a quarter of a mile to the east of Hounslow Station. The approach in question is divided into two flights of steps by a landing, the lower flight is parallel to the line, and the upper is at right angles to it. It was this upper flight which gave way as nine women were ascending it. All were thrown to the ground and received injuries of more or less importance. Examination showed that the tenons of the string boards carrying the steps were quite rotten, and yielded beneath the weight of the persons ascending the staircase. In reporting upon this accident, Colonel Rich strongly recommends the employment of competent persons to inspect such structures.

On the 7th of September a collision occurred on the London and Blackwall branch of the Great Eastern Railway at Brunswick Junction, Blackwall. The collision was caused by the 8.30 up passenger train of the North London Railway going from Blackwall to Broad-street, which ran into a Great Eastern train (the 8.9 a.m. down passenger train) running from Fenchurch-street to Blackwall. At Brunswick Junction the up and down lines of the London and Blackwall Railway are worked as two single lines, the northern or down line being used by the North London trains, and the southern or up lines by the Great Eastern trains. This arrangement involves the necessity of the trains belonging to these companies crossing over on to their respective lines either on approaching or quitting Blackwall. For this purpose crossover roads are laid down and interlocked with the signals. The investigation showed that the driver of the North London train had, disregarding the signals, quitted the Blackwall station, and after proceeding about 100 yards observed the Great Eastern train approaching him. The distance between the two when the danger was noticed was about 200 yards, and the speed of the North London train 10 miles an hour. The driver of this latter used all endeavours to stop his train by the application of hand and chain brakes, while the driver of the Great Eastern train endeavoured to avoid a collision between the two engines by putting on steam. He was successful in this, but the North London engine struck the second and succeeding carriages of the other train. Major-General Hutchinson in reporting on the accident, while stating that it was evidently caused by the carelessness of the engine driver, points out that if the trains had been provided with efficient continuous brakes no collision could have occurred.

On the Great Northern Railway an accident occurred on the 16th of September, at Wortley East Junction, near Holbeck, on the Leeds and Wakefield section of the Great Northern Railway. In this instance the Great Northern 8.40 p.m. passenger train from Leeds to Wake-

field ran into an engine belonging to the Manchester, Sheffield, and Lincolnshire Railway, which was standing on the main line waiting to cross over to an engine shed on the other side of the down main line. The cause of this accident was very simple, the signalman at the Wortley East Junction signal-box, who had passed on the engine about ten minutes previously, forgot its being there, and let on the passenger train, which ran into it at about 20 miles an hour. But little damage was done either to train or passengers, only five having received small injuries. The train was fitted with the vacuum brake, which the driver omitted to apply, although under the circumstances, as Major Marindin very justly remarks, there would not "have been sufficient time for it to have taken effect in stopping the train before the collision occurred." But the tail lights of the standing engine could have been visible for 100 yards to the approaching train—plenty of time with a prompt brake to have arrested it before collision.

OUR FOREIGN IRON TRADE.

Fears are generally entertained lest the improved demand for iron on foreign account, which has given more animation to the iron trade during the past month than it has experienced for a long time, should only prove temporary. The fact that it is the sudden demand for the United States that is accredited with the present "spurt," does not strengthen confidence in its duration, for it is unquestionable that that country has superabundant mineral resources for the supply of its own requirements, and it has also works capable of smelting its own ores, not half the blast furnaces completed there having been in blast at the beginning of the present year. The absence of a corresponding increase in the demand for home consumption is also regarded as discouraging, aggravated as the stagnation of trade is here by the loss, estimated at not less than 25,000,000*l.*, caused by the bad harvest. But gloomy as these circumstances appear, the present revival of foreign demand for iron will appear in a brighter and truer light when we view it in relation to the history of our foreign iron trade during the past ten years. A correct survey of foreign requirements and home production during that period will illustrate the truth of Hallam's remark, that a calm, comprehensive study of (commercial) history, not in such scraps or fragments as the partisans of our ephemeral literature obtrude upon us, is the best antidote to extravagant apprehensions. Our long period of gloom and stagnation is apt to beget pessimist views; and it is in the early hours of sunrise that objects cast the deepest shadow. These influences are reflected in the present estimates of the condition of the iron trade; but a more comprehensive view of the situation can be obtained by taking a more extensive survey of the course of trade.

In respect of the quantity made at home and sold abroad, the iron trade of England reached its highest point in 1872. In that year we produced 6,741,929 tons of pig iron, being 114,000 tons more than the make of any year before or since then. Our exports for that year were also the greatest on record, namely, 3,382,762 tons, being over 200,000 tons more than those of any other year. It thus appears that when trade was most buoyant, we exported fully 50 per cent. of our total production of iron. Let us now compare this ratio with that of last year, when we made 6,381,051 tons of pig iron, and our exports amounted to 2,296,860 tons, or less than 36 per cent. This great contraction of foreign trade left our home market with a redundant supply. When everything was prosperous in 1872, we had only 3,359,167 tons of pig iron for home consumption, while last year, in the midst of prolonged depression, we had 4,084,191 tons to dispose of in the home market. In other words, between 1872 and 1878, the demand for English iron on foreign account decreased 32 per cent., and concurrently the supply (we can scarcely call it demand) for home consumption increased 21 per cent. Bearing in mind the fact that in 1872 we exported as much iron as we used for home requirements, it is obvious that if our home account had decreased at the same rate as our foreign trade, we should have made 53 per cent. less iron last year than we actually did make. Nor was last year the worst in respect of the balances between home and foreign account. The year 1876 shows the most unfavourable comparison of the last decade. We exported less iron that year than we ever did since 1868, and that, too, notwithstanding an unusually large production. The exact figures were: Production, 6,555,997 tons; exports, 2,224,470 tons; ratio, 34 per cent. The decrease in our exports between 1872 and 1876 was fully 34 per cent. We thus see that it is in our foreign trade where revival is really wanted, and where there is most room for expansion. The figures we have quoted also show that in existing circumstances, when the home market is over stocked, it is scarcely reasonable to expect that our own requirements will show the same elasticity as those of foreign countries. It will be in prices rather than in quantities that the home market will be affected. At the present time iron is selling at less than one-third of its average value for the year 1873; and it will be by the demand from abroad relieving us of our redundant supply at home that prices will rise. This tendency is already apparent. Stimulated by the receipt of some foreign orders, the price of pig iron has risen suddenly. The question of the day, then, is whether the present increase in foreign demand will continue; and the chief cause of misgiving on this point is the latent capabilities of the United States for supplying their own requirements; but an analysis of our exports for this year will tend to show that the present movement rests on a broader basis than is generally supposed. We find, for instance, that if we had not sent a single ton of pig iron to the United States this year, our foreign trade in that article would still show an increase of 11 per cent. over the corresponding period of last year; and if we extended the comparison to the two or three preceding years the increase would be greater. Then, again, as to steel rails, it appears that if we had not sent a single rail to the States this year, we would still have sent abroad 24 per cent. more than in the corresponding period of last year. It is necessary to bear in mind that our total exports last year showed a decrease of 32 per cent. as compared with the year of greatest exports—1872. All told, our exports during the first eight months of this year show an increase of about 10 per cent. over those of last year; and after the figures we have quoted with reference to the two principal articles of export to the United States, it need scarcely be pointed out that the present state of the market is not so dependent on orders from that country as is generally supposed. Of course, the quantities already sent there may be no real indication of the orders received and now being executed here, but whatever may be the amount of the orders in hand from America, it is none the less an indisputable fact that our exports show a real and wide-spread revival in the foreign demand for English iron. That demand has been greatest during the last two months; and accordingly we find that our exports for September exceeded those for August last year by 21 per cent. in quantity and 7 per cent. in value. So far this year our largest customers, Germany, Holland, and "other countries," have received larger quantities than they did during the previous three or four years; but last month shows a decrease in shipments to Germany and Holland, due in part, no doubt, to the prohibitive operation of the new tariff in the German market.

A careful examination of the statistics of the iron trade discloses two facts of much significance. The first is the maintenance of the production. In some of our iron manufacturing districts one-half of the furnaces have not been in blast during the last two or three years of depression, and even a few weeks since thirty more furnaces were blown out in Scotland. Still, the total make of pig iron might be said on the whole not to have been below the average of the years of greatest production. If we compare the total production last year with that of 1872, which has never been equalled, we find that last year there was only a decrease of $5\frac{1}{4}$ per cent. If the demand for iron on foreign account continues to improve, English manufacturers will be ready to supply all present requirements; and undiminished as the present production is, it can be greatly augmented by putting idle furnaces in blast. Another significant feature of the present course of the trade is the periodic nature of its recurrence. It is to point out a fact, not a theory, that we call attention to the striking analogy between the present state of trade and its condition ten years ago. Then, as now, our exports were lower than usual in proportion to our production; then, as now, prices were at the lowest point known in course of the decade. It is true that neither prices nor exports stood at such low rates as are current now; but ten years ago the price of iron was at the lowest point it had reached since the trade assumed the dimensions of a leading industry. Then, too, as now, there was a gradual revival in the trade, which reached its highest point in respect of quantity in 1872 and in respect of value in 1873. We know that the English commercial mind distrusts theories; indeed, as Hegel observed, it likes to pride itself in acting contrary to theories, or in showing that experience contradicts theory. Nevertheless, it is no use shutting our eyes to facts; and although the facts to which we call attention are so embedded in the voluminous statistics of our commercial history as to be easily overlooked, their truth is unquestionable; and not only their ratios but their correlations have an important significance at the present critical period in the iron trade.

NOTES FROM CLEVELAND AND THE NORTHERN COUNTIES.

Middlesbrough, Wednesday.

The Cleveland Iron Market.—Yesterday there was a smaller attendance, and the prices were similar to those of last week. While needy merchants who had some iron left which they had bought on the rising market were willing to sell at 41s. per ton, pig makers continue to nominally ask 45s. for No. 3. All the makers are well sold forward. It is calculated that there is an average of fully four months work in hand.

The Finished Iron Trade.—There is rather more inquiry for finished iron, and prices are a little better. The fact that large shipbuilding orders have recently been booked on the Clyde and Tyne, have improved the prospects of plate makers.

Cleveland Steel Making.—Messrs. Bolckow, Vaughan, and Co. are having two large Bessemer converters and steel making appliances made at a cost of 10,000*l.* for their Eston steel works. It has been found, as was stated by Mr. Richards at the Liverpool meeting of the Iron and Steel Institute, that the converters choked up with Cleveland steel at the mouth. The new converters are differently shaped, and will not "gob" as the others have done.

The West Hartlepool Furnaces.—It has been decided to offer for sale the West Hartlepool Iron Works, including the three blast furnaces which have been so long standing idle.

The Wages Disputes.—Beyond what is stated in the newspapers as to the position of the several wages' questions in the North, it may be stated that it is expected the miners of Cleveland will agree to arbitration, and that the blast furnace men will settle their differences by the adoption of a sliding scale.

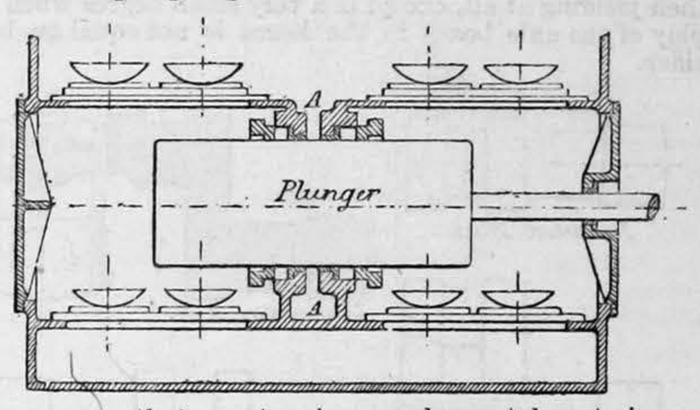
AIR PUMPS.

To the Editor of Engineering.

Sir,—A very general prejudice exists among engineers against horizontal air pumps in surface condensers, where the quantity of water passing through the pump is small, and they are seldom fitted when a vertical arrangement is possible.

Experience has shown that a good result can generally be obtained with a vertical air pump, while with a horizontal pump uncertainty is felt as to its performance. Hitherto I believe with horizontal pumps the best results have been most easily obtained with the plunger arrangement and a careful distribution of valves, but I never have seen the proposal which I enclose put into practice.

The suggestion is to surround the stuffing-box with water in such a manner as to render an air leak there impossible; and assuming the valves to be also well protected in the same way, it appears likely that a pump as efficient as a vertical pump might be obtained.



I am aware that great pains are always taken to insure plenty of water over the valves, but the plunger stuffing-box is left to its own resources, and it is evident that when the water level in the pump chamber falls below the top of plunger, all the exposed part of stuffing-box is open to a direct air leak unless water on the opposite side of the pump mounts high enough to stop it. I should like to submit the matter for the opinions of your readers, and shall be glad to hear whether such an idea has ever been carried out, and with what results?

Yours faithfully,
Duplex.

COMPOUND LOCOMOTIVES.

To the Editor of Engineering.

Sir,—In your issues of the 4th and 18th of July there appears a paper read before the Institute of Mechanical Engineers by M. Anatole Mallet, of Paris, "On the Compounding of Locomotive Engines." This paper is of great interest, and I consider the public are much indebted to the author for the trouble he has taken to elucidate and prove the benefit of the system, which I am glad to observe is now beginning to be used on railways as it is in portable and stationary engines.

I have for years been in favour of this system for steam launches and also for portable and factory engines where a full supply of water is unobtainable, as appears from my letter dated 7th of January, 1876, which appeared in *The Engineer* on the 18th of February, and also that of June, 1876, which appeared in your journal on the 4th of August, 1876. I observe from Mr. Mallet's table that the ratios between the two cylinders vary from 2.78 to 1.86, while he works with steam at 130 lb. pressure above the atmosphere. I am of opinion that if M. Mallet would increase the ratios between the high and low-pressure cylinders, say, 4 to 1, and use steam at the pressure mentioned above, he would work with greater economy and get a better result. I may mention that I have fitted this description of engine into five steamers varying from 62 ft. to 120 ft. long, all of which have given satisfaction in their working, while the consumption of coal is little more than half what it would be with the ordinary high-pressure engines; the ratio between the cylinders varies from 3 and 4 to 1. I also notice in your issue of the 27th of June the report and particulars of a trial of a portable engine made by Messrs. John Fowler and Company, of Leeds, on the compound and non-condensing system; the small consumption of coal required for this engine will, I have no doubt, induce others to try the same principle. Some people condemn the compound engines as being complicated and requiring more attention in working; this, however, is altogether a delusion, for the compound engine as above described is quite as simple in its working as any two cylinder high-pressure engine, while the results in the shape of coal saved at the end of twelve months will show a balance in favour of the compound engine almost sufficient to pay for it. These engines are now being introduced into the tea districts of India, and are giving general satisfaction. I shall be glad if you can give this letter a place in your paper—it may amuse some if it is not interesting.

Yours faithfully,
Calcutta, September 2, 1879. G. Scott.

LOCOMOTIVE CRANK AXLES.

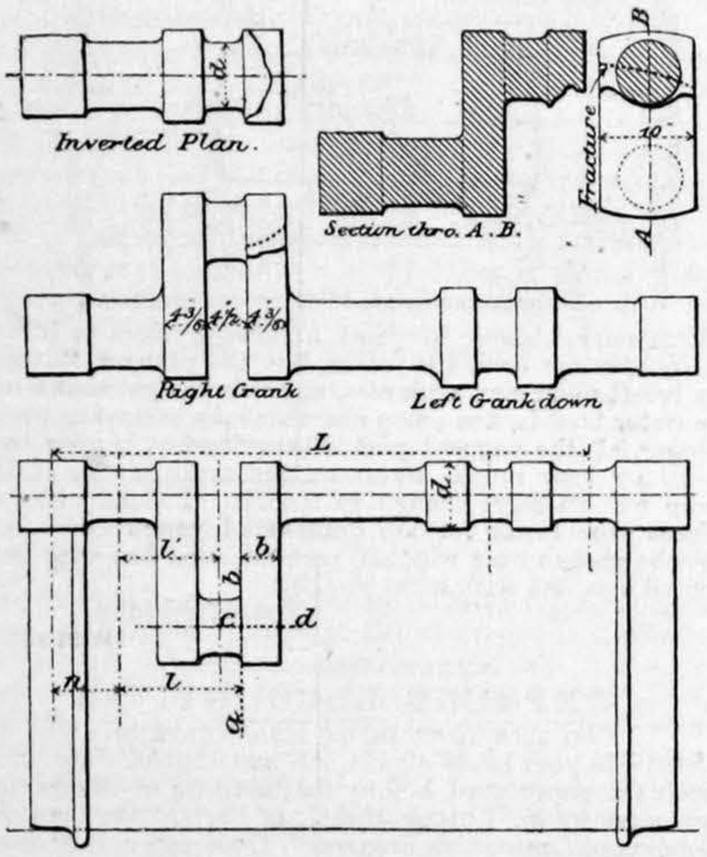
To the Editor of Engineering.

Sir,—In your issue of the 10th inst. an article appears under the above heading by J. J. Birckel.

In it he attempts an explanation of the causes of the failure of locomotive crank axles, and advances a theory based on assumptions which cannot possibly obtain in practice, and which even if true will not account for the failures as they invariably occur, all his reasoning applying with greatest force to the outside web of the crank, whereas it is the inside web of the crank which is most severely strained, as I shall presently show.

In the first place, assuming Mr. Birckel's analysis to be correct, his proposed remedy of lightening the crank-webs for the purpose of taking up the shock due to the lateral displacement of the wheels would be quite as absurd as the lightening of bearing springs suited to a good road to enable them to withstand the additional strain when the engine is changed to an old rough road. A practice which I doubt whether even Mr. Birckel would recommend.

But Mr. Birckel's assumption that the lateral movement of the wheels and axle is arrested by the flexion of the crank-webs is quite untenable, for, in order that it should be so when, as he assumes, the wheels and axle have bodily acquired a sidelong motion, it is necessary that the crank-pin be a fixed point. Now, this can only be if it is rigidly held to the slide bars by the connecting rod, and when we consider the length of this rod, and its small section compared with the crank-webs, also the play of the big and little end bearings and the play of the slide blocks in the bars, it must be plain that this freedom of bearings and the spring of the connecting rod will allow the axle and boxes to move home in the horn-blocks, and thus throw the strain on the frames long before there is any strain worth speaking of on the crank-webs, or any necessity for their yielding at all, except in a very small degree when the play of the axle boxes in the horns is not equal on both sides.



Again, if the big and little end bearings be so tight, and the connecting rod so rigid that it will not spring as easily as the crank-webs (as Mr. Birckel must assume in order to get his fixed crank-pin), the momentum of each wheel, and the portion of the axle between it and the nearest crank, will all be taken up by the outside web of that crank, and the comparatively small momentum of the axle between the cranks will be divided between the two inside webs; how is it, then, I would ask Mr. Birckel, that the inside web is the one that breaks?

Again, the supposed sidelong stress will produce a uniform bending moment in the crank-arm, which will strain the material as severely near the axle as at the crank-pin; and the bending moment due to the cylinder pressure will of course be a maximum close to the axle, diminishing to nothing at the pin.

The other stresses considered by Mr. Birckel, it is easily seen, produce a uniform strain on the web, and hence the sum of these strains is greatest close to the axle, why, then, I would ask Mr. Birckel, does the axle give at the pin where the strain is smallest?

And still again, if it be, as stated, the sidelong stress which ruptures the material, how is it that the fracture invariably commences on the inside of the web near the pin where the material is in compression due to that stress?

Thus much for Mr. Birckel's theory, and it still remains to show the real cause of fracture.

Let us now consider the strains on the crank-webs when they are in a horizontal position, instead of, as he does, in the vertical.

Referring to the sketch, it is clear (*à priori*) that the part of the crank *b* is that which is most severely strained, as it is there that fracture always commences.

An instance of this has occurred in my own experience during the past week, the fracture being as shown in the sketch, where the shading shows the partial fracture which had been some time existing before complete rupture took place. It is then to the strains at this point that I would direct attention.

Firstly, consider the section *a b*. We have:

1. A torsion due to the cylinder pressure on the other crank.
2. A bending stress due to the same cylinder pressure.
3. A bending stress due to the live load.
4. A shear due to the pressure in its own cylinder.

The first of these arises in this way. The cylinder whose crank is vertical is doing all the work for the moment while it is in that position, and it can easily be shown that when the engine is exerting its greatest power that half of this must pass through the axle to each wheel. This of course produces a torsion in the body of the axle between the cranks, but it also produces a torsion upon the pin, the strains on which we are considering, acting with a leverage equal to twice the length of the crank-arm; and it also produces a bending stress of the same moment on the inside crank-arm at the section *c d*.

The second and third stresses require no explanation.

With regard to the fourth, I may mention that immediately on, or even before, the cranks attaining the horizontal position, the full pressure of steam is on the piston, and this will produce a shear on the crank-pin before the other stresses cease to act.

Let us take an example:

The unit stress on section *a b* will be

$$F = \frac{P R}{.196\,2 r^3} + \frac{P l l' r}{L I} + \frac{W r n}{I} + \frac{P}{2 \pi r^2}$$

In which P = total pressure on piston.
W = load on one wheel.
I = moment of inertia of the section *a b*.
R = length of crank-arm.
r = radius of crank-pin.
b and *d* = thickness and width of crank-arm.

If this is worked out for a cylinder 18 in. by 24 in.; pressure 150 lb. per square inch; load on drivers = 10 tons; and 7 in. journal, it will be found that F = 13,050 lb., or, say, 6 tons, a stress which does not allow of a very large factor of safety considering the shocks, vibrations, and consequent deterioration to which these axles are subject in practice.

Secondly, consider section *c d*. The principal stresses are:

1. The bending stress, mentioned above, due to the cylinder pressure on the other crank.
2. A torsional stress due to the live load.

Which give a total stress per square inch,

$$F = \frac{6 P R}{b d^2} + \frac{W n}{.28 d b^2}.$$

If this be worked out as in the first case it will give a strain of about 6300 lb. per square inch.

This is the greatest strain upon the crank-arm in any position of the crank, and it will be noticed that it amounts to only about one-half the strain on the crank-pin, and would of itself be quite insufficient to cause rupture.

Now, in my opinion, fracture takes place in the following way:

There is a point where the two sections, which we have been considering, meet, and the stresses on these sections are to some extent superposed at this point, and here a fracture will commence, and gradually spread, generally in the direction shown in the sketch, viz., at an angle of about 45 deg. to crank-pin and arm.

This crack will not materially lessen the strength of the crank-pin till it has advanced about half through the arm; for the section of the pin may be supposed to have advanced with the crack, and not to have lost in area. When the crack has reached this point, the moment of resistance of the arm will be about half of what it originally was, so that the unit strain upon it now will be equal to that upon the crank-pin, which renders it a matter of uncertainty in which direction the crack will proceed, whether across the arm, as in sketch, or the pin twist out as in a ball-and-socket joint.

This will also account for a crank running for a very considerable time after a crack has first appeared.

The remedy then which I would propose, so far from being a lightening of the cranks at their weakest point as proposed by Mr. Birckel, would be to enlarge the pin, most particularly at its junction with the crank-arm.

Much more might be said in support of this view, but space will hardly admit of it.

I am, Sir, yours truly,
J. Patterson, Jun.

44, Victoria-street, Dublin, Oct. 20, 1879.

THE HALIFAX BOILER EXPLOSION.

(*For Description, see Page* 342.)

Fig. 1.

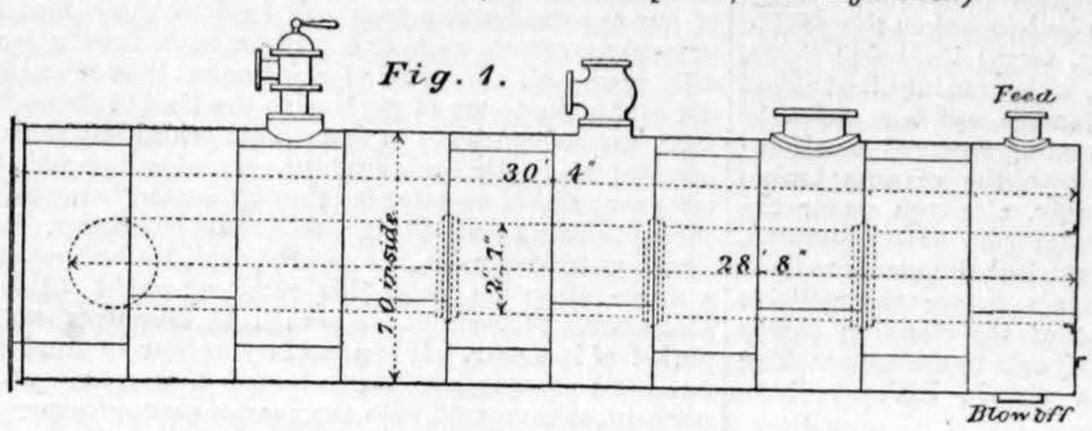


Fig. 2.

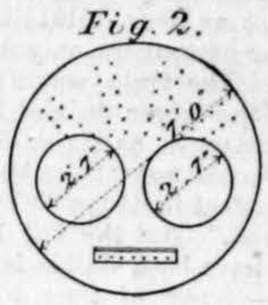


Fig. 3.

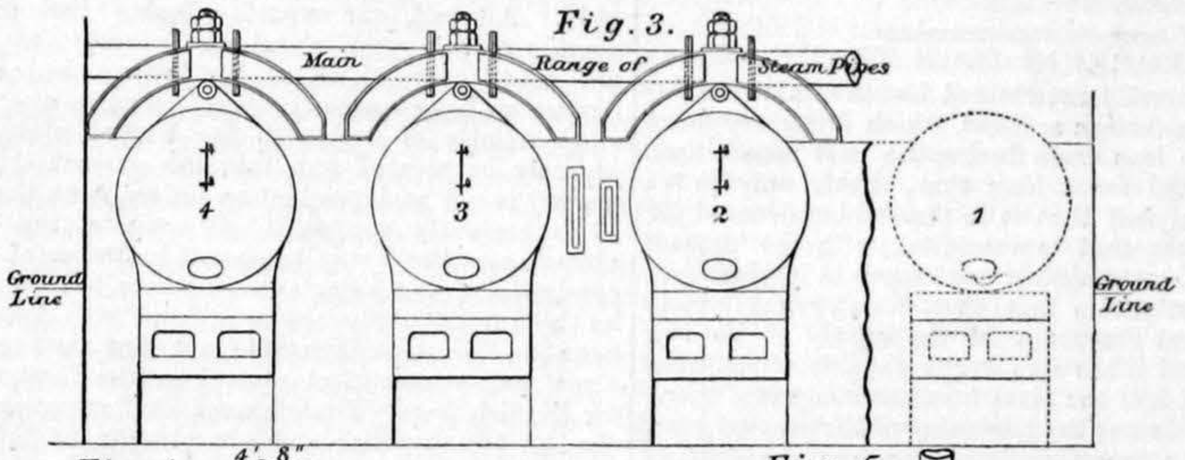


Fig. 4. 4'-8"

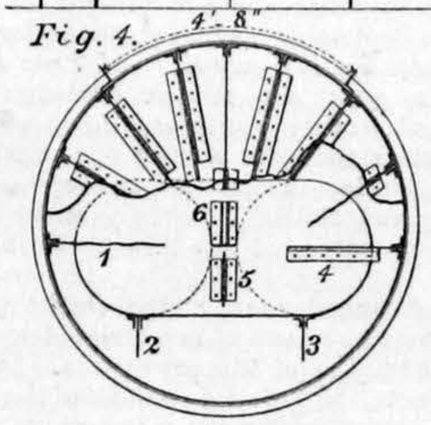


Fig. 5.

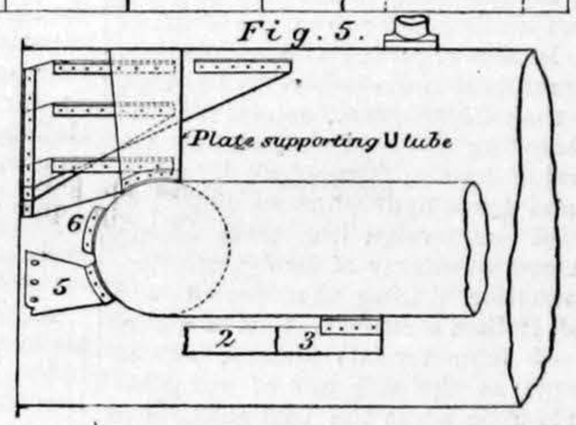


Fig. 6.

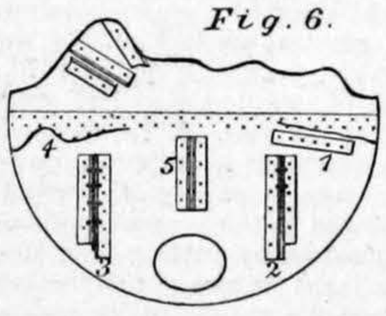
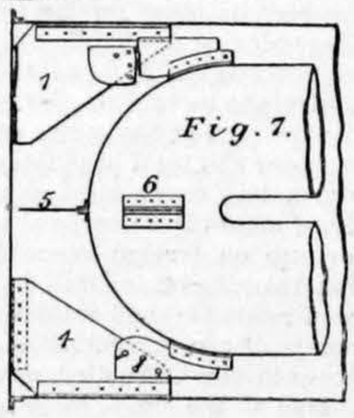


Fig. 7.



STEEL FORGINGS.

To the Editor of Engineering.

Sir,—I regret to find that by an inadvertence I stated in my letter of the 8th inst., that the article referring to my patent appeared in your paper of January 4, 1878. It appeared in *The Engineer* of that date.

Will you kindly insert this explanation in your issue of this week, and oblige

Yours truly,
W. H. Carmont.

The Cyclops Iron Company, Limited, Openshaw, Manchester, 1879.

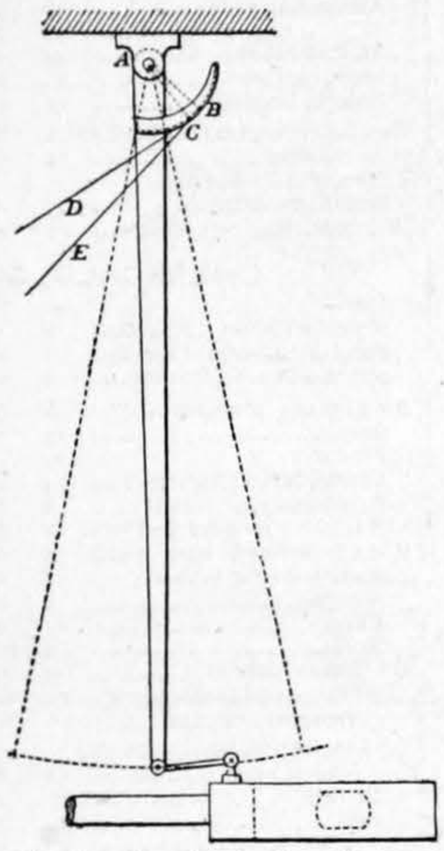
Queensland Coal.—Mr. A. C. Gregory, geological surveyor of Southtown, Queensland, is carrying on a series of experiments with the coal from different Queensland coal pits, and with various sorts of colonial wood, with the object of testing how much water a given quantity of coal or wood can convert into steam of a given pressure, so as to ascertain the economic value of these commodities for fuel. The results, so far, are highly favourable to Queensland, as against New South Wales coal.

GIVING MOTION TO INDICATORS.

TO THE EDITOR OF ENGINEERING.

SIR,—I desire, with your kind permission, to communicate to the profession, through your columns, an elegant improvement in the method of giving motion to the paper drum of the indicator.

The accompanying illustration will make it sufficiently clear. The old-fashioned way has been to lead the cord parallel with the piston motion to a pulley. This pulley has, for various reasons, been a cause of annoyance, especially at high speeds, but although I have probably been worried by it as much as any one, it never occurred to me to try to dispense with it. At the Centennial, Mr. George J. Wardwell, of Rutland, Vermont, exhibited a valveless engine, and on it I found an arrangement for giving motion to the indicator drum that filled me with admiration, not wholly unmixed with mortification, that I had never thought of so obvious a thing myself.



He attached to the vibrating lath a short arm, in which to set a pin, at B for example, if the cord was to be taken in the direction B C, or at C for the direction C D. Of course, I have not used a pulley since then. It was, however, necessary always to make several measurements and prepare a diagram showing the direction of the cord, in order to get the correct position of the pin, and for two different positions of the indicator to have two pins and two cords.

Lately, in preparing to indicate an engine at the works of the Cambria Iron Company, a workman whose name I wish to give, Samuel A. Brumbaugh, after receiving my directions for a rig such as above described, asked, "Why not bolt on the lath a segment of a circle, with a groove turned in the edge, secure your cord at the end, and you can lead it away in any direction you like, it will always leave the circle at the right point, and you will have no measuring to do?"

I did not hesitate to adopt the suggestion. By turning a broad groove the string always falls in it, and nothing can work more admirably. Very truly yours,

CHARLES T. PORTER.

Newark, N.J., September 26, 1879.

[We willingly insert Mr. Porter's letter, for if the method of giving motion to indicators which he describes is new to him it will certainly be new to a large number of our readers. At the same time it is not really novel. We ourselves schemed the same arrangement for our own use some years ago, and we have found it a convenient one in many cases. We believe it has also been used by others, although it is not as well known as it should be.—ED. E.]

HYDRAULIC COMPRESSORS FOR GUN CARRIAGES.*

Description of the Compressors on the Krupp, Rendel, and Vavasseur Systems.

(*Continued from page* 318.)

WE have said that the coefficient of friction of iron on iron is very variable; this is shown from very numerous experiments made by Mr. Butler at Woolwich Arsenal in order to determine the best materials (whether wood, metals, or a combination of both) for the construction of the plate compressor. In these experiments the mode of action of the compressor was followed as closely as possible, and the plates that were tried were made to slide between other plates.

The sum of the experiments proves that constant results could not be obtained, no matter what the materials tried, and it is consequently impossible to determine therefrom exactly the values of the coefficients of friction.

That which here particularly interests us is as to the behaviour of wrought iron sliding upon wrought iron, since this is the only metal now used for plate compressors; we shall give, therefore, only those coefficients which relate thereto.

In that which immediately follows the coefficients of friction are calculated for one entire plate, that is for two rubbing surfaces; it will, therefore, be necessary to take the half of these figures if it be desired to compare them with those of other experimentalists.

The experiments have been divided into five series, and the following is a summary of the results obtained:

* From the *Revue d'Artillerie*.

First Series.—Effect of the Extent of the Surfaces in Contact.

Surfaces in Contact.	Pressure. Total.	Pressure. Per Square Inch.	Coefficient of Friction during Motion.	Remarks.
sq. in.	lb.	lb.		
64	2240	35	.650	Very irregular and jerky.
32	,,	70	.481	,, ,,
16	,,	140	.480	,, ,,
4	,,	560	.568	,, ,,

Second Series.—Effect of Variation in Pressure.

Surfaces in Contact.	Pressure. Total.	Pressure. Per Square Inch.	Coefficient of Friction during Motion. Surfaced Iron through Surfaced Iron.	Coefficient of Friction during Motion. Ground Iron through Ground Iron.
sq. in.	lb.	lb.		
32	1120	35	.418	.446
,,	1680	52.5	.403	.438
,,	2240	70	.425	.426
,,	2800	87.5	.533	.423
,,	3360	105	.573	.379
,,	3920	122.5	.568	.319
,,	4480	140	.546	.322
,,	5040	157.5	.543	.321
,,	5600	175	.535	.299
Means			.505	.375

Third Series.—Effect of the Number of Plates.

Surfaces in Contact.	Number of Plates.	Pressure. Total.	Pressure. Per Square Inch.	Coefficient of Friction during Motion. Surfaced Iron through Surfaced Iron.	Coefficient of Friction during Motion. Ground iron through ground Iron.
sq. in.		lb.	lb.		
32	1	1120	35	.590	.887
,,	2	,,	,,	.430	.918
,,	3	,,	,,	.412	1.110
,,	4	,,	,,	.336	1.140
,,	5	,,	,,	.276	
Means				.408	1.014

Fourth Series.—Effect of Motion.

Surfaces in Contact.	Pressure. Total.	Pressure. Per Square Inch.	Coefficient of Friction at Starting. Surfaced Iron through Surfaced Iron.	Coefficient of Friction at Starting. Ground Iron through ground Iron.
sq. in.	lb.	lb.		
32	1120	35	.390	1.303
,,	1680	52.5	.394	
,,	2240	70	.560	1.137
,,	2800	87.5	.440	
,,	3360	105.	.467	.941
,,	3920	122.5	.473	
,,	4480	140	.453	.675
,,	5040	175	...	.711
Means			.454	.953

FIFTH SERIES.—EFFECT OF SPEED AND OF WEAR, SURFACES IN CONTACT 32 SQUARE INCHES.

Total Pressure.	—		—		—		—		—		Means.
Number of Experiment ...	1.	10.	4.	7.	3.	8.	5.	6.	2.	9.	
Speed per Minuute.											
3 in.	.317	...	...	...	...	...	...	...	.347	.541	.402
5 ,,	.321	...	...	...	...	...	...	...	.472	.588	.460
10 ,,	.326	.476	...	...	...	...	...	...	.385	...	.396
15 ,,	.366	...	...	...	.416	.677	...	...	...	.598	.513
20 ,,	.410	...	.534	.567	.418	.612	.454	.522	...	.497	.502

We have given all these figures in order to prove that no control can be exercised over the co-efficient of friction; consequently, it appears difficult to arrange, at will and with certainty, the resistance of the plate compressor so as to avoid blows; if it cannot be improved it will be advantageous to abandon it and replace it by the hydraulic compressor, which appears much more adaptable to the requirements of both land and sea service.

Hydraulic Compressors.—The hydraulic compressor, the first conception of which originated with Dr. C. W. Siemens, consists of a cylinder filled with suitable liquid, and fixed to the slide. In this cylinder works a piston pierced with holes, the piston rod being attached to the gun-carriage. The resistance which the liquid offers to the motion of the piston, and consequently to that of the carriage, limits the recoil.

Such is the hydraulic compressor (or buffer) adopted by the English Government for several years past, for all heavy garrison carriages, and also for several naval carriages in conjunction with the plate compressor.

This compressor has many advantages; it is very simple, it does not offer resistance to the first motion of the carriage at the commencement of recoil, and is completely automatic, that is, ready to act without being touched; it does not hinder the motion of the carriage while manœuvring; the same compressor will suit carriages of various sizes by simply altering the size of the holes in the piston. To compensate for the volume of the piston rod which passes in and out of the cylinder, it is necessary to leave a certain air space in the latter; this combination of liquid and air is a cause of irregularity.

To employ this hydraulic compressor for naval carriages, it is necessary to add to it a plate compressor, as the former will not serve to regulate the movement of the carriage when the ship is rolling.

The greatest inconvenience of this compressor is that it offers a considerable resistance when the carriage attains its maximum velocity of recoil; its resistance then decreases rapidly; on this account it strains the material considerably, although it does not act by jerks like the plate compressor.

This great resistance at the commencement of the motion considerably increases the couple tending to turn over the carriage, of which mention has been previously made, and accidents may arise from this cause. Thus, when the 38-ton gun is fired on its casemate carriage, this couple is sufficient to lift up the carriage, which, through the holding down clips, lifts the platform as well, the whole system turns against the rear rollers of the platform, and then falls down again violently on the front racer.

Means have been sought to correct this radical defect and to obtain during recoil either a uniform or a progressive resistance. To do this, either the sizes of the holes may be made to vary, or there are constant orifices closed by valves loaded by a weight either constant or variable, which the liquid must lift in order to pass.

Before giving details of the improvements made in the hydraulic compressor, we will first give the theory of these compressors, which will enable us to appreciate with more certainty the advantages and disadvantages of each system.

(*To be continued.*)

THE MISSISSIPPI.—Contracts have recently been signed for the construction of several fast mail steamers to ply on the Mississippi between St. Louis and New Orleans. It is probable that the former city furnishes the capital for building these steamers, and the near future is likely to afford abundant opportunity for further investments of a similar character, if Captain Eads' work at the mouth of the Mississippi has, as is claimed, supplied a permanent channel deep enough for the largest vessels engaged in ocean commerce. Should one or more lines of steamers be established between New Orleans and Liverpool, as is fondly predicted by the friends of the jetties scheme, St. Louis would gain immensely in commercial importance. She ought to become the great central distributing point of the west of the United States for foreign imports, and if her merchants are enterprising, she will not allow that substantial honour to escape her.

PRICE LIST OF MATERIALS.

Thursday, Oct. 30, 1879.

METALS.

	£ s.	£ s.
Antimony Ore (per ton)—		
Regulus (star)	64 0	65 0
Brass (per lb.)—	s. d.	s. d.
Sheets, 48×24	0 7¾	0 8
Yellow metal	0 6½	0 6¾
Castings Tyne and Cleveland (per ton)	£ s.	£ s.
Girders	5 0	6 0
Chairs	3 0	3 10
Pipes	4 10	6 0
Copper (per ton)—		
Chili bars	66 0	66 15
Australian	72 0	74 10
English tough, best	72 0	74 0
,, ingots	71 0	72 0
Sheets, &c.	77 0	78 0
Bottoms	80 0	81 0
Iron Ores (per ton)—	s. d.	s. d.
Red hematite, blast	14 0	14 6
,, ,, puddling	12 0	13 0
Iron Pig (per ton)—		
Barrow No. 1	70 0	72 0
,, ,, 2	63 0	70 0
,, ,, 3	67 0	69 0
Cleveland No. 1	47 0	48 0
,, ,, 3	40 0	41 0
,, ,, 4 (Forge)	40 0	41 0
Foundry	39 0	40 0
Welsh (South Wales)	65 0	80 0
,, (North Wales)	60 0	72 0

Scotch Pig—	No. 1. s. d.	No. 3. s. d.
G.m.b., at Glasgow	56 0	52 0
Gartsherrie	60 0	55 0
Coltness	62 6	56 0
Summerlee	60 0	55 0
Langloan	60 0	55 0
Carnbroe	60 0	55 0
Monkland	56 0	52 0
Clyde	57 6	52 6
Govan, at Broomielaw	56 0	52 0
Calder, at Port Dundas	60 0	55 0
Glengarnock, at Ardrossan	61 0	54 6
Eglinton, ditto	56 0	52 6
Dalmellington, ditto	56 0	52 6
Carron, at Grangemouth	60 0	57 6
Ditto, specially selected	65 0	—
Shotts, at Leith	60 0	55 0

(The above all deliverable alongside).

	s. d.	s. d.
Shropshire	60 0	90 0
North Staffordshire	45 0	80 0
South ,,	75 0	80 0
Yorkshire Thornaby pig No. 3	60 0	62 0

Iron, Wrought—	£ s.	£ s.
Cleveland angles	6 5	6 7
,, bars	6 5	6 7
,, puddled bars	4 15	5 2
,, boiler plates	7 0	8 0
,, rails	6 0	6 5
,, ship plates	6 10	6 15
,, sheets	7 10	9 10
,, hoops	7 10	9 10
Scotch bars	5 5	6 10
,, nail rods	6 10	7 10
Staffordshire bars	6 0	8 10
,, plates	7 0	11 0
,, boiler	8 0	11 10
,, hoops	6 10	7 10
Welsh rails S.W.	6 0	6 5
,, bars ,,	6 0	6 15
,, boiler plates, S.W.	9 0	12 0
,, hoops, S.W.	7 10	8 10
Lead (per ton)—		
Soft English pig	17 0	17 5
,, ,, W.B.	00 0	00 0
Spanish	16 17	17 0
Sheet	17 0	18 0
Phosphor Bronze— (per ton)	110 0	130 0
Quicksilver (per bottle)	7 10	8 0
Scrap (per ton)	4 0	4 10
Spelter (per ton)—		
Silesian, ordinary	19 5	19 7
Spiegeleisen (per ton)—		
Best	6 0	0 0
Common	5 3	0 0
Steel (per ton)—		
Best cast	34 0	50 0
,, double shear	45 0	65 0
,, single ,,	32 0	50 0
English spring	14 0	22 0
Blister	00 0	00 0
Milan	28 10	30 0
Bessemer rails	5 0	5 10
,, tyres	8 15	9 0
,, axles	9 0	10 0
,, billets	6 10	7 0
,, plates	10 15	0 0
,, angles	9 15	0 0
Steel Castings (per cwt.)—		
Hydraulic cylinders in the rough not to exceed 6 ft. in length, guaranteed	s. d. 26 0	s. d. 28 0
Do. do. finished	30 0	34 0
Pinions and cog-wheels	25 0	28 0
Hammer tups, faces, swages, 5 cwt. and above	20 0	24 0
Holders-up for rivetting machines, &c., 1½ to 5 cwt.	25 0	26 0

Steel Castings—*continued*	s. d.	s. d.
Side cranks, cross heads, crane wheels, engine slides, &c.	4 0	30 0
Tumbler bars and other castings for dredging purposes	20 0	26 0
Swedish Iron (F.o.b) at Gottenburg (per ton)	£ s.	£ s.
Pig	4 5	5 0
Bar rolled	9 0	10 10
,, hammered	11 0	12 0
Tin (per ton)—		
Straits	89 0	89 10
Billiton	00 0	00 0
Banca	00 0	00 0
English ingots	96 0	97 0
English bars	92 0	94 0
English refined	95 0	97 0
Australian	89 0	89 10
Tin Plates (per box)—	s. d.	s. d.
I.C. charcoal	26 0	30 0
I.X. ,,	32 0	35 0
I.C. coke	24 0	28 0
I.X. ,,	30 6	31 6
Zinc (per ton)—	£ s.	£ s.
Sheets, English	24 0	24 10
Wire, fencing	14 0	16 0
,, Telegraph (galvanised)	16 0	21 0

COALS AND COKE.

Coals (per ton)—	s. d.	s. d.
Barrow	9 0	11 0
Bristol	9 0	10 6
Derbyshire	8 0	10 6
Lancashire	8 0	10 0
Newcastle and Durham	8 6	12 0
Scotch	7 0	10 0
Staffordshire	8 6	11 6
Welsh	9 0	10 0
Yorkshire	8 0	12 0
Coke—		
Cleveland	11 6	12 0
Durham	16 0	18 0

OILS, GREASE, & LUBRICATORS.

Oils (per tun)—	£ s.	£ s.
Engelbert's lubricator	44 2	00 0
Seal, brown	23 0	24 0
,, pale	28 0	29 0
Sperm	52 6	53 0
Whale, pale	23 0	24 0
,, yellow	22 0	23 0
Lard	40 0	41 0
Glue	30 0	50 0
Petroleum—	s. d.	s. d.
Fine (per gallon)	0 6¾	0 7¼
Coal oil, refined	0 6½	0 7
Rangoon engine oil	2 6	3 6
Linseed oil	28 0	29 0

Pitch (per cwt.)—	s. d.	s. d.
British	5 6	5 9
Archangel	7 6	8 0
Plumbago (per cwt.)—		
Ceylon lump	13 0	16 6
,, chips	14 9	15 3
,, dust	6 0	12 9
Railway Grease (per cwt.)—Rose's	28 0	00 0
Pritchard, Offer and Co.'s concentrated	60 0	00 0
Resin (per cwt.)	4 6	5 6
Tallow (per cwt.)		
N. American	00 0	00 0
S. American beef	00 0	00 0
,, sheep	00 0	00 0
Australian beef	38 0	39 0
,, sheep	39 6	40 3
St. Petersburg, Y.C.	41 0	42 0
English, town	38 0	39 0
Rough, English	12 0	14 0
Tar—Stockholm (per barl.)	16 6	17 0
Archangel	12 6	13 0
Turpentine - Spirit—		
American (casks)	29 0	30 0
Wipings, engine (per cwt.)	20 0	35 0

CHEMICALS, &c.

Acids—	s. d.	s. d.
Aquafortis (per lb.)	0 4½	0 0
Sulphuric acid (per lb.)	0 0¾	0 1
Sulphuric acid, brown	0 0½	0 0¾
Ammonia — Muriate (per ton)	£ s.	£ s.
Arsenic—	s. d.	s. d.
White, lump (per cwt.)	24 0	25 0
Powdered (per cwt.)	8 6	10 6
Bleaching powder per cwt.	6 6	6 9
Borax—refined (per cwt.)	35 0	37 0
Brimstone (per ton)—	£ s.	£ s.
Rough	5 2	5 5
Flour	11 0	12 10
Roll	9 10	10 15
Copperas—green	50 0	55 0
Copper — Sulphate (per cwt.)	s. d. 18 6	s. d. 21 0
Leads, Salts, &c., (per cwt.)		
Acetate, best	37 0	38 0
Brown ,,	22 0	26 0
Red	14 0	18 0
White	20 0	22 10
Litharge (per cwt.)	18 0	22 0
Potash—Bichromate (per lb.)	0 4½	0 5
Saltpetre (per cwt.)		
English refined, kegs	25 0	26 0
Bombay	00 0	00 0
Bengal	20 6	21 6
Soda Caustic	12 6	13 0
,, Crystals (per ton)	£3 10	£3 17

FOREIGN AND COLONIAL NOTES.

Shipping Accommodation at Port Adelaide.—With additional wharfage to be given by the South Australian Company and the Port Dock Company, and also mooring berths to be provided by the South Australian Government, there would appear to be ample shipping accommodation promised for Port Adelaide for some time, as the outports too have of late relieved the harbour of much shipping which otherwise would have had to be accommodated in it. The South Australian Company are enlarging their basin, from which a jetty will be constructed. Moorings to accommodate twelve large ships are to be laid in the stream.

Coal in France.—The production of coal in France in the first half of this year was 8,331,138 tons. This total was 80,966 tons in excess of the corresponding production for the corresponding period of 1878.

Nova Scotian Railways.—The rails are laid on the Eastern Extension Railway of Nova Scotia for about 30 miles east of New Glasgow, and track laying and ballasting will probably be completed this month.

Submarine Telegraphic Progress.—A short cable has lately been laid for the Russian Government across the Caspian Sea, and a new cable to connect Scandinavia directly with Germany has been submerged. Hitherto Germany has been obliged to send all her telegrams to Norway through Denmark and Sweden, which was not pleasant considering her delicate relations with Denmark; and therefore she lays the line at her own cost, and all telegrams between Norway and Germany are to pass through it. Of two American projected cables, one from California by way of the Sandwich Islands, to Japan and China, is the more interesting and nearest to realisation. Mr. Cyrus W. Field has an exclusive concession from the Government of the Sandwich Islands for such a cable, and he expects to obtain, without difficulty, similar privileges from Japan and China, since Japan has for several years been greedy of telegraphic communication, and even China has woke up to the advantages of the electric wire. When this line is laid it will complete the telegraphic circuit of the world. The other projected American cable is still a matter of talk only. It is a proposition to lay a line from New York to Flores, an island of the Azores, with a connecting line from Flores to France, England, and Holland, and another from Flores to Fayal, San Miguel, and Lisbon, the whole comprising 7300 miles of cable. This, it will be seen, is a big project.

American River Steamers.—A projected line of fast steamers to carry mails to all river towns between St. Louis and New Orleans has so far advanced that contracts have been signed by Mr. John H. Baldwin and associates, owners of the line, with Messrs. Billings, Powell, and Co., of the American Foundry, New Albany, for all the machinery, including boilers, for the vessels. Contracts will also be closed at once for six hulls, cabins, and outfits. The steamers are to be completed and ready for business by December 1.

The Nervion.—The bar at the mouth of the Nervion is a great obstacle to navigation. It practically closes the entrance during half of each month, and vessels of great draught can pass it only at spring tides. The most advantageous type of vessel for the Spanish iron ore trade is a steamer drawing 13½ ft. to 14 ft. of water, carrying a cargo of 1000 tons, with engines of 100 to 120 horse power. The quantity of Spanish iron ore shipped in 1877 was 964,533 tons, while in the first ten months of 1878 it had already reached 1,040,000 tons.

Costa Rica.—The Government of Costa Rica is constructing a railroad from the Atlantic to the Pacific. It will probably be finished within a year or two, when it will vigorously compete with the Panama Railroad.

Defence of Port Phillip.—A supplementary report has been drawn up by Sir William Jervois on the defence of Port Phillip. It is dated March 1, and has been withheld from publication to enable the Victorian Government to purchase Swan Island, which has been recommended as the site of a battery. Sir William Jervois has advised the Government to buy the 10-in. guns which are now being constructed in England on the new principle of an enlarged bore at the part occupied by the charge of powder and increased length of the gun itself. The new 10-in. guns are recommended in place of the 11-in. "service" guns formerly used. For the defence of the South Channel, by which vessels of deep draught can alone approach Melbourne, he advises the Government to push on the construction of the fort on the shoal near to No. 5 buoy. In lieu of the proposed fort on the shoal between West and Symonds' channels, it is recommended that there should be a battery of seven guns on Swan Island. Since the report was received the Victorian Government has completed the purchase of Swan Island for 2750*l.*

A Great German Company.—The Dortmund works of the German Union Iron and Steel Company have three blast furnaces and 100 coking furnaces, the annual production of Bessemer pig being 48,000 tons. There are also Bessemer steel works, with hammer works, a rail-rolling mill, and a tyre mill capable of producing from 60,000 to 70,000 tons of steel rails and 12,000 to 15,000 tons of tyres, axles, and forgings respectively; Siemens-Martin works, puddling furnaces, and iron rolling mills, with an average production of 30,000 tons of merchant iron, &c.; bridge works with a capacity of 10,000 tons per annum of bridges, roofs, turntables, &c.; railway switch and crossing works, with a yearly production of 600 switches, &c.; an iron foundry, producing 4000 tons of castings per annum; and wheel and axle works, with forge and turning shops, capable of sending off 3750 sets of wheels and axles for wagons, tenders, and locomotive engines per year. This will give some idea of the great extent of the company's Dortmund works, but the establishment is only one of several. At Aplerbeck they have puddling furnaces and rolling mills, capable of turning out 15,000 tons of iron merchant bars of all kinds in the year. At Horst, near Steele, on the Ruhr, the Union Company have two blast furnaces and 80 coking furnaces, with an annual capacity of from 33,000 to 35,000 tons of puddled pig iron per annum, puddling furnaces and rolling mills for I, angle channel iron, &c., and iron sleepers for railways, wire-rod mills; steel works with 12 Siemens-Martin furnaces. At Heinrichshütte, near Hattengen, the company own four blast furnaces and 170 coke ovens capable of producing 72,000 tons of pig iron both for puddlers and Bessemer steel manufacturers; puddling furnaces and rolling mills, with an annual capacity of 18,000 tons of plates, sheets, and angle-iron, from the smallest to the largest dimensions; foundry with mechanical workshops, capable of turning out from 4000 to 5000 tons of castings per year; malleable steel casting works with a capacity of about 1000 tons per annum, and lastly Bessemer steel works with two 8-ton converters. At Othfresen and Hasslinghausen, there are six blast furnaces calculated to make 87,500 tons of pig iron per year. The company has 388 boilers; 289 steam engines, equal to 18,800 horse power; 28 blowing engines for blast furnaces and Bessemer works; 23 locomotive engines; 24 portable engines; 85 steam hammers from 1½ cwt. to 15 tons; 27 rolling mills; 164 puddling furnaces; 95 welding and reheating furnaces; 498 coke ovens; 197 machine tools of all descriptions, and 15 blast furnaces. The company have several collieries producing 460,388 tons per annum; of this the Glück-auf-Tiefbau turns out 331,000 tons per annum. The collieries are in the mining district of Dortmund, in the Ruhr Valley, as are also the company's most important iron ore mines. They have also iron mines in the mining district of Bonn (sub-district of Liegen), several mines in the Hartz Mountains, in Nassau, and in Sweden, and the production of all the mines is 122,536 tons per annum.

A Large Russian Bridge.—The largest bridge in Europe will be completed next year. It will cross the Volga in the government of Samara, Russia, on the Siberian Railroad. The river at the point of crossing is four miles wide in the spring and 4732 ft. wide in the autumn. The cost of the bridge will be 700,000*l.* Twelve piers, 85 ft. high and 364 ft. apart, will support the structure.