THE DRAINAGE OF FENS AND LOW LANDS BY STEAM POWER.

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

No. I.

WHILE engines and machinery for agricultural purposes have received great thought and care at the hands of the makers, owing to the large amount of competition, very few firms in this country have paid any special attention to the machinery for draining land. No information in a collected form exists to which those who are called in to advise on the subject can refer. The object of this article is to give a general description of the pumps and engines used in draining low land, with such information and practical hints as may be of service to those having to superintend drainage districts or to design new works. Living in the midst of the Fenland, where, with the exception of Holland, the science of drainage has been applied to the improvement of land on a larger scale than any other part of the world, and having been engaged professionally as an hydraulic engineer for the last twenty-five years, the author has had the opportunity of collecting together a large amount of facts and experience relating to this particular subject, and hopes that, by rendering these accessible to others who have not had the same opportunities, he may be doing some service.

A civil engineer called in to advise as to drainage has not, as a rule, had the experience necessary to enable him to design the details of machinery required for the purpose, but he ought to have sufficient knowledge of the subject to enable him to judge as to what type of machinery is best suited for the particular work required, and to be able to draw up such a specification that tenders for the work may be furnished upon a similar basis. While a certain amount of freedom as to details may be allowed to the makers tendering for the machinery, the responsibility of the successful carrying out of the work must rest with the engineer.

The want of sufficient knowledge of this special subject, and experience of what has been done, has led in several cases to the erection of unsuitable machinery, waste of money, and failure to effect the object required in the most effective and economic manner.

Very large tracts of rich land suitable for cultivation lie at so slight an elevation above the sea, that this land can only be rendered fit for cultivation by artificial means. The Polders in Holland, the Fens and marsh land in England, the sites of old lakes in Italy and other parts of Europe, and considerable quantities of low land in South America and the colonies, have been brought into cultivation and made to yield large quantities of produce by a complete system of drainage. The surplus water is discharged from the district drained either by large artificial cuts, with self-acting sluices discharging into rivers or estuaries by gravitation, or by having it lifted by mechanical means, or by a combination of the two.

In Holland the reclaimed land, consisting, for the most part, of the beds of lakes, has been at so low a level that pumping has been almost universally resorted to.

In the valley of the Po upwards of 600,000 acres of marshy land have been drained and transformed into rich country by means of pumps and lifting wheels, the drainage of which was only practical since the introduction of steam power, owing to the difficulty of getting rid of the water by gravitation. The engineers who originally designed the drainage for the fen land in England endeavoured by means of long straight cuts to obtain a natural outfall into the sea or main rivers at low water, excluding the tidal flow by sluices having self-acting doors. Modern engineers have followed the example thus set, and consequently, while the chimneys of pumping engines are everywhere to be seen scattered over the fens, the improvement of the main tidal outfall rivers has been more or less neglected, and immense sums have been spent in artificial cuts with the object of obtaining drainage without the aid of mechanical power.

DRAINAGE BY GRAVITATION AND STEAM POWER.

In no instance in the Fenland has the attempt to obtain what is called a "natural drainage," that is, drainage by gravitation, been completely successful. While the higher land is well drained, the lower fens, which often lie at the greatest distance from the outfall, can only be kept fit for cultivation by lifting the water out of their drains. The lift of the water, and consequently the cost of the pumping, has been considerably reduced, but the taxes to meet the interest on the outlay for the works, in addition to the cost of pumping, is much higher than in adjacent districts where more reliance has been placed on pumping. Fen land which was well drained when the main outfall drains were first constructed, afterwards has had to resort to pumping, owing to the lowering of the surface from the consolidation and shrinking of the peat. Such has been the case in the East Fen in Lincolnshire, where a district of 30,000 acres formerly drained by gravitation is now kept free from water by engines driving centrifugal pumps erected in 1868, a description of which will be given further on.

In the Black Sluice district the main drain, twenty-one miles in length, was enlarged and deepened, and a complete system of internal drainage carried out in 1848, with the hope that the fen land would by this means be effectually drained. One district after another has, however, resorted to pumping as the only means of giving complete relief to flood water, till now all the low land at the upper end of the main drain is kept free from water in floods by steam-power. On the river Witham, fourteen districts, containing an area of over 30,000 acres, are drained by steam power.[1] In the North Level of the Bedford Level, where the taxation is already very high, owing to the large amount expended in erecting outfall sluices and perfecting the main drains, the lower districts suffer greatly from flooding in wet seasons, and power was obtained in the session of 1881 to erect a large pumping station for the better drainage of the district.

[1] "The Fens of South Lincolnshire," by W. H. Wheeler, C.E. Simpkin and Marshall.

An enormous outlay was incurred in the Middle Level in Norfolk in cutting a large main drain eleven miles long with an outfall sluice discharging into the river Ouse at a point nine miles lower down the channel than where the old drain discharged. It was considered at the time that this drain would afford such a good discharge for the water that pumping would become unnecessary. The numerous engines which are now at work in this level prove that these expectations were not justified by the result. Although the cost of lifting the water has been reduced, yet nine-tenths of the land have to be secured from flooding in wet seasons by mechanical means. There are certain districts in this level which refused at the time to be brought into the new system, preferring to rely on their engines and pumps. The taxation for paying for the maintenance of the pumping stations in these districts is so light, compared to those which are in the rest of the Middle Level and have to contribute to the outfall-tax, as fully to have justified the opposition to the scheme, and proves conclusively that there are instances where drainage by gravitation is often more expensive than drainage by steam power.

In the South Level, owing to the want of improvement in the river Ouse, the main outfall of the district, the discharge from the main drains is so defective as to prevent the floods getting away with sufficient rapidity. The water consequently rises to an undue height in the river above the tidal outfall at Denver, bringing pressure on the banks beyond what they were intended to stand, a greater head to pump against, and additional water from leakage to be lifted. The question as to whether the better course for the improvement of the drainage of this level would be to imitate the example of the Middle Level, and make a new cut discharging nine miles lower down the river than the present outfall sluice at Denver, or to improve the outfall and its discharging capacity, and so lower the height of the water in floods within safe limits, and still rely on steam drainage, was referred to the author to report on. The conclusion arrived at after a thorough investigation of the subject was that efficient drainage of the low fen lands in this district by gravitation was impossible, and that the cost of draining by steam power would be less than by gravitation.[2] The interest on the outlay for the money required for carrying out the gravitation work would have put a greater tax by about two shillings an acre on the land than that required for the improvement of the present outfall and the continuance of steam power.

The great improvements which have been made in the steam engine and water-raising machines, together with the greater facilities for obtaining, and the lower price of coals, have very considerably reduced the cost of lifting water as compared to what it was when many of the improvements for the drainage of the fen land were carried out. There is no doubt if the work had to be done now the engineers engaged in those works would have trusted more to mechanical lifting than to gravitation.

The choice as between gravitation and steam power for draining low lands resolves itself into a question of cost. If the annual charge for interest on the outlay for a gravitation scheme, with a proportionate sum for repayment of the principal, exceeds the average annual cost for a pumping station, then the steam power is decidedly preferable, not only as being more economical, but as rendering the district more thoroughly independent of outside circumstances. The annual charge for a gravitation scheme is constant, be the season wet or dry; whereas a pumping station adapts itself more readily to the actual work to be done, the charge for coals varying with the amount of water to be pumped.

One obstacle to the more general use of steam power has been the excessive cost of pumping stations in some localities from the use of imperfect machinery, and ignorance on the part of those concerned in the management. While some engines and pumps are so efficiently designed and managed as to leave little or no room for improvement, others are being run with a most extravagant use of coals, and imposing a rate of taxation for their maintenance that is quite uncalled for.

MACHINES FOR RAISING WATER.

The machine required for efficiently draining low lands is one that will readily adapt itself to the varying amount of work to be done, owing to increase or decrease of lift from the rise and fall of the tide, or of floods in the outfall into which it discharges, and from the lowering of the water in the feeding drain as pumping proceeds. The parts should be as simple as possible, and the machine should be so constructed as not to get out of order from lying by, owing to the intermittent character of the work, most pumps being idle for the greater part of the year.

Setting aside special contrivances which have occasionally been used, and, owing to their unsuitability, the use of which has not been repeated, the machines used for raising water for the drainage of land are scoop wheels, screw pumps, bucket pumps, and centrifugal pumps. Of these the scoop wheels are the oldest type of machine, and still most generally in use, both in this country, in Holland, and in Italy. They are, however, gradually being superseded by centrifugal pumps.

The Scoop or float wheel, a full description of which will be hereafter given, resembles a breast water-wheel with reverse action. It meets most of the requirements of a machine for land drainage. It is simple, and easily repaired by such mechanical skill as is generally found in country districts. Owing to the slow velocity at which a Scoop wheel travels, it is well adapted for being driven by wind power or by the old type of engines running at slow speeds, and using steam of very low pressure. It is not easily damaged by pieces of wood or other hard substances that may escape the gratings and be carried into the raceway, or by ice, and is not affected by weeds to the same extent as pumps. With low lifts, and not much variation in the height of the lift, a properly constructed wheel gives off a very large proportion of the power applied.

It is, however, a ponderous machine—large wheels weighing from 40 tons to 50 tons—by which a great mass of material is put in motion at a slow speed, its dead weight in proportion to the water lifted comparing very unfavourably with the pumps. It requires considerable space, a large amount of masonry, and expensive foundations. The slow speed at which a wheel revolves unfits it for working economically with modern engines, the gearing required to diminish the speed detracting from the useful effect of the power applied. This machine is not well adapted for situations where a high lift is required or where there is much variation in the lift. As the angle at which the floats enter and leave the water affects the efficiency of the wheel, any material alteration of the level of the water, either by the rise and fall of the tide or by sudden floods on the exterior, or by the lowering of the water as pumping proceeds on the interior, seriously affects its discharging capacity. Nearly all land, and especially peat, continues to settle for many years after a pumping station is erected. If a wheel is placed low enough to meet this contingency in the first instance a considerable amount of further capital is required to meet the cost, while the wheel will for many years be doing an unnecessary amount of work. A subsequent lowering necessitates the reconstruction of the masonry of the raceway and of the wheel. Notwithstanding these drawbacks, the scoop wheel is an instrument that has done very excellent work in its day; for the colonies and remote places where wood is more plentiful and available than a trained mechanic's services, it is still worthy of use. Some of the old wheels have been very considerably improved and made to perform a very efficient duty, and there is, perhaps, little to choose between the work done by a centrifugal pump and some of the best wheels. Most of the wheels, however, which are now in use are so constructed as to be extremely wasteful of power, some not usefully employing more than 30 per cent. of power applied. The defects of some of these can only be remedied by their being replaced with more efficient machines; others, by means of alterations to the wheel and engines which could be effected without incurring great outlay, could be made to run with half the coals now used, and be made to deliver a larger quantity of water.

[2] "Report on the Improvement of the River Ouse, between Denver Sluice and the Eau Brink Cut," by W. H. Wheeler, M. Inst. C.E. February, 1884.

PRECIPITATION WORKS AT THE BARKING SEWAGE OUTFALL.

WE now proceed to lay before our readers the leading features of the extensive and remarkable works about to be constructed at the northern outfall of the Metropolitan main drainage, for the purpose of purifying that part of the London sewage. The works which we are about to describe have been designed by Sir Joseph W. Bazalgette, C.B., the Engineer to the Metropolitan Board, and the chemical process has been devised by Mr. W. J. Dibdin, the Board's chemist. The contract for the undertaking has been taken by Messrs. J. Mowlem and Co., the amount of their tender being £406,000. The works are to be finished in eighteen months; and, looking at the magnitude of the task, the time seems brief, though we may expect to see the whole completed in the specified period. Great interest attaches to the project, and considerable discussion has been excited by the proposal to subject the whole of the immense volume of the London sewage to a chemical process. Whatever opinions may be held on this point, it must be acknowledged on all hands that the works requisite for carrying out the chemical plan have been admirably devised by Sir J. Bazalgette. The use made of the existing sewage reservoir, as we shall explain presently, is a happy feature in the plan; and the laying out of the works altogether is worthy of the high reputation of the eminent engineer who has given London the benefit of the main drainage works, as well as the adornment of the Thames embankments, and sundry noble streets.

At the present time the whole of the sewage of the metropolis, north of the Thames, is conveyed into the river at a spot about 400 yards above the mouth of Barking Creek. The sewage travels to this point in three parallel culverts, each 9ft. high by 9ft. wide, and, before passing into the Thames, enters a reservoir divided into four compartments, extending over an area of nine acres. This week we publish two pages of drawings, illustrative of the works, and in our next impression we shall give a third. On page 84, the course of Barking Creek is shown, with the present outfall lying westward. The curved line coming down towards the outfalls shows the course of the embankment containing the three culverts. The existing reservoir with its four compartments lies between the culverts and Barking Creek and extends southward to the river bank. At the present time the sewage is stored in the reservoir during eight hours of each tide, and is discharged into the Thames at the top of the ebb.

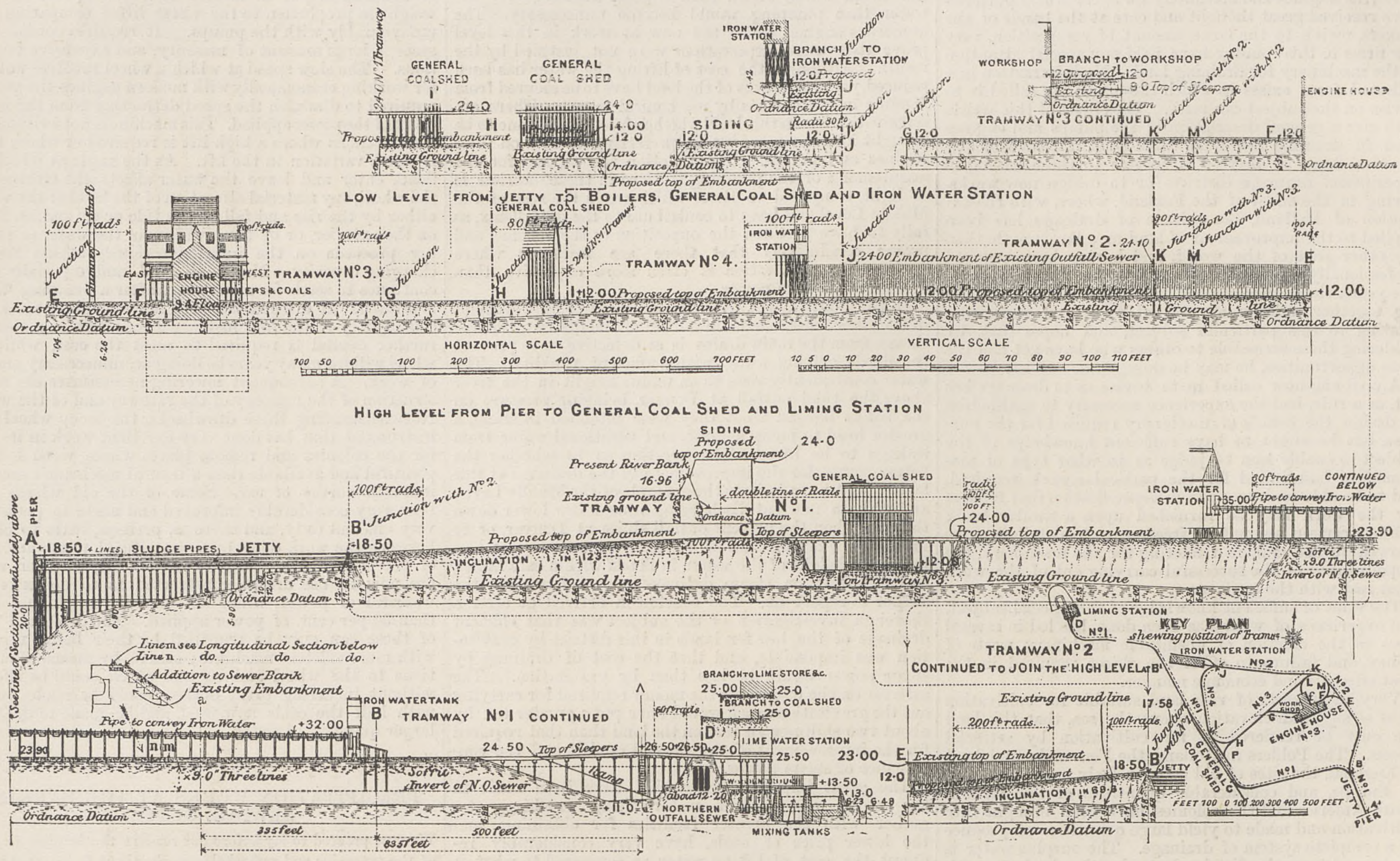
According to the plan of the new works now just commencing covered precipitation tanks will be constructed adjacent to the present reservoir on its northern side, covering an area of between ten and eleven acres. Their position will be seen on page 84 between the outfall sewer and Barking Creek, occupying ground traversed by a portion of an embankment containing a culvert connected with the old Essex Reclamation scheme. This will have to be removed, and a stream discharging at Old Galleon's Sluice will have to be got out of the way, as also a couple of ponds. The precipitation tanks are shown in plan on page 85. They will be thirteen in number, each 31ft. 6in. wide, and placed parallel to the northern side of the existing reservoir. Their lengths will be somewhat unequal, but averaging about 1000ft. Communications will be made between the outfall sewer and each of these tanks, each tank being fitted with two penstocks, so that communication may be opened or shut off at pleasure.

The sewage will be admitted into each of these tanks in succession, and allowed to remain quiescent for a sufficient time to admit of the deposit of the matters in suspension, the precipitation of which is to be expedited by the admixture of 3·7 grains of lime and one grain of protosulphate of iron. The effluent will then be run off over a weir, which will fall as the water in the tank lowers, so that only the top stratum of the liquid will be taken off. The tank will thus be emptied gradually, and any disturbance of the precipitated matter will be avoided. The effluent, after flowing over the weirs—of which there will be ten in each tank—will pass into the culverts carried transversely under the tanks, shown on the plan on page 85, and in section

LONDON SEWERAGE—NEW PRECIPITATION WORKS AT BARKING.

SIR JOSEPH W. BAZALGETTE, C.B., M. INST. C.E., ENGINEER.

(*For description see page* 83.)



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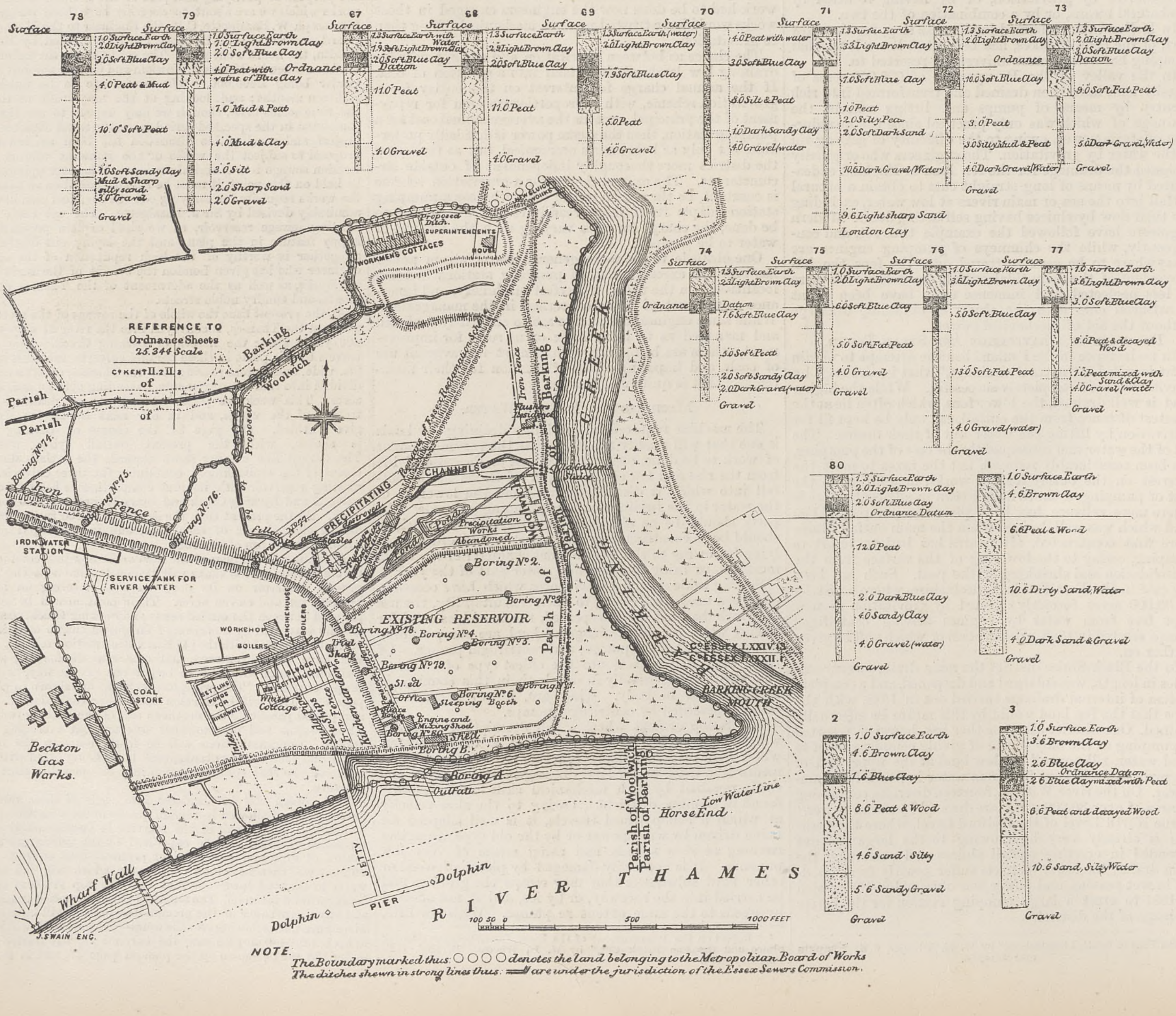

NOTE.
The Boundary marked thus ○○○○ *denotes the land belonging to the Metropolitan Board of Works*
The ditches shown in strong lines thus ═ *are under the jurisdiction of the Essex Sewers Commission.*

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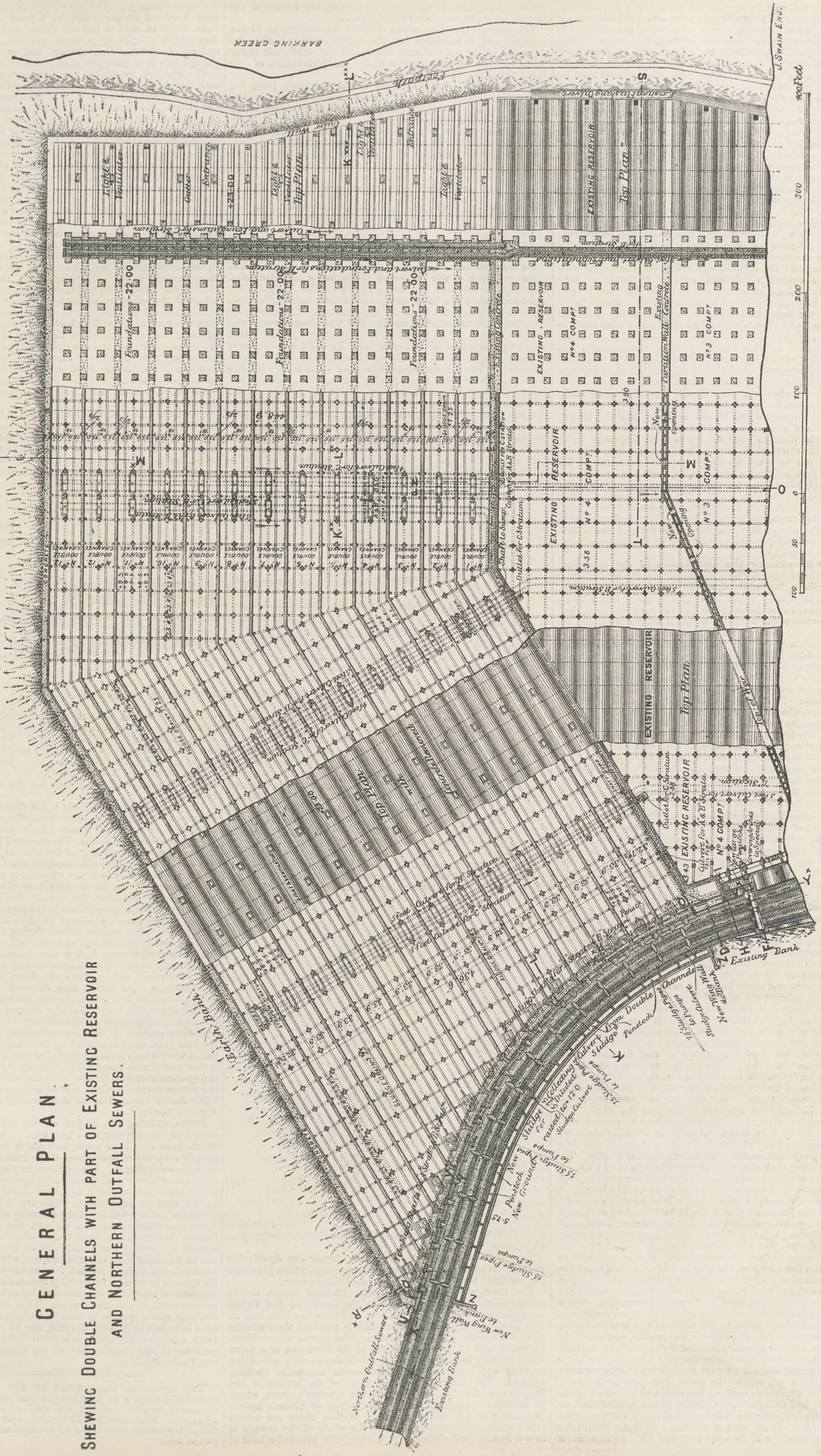


GENERAL PLAN.

SHEWING DOUBLE CHANNELS WITH PART OF EXISTING RESERVOIR AND NORTHERN OUTFALL SEWERS.

next week. Some of these culverts extend into the compartments of the existing reservoir, and some into a chamber under the outfall sewer, through which at present the sewage is discharged into the river from the existing reservoirs. When the level of the tide will admit, the effluent will be discharged through this chamber direct into the river; but when the water in the river is too high to admit of this, the effluent will be conveyed by the other culverts into the several compartments of the present reservoir, and stored there until the level of the water in the river will admit of its discharge.

When each compartment in the precipitation tanks is emptied of its effluent, the sludge, which will be in a semi-liquid state, will be discharged through culverts passing under the outfall sewers into a collecting culvert, from which it will be conveyed by pipes into a receiving well or sump, and pumped into a series of twelve tanks placed side by side and situate between the outfall sewer and the river. The position of these tanks, called the sludge settling channels, will be readily seen on the plan on page 84. Each tank will be 20ft. wide and 140ft. long, and the entire set will cover an area exceeding an acre and a-half. These, as well as the precipitation tanks, will be covered, so as to prevent nuisance. The sludge will be allowed to remain quiescent in the twelve settling tanks, so as to allow of a further precipitation, and the effluent water will be discharged over weirs into a culvert which will convey it into a store under the tanks, from which it will be lifted and discharged through pipes to the liming station, there to be mixed with the lime which is used for precipitation. A section of the precipitating channels or tanks will be shown next week, as also a section of the sludge-settling channels and the connection between them. In the former section the culverts are shown which are to draw off the purified liquid at the different levels. In all reference to the sections, the difference between the horizontal and vertical scale must be noted.

The settled sludge remaining in the second series of tanks after the supplemental precipitation will be discharged through culverts into a sludge store situate under the tanks. Thence it will be lifted and conveyed through pipes along a jetty, as shown on the plan on page 84, on to a landing-stage to be erected in the river, where it will be discharged into ships for conveyance out to sea. To provide against the event of the ships being detained by stress of weather, there will be a further store for sludge at a lower level extending over the whole of the area occupied by the upper stores. On the north side of these sludge-settling tanks will be erected engine and boiler-houses and workshops in connection to contain engines and machinery for lifting the sludge into the settling tanks and the settled sludge into the ships, as well as for pumping the sludge effluent to the liming-station.

The lime for assisting the precipitation of the suspended matters in the sewage will be introduced into the outfall sewer at a point about 700 yards above the precipitation channels, and the protosulphate of iron about 530 yards above them. A plan of these two stations will be given in our next impression. The liming station will comprise a lime store, floors for slaking the lime, and six tanks for mixing the slaked lime with the effluent water from the sludge settling tanks, or with sewage taken direct from the outfall sewers. An elevated lime water tank or reservoir will be built above the lime store, into which the lime water will be lifted by pumps, for which machinery and requisite engine and boiler houses will be erected adjacent to the lime stores. From this elevated tank the lime water will be conveyed to the sewage and ejected into it, passing through cast iron injectors placed in the sewers. Means will be provided for turning the lime water into any one of the three lines of sewers, and of regulating the supply. For this purpose sluice valves will be fitted to the pipes leading to the injectors. The injectors will consist of cast iron chambers 4ft. 6in. in length, 6in. wide, and 6ft. in height, fitted with a number of nozzles through which the lime water will be injected and mixed with the volume of the sewage as it flows past.

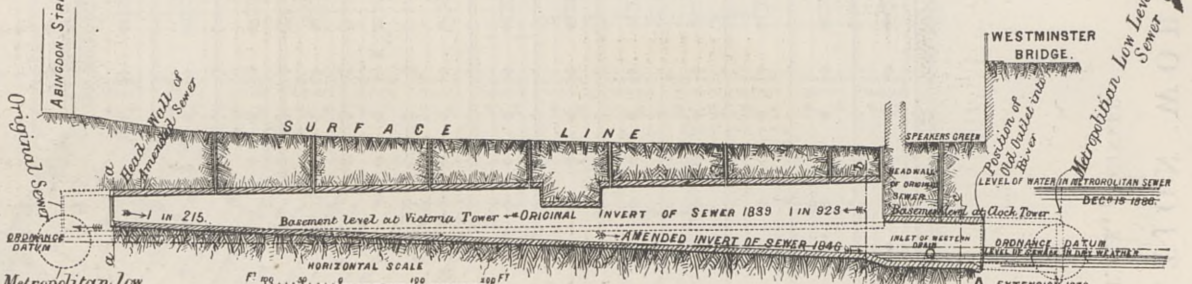
The iron water station comprises timber sheds for storing the protosulphate of iron, a mixing shed, in which the iron will be crushed and mixed with water, an engine shed to contain engines and machinery for crushing the iron and mixing it, as well as for raising water for the boilers and into the mixing tank. The iron water will be conveyed by cast iron pipes carried above ground, and along the top of the outfall sewer into a service tank, from which it will be carried by pipes into each of the three outfall sewers and injected into the sewage through perforations in a pipe fixed vertically in each of the sewers. As with the lime water, there will be appliances for regulating the supply of iron water to each of the sewers to meet the varying requirements of the discharge. There will be a large settling pond, covering an area of one and a-quarter acres, situate near the river, and divided into six compartments, each 60ft. square and about 7ft. deep, into which water will be received from the river and allowed to settle, the clear water being used for the supply of the several boilers as well as for slaking the lime and for mixing with the protosulphate of iron. This settling pond will be seen on the plans already mentioned, lying to the westward of the sludge settling channels. A timber coal shed will be erected for storing a supply of coal for the various engine stations. It will be placed on the western boundary of the Board's land, and will be 126ft. in length by 31ft. in width. In consequence of the unsatisfactory nature of the ground this shed and the other timber buildings will be carried upon piles which will be extended upwards to support the roofs. The jetty will extend 576ft. into the river from the present river bank, and will be 15ft. wide. It will be a timber structure supported upon piles. The pier, or landing-stage, at the river end of the jetty will be 300ft. in length and 20ft. wide. The front will range with the pier of the Beckton Gasworks. It will be made of timber, and supported upon piling like the jetty, and will be protected by dolphins at each end. The iron pipes for conveying the sludge to the ships will be carried under the platform of the jetty and pier, and will be furnished at the end with a delivery pipe socketted to admit of a vertical movement, so as to discharge the sludge into the ship at the varying levels of the tide. The pier and dolphins are designed for two ships to lie alongside at the same time. A tramway will be laid along the full length of the pier and jetty, with a turntable at the intersection, and will be extended through the works on the west on a higher level to the coal store and liming station, and to the east on a descending level to the iron water station. There will be a branch from this on the low level to the general coal store and the main engine station to the north of the sludge-settling tanks. The trams will all be above the present surface of the ground, and will be generally carried upon earth in embankments, but in some cases upon timberstaging. The plan to be given next week and the sections on page 84 show the leading features. These tramways will enable the coals, lime, proto-sulphate of iron, and other materials used on the works to be loaded at the pier or jetty and delivered with facility to the several stations. They will also facilitate the distribution of coal from the general coal store to the several engine-stations. Sections illustrating these arrangements will be seen on page 84. A number of borings giving interesting details concerning the nature of the ground are represented on the same sheet.

The contract for these works includes the erection of twelve cottages and a residence for the superintendent; also the diversion of the old Galleon's Sluice and the ditch, the latter being one of the main sewers under the jurisdiction of the Essex Commissioners of Sewers.

There will be a large quantity of surplus earth from the excavations, which will be used in forming the banks for the tramways and in raising the general level of the ground, which is now 6ft. or 7ft. below the level of Trinity high water. The works extend over an area of about fifty acres; the quantity of sewage to be dealt with will amount to about 90,000,000 gallons per day; and the quantity of lime to be used in precipitation to twenty-three tons per day.

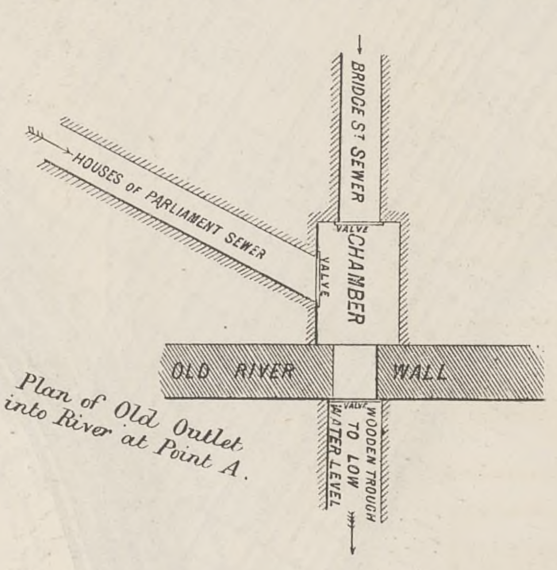
THE DRAINAGE OF THE HOUSES OF PARLIAMENT.

AVAILING ourselves of the courteous invitation of H.M. Office of Works, we have recently had the opportunity of inspecting what has been done to remove the serious evils to which the late drainage system of the Palace at Westminster had given rise. The original drainage laid down by Sir Charles Barry in 1839 consisted mainly of a large, nearly flat-bottomed sewer, discharging into the public sewer at Abingdon-street. Its inadequacy soon became demonstrated, and in 1846 the Houses' sewer was extended to the public system at Bridge-street, by doing which an additional 5ft. of fall was obtained. In 1873, the execution of the Metropolitan Main Drainage Scheme necessitated a further alteration. The Palace sewer was then connected with the Metropolitan low-level sewer passing through Westminster, the junction being made at about 21in. above the bottom of the public sewer. Even in dry weather there has always been from 3ft. 6in. to 4ft. of sewage passing through the last-named sewer; this giving a constant head against the Palace drainage, and forcing the latter back so as to cause a standing creek, so to term it, of about 200ft. in length, and varying from 1ft. 9in. to 2ft. 3in. in depth, below the Houses of Parliament. This evil became seriously augmented in wet weather,



THE MAIN DRAIN OF THE HOUSES OF PARLIAMENT.

the flood water rising sometimes as high as 10ft. above the crown of the Metropolitan sewer, with the result that the entire drainage of the Palace was checked until the flood level was sufficiently lowered by the pumping power of the Metropolitan system. The evil thus produced was at all times augmented by the discharge into the sewer system of the Palace of the waste hot water and steam from its warming and ventilating appliances, which gave rise to extensive fermentation. This last-named source of trouble has now been got rid of by giving to these a separate discharge into the Thames. Surprise must be naturally felt that the evils complained of—which were so patent to all those resorting to the Palace—were for so long borne without remedy for them being attempted; but it was not till 1886 that any active steps were taken towards that end. In that year a Committee reported upon the subject, with the result that a plan designed by Mr. John Phillips was adopted and its execution sanctioned. It is the



works carried out on the basis of that plan that we now purpose to describe.

To enable our readers to more fully follow our descriptive remarks we give the accompanying engravings, which illustrate the causes to which the evils now remedied were due.

The more salient features of Mr. Phillips' design are as follows:—Imbedded in concrete on the invert of the Palace main sewer—now utilised only as a subway—has been laid an iron pipe of 12in. diameter, into which is received the discharge of all the various subsidiary drains. The pipe is about 800ft. in length, and it is provided both at its head and at a point about midway between that and its discharge with self-acting flushing appliances — Shone's automatic hydraulic flushing ejectors. This main conveys the whole of the sewage of the Houses to a chamber situate below the Speaker's Green, where it delivers its contents into three ejectors on Shone's hydro-pneumatic sewage ejector system. Within these the action takes place automatically whereby the whole of the sewage is raised into a final discharge pipe about 8ft. above the level of the main sewage pipe, the issue being made into the Metropolitan low-level system somewhat beyond the point at which there has been built in the old Palace sewer a strong masonry dam which completely prevents any ascent into the Palace system of accumulating sewage, and as fully excludes any passage into it of gases from the public drainage system.

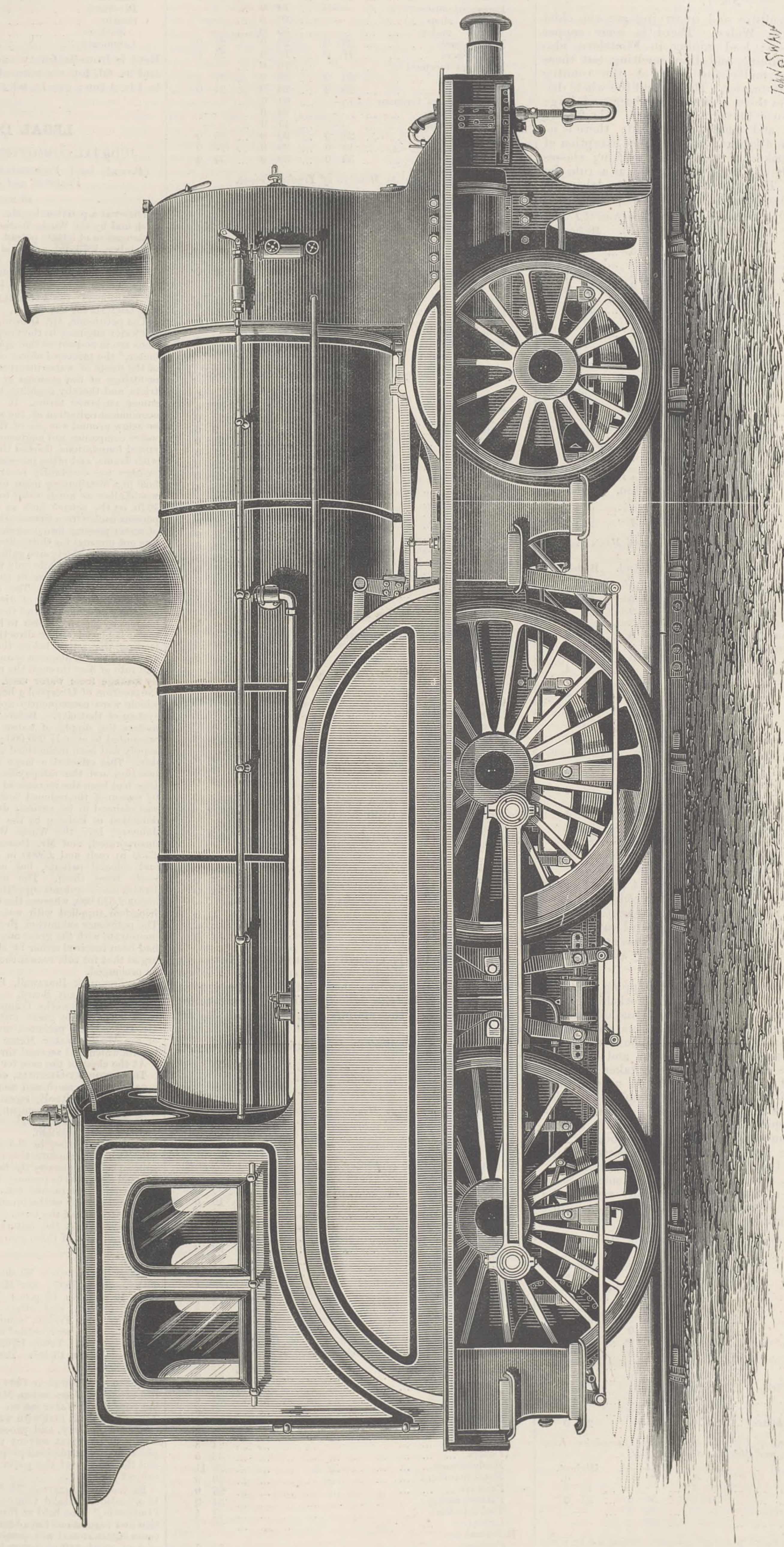
The ejectors by which the above-described operation is carried out are three strong cast iron cylinders, two of these being perfectly globular. One of the three has a capacity of 500 gallons, and the others of 350 gallons each. The larger one is sufficient of itself to discharge all the drainage from the Houses, even when there is a rainfall over their entire area of one inch in twenty-four hours. When, owing to a rainfall above that average, greater capacity for discharge is required, one of Julius Sax's electric water gauges signals the fact both to the ejector chamber and to the engine room. The attendant in the former then opens the valves admitting the sewage into the second and third of the ejectors, as he may be warned to be necessary. The principle on which Shone's pneumatic ejectors are worked is well known, but it may be desirable briefly to describe it. When the ejector is filled, the pressure of the fluid compresses the air within a cup at the top of the vessel. This actuates a valve which admits the compressed air, while it also at the same time closes the inlet valve and opens that for ejection, reverse action occurring when the sewage is fully discharged. The refilling is then automatically resumed. The whole of the valves are so constructed, and the discharge from the bottom of the ejectors is so free, that even foreign substances—such as ginger-beer bottles, &c.—can be passed without affecting the working, while the parts of the whole machine are so completely air and gas tight that the air in the chamber containing the ejectors is maintained perfectly sweet. A pressure of ten pounds to the square inch is found to be ample to raise the sewage to the greatest height required, the minimum lift being 12ft., while the maximum will never probably exceed 20ft.

The compressed air—which after service in the ejectors ascends the ventilating shaft in the Victoria Tower—is supplied by air compressors driven by Atkinson's patent differential gas engines. There are four of these engines, each being of 4-horse power. They are located in the basement, about 650ft. from the ejector chamber. One is sufficient to do the ordinary work of the Palace, the others being worked as reliefs or on occasions of considerable rainfall. The gas consumption of a single engine per hour is 56 cubic feet. The gas is drawn from the Palace mains, which are supplied by a special main from the public gas works with cannel coal gas. This is delivered at the rate of 3s. 9d. per 1000ft., so that the cost per hour of the ordinary drainage of the Palace for the item of fuel is only about 2½d.

The pressure gauges indicate a fall during the action of the compressed air in the ejectors from the standard of 10 lb. to about 7 lb., of which fall about ¾ lb. is estimated to be due to work in overcoming friction. The standard is re-attained during the progress of the refilling of the ejectors with sewage. This last operation in dry weather occupies about fifteen minutes, but under any circumstances the ejection is accomplished in but half a minute. No inconvenience is felt from the air compressors being situate at the distance before named from the ejectors. Three large cylinders in the pipe circuit which conveys the air pressure store a reserve which is ample to prevent the compression being unduly tasked during the emptying of the ejectors, and neutralise any excessive fall of the gauges which might otherwise arise during that operation. Attention has been strictly bestowed upon all subsidiary drains. Most of these have been relaid, and in iron, while their connections with the main sewage pipe having been enclosed within the concrete envelopment of the latter, perfect innocuousness in case of leakage of gas has been ensured. Beyond this, every care has been taken with respect to the efficient working of the closets and other sources of sewage contribution. The ventilation of the new 12in. main is secured by the admission of fresh air into the subway which formerly served as the main sewer; this last is now paved and limewhited. The air entering it passes into the ejection chamber, thence by an air duct at the top of it into the sewage manhole, where part of it enters the 12in. sewer; it being finally disposed of in the furnace at the base of the Victoria Tower.

Before quitting the subject of the improvements we have described, we may fitly refer to others of a different character which have also been made, and which are calculated to add greatly both to the healthiness of the Palace and to the comfort of those occupying it. Among these may be noted the improved ventilation of the writing and smoking-rooms, and the fitting of a new steam serving table, open ranges, and other improvements in the kitchen department, while the new entrance to the strangers' gallery will avoid the necessity at present existing for those resorting to it to pass through the members' lobby. A further desideratum is being constructed in the shape of a new shelter for setting down members in the Star Court. There can be no doubt that, taken altogether, a large amount of very excellent and useful work has been accomplished, and the outlay upon it is certain to be fully remunerated by the security obtained against the dangers and inconveniences which were present until it was undertaken. That outlay as regards the drainage works appears to have been moderate, it being stated to have been but little over £11,000, the amount of the approximate estimate originally submitted by the engineer for the guidance of the Treasury and of the Commissioners of Works and Public Buildings.

THE aquarium constructed by the Executive of the Fisheries Exhibition in 1883 has just been sold by the Royal Commissioners by public auction, the property realising £100 in the aggregate. This shows how little value, apart from a money providing institution, even those so much interested place upon this sort of thing.



COMPOUND EXPRESS ENGINE, NORTH EASTERN RAILWAY.

MR. T. W. WORSDELL, M. INST. C.E., GATESHEAD, ENGINEER.

(*For description see page 97.*)

WAGES IN GREAT BRITAIN.

No. V.

Holyhead.—Agriculture and quarrying are the chief industries of North Wales. There is some copper mining in Anglesea; lead mining in Flintshire, also considerable coal mining and iron smelting, but these latter come more under the head of the country generally than of the district. Throughout the whole district of North Wales there is an entire absence of large towns, none being over 14,000 in population. The feeling between employer and employed is good; there is no organised condition of labour; and, with the exception of slate quarrying, strikes are rare. The working classes generally are steady and trustworthy, and as a rule the people are saving. The rates of wages paid to labourers of every class average from 6s. 1d. to 18s. 3d. a week.

Wages per Week of Fifty-four Hours in Holyhead.—General Trades.

	Lowest. s. d.	Standard. s. d.	Highest. s. d.
Bricklayers	—	31 3	—
Carpenters	24 3	25 0	30 4
Masons	26 2	31 3	36 5*
Blacksmiths	25 3	27 9	30 4
Strikers	16 2	18 2	20 3
Horseshoers	15 2	23 9	30 4
Millwrights	24 3	25 0	30 4
Tinsmiths	24 3	25 0	30 4
Labourers	12 2	15 10	20 3

Wages Paid per Week of Sixty Hours in Foundries, Ironworks, and Machine Shops in Holyhead.

	Lowest. s. d.	Standard. s. d.	Highest. s. d.
Engineers	30 4	36 3	42 6
Fitters	27 3	34 10	40 5
Moulders	30 3	35 4	40 5
Patternmakers	29 2	34 5	39 7
Labourers	16 2	20 8	25 3

Wages Paid per Week to Railway Employés in Holyhead.

	Lowest. s. d.	Standard. s. d.	Highest. s. d.
Inspectors	25 3	27 1	29 6
Labourers	16 2	18 7	24 3

Wages Paid per Week of Forty-eight Hours in Lead Mines in North Wales.

	Lowest. s. d.	Standard. s. d.	Highest. s. d.
Day work, surface	12 3	13 0	13 9
Driving levels	15 3	16 0	16 9
Engine drivers, pumping	17 3	17 9	18 3
,, ,, winding	—	17 3	—
Engineer for repairs	18 9	19 6	20 3
Filling underground	13 9	16 0	18 3
Landing surface	—	13 9	—
Orewashers overlookers	20 9	22 6	24 4
,, men	12 3	13 9	15 3
Sawyers	15 3	16 9	18 3
Sinking shafts	—	18 9	—
Stoping	15 3	16 0	16 9
Smiths	15 3	17 9	20 3
Trammers underground	15 3	16 9	18 3

Wages Paid per Week in the Penrhyn Slate Quarries, Carnarvonshire.

	s. d.		s. d.
Blacksmiths	24 3	...	—
Engine driver	24 3	—	26 4
Rockman (working in and removing bad rocks)	25 3	—	27 4
Slate workers	30 5	—	32 5
Labourers	20 3	...	23 1

Wages Paid per Month to Engineer of Coasting Steamer in Holyhead.
Lowest, £7 2s.; Standard, £9 12s.; Highest, £12 3s.

Rent paid by quarrymen varies from £4 1s. to £8 2s. a year. In the largest quarry in Carnarvonshire houses are provided for most of the men at rents of from £2 10s. 6d. to £4 1s. a year. The general condition of the working classes is good, and their homes are comfortable. The average cost of living of a family six in number in Holyhead is 21s. a week.

Hull.—Hull is one of the principal shipping ports for the manufactures of Lancashire and Yorkshire. The staple industry is seed crushing for cake and oil making. There are also extensive cement, chemical, and engineering works, foundries, and large iron shipbuilding yards. The general relations between employers and employed are good, no strikes of importance having taken place for years. In cases of accident, employers, as a rule, allow the injured a small weekly sum. The organised condition of labour has for a long time been in a depressed state owing to the shipping trade being very dull, and so causing a great number to be out of employment. As a rule, the working classes are clean, respectable, and steady. Latterly they have become more trustworthy, they dress neatly, and have comfortable homes. Some rise gradually to a better position; many save; and a large number are members of building and insurance and provident societies.

Wages Paid per Week of Fifty-Three Hours in Hull.—General Trades.

	Lowest. s. d.	Standard. s. d.	Highest. s. d.
Bricklayers	—	30 11	—
Carpenters	—	31 0	—
Masons	—	33 2	—
Blacksmiths	32 0	35 0	38 0
Strikers	18 0	20 0	20 11
Brassfounders	25 0	31 0	35 0
Cutlers	25 0	25 6	30 0
Horseshoers	27 0	—	29 8
Ironmoulders	23 10	33 9	44 9
,, (York)	25 10	29 11	—
Millwrights	—	33 2	—
Tinsmiths	—	24 0	—
Labourers (sixty hours)	20 0	—	24 0

Wages Paid per Week of Fifty-Three Hours in Foundries, Ironworks, and Machine Shops in Hull.

	Lowest. s. d.	Standard. s. d.	Highest. s. d.
Apprentices†	4 0	—	10 0
Borers	30 0	30 0	33 0
Brassfinishers, foremen	—	36 0	—
,,	—	29 2	—
Fitters	30 0	30 0	34 0
Foremen, outdoor	—	70 0	—
,, shop	—	60 0	—
,, under	—	35 0	—
Machinemen	20 0	23 0	28 0
Labourers	17 0	19 0	25 6
Moulders' foremen	—	70 0	—
,,	34 0	34 0	37 0
Labourers	20 0	23 0	24 0
Patternmakers' foreman	—	60 0	—
Patternmakers	—	33 0	—
Smiths' foreman	—	45 0	—
Smiths	28 0	30 0	35 0
Strikers	19 0	20 0	23 0
Turners	30 0	30 0	34 0

* Extensive works in North Wales are generally carried out by workmen from Liverpool, Manchester, &c., at the rates of wages paid in their respective localities.

† Commence at 4s. a week, and rise by 1s. a week per annum to 10s. a week.

Wages Paid to Members of Trades Unions.

Stonemasons (Goole) ... per hour 6d. & 7d.
Boilermakers & iron shipbuilders (Hull) per week, 30s. 5d.

Wages Paid per Week of Fifty-three Hours in Factories and Mills in Hull.

	Lowest. s. d.	Standard. s. d.	Highest. s. d.
Engine-driver, oil mill	25 0	—	30 0
,, steam saw mill	—	24 0	—
Foremen	30 0	—	35 0
Men	22 0	—	25 6
Grinders, oil mill	—	25 0	—
Parers	20 0	—	22 0
Pressmen	—	32 0	—

Wages Paid per Week of Fifty-four Hours in Iron Shipbuilding in Hull.

	s. d.
Angle iron smiths	37 6
Strikers	21 0
Apprentices	9 6
Caulkers	31 0
Chippers	31 0
Drillers	21 0
Engine driver	29 0
Fitters	28 6
Labourers	19 0
Foremen	60 0
Platers	36 0
Rivetters	31 0
Shipsmiths	28 6
Strikers	20 0
Helpers	21 0
Holders-up	25 6
Labourers	20 0

Wages Paid to Men in Employ of Corporation of Hull.

			s. d.
Borough engineer's department	...	per week	30 0
Coal	,,	,,	16 10
Waterworks	,,	,,	20 0

Wages Paid per Month to Engineers of Steamers in Hull.

	£ s. d.
Ocean—	
Chief engineer	13 10 0
Second ,,	9 0 0
Donkey man	6 0 0
Coast—	
Chief engineer	10 0 0
Second ,,	8 0 0
Donkeyman	5 10 0

Rent is from 3s. to 4s. a week; coal is from 10s. 4d. to 16s. 8d. a ton; gas is from 2s. to 3s. per 1000 cubic feet.

Example of Cost of Living per Annum for a Family, Six in Number, in Hull.

	£ s. d.
Food and fuel	42 3 0
Clothing	15 0 0
Rent	8 18 0
	66 1 0
Income	72 16 0

Jarrow.—Jarrow is virtually a suburb of Newcastle-on-Tyne and South Shields, and the conditions of labour will be found under the head of the former town. The principal industries are coal-mining, ironfounding, iron shipbuilding, the manufacture of chemicals, and paper.

Wages Paid per Week in Jarrow.—General Trades.

		d.
Bricklayers	per hour	8¼
Carpenters	,,	8
Masons	,,	7½

Wages Paid to Members of Trades Unions.

		s. d.	s. d.
Bricklayers	per hour		0 8¼
Ironfounders (South Shields)	per week	24 0—	36 0

Wages Paid per Week of Fifty-four Hours at Jarrow Shipyard.

		s. d.
Caulkers	Day work	30 0
Drillers	,,	19 0
Fitters	,,	28 0
Painters	,,	28 0
Platers	,,	32 0
Rivetters	,,	30 0
Smiths	,,	29 6
Angle-iron smiths	Piecework	55 8
Caulkers	,,	40 7
Drillers	,,	25 8
Platers	,,	57 1
Rivetters	,,	37 3

Average Rates of Wages Paid per Week of Fifty-four Hours in Messrs. Palmer's Shipbuilding and Iron Company, Jarrow.

	s. d.
Blacksmiths	31 6
Strikers	19 0
Brass-finishers	32 6
Brass moulders	30 3
Coppersmiths	33 2
Drillers (machine)	21 3
Engine-men	24 8
Fitters	32 5
Machine-men	29 11
Metal moulders	30 9
Painters	26 0
Pattern-makers	34 0
Tool repairers	32 4
Labourers	20 4
Boilermakers—	
Caulkers	32 0
Drillers	22 10
Flangers	38 0
Holders-up	27 1
Planers	25 6
Platers	37 3
Rivetters	34 0
Smiths	29 3
Strikers	21 3
Labourers	19 11

Rent is from 3s. for two-roomed houses, to between 7s. 6d. and 9s. 6d. for six-roomed houses a week; coal from 10s. to 14s. a ton; gas 1s. 9d. to 2s. 3d. per 1000 cubic feet.

LEGAL INTELLIGENCE.

JUDICIAL COMMITTEE OF THE PRIVY COUNCIL.

(*Present*—Lord FITZGERALD, Lord HOBHOUSE, Sir BARNES PEACOCK, *and* Sir RICHARD COUCH.)

DEACON'S PATENTS.

THIS was a petition by Mr. George Frederick Deacon, of Liverpool, and by the Waste Water Meter Company (Limited) for the prolongation of letters patent granted to Mr. Deacon in March and December, 1873, for a period of fourteen years, in respect of his inventions of improvements in the apparatus for measuring the flow and indicating the velocity of water in pipes.

Mr. ASTON, Q.C., and Mr. CHADWYCK HEALEY were counsel for the petitioners; the ATTORNEY-GENERAL, Mr. R. S. WRIGHT, and Mr. LOEHNIS for the Crown.

The petitioner, Mr. Deacon, is now, as he has been since 1871, the water engineer to the Corporation of Liverpool, and the inventions are in respect to the apparatus known as "the waste water meter," the principal object of which is to facilitate the detection of the waste of water incurred by leakage from the mains, pipes, or fittings of the systems of water supply in large towns or districts, and thereby enabling the water to be obtained by the consumer on lower terms. It was stated that the detection and economical reduction of the waste of water due to leakage above or below ground was one of the most difficult questions with which water companies and engineers had to deal. Waste water undermined foundations, flooded the basements of buildings, interfered with drains, and often poisoned the supply of water itself. Such leakage was constantly recurrent in all large water systems. A hole in a distributing main no larger than a needle in diameter would allow as much water to discharge itself under a pressure of 40 lb. on the square inch as would supply two households of six persons each with a liberal allowance, and out of every 100 gallons of water passing into a service main during twenty-four hours it was not unusual for thirty-five gallons to be lost by continuous or hidden waste, thirty-five gallons more by superficial waste through defective fittings, while only thirty were drawn off for use. The inventions of Mr. Deacon gave an easy means of detecting and localising the waste. The advantages of his system were the reduction of the labour of discovering waste; the increase of the certainty of discovery and the removal of the annoyance to householders by internal house to house inspection. The waste water meter is placed either directly upon the main or on a loop pipe leading the water below the footway. The mechanism is so arranged that a diagram is automatically drawn recording the time and rate of flow through the main and distinguishing water wasted by leakage from water used. In 1874 Mr. Deacon granted the Corporation of Liverpool a licence to use the meter and apparatus, which were consequently applied over the whole of the water system of that city. Before the introduction of the waste water meters the supply of water to Liverpool was intermittent, and amounted to over 17,000,000 gallons daily. Since then a constant supply had been maintained at a direct saving of 598,000 gallons a day. This effected a large annual saving of money to the Corporation and the ratepayers, and an important incidental advantage had been the increase of water pressure for extinguishing fires by reason of the reduced flow for ordinary purposes. This saving was claimed to be entirely due to the reduction of waste by the detection of leakage by the use of the waste water meters. In January, 1877, the Waste Water Meter Company, Limited, was incorporated, and Mr. Deacon assigned his patents to them for £350 in cash and £5000 in shares. There were several foreign and colonial patents, but no profits had, it was stated, been made from them. The meters had now been adopted by British water systems supplying in the aggregate a population of about 2,310,000, whereas the total of the population of the United Kingdom supplied with water by systems was about 20,170,000. The petitioner submitted that no remuneration in any way commensurate with the great merit and public utility of the inventions had been received either by Mr. Deacon or the company, and they urged that for this reason the term of the letters patent ought to be prolonged.

Sir Frederick Bramwell, F.R.S., Sir Robert Rawlinson, of the Local Government Board, and Mr. Louttit, the engineer of the Lambeth Waterworks Company, were called, and gave strong evidence as to the great utility and value of the inventions, and Mr. Deacon, the patentee, and Mr. Hope, the managing director of the Waste Water Meter Company, were examined as to the profits which had accrued through the invention.

At the close of the case for the petitioners,

The ATTORNEY-GENERAL, on the part of the Crown, said he did not dispute the merit and usefulness of the invention, but, as Mr. Deacon had admittedly received a remuneration of about £5000 in respect of it and the company had been very successful, he left it to their Lordships to decide whether that amount was adequate or justified a prolongation.

Their LORDSHIPS, in the result, intimated that, although the amount of the remuneration received by the patentee in this case approached very nearly the line where in the past it had not been deemed desirable to prolong letters patent, and that the company had earned large profits, yet, taking into account the great merit and public utility of the invention, they were disposed to grant a short extension of the term. They would therefore humbly advise her Majesty that the letters patent should be extended for an additional term of three years.

SOUTH KENSINGTON MUSEUM.—Visitors during the week ending 29th January, 1887:—On Monday, Tuesday, and Saturday, free, from 10 a.m. to 10 p.m.: Museum, 8422; mercantile marine, Indian section, and other collections, 2824. On Wednesday, Thursday, and Friday, admission 6d., from 10 a.m. to 4 p.m.: Museum, 683; mercantile marine, Indian section, and other collections, 116. Total, 12,045. Average of corresponding week in former years, 13,487. Total from the opening of the Museum, 25,386,304.

FINSBURY TECHNICAL COLLEGE.—At the January meeting of the Old Students' Association, Mr. F. Graham Ansell read an interesting paper on "Water as an Agent in the Economy of Nature." The author dealt first with water in its important relations to the science of geology, and proceeded to show the value of rain, by virtue of its great solvent properties, in the vast laboratory of plant life. The physical properties of water were also duly noted, and the reading of the paper was followed by a discussion on the subject generally.

BRUSSELS EXHIBITION, 1888.—A Commission has been appointed to organise a "Grand Concours International des Sciences et de l'Industrie," to be held at Brussels in 1888, and a plan of classification and regulations have been printed. The galleries of the Concours International will consist of a series of special exhibitions, each of which will be devoted to objects of the same class. There will also be an Exhibition of Importation and Exportation, divided into five sections and fifteen groups. Conferences will be held in connection with the Concours.

ABSTRACTS OF CONSULAR AND DIPLOMATIC REPORTS.

No. IV.

Argentine Republic—New Railways.—Numerous railways are in course of construction; concessions have just been granted for a line from Monte Caseros, on the river Uruguay to Carrientes, on the Parana; and another from the same starting point to Posadas in Missiones, thus bringing that part of the Upper Parana, on the borders of Paraguay, in communication with the Argentine banks of the river Uruguay at Concordia. A project is on foot for a line on the same gauge as the Buenos Ayres and Rosario railways, starting from Sunchales, in the province of Santa Fé, the furthest point in the extension, to Tucuman, thus avoiding the transhipment necessitated by the break of gauge on the present route *viâ* Cordoba. The Northern Colonies of the province of Santa Fé are being connected with the city of that name by a narrow gauge line which is to be extended to Cordoba, and connect with the line of similar gauge from Tucuman to the latter place. Schemes for new railways are being constantly brought forward.

Greece—New commercial treaty.—Rates of duty now levied on imports into Greece under the Anglo-Greek treaty of commerce, signed on 10th November last.

Articles.	Duty per cwt. s.	d.
Bronze in bars, blocks, plates, sheets, and wire ...	9	7
Copper and copper ore, copper in bars, blocks and sheets, and old copper	12	10
Lead and lead ore, lead in blocks, plates, and sheets	3	2½
Lead, other than pipes, printing types, rolls, sheets, and shot	160	0
Tin and tin ore, tin in bars, ingots, plates, and sheets	6	5
Zinc and zinc ore, zinc in bars and sheets, with or without alloy	3	2½

Morocco—Successful British competition.—The French Consul at Mogador complains that both the English and German merchants take much greater pains than the French to distribute and recommend their goods in the Moorish markets; copper and lead, which were formerly supplied from France, are now entirely furnished by England and Germany.

Peru—New customs tariff.—A new Peruvian tariff came into operation on the 1st January. The following articles pay an *ad valorem* duty of 10 per cent.:—Boats; bolts for ships; bricks, building and fireclay; composite metal plates for sheathing vessels; copper in bars, pipes, and leaves; fire engines; implements and tools used in agriculture, industry, mining and trade; iron knees; iron, pig; iron poles; iron wire; lead in bars or plates; miners' fuses; steam engines for agricultural, industrial, and mining purposes; tin and copper soldering; tin in plates, vessels, and boilers; vices; zinc in bars, ingots, or plates. Articles paying an *ad valorem* duty of 20 per cent.:—Copper boilers over 101½ lb.; iron in plates, corrugated, and galvanised; iron troughs; metal for alloying; nails, iron, wire, or zinc, excepting those with brass, china, or porcelain heads. Articles paying an *ad valorem* duty of 40 per cent.:—Articles of brass, bronze, and copper cutlery.

Russia—Sewerage and waterworks of Warsaw; openings for British goods.—The works undertaken in 1883, by Mr. W. H. Lindley, for securing and providing Warsaw with a water supply, will be completed in the ensuing spring. As upon completion they will suffice for a population only half that of Warsaw, it is expected that both the sewerage and waterworks will be extended. The following articles have been supplied from England:—Boilers, cocks, fire-bricks, sluice valves, steam engines, stoneware invert lining, and pipes. There are openings for lead piping—but it is doubtful whether Great Britain can compete in this article—stoneware gullies, pipes, and specials for house drainage—4in., 6in., and 8in. in diameter—sewer and water fittings, gullies, street and yard, syphons, traps, and water-closets.

Servia—Opening of new railway.—In November last a railway from Veleki-Plana, on the Belgrade-Kisch railway to Semendria, a commercial town of considerable importance on the Danube, was opened for goods and passenger traffic. Veleki-Plana is about forty-six and a-half miles from Belgrade, and twenty-seven miles south of Semendria. Imports from Roumania, and all river traffic below Semendria, will reach the south of Servia by this route.

Sweden—Purchase of railways by the State.—In consideration of great depression in all the industries of Sweden, more especially among the farmers, the Government last March appointed a Committee to examine into the cause of, and propose the most effectual measures for obviating or alleviating the prevailing distress. The Committee examined the question in detail, and made reports from time to time as the work proceeded. The first subject that came under their consideration was as to whether any benefit would accrue from a reduction of the present railway rates. Owing to the existing low price of produce, the railway rates press heavily on much of the staple productions of the country, which being heavy, such as coal, grain, iron, manure, ore, and timber, cannot bear the expense of long transit by rail. The railway lines are in length 4284 miles, of which 1483 belong to the State, and 2841 to private companies. A reduction on the State lines would be of partial benefit, and would only be effectual so far as a corresponding reduction was carried out on the private railways. This reduction, depending on the shareholders, could not be expected. The only way of securing the desired object seemed to be that all the private lines should be purchased by the State and a uniform tariff established. The Committee recommended "That steps be taken for the purchase by the State of all private railways in Sweden, excepting those of a purely local character, provided that they can be acquired at such a price as will not entail any serious loss to the country."

Turkey—Balkan Railways.—According to the Railway Convention of 1883, the Turko-Servian Junction Railway from Vranza, on the Servian frontier, to Uscup on the Salonica and Mikoulria should have been completed and opened for goods and passenger traffic in the middle of last October, but there does not seem any prospect of its completion before next June, owing to the works having been delayed through military preparations in Turkey. The line starts one and a-quarter miles below the town of Uscup, and proceeds for fifty-two miles through a fertile country to Vranza on the Servian frontier, and there joins the railway to Nisch and Belgrade, the Nisch-Vranja portion of which was opened in September last. Vranja is the southernmost town of Servia, and the depôt for the produce of the extensive and rich plains and valleys of the Upper Norava; and as it is the point where Servia and Upper Macedonia meet, and through which all communication from Albania, and Macedonia, with Servia Proper, passes, it will serve as an *entrepôt* and distributing centre for the direct trade which the Turko-Servian railway junction, when completed, will develope between Servia and foreign countries through the port of Salonica. The line is laid with a single track on a gently undulating country, so that there are few engineering difficulties of a serious nature. The road is firmly laid, well ballasted, and efficiently drained. There are fifty-nine gradients on the line, the heaviest of which is 1 in 67. There are not many curves—the largest has a radius of 6560ft., and the smallest of 843ft. There are no tunnels. The bridges number 170, 166 being under 33ft. in length, and four over. The largest bridge crosses the Vardar a little below the town of Uscup; it is 394ft. long. The platforms of all the bridges are of wrought iron, laid on stone buttresses, and piers of granite from quarries in the vicinity of the line. All the iron bridging comes from the works of Messrs. Lecoq, of Hal, and Nicaisey Deleave, of La Louvière and the Usine Oyle of Louvain and the *ateliers* of Seneffe, in Belgium, and was imported through Salonica. The sleepers are of red and white oak, imported chiefly from Austria, Russia, and Servia, and are laid at distances of 2ft. 6in. apart. The whole of the rails are steel, imported from Belgium and France, fished and fastened to the sleepers with iron spikes. There are four iron tanks containing about 1000 gallons of water each fixed on stone foundations. The line has been built by Messrs. Vitali and Co., who constructed the Belgrade, Nisch, and Vranja Railway. Most of the permanent lines have been made by sub-contractors, chiefly Belgian and French. The workmen employed were Albanian, Bulgarian, Italian, and Servian. The native workmen are well spoken of, and said to be easily formed into first-rate masons and navvies.

It is expected when this line is completed that the facilities which the railway junction will afford to trade in general will tend to promote the development of a direct trade between England and Servia, and that the important advantage of low freights to Salonica will enable British manufacturers to compete successfully in the markets of Southern Servia with Austrian and German industry; but much will depend upon the Customs arrangements of Servia and Turkey regarding the transit trade from and to Servia *viâ* Salonica.

AN AMERICAN AMMONIA REFRIGERATING MACHINE.

THE thermal advantages offered by ammonia for the artificial production of cold will be seen on comparison of its properties with those of other agents in use. The quantity of the agent which must be handled to produce a given effect is also a matter of great importance, for on this depends the bulk of machinery needed, and therefore the power. The relative volumes of several agents to produce the same effect are as follows:—Ammonia, 1; sulphurous acid, 2·9; ether, 18; air, 43. This indicates an immense advantage for ammonia as to the size of machinery, and cost of fuel to run it. When a leak occurs, if it takes place from the machine outwards, it is easily detected, and the only loss is that of a portion of the charge. If the leakage takes place from the outside inwards it is not so quickly discovered, and is generally productive of disastrous results. In the case of ether, the charge is destroyed and the apparatus stopped; in the case of sulphurous acid, a highly corrosive acid is formed. Ammonia under these circumstances would suffer no chemical change; but the case can never occur, since the pressure in the apparatus is always greater than that of the outside atmosphere, so that any leakage is outwards. Ether machines are liable to stoppage from this cause, being always worked below the atmospheric pressure. Sulphurous acid machines when worked to produce a temperature under 15 deg. Fah. run under the same disadvantageous conditions.

The machine illustrated by the engravings on pages 90 and 91 is made by Messrs. W. H. Wood and Shipley, of Liberty-street, New York, and is the result of much experience and study of all that has been done in this direction. Everything of a complicated nature has been excluded. The principle on which it acts is very simple. Ammonia gas is compressed by means of a pump until through reduction of temperature—by a flow of cold water—it liquefies. The liquid thus formed under pressure is conducted to the refrigerators, where, in again assuming the gaseous form, it produces the cooling effect required, and thence returns to the pump to be again compressed and liquefied.

The machine has been constructed of a number of duplicate sectional parts, each of simple construction, and so combined that any one of them can be disconnected for examination or repair without in any way interfering with the working of the remainder.

The pump in a cold air machine is really the heart of the whole mechanism, and on its efficiency the success of the plant much depends. It will be seen from the engravings, Figs. 1, 2, and 3, that this pump has vertical cylinders and is very simple. The valve-box forms the head of the cylinder, and has two compartments to receive the suction and compression valves, as seen in Figs. 1, 2, 5, and 6.

The valves, Figs. 24 and 25, are fitted up in cages, and are of the equilibrium type to prevent noise in working and to minimise the wearing of the valve faces. They are easily fixed in their places, and can be removed in a few minutes and replaced with duplicates.

A pump, to be efficient, must clear out the whole of the ammonia gas at each stroke, otherwise the compressed gas will re-expand on the return stroke, and, by partially filling the cylinder, prevent the entrance of fresh gas. In this pump a novel and ingenious application of the lubricating liquid forms a seal on the piston—see Fig. 7—by means of which every particle of ammonia gas is expelled from the cylinder at each stroke, and it is utterly impossible for any to return; at the same time, the whole internal mechanism is thoroughly lubricated.

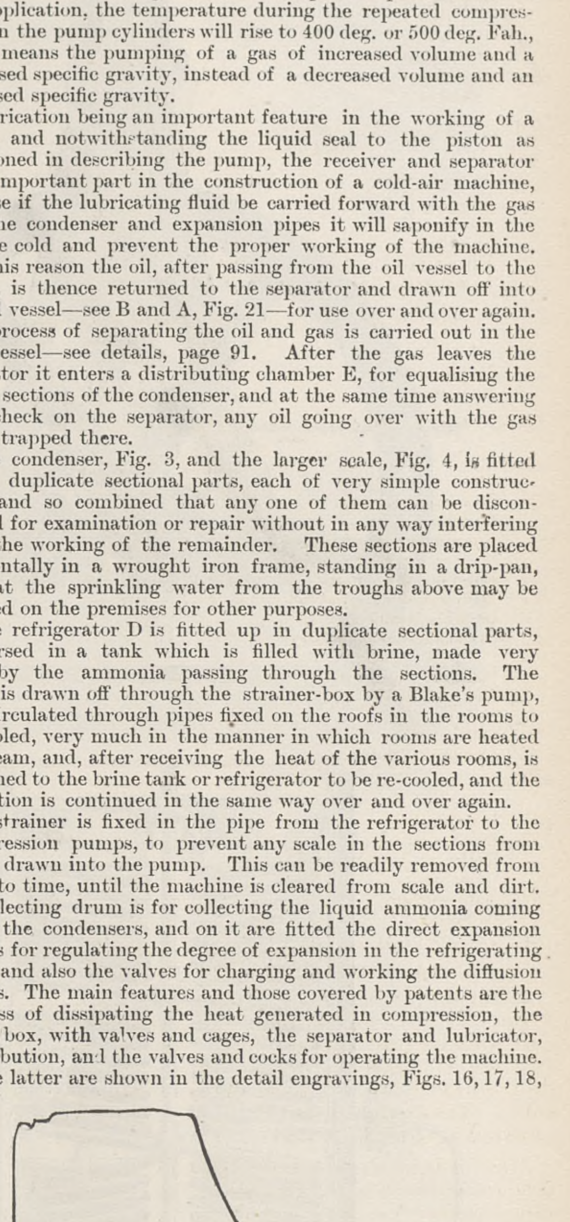
In the compression of ammonia gas a large amount of heat is generated in the cylinder, causing not only great practical inconvenience, but a considerable loss of power. A number of plans have been adopted for diminishing this evil, none of which are perfect. A distinct feature in Mr. Wood's invention has met and overcome this difficulty in a very pretty and simple manner. Ammonia, in passing from the liquid to the gaseous state, absorbs heat. A certain quantity, therefore, is introduced through an atomising nozzle into a diffusion valve placed between the refrigerator and the vacuum side of the pump, so that the gas, passing from the refrigerator to the pump, is partly saturated, and is evaporated by the compression and by adjusting the proportion of the injected gas. The temperature is thus brought under perfect control, and the temperature of the pump cylinder is made independent of the piston speed. Without this application, the temperature during the repeated compressions in the pump cylinders will rise to 400 deg. or 500 deg. Fah., which means the pumping of a gas of increased volume and a decreased specific gravity, instead of a decreased volume and an increased specific gravity.

Lubrication being an important feature in the working of a pump, and notwithstanding the liquid seal to the piston as mentioned in describing the pump, the receiver and separator is an important part in the construction of a cold-air machine, because if the lubricating fluid be carried forward with the gas into the condenser and expansion pipes it will saponify in the intense cold and prevent the proper working of the machine. For this reason the oil, after passing from the oil vessel to the pump, is thence returned to the separator and drawn off into the oil vessel—see B and A, Fig. 21—for use over and over again. This process of separating the oil and gas is carried out in the one vessel—see details, page 91. After the gas leaves the separator it enters a distributing chamber E, for equalising the gas to sections of the condenser, and at the same time answering as a check on the separator, any oil going over with the gas being trapped there.

The condenser, Fig. 3, and the larger scale, Fig. 4, is fitted up in duplicate sectional parts, each of very simple construction, and so combined that any one of them can be disconnected for examination or repair without in any way interfering with the working of the remainder. These sections are placed horizontally in a wrought iron frame, standing in a drip-pan, so that the sprinkling water from the troughs above may be utilised on the premises for other purposes.

The refrigerator D is fitted up in duplicate sectional parts, immersed in a tank which is filled with brine, made very cold by the ammonia passing through the sections. The brine is drawn off through the strainer-box by a Blake's pump, and circulated through pipes fixed on the roofs in the rooms to be cooled, very much in the manner in which rooms are heated by steam, and, after receiving the heat of the various rooms, is returned to the brine tank or refrigerator to be re-cooled, and the operation is continued in the same way over and over again.

A strainer is fixed in the pipe from the refrigerator to the compression pumps, to prevent any scale in the sections from being drawn into the pump. This can be readily removed from time to time, until the machine is cleared from scale and dirt. A collecting drum is for collecting the liquid ammonia coming from the condensers, and on it are fitted the direct expansion valves for regulating the degree of expansion in the refrigerating coils, and also the valves for charging and working the diffusion valves. The main features and those covered by patents are the process of dissipating the heat generated in compression, the valve box, with valves and cages, the separator and lubricator, distribution, and the valves and cocks for operating the machine. These latter are shown in the detail engravings, Figs. 16, 17, 18,



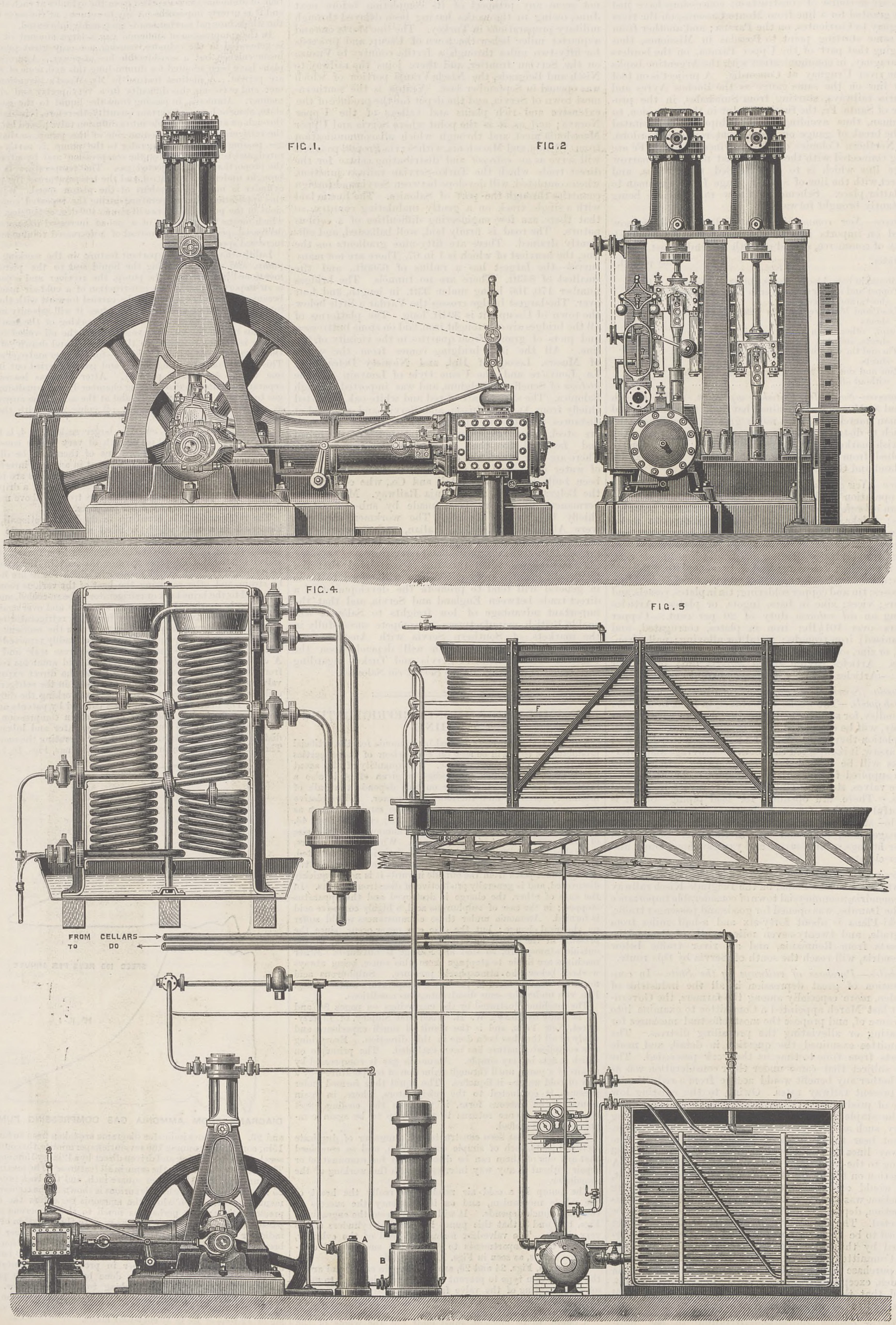
DIAGRAMS FROM AMMONIA GAS COMPRESSING PUMPS.

and 20. The above indicator diagrams are taken from an 8in. by 15in. compressor running 100 revolutions per minute, the compressors being single-acting and driven direct by a 12in. by 15in. engine. The diagrams are much the same in all features. The maximum pressure shown is 118 lb. per square inch, and the back pressure 25 lb. A palpitation which is curious is shown at the commencement of the stroke on which the ammonia gas enters the compressor cylinder, due perhaps as much to the numerous small passages through which the gas passes as to the vibration of the indicator spring. The machine is refrigerating a lager beer brewery with 55,000 cubic feet of storage, with insulation not of the most perfect character, having from 8000 to 9000 barrels of beer on storage besides beer in process of fermentation. This work during the summer is done by working each pump alternately with the engine working to 21-horse power. As another mode of expressing the power of the machine the makers say that it is calculated to do cooling equal to the melting of 12 tons of ice in twenty-four hours.

AMERICAN AMMONIA REFRIGERATING MACHINE.

MESSRS. WOOD AND SHIPLEY NEW YORK ENGINEERS.

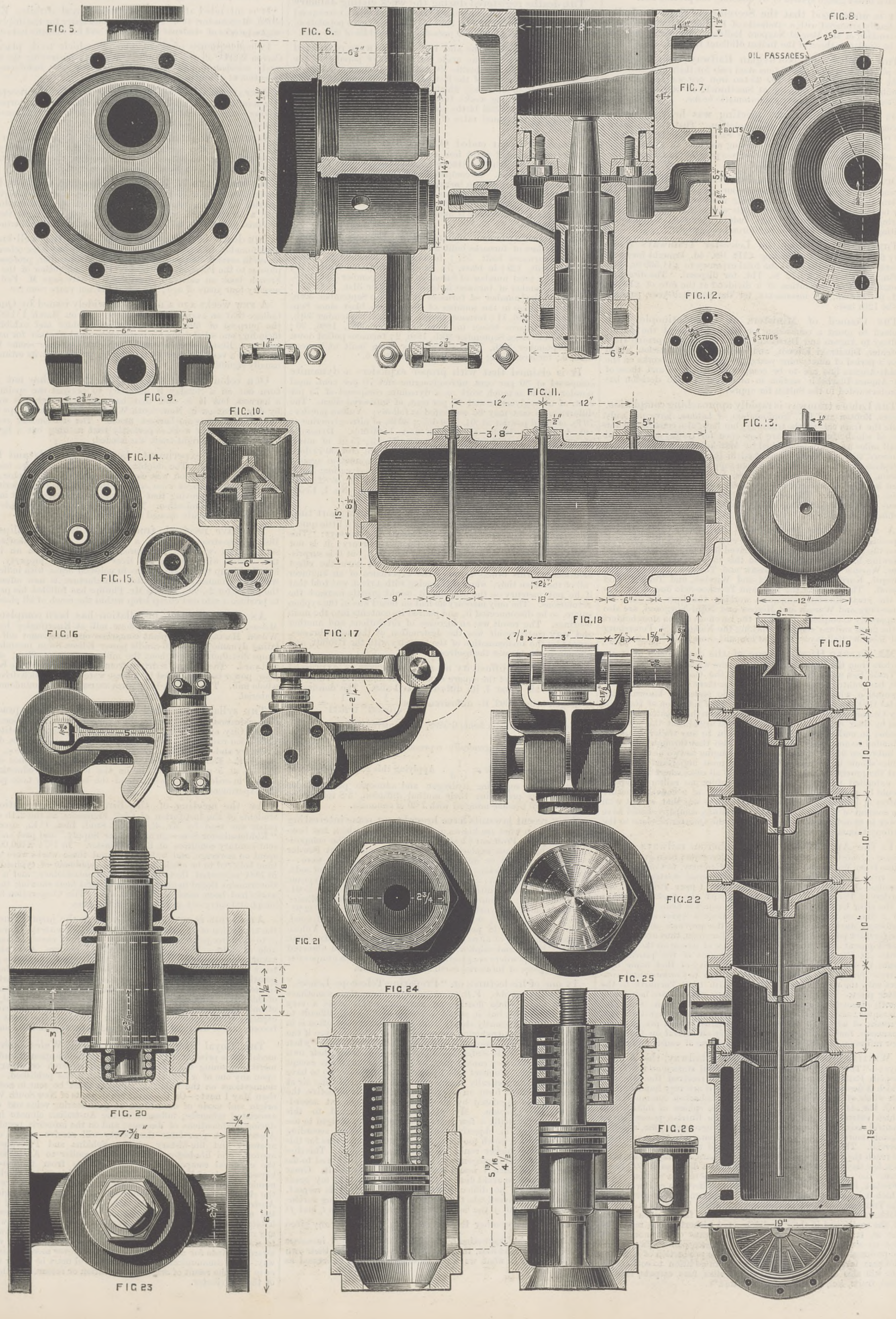
(*For description see page 89.*)



AMERICAN AMMONIA REFRIGERATING MACHINE.—DETAILS.

MESSRS. WOOD AND SHIPLEY, NEW YORK ENGINEERS.

(For description see page 89.)



RAILWAY MATTERS.

THROUGH railway communication has been opened between Melbourne and Adelaide, thus saving a day in the delivery of mails in Victoria.

A PROPOSAL is under consideration for increasing the carrying capacity of the Rajpootana Railway, either by converting it into a broad gauge system or by doubling the present line.

IT is understood that the Secretary of State for India has finally arranged with a syndicate of English capitalists for the construction of the Bengal-Nagpore Railway. The terms granted will be similar to those of the Indian Midland Railway.

THE Swedish and Norwegian Railway Company have just placed an order for 5000 tons steel rails for their line with Mr. Fried Krupp at Essen, and 100 25-ton iron ore wagons with the Birmingham Wagon Company at Smethwick, all of which are to be fitted with the Westinghouse automatic brake.

ON Friday last a vestry meeting was held at Flamborough to consider and pass the resolution, "That the consent of this vestry be given in favour of the Flamborough Head Tramway Bill." Afterwards a public meeting was held in the National School-room, when another resolution was passed "in favour of the Flamborough Head Tramway Bill."

OUR Birmingham correspondent writes:—"The Indian railways are again affording some encouraging work. The South Indian Railway Company is requiring ironwork and fittings for fifty ballast wagons, 200 pairs of wheels with axles, and 200 wagon bearing springs; and the Great Indian Peninsula Company is inviting tenders for some steel and iron bridgework."

THE total receipts of the Leicester Tramways Company for the half-year, including £118 10s. 4d. brought forward, amount to £15,332 18s., and the total expenses to £11,560 9s. 1d., leaving a balance of £3772 8s. 11d. for disposal. The directors recommend the declaration of a dividend at the rate of £10 per cent. per annum, less income-tax, for the past half-year, payable on the 12th inst.

THE Council of Ministers at Constantinople have resolved to grant a concession for the extension of the Ismidt Railway to Angora and Diarbekir, to a company comprising Herr Seefelder, Dimitraki Effendi, and others. The concession, which is for a period of ninety-nine years, provides that the works on the Ismidt-Angora line are to be completed within five and those of the Angora-Diarbekir section in nine years. The decision has been forwarded to the Sultan for approval.

THE Lahore tramway is rapidly approaching completion. Messrs. Robson and Co., ironfounders, of Lahore, have not only made the tram cars for the tramway, but have also constructed the line, of which three miles are now open for traffic, and two and a-half miles more will be finished by March next. This is the first tramway that has been established in the Punjab, and with the exception of the rails which have been supplied by Messrs. Fleming, Wilson, and Co., Rood-lane-chambers, London, the whole of the plant has been manufactured by Robson and Co., including wheels, axles, springs, &c. There is every probability of several other towns in the Punjab following the example of Lahore, and establishing tramways.

A NEW law was promulgated in Russia on Saturday imposing a tax of 5 per cent. upon the guaranteed and of 3 per cent. upon the unguaranteed revenues derived from railway shares. The following lines are exempted from this tax:—Warsaw and Bromberg, Warsaw and Vienna, Warsaw and Terespol, Dünaburg and Witepsk, Kursk and Kieff, Orel and Witebsk, and Tamboff and Kosloff. The shares of the Lodz and Tzarskoe-Selo lines, as well as of the great Russian companies working the lines between St. Petersburg and Warsaw and Moscow and Nijni-Novgorod, are also temporarily exempted, as well as the revenues of the shareholders of the great railway company working the Nicholas (St. Petersburg and Moscow) Railway. The new law will come into force at once.

MR. ALFRED HICKMAN, one of the deputation of ironmasters from the Birmingham district who waited upon the Board of Trade last week in connection with the Government Railway Bill, has pointed out some important matters dealt with by the deputation which have not been made generally known. He states that the deputation recommended the retention of the Railway Commissioners, who they said had given the greatest satisfaction by their decisions. It was likewise urged that the provision against an undue preference being given to any trader should be extended to any district or place, and also that through rates over an unbroken line of communication belonging to two or more companies should be granted. One of the most important points was that the provisions of the Act should, in all cases where applicable, be extended to canals, and that in future no railway company should be permitted to acquire the control of a canal. Another matter of great importance to small traders was that, except with the consent of the local authority, no railway company should have power to transfer a rating appeal from the Quarter Sessions to the Railway Commissioners.

IN the Argentine Republic numerous railways are in course of construction, and concessions have just been granted for a line from Monte Caseros, on the river Uruguay, to Corrientes, on the river Parana, and another from the same starting point to Posadas, in Missiones, thus bringing the Upper Parana on the borders of Paraguay in communication with the Argentine banks of the river Uruguay at Concordia. A project is being put forward for a line on the same gauge as the Buenos Ayres and Rosario Railways, starting from Sunchales, in the province of Santa Fé, the furthest point on the extension, to Tucuman, thus avoiding the transhipment necessitated by the change of gauge on the present route *viâ* Cordoba. The northern colonies of the province of Santa Fé are being connected with the city of that name by a narrow gauge line, which is to be extended to Cordoba, and connect with the narrow line of similar width from Tucuman to the latter place. Other propositions for new railways are being constantly brought forward for Government sanction, some for guarantee, and others without. In regard to immigration, new arrivals, of whom 70 per cent. are Italians and 10 per cent. are Spaniards, find employment immediately on arrival on the many new railways, buildings, docks, &c., in course of construction.

WRITING upon the Transcaspian Railway, the *Novosti* says:—"The inauguration of the Tchardjui station on the Transcaspian Railway is an event which has not received the attention which it deserves. The consequences of it are very important, as the whole of Russia is thus brought into unbroken communication with the Amu Darya, the basin and the sphere of influence of which extend beyond the borders of the Russian possessions of Central Asia. The importance of the Transcaspian line, which is already more than 1000 versts long, is at once strategic and commercial. The Caucasus forces, instead of taking several months to reach the frontiers of Khiva and Bokhara, can now reach them in a few days. The English know that at a distance of 600 versts from the shores of the Caspian Sea there is a station called Duschak, from which the line bends in the direction of Herat, from which it is only 400 versts distant. The commercial importance of the Transcaspian line is not less considerable. The districts around Bokhara and Samarcand are among the most fertile upon the face of the earth, and if their wealth has not hitherto been made full use of, it is because of the defective means of communication. But no sooner was it known that the Transcaspian Railway would be prolonged to the Amu Darya than the production of cotton in Bokhara increased considerably, while, in addition to cotton, this line will also carry large quantities of silks, furs, carpets, leather, wool, fruits, &c., from the two khanates."

NOTES AND MEMORANDA.

THE population of the colony of Tasmania at the end of last year was estimated at 13,379.

THE six healthiest places in England and Wales last week were Derby, Birkenhead, Salford, Wolverhampton, Brighton, and Bolton.

THE deaths registered during the week ending January 29th in twenty-eight great towns of England and Wales correspond to an annual rate of 21·1 per 1000 of their aggregate population, which is estimated at 9,245,099 persons in the middle of this year.

IN London 2579 births and 1585 deaths were registered last week. Allowance being made for increase of population, the births were 284 and the deaths 391 below the average numbers in the corresponding weeks of the last ten years. The annual death-rate per 1000 from all causes, which had been 26·3, 23·0, and 21·8 in the three preceding weeks, further declined last week to 19.6. In Greater London 3356 births and 1956 deaths were registered, corresponding to annual rates of 32·3 and 18·8 per 1000 of the population.

DURING the year ended October 31st, 1886, the total quantity of steel and ingot iron made from phosphoric pig was 1,313,631 tons, of which 927,284 tons were ingot iron containing under ·17 per cent. of carbon. As compared with the make of the previous twelve months, there was an increase of about 368,314 tons. The total quantity produced represents about 394,000 tons of slag, containing from 30 to 35 per cent. of phosphate of lime. Much of the basic slag made in Germany is finely ground, and used in place of superphosphates.

THE following from "Ryland's Blast Furnace Returns," give particulars of furnaces built and in blast on December 31st. England, furnaces built, 587; furnaces in blast, 263; Wales, furnaces built, 129; in blast, 5; Scotland, furnaces built, 141; in blast, 75; total number of furnaces built December 31st, 1886, 857; total number of furnaces in blast December 31st, 1886, 377; decrease in the number of furnaces built since September 30th, 1886, 2; increase in the number of furnaces in blast since September 30th, 1886, 11; furnaces blown out since September 30th, 1886, 19; furnaces blown in since September 30th, 1886, 30; furnaces built since September 30th, 1886, 2; furnaces pulled down since September 30th, 1886, 4; furnaces being built at present time, 6; furnaces being re-built at present time, 6.

IT is claimed that with proper exploders a dynamite composed of 30 per cent. nitro-glycerine and 70 per cent. meal powder will do as much work as a dynamite composed of 75 per cent. of nitro-glycerine and 25 per cent. of infusorial silica. The difference in cost may be estimated as follows:—Vulcan powder: 70 lb. of meal powder at ·04, 2·80 dols.; 30 lb. of nitro-glycerine at ·40, 12·00 dols.—100 lb. of powder cost 14·80 dols. Dynamite No. 1: 25 lb. of infusorial silica at ·03, ·75 dol; 75 lb. of nitro-glycerine at ·40, 30·00 dols.—100 lb. of dynamite cost 30·75 dols. In a previous suit Judge Blatchford issued an injunction against the manufacture of the following powders:—Nitro-glycerine: No. 1, 67·64; No. 2, 27·86. Cellulose: Paper stock, No. 1, 16·82; sawdust and charcoal, No. 2, 5·59. Nitrate of soda: No. 1, 15·54; No. 2, 66·55.

REFERRING to a paragraph in this column a short time since concerning the effect on a bar of tin of rubbing a little quicksilver on its surface, the American *Mechanical Engineer* says: "This would seem to form an amalgam of tin and mercury; it is not surprising that such an amalgam should be rotten, but it is surprising that a little rubbed on the surface should have the effect mentioned. This brings to mind the experience of an engineer 'all of the olden time,' who, when racing with a rival, was told that if he put mercury on the bearings it would greatly increase the revolutions. The only mercury he had on board was in the syphon gauge, so he disconnected it, and poured its contents into the main bearings. The result was an increase of revolutions, and another and very costly result was the destruction of the main brasses, caused by the amalgamation of the mercury with the Babbitt, and ultimately the brasses themselves."

THE relative diffusivity of any two gases is expressed by the reciprocals of the square root of their densities. Thus, the density of air being 1, its diffusivity is 1 also. The density of hydrogen being 0·693, its diffusiveness is $\frac{1}{\sqrt{0{\cdot}693}} = \frac{1}{0{\cdot}2633} = 3{\cdot}8$; the density of ammonia being 0·5898, its diffusiveness is $\frac{1}{\sqrt{0{\cdot}5898}} = \frac{1}{0{\cdot}7681} = 1{\cdot}30$; and generally representing the density of a gas by d, its diffusiveness is $= \frac{1}{\sqrt{d}}$. Applying this rule to practice it appears that, supposing hydrogen and ammonia placed under circumstances promoting their mutual diffusion, 3·8 volumes of hydrogen will become mingled with 1·30 of ammonia.

SOME recent lawsuits have brought out some interesting information on what are known as high explosives, which has been summarised by Professor Chas. E. Monroe, U.S.N. The compositions of the various explosives that the Atlantic Giant Powder Company regarded as infringements of their patents were:—Vulcan powder consisting of nitro-glycerine, 32·60; nitrate of soda, 49·46; charcoal, 9·63; and sulphur, 8·31 per cent. Neptune powder consisting of nitro-glycerine, 32·66; nitrate of soda, 45·04; charcoal, 17·44; sulphur, 4·86; and ash, 0·94 per cent. Miners' Powder Company Dynamite consisting of nitro-glycerine, 32·91; nitrate of soda, 49·88; charcoal, wood, and partially charred wood, 17·21; and ash, 1·18 per cent. Brady's dynamite, or Vulcan powder, consisting of nitro-glycerine, 33·00; nitrate of soda, 50·00; charcoal, 10·00; and sulphur, 7·00 per cent. It will be observed that all these powders are practical dynamites, in which gunpowder is used in place of infusorial earth as the absorbent.

IN one of his lectures on "Preparing Telescope Lenses," Mr. Howard Grubb, F.R.S., said:—"I have also sometimes polished lenses while floating on mercury. This gives a very beautiful support, but it is not so convenient, as it is difficult to keep the disc sufficiently steady while the polishing operation is in progress without introducing other chances of strain. Even if the surface be finished absolutely perfectly, very large lenses when placed in their cells suffer considerable flexure from their own weight alone, as they cannot then be supported anywhere except round the edge. To meet this I proposed many years ago to have the means of hermetically sealing the tube and introducing air at slight pressure to form an elastic support for the objective, the pressure to be regulated by an automatic arrangement according to the altitude. My attention was directed to this matter very pointedly a few years ago from being obliged to use for the Vienna 27in. objective a crown lenses which was, according to ordinary rules, much too thin. I had waited some years for this disc, and none thicker could be obtained at the time. This disc was very pure and homogeneous, but so thin that, if offered to me in the first instance, I would certainly have rejected it. Great care was taken to avoid flexure in the working, but to my great surprise I found no difficulty whatever with it in this respect. This led me to investigate the matter, with the following curious results. If we call f the flexure for any given thickness t, and f^1 the flexure for any other thickness t^1, then $\frac{f}{f^1} = \frac{t^2}{t^{12}}$ for any given load or weight approximately. But as the weight increases directly as the thickness, the flexure of the discs due to their own weight, which is what we want to know, may be expressed as $\frac{f}{f^1} = \frac{t}{\ }$."

MISCELLANEA.

ON the Tasmanian Railway some of the Mount Nicholas Coal Company's coal from the 8ft. seam has been tried with a satisfactory result.

A CONTRACT is being placed upon the market, on account of the Barry Dock, for two pairs of wrought iron or steel dock gates and a wrought iron or steel caisson.

IT is intended at the forthcoming Royal Jubilee Exhibition, Manchester, 1887, to allot a certain space for the display of original works of students and artisans and for women's industries.

IN consequence of a serious fire which took place at Carron Works on the 26th ult., completely destroying the fitted goods warehouses and stores, the company asks indulgence in execution of orders in hand.

PREPARATIONS are being made at Rye for the reception of a number of convicts who will be sent there for the purpose of making concrete blocks from the shingle, to be used in the construction of the harbour works at Dover.

SATURDAY, the 12th inst., has been appointed for the private view of the Spring Exhibition of the 19th Century Art Society, at the Conduit-street Galleries, and the Exhibition will open to the public on Monday, the 14th instant.

MESSRS. J. AND W. WEEMS, of Johnstone, Glasgow, have brought out a new system, invented by Mr. Alexander Wylie, of covering telegraph, telephone, and all other electrical conductors with a casing of lead or lead composition pipe, which are thereby rendered impervious, non-corrosive, and proof against induction.

THE death is announced of M. Feil, the well-known glass founder, who prepared so many discs for the large telescopes in use in several observatories; and of M. Mercadier, professor of physics to the Polytechnic School of Paris, and author of the only French book on electrical measures. *Nature* says M. Feil was seventy-four years of age; M. Mercadier ten years younger.

A FEW weeks ago a notice was widely issued by Queen's College that an examination would be held on March 1, 1887, for the purpose of filling up various scholarships and exhibitions, including one scholarship for mathematics and another for natural science. Result, one candidate. Natural science seems to be valued at a very low rate by the British public, and its estimate is usually significant.

OUR colonists can sell corn cheap, for they not only turn out on a Sunday if necessary to prevent the spoiling of a harvest, but it is said that harvesting by night, as well as by day, went on in New South Wales in December, lamps being used as there was no harvest moon. The self-binding reaping machines did their work so perfectly that nothing but a light to keep them in the right track was needed.

TELEPHONIC experiments between Brussels and Paris have been made. The double phosphorus bronze wire used for telephonic transmission was connected with the telegraphic apparatus, whilst messages were sent by the latter. The experiments were decisive in proving that telegraphic messages do not impede telephonic communication. The service between Brussels and Paris will be officially opened in a few days.

WE have received from Mr. Edward Phillips, of Bishopsgate-street Within, a specimen of the Shaftesbury safety lamp, which is considered by experts to be an invention which will save many lives and much property. An identical lamp to the one sent us in polished brass, with indicating wick and chimney, all of British manufacture, is now offered to the public for 2s. 9d., so that Mr. Phillips has fulfilled his promise to produce a safe and cheap lamp within the reach of all classes.

AN electric lighting installation has been completed at Messrs. Croysdale and Sons' flour mill at Knottingley by Mr. Wilson Hartnell. The plant comprises one compound self-regulating dynamo and 63 16-candle power Edison-Swan incandescent lamps distributed throughout the mill, warehouse, offices, stables and yard. The dynamo is driven from the line shaft on the bottom floor, power being supplied by a large water-wheel which drives the whole mill. The pendant lamp wires are coated with uninflammable material.

THE syllabus is issued of a course of seven practical demonstrations, to be given in the dynamo-rooms and laboratories of the City and Guilds of London Institute, Central Institution, Exhibition-road, S.W., on testing of dynamos and motors, during February and March, by Professor Ayrton, F.R.S., Assoc. Mem Inst. C.E. Each demonstration will be given twice, once on the Friday, at 5 p.m., and again on the following Wednesday, at 5 p.m., in order that all who attend the course may take part in the experiments.

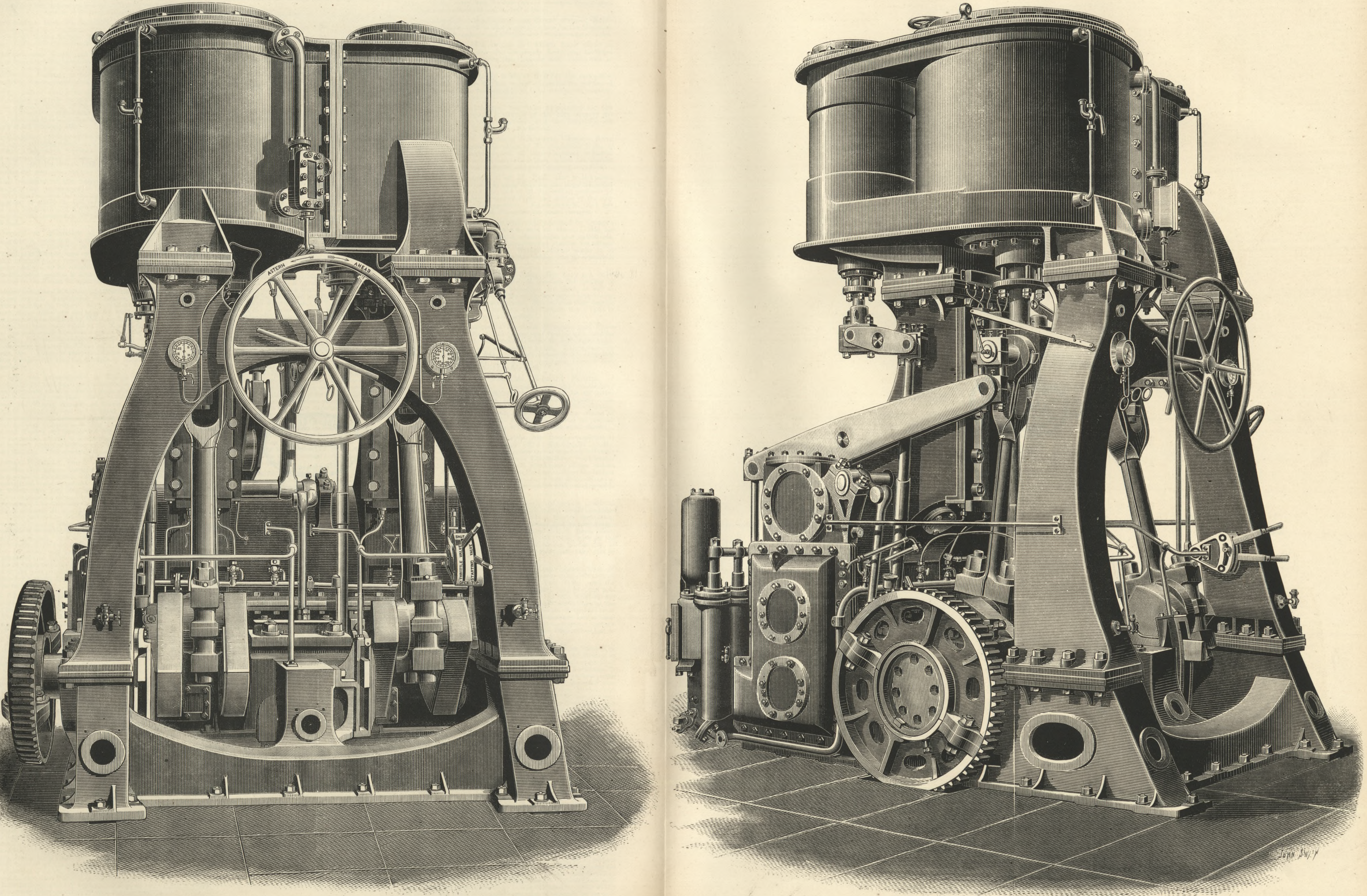
AT the meeting of the Birmingham Association of students of the Institution of Civil Engineers, on the 27th ult., a paper was read by Mr. R. Peirce, Stud. Inst. C.E., upon the "Kidderminster Sewerage and Water Supply," and past and present sanitary condition of Kidderminster. In 1874 £100,000 was spent on sewerage and waterworks, and these works were at the time believed to be efficient. A severe epidemic of typhoid fever in 1884 suggested that they were not satisfactory, and a Local Government Board inquiry brought to light facts showing that the works had been carelessly carried out. The Corporation had to adopt and carry out an improvement scheme.

ATTENTION is again being drawn to the improvement of the navigation of the Trent and its connection with the Mersey, so as to allow free passage from Liverpool to Hull of vessels of considerable draught. The Railway and Canal Traders' Association is taking steps to secure the placing of this navigation under a public trust or conservancy board, and is seeking to influence the Corporation of Nottingham, and the towns of Burton, Newark, and Gainsborough, in order to secure what is termed the independence of this river navigation. It is pointed out that an additional depth of only 12in. in the channel would add 50 per cent. to the carrying capacity of the vessels used, and that ultimately the Trent would become one of the most efficient inland waterways in the country.

THE Royal Society of New South Wales offers its medal and a prize of £25 for the best communication of sufficient merit containing the results of original research or observation upon any one of a list of subjects which it has published. Communications on the following subjects must be sent in not later than May 1 next:—On the silver ore deposits of New South Wales; origin and mode of occurrence of gold-bearing veins and of the associated minerals; influence of the Australian climate in producing modifications of diseases; and on the infusoria peculiar to Australia. A year later the society will receive papers on the anatomy and life-history of the Echidna and Platypus; the anatomy and life-history of Mollusca peculiar to Australia; and the chemical composition of the products from the so-called kerosene shale of New South Wales. The subjects on which communications must be sent in not later than May 1, 1889, are:—On the chemistry of Australian gums and resins; on the aborigines of Australia; on the iron ore deposits of New South Wales; list of the marine fauna of Port Jackson, with descriptive notes as to habits, distribution, &c. The competition is open to all without any restriction whatever, excepting that a prize will not be awarded to a member of the council for the time being; neither will an award be made for a mere compilation, however meritorious in its way. The communication to be successful must be either wholly or in part the result of original observation or research on the part of the contributor.

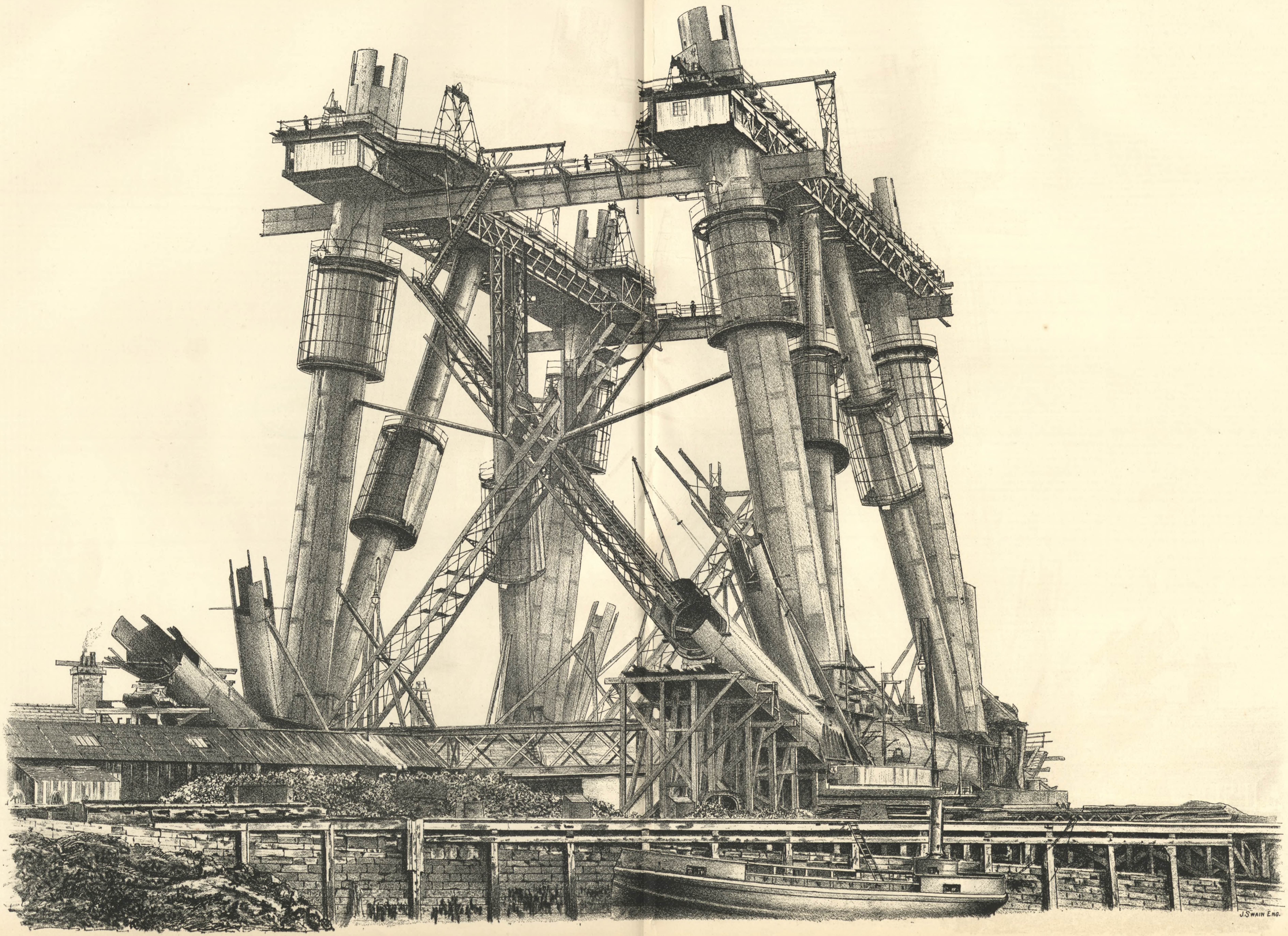
COMPOUND ENGINES OF THE STEAMSHIP POPLAR.

THE CENTRAL ENGINEERING COMPANY, WEST HARTLEPOOL, ENGINEERS.



THE FORTH BRIDGE.—THE NORTH QUEENSFERRY CANTILEVER PIER IN COURSE OF CONSTRUCTION.

SIR JOHN FOWLER AND MR. BENJAMIN BAKER, MM.I.C.E., ENGINEERS.



PUBLISHER'S NOTICE.

*** *This week is published a Double Number of* THE ENGINEER *containing the Index to the Sixty-second Volume, and Two Supplements, one being a double-page view of the Fife Pier of the Forth Bridge, the other a double-page engraving of the Compound Engines of the Steamship Poplar. Every copy as issued by the Publisher contains these Supplements, and subscribers are requested to notify the fact should they not receive them. Price of the Double Number,* 1s.

CONTENTS.

TO CORRESPONDENTS.

Registered Telegraphic Address "ENGINEER NEWSPAPER, LONDON."

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

*** *We cannot undertake to return drawings or manuscripts; we must therefore request correspondents to keep copies.*

*** *In order to avoid trouble and confusion, we find it necessary to inform correspondents that letters of inquiry addressed to the public, and intended for insertion in this column, must, in all cases, be accompanied by a large envelope legibly directed by the writer to himself, and bearing a* 1d. *postage stamp, in order that answers received by us may be forwarded to their destination. No notice will be taken of communications which do not comply with these instructions.*

D. C.—*Address the Secretary, Mr. T. Cole,* 6, *Westminster-chambers, Victoria-street, Westminster, S.W.*

EXPERIENCE.—*We have never heard of safety valves at sea being stuck to their seats by the deposit of oil residue carried over to the boilers from the surface condenser. Your experience seems to be unique.*

W. H. S.—*The loop at the lower corner of the diagram is due to the presence of water in the cylinder. The steam remaining at the end of the stroke is saturated, and liquefies when a certain pressure has been attained; so that compression no longer causes the pressure to rise. The lead of the steam valve is a great deal too late, the piston having made so much of its stroke as corresponds to the length of the loop before the port opens.*

B. C.—*Condenser tubes working in sea-water do not become incrusted, because the temperature is too low to throw down the salts of lime, &c., and the current through them keeps the surface washed. But on the steam side the tubes become foul with grease from the engines, and require to be cleared out occasionally by filling the condenser with a strong solution of soda in water; letting this lie for a couple of hours, and then blowing it out with steam.*

T. S. (Leamington).—*The heat of the steam at any pressure can be obtained from steam tables published in every treatise on the steam engine. The pressure of the steam issuing from the spout of the kettle is equal that of the atmosphere,* 14·7 *lb. on the square inch; its temperature is* 212 *deg. Molesworth gives the total or absolute pressure of the steam. Thus, the* 25 *lb. steam you speak of using has a total pressure of* 25 + 14·7 = 39·7 *lb., or, in round numbers,* 40 *lb.; its temperature is* 267 *deg. Steam of* 5 *lb. boiler pressure is really* 20 *lb., because the atmosphere loads the safety valve with* 15 *lb. per inch; its temperature is* 228 *deg. Steam of* 10 *lb. is nearly* 25 *lb.; its temperature is* 240 *deg.; and so on.*

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Advertisements cannot be inserted unless Delivered before Six o'clock on Thursday Evening in each week,

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

MEETINGS NEXT WEEK.

THE INSTITUTION OF CIVIL ENGINEERS, 25, Great George-street, Westminster, S.W.—Session 1886-87. Tuesday, February 8th, at 8 p.m.: Ordinary meeting. Papers to be further discussed:—"Sewage Sludge and its Disposal," by William Joseph Dibdin, F.C.S., F.I.C.; "Filter Presses for the Treatment of Sewage Sludge," by William Santo Crimp, Assoc. M. Inst. C.E., F.G.S.

SOCIETY OF ENGINEERS.—Monday, February 7th, at the Town Hall, Westminster, the President for the past year, Mr. Perry Fairfax Nursey, will present the premiums awarded for papers read during the year. The President for the year 1887, Professor Henry Robinson, will deliver his Inaugural Address.

SOCIETY OF ARTS, John-street, Adelphi, London, W.C. — Monday, February 7th, at 8 p.m.: Cantor Lectures. "The Diseases of Plants, with Special Regard to Agriculture and Forestry," by J. L. W. Thudichum, M.D., F.R.C.P. London. Lecture III.—Animal parasites as causes of epidemic and endemic plant diseases, illustrated by the Phylloxera—Comparison with Oïdium—Aphides or green-fly—Survey of parasites on forest trees—Necessity of greater attention to forest culture as a science—Physical and chemical causes and effects of diseases of plants—Comparison with vegetable ferments, beneficial and hurtful—Diseases of wine and beer—Conclusion. Wednesday, February 9th, at 8 p.m.: Ordinary meeting. "Purity of Beer," by A. Gordon Salamon. J. H. Puleston, M.P., will preside. Friday, February 11th, at 8 p.m.: Indian Section. "The Economical Condition of India," by Dr. George Watt, C.I.E. Sir George Birdwood, M.D., LL.D., C.S.I., will preside.

THE SOCIETY OF TELEGRAPH ENGINEERS AND ELECTRICIANS.—Thursday, February 10th, at 8 p.m.: Ordinary general meeting. For adjourned discussion:—"Telephonic Investigations," by Professor Silvanus P. Thompson, B.A., D.Sc., Member.

SOCIETY OF ARCHITECTS.—Tuesday, February 8th, in the Freemasons' Tavern, Great Queen-street, W.C.: Ordinary meeting. Paper to be read:—"Quantity Taking," by Mr. C. H. Searle.

DEATH.

On the 1st instant, at San Remo, COLONEL SIR JOHN U. BATEMAN-CHAMPAIN, R.E., K.C.M.G., in his fifty-second year.

THE ENGINEER.

FEBRUARY 4, 1887.

SHIPOWNERS AND THE PORT OF LONDON.

A LETTER has been addressed by the shipowners of the port of London to the Thames Conservators, which raises an important issue of considerable engineering interest. The shipowners point out that an urgent necessity exists for the immediate adoption of energetic measures to improve the navigable channel of the Thames between Gravesend and the docks above. Safety and commerce demand that the channel of the river should be of such a depth that vessels either entering or leaving the port with cargoes should be able, if necessary, to come to anchor. In the present state of the river they cannot anchor without going ashore, and so they are compelled to continue moving, even in dense fogs. The shipowners further hold that the channel should be as deep as the Suez Canal, say 26ft. at low water. They suggest that the necessary work can be done by dredging, and that the requisite funds are available in the shape of £41,000 a year paid to the Board of Conservancy as tonnage dues. There are numerous places between the Albert Dock and Purfleet in which there are only 18ft. at low water. It is to these that the shipowners take exception. Such, in brief, is the case made out for dredging.

The first thing that suggests itself to our mind is that whereas in 1871 the tonnage of vessels entering inwards and outwards was about 7,600,000 tons, and in 1885 it reached 12,000,000 tons, the condition of the river can not be so bad as the shipowners make out. Admitting that they are right for the sake of argument, the Thames, with all its faults, seems to be able to accomodate a stupendous traffic. It may, of course, be argued that what sufficed in 1871 will not suffice now, and no doubt this line of reasoning is not without force. The real objection to the scheme is that it is so vague and indefinite that it is impossible to say what it actually means. Take, for instance, the hint that the £41,000 per annum above-named would supply the necessary funds. Any engineer of experience, had he been consulted by the shipowners in the first instance, would have told them that £40,000 a-year would be a very inadequate amount to expend on such a scheme. But the money even if it were sufficient, is not available. The Thames Conservators have a great deal to do, and they could not possibly devote the whole of the tonnage dues, or even any large part of them, to dredging the river wholesale. If they do that they must leave something else undone, about which there would very soon be an outcry. Anything like such a radical change in the bed of the Thames as the shipowners want effected must be made by some body with special funds for the purpose, and with far larger powers than the Conservancy Board possesses. It is a noteworthy circumstance that the shipowners speak only of the depth of the channel they want. Nothing is said about its width. The object had in view is to suffer ships to anchor in the fair way, as, for example, they can anchor in the Sloyne and other portions of the Mersey. But it is evident that a channel only wide enough for one or two ships would not suffice. Under the existing *régime* a ship cannot anchor, because when she swung with the tide she would tail on the shore at either side. Even if we assume that she moored with two anchors down, a ship 400ft. long would require a width of at least 900ft. in which to swing with safety. Rotating round the shackle where the two cables unite, she would herself be the radius of a circle 800ft. in diameter, and another hundred feet is a very moderate allowance for the slack of the cables. It appears, therefore, that a width of less than 300 yards would not suffice. It may be argued that the ship would only drop anchor for one tide, but this is nonsense. The fog might last for days—for several tides at all events; and in a narrow channel, if it was a hundred fathoms deep, the ship at anchor would be just as badly off as ever. It is necessary to insist on these things, because the shipowners have apparently entirely overlooked them. It is possible, however, that although they speak of a channel, they really contemplate dredging the whole river from shore to shore in such a way that there shall be 26ft. of water in it at low tide.

Now it is not as well known as it ought to be that below Erith the navigation of the Thames is at low water exceedingly intricate, and only to be accomplished by any craft drawing over 8ft. by experienced pilots, or captains who possess special knowledge. There are sand banks and gravel banks and mud banks in all sorts of places. The channel down to the sea has been very carefully buoyed, but it is a crooked, awkward channel nevertheless, especially for large ships. What would be the effect on the lower reaches of the Thames if the section from Purfleet to the Albert Dock was made deeper in the way proposed? No one knows. The probability is that the scour would be increased and that bars would be thrown up further down. To interfere with the *régime* of a great tidal river is a far more serious matter than the shipowners understand. It is a thing not to be undertaken lightly, as their friends in Liverpool would not be slow to tell them if consulted. Apart from the shipping interests involved, let us ask what would be the condition of the foreshore for miles in certain places. Would not the deepening of the channel leave vast expanses of mud uncovered at low water which are now covered? Putting these things on one side, however, the fact remains that to render the Thames a good anchorage between Purfleet and the Albert Dock, an enormous amount of dredging work must be done, and the cost would for some years to come be more like £100,000 per annum than £40,000. If it is said that a small sum would suffice, then the evil of which the shipowners complain must be small; if it is large, then to abate it will cost a great deal of money.

The letter as it stands is a very curious document, and it is difficult to believe that it received due consideration before it was dispatched. "We apprehend," say the writers, "that safety and convenience require that the channel of the river should be dredged to such a depth that vessels either entering or leaving the port with cargoes should be able to anchor without danger." We have already shown that this implies that the whole or nearly the whole width of the river must be dredged. But the shipowners no not seem to contemplate this, or they would not suggest that the Thames Conservancy Board could find the necessary funds. The letter as it stands can effect no good whatever. We are far from saying that the Thames should not be dredged and improved, but we repeat that it is a task not to be entered upon lightly. The shipowners ought to fortify themselves with the opinions of some highly-competent civil engineer, and obtain an estimate of the cost of the works which he might suggest. Then, and not till then, will there be a tangible proposition to deal with. As to the proposal in its present form, it may be said that it means anything or nothing. If, as the shipowners seem in one place to imply, one dredger, now employed in getting gravel, would, if used to more purpose, do all that they want, we can only think that they are making a great deal of fuss about nothing. If, on the other hand, their letter means what it says—namely, that seven miles of the Thames should be converted into safe anchoring ground for ocean steamers of the highest class at low water, then we say that the scheme is gigantic, and must be carried out by others than the Thames Conservancy Board. The first step to be taken in the latter case is obviously to call in the aid of an engineer.

CYLINDER CONDENSATION.

IN another page will be found a letter from the pen of Mr. Bodmer, which requires some comment. Mr. Bodmer takes exception, it will be seen, to a statement which appeared in our impression for January 7th. We said that the presence of water in a cylinder had, in some obscure way, a powerful influence on the condition of steam. Mr. Bodmer draws from these words a deduction which we did not intend them to supply. Our meaning was, and is, that wet steam is less economical than dry steam, for reasons which are not generally understood. Mr. Bodmer advances nothing to show that they are fully comprehended, nor does his letter throw any real light on the matter, because the theory which he therein enunciates does not obtain in practice, either because the theory is unsound or the requisite conditions are not present. Inasmuch as cylinder condensation is a most powerful source of waste of fuel in steam engines, we need not make any apology for returning again and again to the subject. Indeed, it is so full of anomalies and puzzles that the fullest and freest discussion is not only expedient but necessary, because in such full and free discussion lies the promise of devising means of reducing it, or at least of ascertaining under what conditions it does or does not take place—a point on which very great ignorance now exists. For example, at least in some triple expansion engines with the high and intermediate cylinders carefully jacketted the condensation in the high-pressure cylinder is enormous; on the other hand, in unjacketted cylinders the condensation is sometimes very small. Thus, in the compound Paxman engine reported on by Professor Kennedy and the late Mr. Rich, it seems that though the cylinders were unjacketted the condensation was very small. There is probably no better authority on the application in practice of the theory of heat than Mr. W. Anderson. In his recently published treatise, "The Conversion of Heat into Work," he says, page 78:—"What has already been said on this subject shows that there is no theoretical gain in steam jackets. They can produce no effect whatever upon the fact that every foot-pound of work is represented by a corresponding absorption of heat; but a steam jacket makes the curve of pressure follow more nearly the isothermal line, and so enables the engine to do a larger quantity of work without sensibly increasing friction and other resistance, and to use a higher rate of expansion to obtain the same power, which in the case of steam implies higher initial pressure, and consequently temperature, and a greater fall of the latter in the working substance, and hence economy." Need we say that dozens of engineers hold on the other hand that jacketting is a direct, not an indirect source of economy? When we find that the widest diversity of opinion exists among engineers as to the value or the reverse of steam jackets, it may, we hold, be conceded that the laws of cylinder condensation are not fully understood.

So much premised, we may go on to consider Mr. Bodmer's letter. We do not hesitate to say that we have never heard of Zeuner's investigation, and in this we are not singular. We cannot name a single author who, writing on heat or steam, asserts that condensation and re-evaporation, and then condensation again, can take place in a steam engine. Such a sequence of phenomena is not referred to by Clausius or Rankine, and until we are put into possession of the experimental data on which Zeuner's theory is based we must, with all deference to Mr. Bodmer, hesitate to accept the statement as true of any conditions which can exist in practice. It has, of course, been long known that every vapour has a critical point, at which it may be either vapour or liquid almost indifferently; but it remains to be proved that there is more than one critical point for a vapour. Let us take, for example, a well-known lecture experiment. A barometer tube filled with mercury is supported over a deep tank containing mercury. As soon as the metal in the tube has steadied itself at the height proper to the pressure of the air at the time, let a small quantity of ether be passed up the tube through the mercury. Part of this ether will be instantly vaporised, and the mercury will fall a little in the tube. If now the tube be depressed in the mercury tank or raised, the level of the metal within it will remain unaltered, that is to say, the space above the column will play the part of a vacuum. As the mercury column tends to rise in it the ether will be compressed, and, being just at the critical point, it will be liquefied and reduced in volume, its pressure remaining unaltered. In like manner, if we try to reduce the pressure, more will be evaporated to fill up the space, and its pressure will remain, as before, unchanged. It is, of course, essential that there should be sufficient unevaporated ether present to saturate the vapour. It is open to doubt if a precisely similar result will take place with water under similar conditions. Quoting again from Mr. Anderson's book, after referring to the isothermal curve of a gas, he says:—"But if the gas operated on be near its point of liquefaction, matters are not so simple. Such a gas we have in steam. Let us suppose a cylinder 5ft. long filled with steam at 3 lb. absolute pressure and 212 deg. temperature. If the piston were pushed in, the pressure would rise nearly according to the isothermal curve until a pressure of 14·7 lb., or one atmosphere, was reached, and then we should attain a pressure and temperature at which water may exist either as a liquid or a gas. The slightest increase of pressure causes the steam to condense, and therefore the isothermal curve will cease to be a curve, but will be a line parallel to the base, indicating that there will be no further rise of pressure till all the steam is condensed. When that happens, there will be less than one-seven-thousandth part of the original bulk of steam reduced to water at 212 deg., and practically incompressible." He then goes on to show that by reversing the process all the water would be reconverted into steam. Now if we turn to Clausius, it will be found that all fluids do not behave in the same way. Thus, for example, ether vapour is liquefied by compression, but steam is not. "If steam is compressed, heat is generated by the work thereby expended, and this heat is more than sufficient to raise the temperature of the steam to the point at which the new density is the maximum density. Accordingly, if the steam is to be treated in such a way that it remains saturated, it must be deprived of part of the heat thus generated. In like manner, in the expansion of steam more heat is converted into work than is necessary to cool the steam so far only that it remains exactly in the condition of saturated steam; accordingly, if this last condition is to hold, heat must be imparted during the expansion." Apparently, this is a flat contradiction of the passage by Anderson which we have quoted above. The apparent contradiction disappears, however, if we bear in mind that Clausius is speaking of ordinary steam, while Anderson is dealing with steam in presence of water. Clausius gives, indeed, a complete investigation of the cyclical process of expansion and compression in the case of vapour at its maximum density in the presence of water, but he says nothing whatever of such alternate evaporations and condensations as Mr. Bodmer speaks of. If Zeuner be right, then it is clear that when steam is compressed in presence of a large quantity of water, the line of compression will be made up of straight lines and curves, the straight lines being proper to condensation, the curved lines to compression. Nothing analogous to this is known in practice, and we are disposed to think that Mr. Bodmer has neglected to state some limiting conditions as to the performance of external work on which the accuracy or the reverse of Zeuner's formulæ turn. As the matter stands at the present moment, we neither accept nor dispute the accuracy of Mr. Bodmer's conclusions. If he will supply further information, we shall be in a position to form an opinion. So far as we can see at present, the conditions necessary do not exist in practical steam engines. Leaving practical steam engines and turning to theory, we see more reason for doubting the soundness of Zeuner's conclusions. The isothermal curve of water is probably better known than that of any other fluid; and in this curve no evidence whatever is to be found of that peculiar form of spontaneous condensation and re-evaporation, and condensation again in a neutral cylinder of which Mr. Bodmer speaks. No one has suggested the possibility of such a thing, if we except Professor—now Sir—W. Thomson, who several years ago assumed that it was theoretically possible that under certain conditions the isothermal of water should become a waved line instead of an approximate hyperbolic curve. But Clerk-Maxwell expressly states that this theory is incapable of experimental verification. "The condition can never be realised in a homogeneous mass, and we cannot expect any experimental evidence of the existence of this part of the curve, for the substance must be in unstable equilibrium, pressure increasing with the volume." Clerk-Maxwell is perfectly definite on the point. After showing how the isothermal is to be traced, he goes on, "When the liquid is in contact with the vapour, the rate of evaporation depends on the temperature of the liquid and the rate of condensation on the density of the vapour. Hence for any temperature there is a determinate vapour density, and therefore a determinate pressure represented by a horizontal line at which the evaporation exactly balances the condensation. At this pressure the liquid will be in equilibrium with the vapour. At all greater pressures the vapour will be condensed; *at all smaller pressures it will evaporate.*" The words we have italicised flatly contradict Zeuner; who, as we understand Mr. Bodmer, asserts that with a falling pressure we can have in succession condensation and re-evaporation, while Maxwell, Balfour Stewart, and every other author we can call to mind, hold that with a falling pressure there can only be re-evaporation. If Mr. Bodmer will calculate and draw the isothermal of water between, say, 371 Fah. and 102 Fah., we shall be in a better position to understand whether the formulæ are or are not consistent with existing theories. May we also ask for some account of the experiments on which the formulæ are based?

There is an aspect of the question, which is quite apart from Mr. Bodmer's letter, and which has never yet received, so far as we are aware, adequate, or indeed, any consideration. Unless there is plenty of water present steam cannot be condensed by compression. If there is, it can be condensed. The curious loop found sometimes at the compression corner of diagrams is often due to the circumstance that so much water is present that the steam being at the critical point is condensed. The compression curve then becomes a horizontal line parallel to the atmospheric line. The cure is either to keep the cylinder dry as to give more lead. Returning to the general question, let us suppose that an engine is supplied with very wet steam. At the instant the steam port opens, and steam rushes into the cylinder, a certain amount of compression takes place for obvious reasons. The result will be, if the steam be at the critical point—condensation—not due, be it observed, to any cooling action whatever, but solely to a rise in pressure. If the steam is dry no such condensation will take place. The very fact that one portion of the steam is condensed is sufficient to supply water to saturate another portion, and so augment the evil. If our readers have followed us thus far they will be able to understand to what we alluded when we said that there was a certain point about cylinder condensation still obscure. It is this. When vapour is at the critical point, is it certain that compression is the only cause which will convert it into water? We think not; on the contrary, it seems likely that shock or collision will sometimes have the same effect. It is said that certain forms of cross-plate separators "knock" free water out of steam. It seems quite as probable that they produce a shock or jar which causes the liquefaction of a portion of the unstable vapour, and thus dry the rest. The fact that the noise and concussion produced by firing heavy cannon will bring down rain is well known. In the same way it is not at all improbable that the concussion of thunder operates to the same end. It is easy enough to see that the conditions under which steam enters a cylinder by a series of jerks are peculiarly well adapted to cause liquefaction. The obvious remedy is, of course, to use steam which shall not be a saturated vapour; and it is probable that the difference in the performance of various engines at various times is much more affected by the dryness or wetness of the steam used than is commonly supposed. Thus, a jacket may be of little use to an engine getting dry steam, and of much value to one getting wet steam, but it is the custom in comparing engines to assume that they all get steam of the same quality.

THE BRIGHTON ELECTRIC RAILWAY.

THE Brighton electric railway has done much to show how electricity may be successfully employed as a perfectly unobjectionable motor for many tramways and light railways, and has been patronised by hundreds of thousands of passengers. It has, moreover, earned the substantial support of electrical engineers as a public exhibition of a successful electrical application, and has been visited by very many with a view to witnessing its operation, construction, and equipment. It has, however—like the early railways—proved a red rag to a few of those to whom an engineering novelty is a thing to be denounced, and a thing which affords them a cheap means of gaining a brief though disagreeable local celebrity. This actively obstructionist minority has long endeavoured to find some reason for stopping the working of the line, and the chance of rescuing itself from the oblivion which usually attends the existence of Carlisle's majority recently presented itself. A boy on a bicycle took the wrong side of the road and attempted to shoot between a horse and the electric tramcar. The horse seems to have suddenly heard the whiz of the bicycle, and sufficiently swerved to cause the bicycle to be caught between himself and the car. The horse was apparently mistaken as to the side on which the bicycle was running, and shied towards the car, to which he was accustomed, and of which he was not afraid. The accident resulted in some injury to the rider, in an action in the county-court, and in the county-court judge finding that the accident was caused by the tram-car and not by the bicycle, and that Mr. Volk, the owner of the electric railway, must pay damages and costs amounting to a very considerable sum. The same county court judge has since, however, done something to remove the bad impression this verdict has caused, for he came to a directly opposite conclusion in a case brought by the owner of a horse and cart which were run into by the steam car of the Brighton District Tramways Company, the man being injured and the horse reduced in value to 70s. The one fault of the owner and driver of the horse seems to have been that he had no light. He was within half-a-dozen yards of his stable when run into by the steam car, the driver of which could not see the horse and cart in consequence, it was said by witnesses of the Tramway Company, of the tram engine lamps. It was also said that the driver was not likely to be able to hear the plaintiff call out, as he said he did, because of the noise of the engine. The verdict was virtually that if the horse and cart had not been there they would not have been run into. The Tramway Company therefore has nothing to pay, while Mr. Volk is called upon to pay heavily. An injunction was asked for by the party represented by the plaintiff to stop the working of the electric railway altogether, but this was of course refused. In consequence of this action, and of the heavy losses which resulted from the destructive effects of the storms, which did so much damage along the whole line of the Brighton coast, it has been resolved by a large and influential committee, of which Mr. John Crapps, of Powis-road, Brighton, is the secretary, to invite subscriptions to a public testimonial to Mr. Volk, as a recognition of his pioneer work in light electric tramway locomotion, and as an expression of support in an enterprise the failure of which from any cause would now be very harmful to electrical engineering interests. The line has been opened over three years, and Mr. Volk has fought single-handed through great difficulties, and it may be hoped that suitable recognition of his work will now be forthcoming—at least from all those interested in electrical development.

STRIKE IN THE STEEL TRADE.

MUCH disappointment prevails among the thoughtful classes of the North of England at the readiness still shown by workmen to strike without sufficient reason, and so do their utmost to destroy the more hopeful feeling as regards trade and commerce which has only so recently arisen. The long years of suffering which they have gone through since the last good times would, it might be supposed, have taught them a salutary lesson, and it has been fondly hoped by many that returning prosperity would find them more prudent, more cautious, and less precipitate than formerly. Possibly this belief has had something to do with the restoration of confidence. Certain it is that the disastrous times of 1875 and later were largely caused by the withdrawal of capital from industrial enterprise, because the conditions then insisted on by workmen and other producers was simply prohibitive. Notwithstanding this lesson, and notwithstanding all the enforced idleness, and the consequent poverty and want which has since prevailed, we now see British operatives again refusing work by the hundreds, and even thousands, because they are unable to obtain a share of profits which are not yet realised, and which they are doing their best to make impossible of realisation. At the Eston Steel Works something like 2000 men are on strike for a 10 per cent. advance in their wages. Though the quoted price of rails is undoubtedly higher, and in two or three months increased wages might be afforded from them, still old contracts at minimum prices are not yet worked off, and, until they are, no concession can be afforded. It is curious how the unexpected has happened in this case. Instead of raising the price of steel rails, by ceasing to manufacture them—a result which the operatives always expect to produce—the very opposite seems likely to ensue. For it must be remembered that the recent enhancement of values in the iron and steel trades began with the raw material, and the finished product only followed suit. Now that the latter is being produced in diminished quantities, less pig iron is needed. The price of this is therefore falling rapidly, and it is more than likely that it will carry the value of steel rails down with it. And so it is not improbable that the better prices, which the men are endeavouring prematurely to get a share of, may be dissipated by their own action and disappear altogether. If this does not happen, it will not be by reason, but in spite, of their ill-advised, inopportune, and, under the circumstances, unpatriotic action.

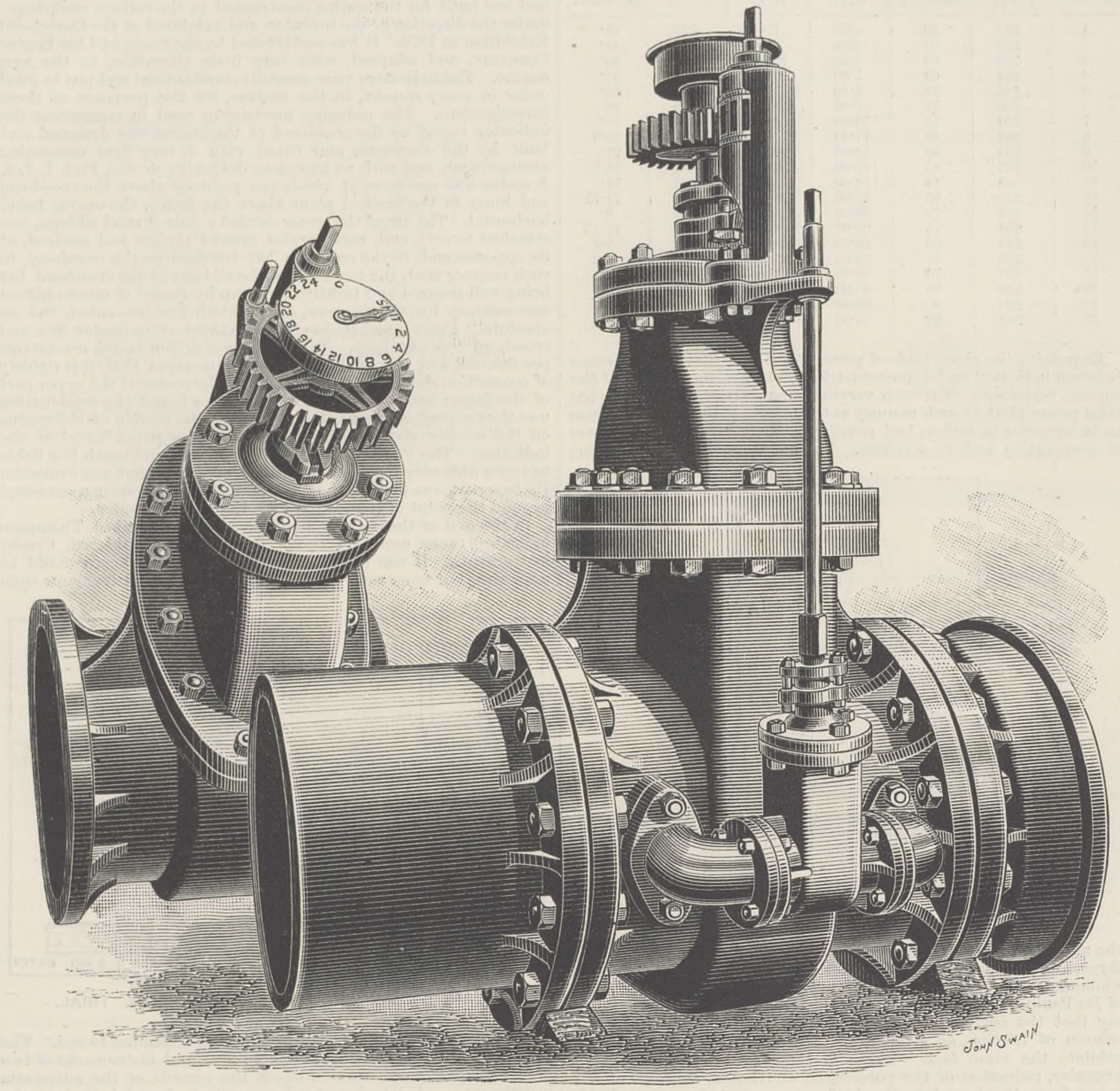
NORTH-EASTERN RAILWAY WORKS.

THE new lines and works in course of construction by the North-Eastern Railway Company are now growing few in number. There are only four works in progress which may be called large. These include the long-needed additions to the lines between Newcastle and Heaton, the branch railway from Alnwick to Cornhill, the railway from Darlington to Fighting Cocks, and the extension of the Middlesbrough Dock. The first of these works—that of additional lines from Newcastle to Heaton—has had already £118,393 spent on it, the most recent rate of expenditure having been close upon £7000 monthly. It is contemplated that about £60,000 more will be spent thereon, and the larger part of this will be in the first half of the present year, so that it is evident the work is now rapidly approaching completion. The Alnwick and Cornhill Railway was recently sketched by us in THE ENGINEER as far as the route is concerned, and it may be said that the large sum of £353,126 has already been expended, at the rate recently of over £11,000 per month. From the beginning of this year a lower rate of expenditure has been known, the total further sum to be spent being £30,000. On the extension of Middlesbrough Dock the sum spent has been £110,890 down to the end of the year 1886, and an accelerated rate of expenditure will be known now, as the total further amount needed is £187,317. On the small railway from Fighting Cocks to Darlington, the sum spent up to the end of last year was £72,209; whilst to complete the work £10,070 will be needed. It is thus evident that as far as absolutely new work is concerned—work on lines not open for traffic—there is only a very small number of projects in course of construction by the North-Eastern; and most of these are rapidly approaching completion. Some of these works are works which are scarcely likely to be very remunerative: the costly line from Alnwick will need agriculture to be much more profitable before it will pay a dividend such as it should, and it is evident that Middlesbrough dock will need to draw much more traffic than is likely for it to pay. But the North-Eastern cannot be held to be a "complete" line for long; it has many scattered members of its system, and it ought to endeavour to unite these, and especially to make lines and works to enable the coalowners of the North to ship their coal more cheaply than they now do. If the North-Eastern Railway takes a fair view of the needs of its district, there will be work for long, especially in the Durham part of that district.

THE PROPOSED LAKE DISTRICT RAILWAY.—At a meeting opposed to the construction of the proposed railway from Windermere to Ambleside, held in Manchester on Tuesday, a committee was appointed to take such steps as they thought desirable to oppose the scheme.

LARGE SLUICE VALVES.—BRADFORD WATERWORKS.

MESSRS. BLAKEBOROUGH AND SONS, BRIGHOUSE, ENGINEERS.



LARGE SLUICE VALVES—BRADFORD WATERWORKS.

THE sluice illustrated by the accompanying engravings is one of a number designed and made by Messrs. Blakeborough and Sons, Brighouse, for use on a new high-pressure pumping main on the Bradford Corporation Waterworks. One condition concerning their construction was that they were to be tested under inspection to a pressure of 500 lb. on the square inch. They are on the double-faced principle, with gun-metal faces fixed in the body and on the plug or door. These faces are scraped together until perfectly tight at the pressure named, and the valve is opened and closed by a strong gun-metal square-threaded spindle and nut, on the top end of which is fitted spur-wheel gearing working in a bracket, as shown. On the top of this bracket, and over the main spindle, and actuated by the latter, is a train of wheels in iron casing, having enamelled figured dial plate and pointer for indicating the position of the plug in the valve. This can be read from above when opening or closing the valve with the usual key.

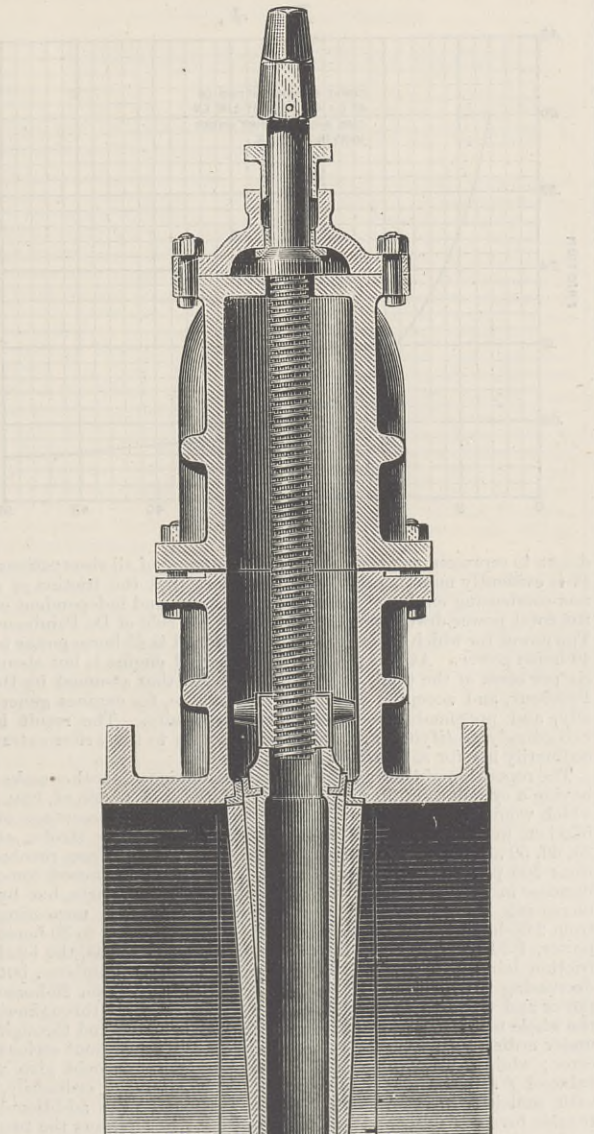
To enable the main valve plug to be moved easily when under pressure, the valves are fitted with an auxiliary sluice valve and bye-pass pipes, connecting the main pipe on each side of the main valve, so that when the main valve is closed and the full head or pressure thereon, and it is desired to open the valve, the small valve is first opened, thus admitting water to the other side of the main valve, and producing an equilibrium of pressure on each side; the main plug can then be lifted freely. The valves have flanged ends, with loose spigot and socket pieces bolted on, so that the valves can be taken out if required.

It will be seen that the valves are well designed, compact, and strong, valves of the kind being a speciality of the makers.

ERECTION OF THE FORTH BRIDGE.

THROUGH the courtesy of the engineers, Messrs. Sir John Fowler and Mr. Benjamin Baker, we are enabled to place before our readers a view of the great cantilever pier superstructure at North Queensferry as it appeared in the beginning of December last. Since that date a good deal of progress in the vertical columns has been made, and the great 12ft. steel tubes now seem to grow magically. At the end of last November the highest part of the structure shown in our supplement was 171ft. above Ordnance datum, and although the Christmas holidays and many weeks severe frost have intervened this height is now 234ft., so that the hardiness of the North British men cannot be much less than in days gone by. If they can work 200ft. up in the piercing elements of the stormy Forth they can stand anything. The men are provided with thick flannel jackets, but even this will not keep the biting and freezing grip of the weather from face and hands. There must be no shivering and uncertain movements up on those small and often slippery footings, 200ft. above the turbulent estuary, for in most places there is nothing between them and its rushing waters, and the individual who slips completes his history. In spite, however, of the risks run accidents are few, and the number of men employed large, at the present time about 3500.

From the double-page engraving which we publish this week some idea of the method of erection will be gathered without explanation, but we may refer to THE ENGINEER of the 9th and 16th of October, 1885, for a complete description, with engravings, of the method of erecting these monster tubular and trussed girder structures. It will be seen that the erecting stages are carried on girders which are lifted by means of rams within the tubes as the tubes grow, and the rivetting is done by special



SECTION OF SLUICE VALVE.

machines partly within and partly outside, and forming the cages seen outside the tubes. All are raised as the plates are put into place and bolted temporarily until reached by the rivetters.

The erection of the superstructure is now in active operation on all the main piers, large additions to the plant for that purpose continue to be made, and consist chiefly of compressors, accumulators, and rams for high-pressure rivetting, machines for rivetting 8ft. and 12ft. tubes, such as described in previous numbers of THE ENGINEER. Steam cranes, steam winches, hydraulic rams, and other appliances of a similar kind also grow in number.

On the South Queensferry main piers the four skewbacks together with the horizontal tubes and bracing girders connecting them, are practically complete; a small proportion of the special rivetting inside the skewbacks has yet to be executed, and a few plates have to be added outside at the foot of the vertical columns. The curved bottom member at the north-west pier is bolted up and partly rivetted for a length of 40ft., and those on the other piers for a length of 20ft. The bracing between the vertical columns is being erected. The method of erection of the upper portion of the main and bracing columns described in October, 1885, is in operation here as well as at North Queensferry. The vertical columns have been built up to about 196 O. D, and the average level of the diagonal struts is about 192 above O. D. The vertical columns are rivetted to the level of 148ft., and the diagonal struts to 94 O. D. The platform is at the level of 191 O. D. Including the tubes and girders about 2300 tons have now been rivetted. The girders on the nine northern spans of the cantilever and viaduct piers have been raised to 96 above O. D. and the masonry to 92 above O. D. The foundation has been put in for the large pier at the south end of the girder viaduct. On the main piers at Inch Garvie the four skewbacks with the horizontal tubes and bracing girders are complete. The main ties supporting the horizontal tubes are being erected, and are used as columns for support of the erecting platforms. The vertical columns have been built up to a height of 108ft., and the diagonal struts to 82 O. D. The bottom members on the north average 26ft. in length, and on the south 28ft. The total quantity, including tubes and girders, of rivetted work complete, is about 2500 tons. Of the main piers at North Queensferry, the rivetting of the skewbacks is still proceeding, and about two-thirds of the total is executed. The erecting platforms have been raised to 220 above O. D. The vertical columns have been built to the average level of 226 above O. D., and rivetted to 188 above O. D. The diagonal struts have been built to the level of 215 above O. D., and have been rivetted for an average length of 90ft. The bottom members on the south side have been rivetted for a length of 60ft. from the skewbacks. The bracing to the vertical columns is completed to the level of rails. The total quantity of steel work rivetted at North Queensferry amounts to about 2400 tons. The cantilever pier has been raised to 128ft. and the viaduct piers and abutment to 131ft. above O. D. The girders now stand at 135 above O. D.

Up to the present date 448,000 cubic feet of granite have been delivered, and 424,000 cubic feet set. About 102,000 cubic yards of rubble masonry and concrete work have been built. In steel work the fitting of the plates and angles at the junction of crossing of the 8ft. tubes between the vertical columns and the bracing connected with the latter is practically complete for both north and south Queensferry. The internal viaduct for the space over the piers at both North and South Queensferry has been drilled and fitted, and a commencement made with the drilling of that for Garvie. A considerable portion of the first bay of the bracing of the bottom members for the south end of cantilever at north Queensferry is drilled and fitted. In all 35,000 tons of steel have been delivered. The average number of men employed on the works has been increased to 3250.

It will thus be seen that the whole structure is making rapid progress.

COMPOUND ENGINES OF THE S.S. POPLAR.

IN these days of triple and quadruple expansion ordinary two-cylinder compound engines are, for marine purposes, quite the exception in new steamers rather than the rule. A few special cases yet arise, however, in which this type is considered preferable; and on our two-page supplement of the present issue we publish views of an interesting pair of engines manufactured by the Central Marine Engineering Company, of West Hartlepool, from designs by their manager, Mr. Thomas Mudd. Both the cylinders of these engines are fitted with piston valves placed at the back of the cylinders and worked by the single excentric valve gear, which has been so largely adopted and so successfully carried out by this firm in triple expansion as well as compound engines. It will be noticed that whilst this valve gear permits of the cylinders being close together, it allows of the crank shaft being made in two similar pieces, and affords exceptionally long main and crank-pin bearings, of the former of which there are only three instead of the usual four. In the case of the Poplar the cylinders are 29in. and 55in. in diameter and 33in. stroke, and the crank pins are 11in. long, whilst the centre main bearing, which does duty for both the engines, is 23⅞in. in length, each of the outer bearings being 18in. in length, the diameter of the crank shaft being 9½in. Another very interesting feature about these compact little engines is the design of the front framework. Instead of the ordinary upright columns in front of each engine, there is an arrangement which gives exceptional stiffness to the whole structure whilst affording the fullest possible accessibility to the main working parts, and which has the appearance of an arch, from the shoulders of which there are branches worked up to receive the feet of the cylinders, thus accommodating the close centres and providing for the support of the reversing wheel, without in the least obstructing the gear below. The condenser is divided horizontally through the centre on a plan strongly advocated by the builders, the whole of the base of the engines being cast in one piece and made level on the underside, so as to enable it to receive support from, and be bolted to, the engine seating immediately beneath the crank shaft, as well as round the margin.

The plan now universally adopted by the Central Marine Company of planing the bottom of the bed-plate and erecting the engines on a rigid iron erecting table was carried out in this case, and the engines steamed in the shops for several hours at 80 revolutions per minute. The greatest care is taken at the Central Works to make a thoroughly good job of crank-shafts. As a reward for all the trouble they take in this direction, the builders are able to point with deserved satisfaction to the fact that they have never yet known a single case of a main bearing heating in any of the engines built at the Central Works.

That the substantial and well-designed work of this firm is becoming recognised is borne out by the fact that at the present time they are engaged upon no less than seven sets of triple-expansion engines, all above 1000-horse power, besides the tripling and the quadrupling of certain existing compound engines.

ON THE FRICTION OF NON-CONDENSING ENGINES.[1]

By Prof. R. H. THURSTON, Ithaca, N.Y.

THE assumption of the distinguished engineer, De Pambour, that the wasteful resistance of a steam engine consists of a constant quantity, the friction of the unloaded engine, increased by some increasing function of the added load, has been accepted as correct by probably all recognised authorities since his time. Calling R_0 the resistance of the engine running free and under no other load than its own friction, and calling R_1 the resistance coming upon it as a useful factor of its work, and making f the coefficient measuring the proportion of increased friction due to the load, the total resistance to be overcome by the engine piston is thus

$$R = (1 + f) R_1 + R_0 \quad . \quad . \quad . \quad . \quad . \quad (1)$$

So far as the writer has observed it has never been questioned whether the quantity f is constant or variable, and no recent attempts have been made to ascertain its value by experiment. It has long been the intention of the writer to settle this question, which had for years existed in his own mind, and the opportunity has recently been offered to do so, at least as that question affects the modern forms of non-condensing high-speed engines now so generally in use, especially for electric lighting purposes. The first investigation was made at the suggestion of the writer and under his general direction, in the winter of 1883-84, upon a "straight-line engine," exhibited that year at the Annual Exhibition of the American Institute, by the Straight-Line Engine Company, of Syracuse, N.Y., and built by them from the designs of Professor John E. Sweet, the inventor of its special features. The work was done with equal care and skill by Messrs. Mitchell and Aldrich, graduates of Stevens Institute of Technology, of the class of 1884. The results were sufficiently exact and satisfactory in every respect to have been made the basis of the conclusions here to be stated; but it seemed to the writer desirable that they should be checked by similar work upon another engine, if possible of a different make, before attempting to state definite conclusions of any kind. The opportunity to secure such a repetition of the investigation was offered, during the past winter, at Cornell University, using a straight-line engine, which could be fitted with a brake, and conveniently submitted to test. The engine is of the same make as the first described, but of a different size, and the results of the two sets of experiments are considered to accord so thoroughly as to justify publication. The following are the data and results of these two sets of determinations:—The first of these two engines was built from designs brought out in the year 1880, of which illustrations may be seen in the *Electrician* of December, 1883. As is well known, the engine derives its name from the fact that, in its design, the attempt has been made to take all stresses through straight members, the frame thus being made to consist of two straight compression and thrust members, connecting the cylinder-heads directly with the main pillow-blocks, and giving a characteristic appearance

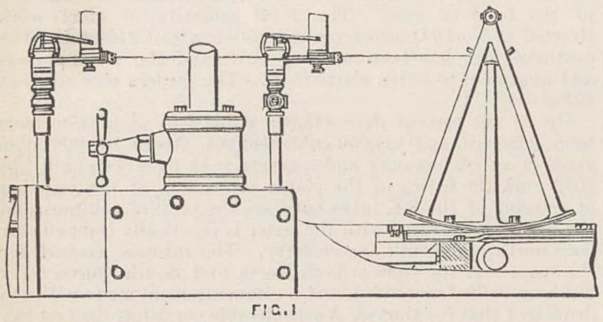


FIG.1

METHOD OF ATTACHING THE INDICATORS.

to the whole machine. The valve-gear is of the "positive" type, the expansion made variable by the introduction of a governor on the main-shaft actuating the eccentric, in the manner familiar to all who have seen the more common forms of high-speed engines. In the design of this governor, as throughout the whole engine, special care has been taken to provide against the impeding action of friction, the machine being intended to be as nearly frictionless as possible. The engine rests upon three points of support, and thus is not liable to be thrown out of line by any inequalities of foundation or bolting. When tested, the engine to be experimented with was simply set on blocking, and had no foundation; but so well was it balanced, and so perfectly was its alignment maintained, that it ran with absolute smoothness, and as steadily as if it had been given the heaviest foundation possible.

For the purposes of test, it was fitted with a pair of carefully standardised indicators and a Prony brake. Cards were taken simultaneously from both ends of the cylinder, and readings from the brake were at the same instant obtained. A comparison of the power indicated by the diagrams with that shown by the brake

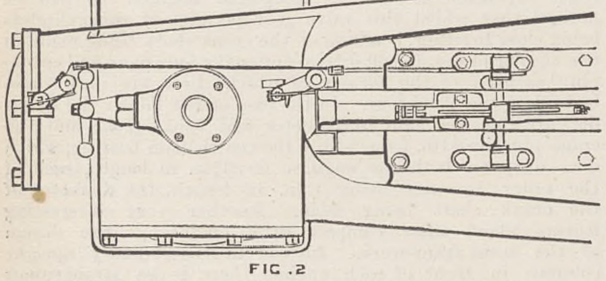


FIG.2

METHOD OF ATTACHING THE INDICATORS.

gave a difference which measured the friction of the engine. During the trial, the engine, when working at its rated power, consumed, according to the indications of the diagrams, 28·2 lb. of steam per horse-power per hour, or probably between 35 and 38 lb., allowing for the loss by cylinder condensation not accounted for on the indicator card, a very excellent performance for an engine of but 35-horse power. The action of the governor was extraordinarily perfect. The engine was adjusted to make 230 revolutions per minute under 90 lb. steam pressure. The observers reported that it made the same number of turns whether loaded or unloaded, an evident impossibility with a governor of this class, in which only approximate isochronism can be attained. The writer, to settle the question, counted the revolutions, minute by minute, with a hand-speed counter, and made it 230 revolutions with the whole rated load on the engine—35 to 40-horse power—and 231 when entirely unloaded, the brake strap being loosened until it could be shaken about on the pulley, by the hand, with perfect ease. This was repeated until no question could longer exist in regard to the matter. The variation with variable steam pressure was greater.

This engine was 8in. in diameter of cylinder, 14in. stroke of piston, having a rod 44in. long between centres, a balanced valve with stroke of 2in. to 4in., according to position of governor and eccentric, a fly-wheel 50in. in diameter, weighing 2300 lb., the steam and exhaust pipes having diameters of 2½in. and 4in. respectively, and the whole machine weighing two and one-half tons. The space occupied by the engine was 9ft. 4in. in length, by 4ft. 8in. in width, and 3ft. 10in. in height.

[1] A paper read at the meeting of the American Society of Mechanical Engineers, New York, November 30th, 1886.

The following are the data obtained from the brake and indicator readings:—

Number of Card.	Revolutions.	Steam-Pressure.	Brake H.P.	Indicator H.P.	Diff.	Friction per Cent.
1	232	50	4·06	7·41	3·35	45·
2	229	65	4·98	7·58	2·60	34·
3	230	63	6·00	10·00	4·00	40·
4	230	69	7·00	10·27	3·29	32·
5	230	73	8·10	11·75	3·65	32·
6	230	77	9·00	12·70	3·70	29·
7	230	75	10·00	14·02	4·02	28·
8	230	80	11·00	14·78	5·78	25·5
9	230	80	12·00	15·17	3·17	21·
10	230	85	13·00	15·96	2·96	18·5
11	230	75	14·00	16·86	2·86	17·
12	230	70	15·00	17·80	2·80	15·75
13	231	72	20·10	22·07	2·06	9·
14	230	75	25·00	28·31	3·36	11·75
15	229	60	29·55	33·04	3·16	9·5
16	229	58	34·86	37·20	2·34	6·3
17	229	70	39·85	43·04	3·19	7·4
18	230	85	45·00	47·79	2·75	5·8
19	230	90	50·00	52·60	2·60	4·9
20	230	85	55·00	57·54	2·54	4·4

Examining the above table of powers, it is seen that the difference between indicated and dynamometric power, *i.e.*, the friction of the engine, varies somewhat with varying steam pressures and varying total power; but in such manner as to indicate the controlling cause to be irregular in action, and possibly to some extent due to errors of observation and to accident. The maximum is 4-horse power,

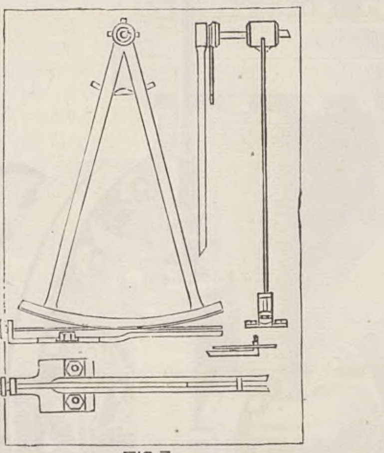
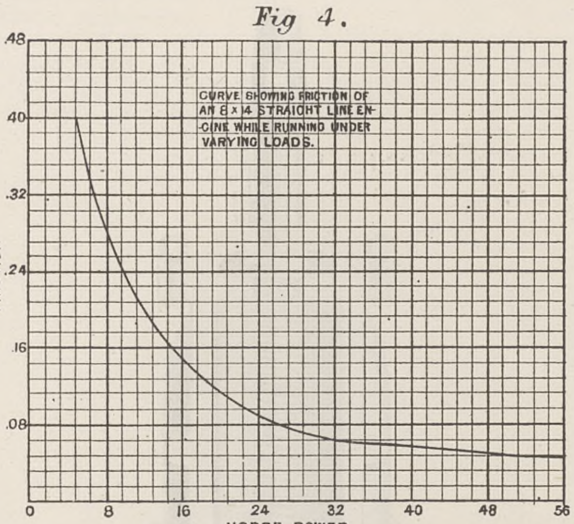


FIG.3

DETAILS OF REDUCING MECHANISM.

the minimum about 2-horse power. The usual difference is about three, and the variations are irregularly distributed throughout the whole range of experiments. It is evident at a glance that the law of De Pambour does not hold, and that it is much nearer correct to say that the friction of engines is constant as otherwise. The column of friction, as given in percentages of the total power, exhibits the same fact. There is continual, though somewhat irregular, reduction of the percentage of friction, throughout the range from the lowest to the highest power, and very nearly inversely as the power exerted. This is best shown by the curve given in the accompanying plate, Fig. 4, in which a smooth line has been

Fig 4.

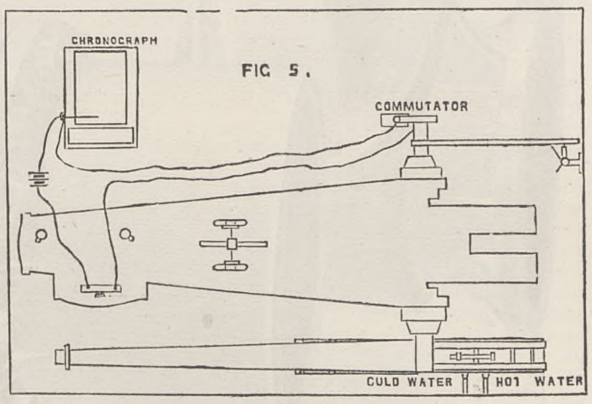


drawn to represent as nearly as possible the mean of all observations. It is evidently more nearly correct to assert that the friction of a non-condensing engine of this class is constant, and independent of the total power developed, than to accept the rule of De Pambour. The power for which the engine is proportioned is 35-horse power to 40-horse power. At this power, the friction of engine is but about six per cent. of the total, or less than one-half that assumed by De Pambour, and accepted as correct by Rankine, for engines generally, and presumably for locomotives especially. The result is exceedingly gratifying, and the friction seems to the writer extraordinarily low for so small an engine.

The repetition of the experiment upon an engine of another make, having a cylinder 9in. in diameter, and a stroke of piston of 12in., which would naturally give a somewhat increased percentage of friction, in consequence of the proportionally smaller stroke, at 20, 30, 50 and 65-horse power, by brake, and running free, revolutions 300 per minute—a speed which may also have caused some increase in frictional resistance, not only in rubbing parts, but by increasing back pressure—gave a friction of engine measuring from 2·66-horse power unloaded, to 4-horse power at 20 to 30-horse power, 4·8-horse power at 50, and 5·3-horse power at 65, the total friction increasing perceptibly, as assumed by De Pambour, but decreasing in percentage of load, from 16 to 7·5, between 20-horse power and 65-horse power. It is very nearly constant throughout the whole range of power that the engine would be worked through under ordinary circumstances, and may be so taken without serious error; while the adoption of the Pambour formula would give a value of f so small that its use would not be attended, ordinarily, with sufficient increased exactness to compensate the additional trouble involved in its application. At their rated powers the two engines thus exhibit efficiencies of mechanism of about 94 per cent. and 90 per cent. respectively.

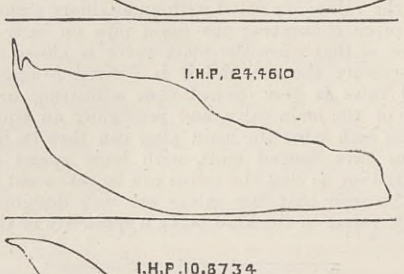
The second series of experiments were made by Messrs. W. A. Day and W. H. Riley, at Cornell University, during the latter part of last college year, confirming the deductions already given, while some very interesting and original modifications were made in the details of method and trial. The engine taken for testing was a machine recently built, and sent to the Cornell University, for purposes of experimental investigation in electrical measurement and other work of the college. It is an engine 7in. in diameter of cylinder and 12in. stroke, or, more exactly, 6½in. in diameter, the cylinder having been bored slightly under size. The general plan of the engine is similar to the first of those already described, and, like that, is carefully designed with a view to reducing friction to a minimum and giving a regulation of maximum efficiency. The brake was precisely like that used in the first described experiments and was built for the engine constructed in the college workshops under the direction of the inventor, and exhibited at the Centennial Exhibition in 1876. It was constructed by the Straight-Line Engine Company, and adapted, with very little alteration, to the new engine. The indicators were carefully standardised and put in good order in every respect, by the makers, for the purposes of these investigations. The reducing mechanism used in connecting the indicator barrel to the crosshead of the engine was designed and built by the observers, and fitted with a very firm connecting arrangement, and with an ingenious detaching device, Figs. 1, 2, 3. A sector was constructed which was pivotted above the crosshead and hung in the vertical plane above the latter, the engine being horizontal. The arc of the sector carried a pair of steel ribbons, one attached to each end, each carried around the arc and secured, at its opposite end, to the end of a bar fastened on the crosshead, in such manner that, the two ends of the ribbons at the crosshead bar being well secured and tightly drawn up by means of screws placed conveniently for the purpose, all backlash was prevented, and an absolutely exact synchronism of movement of indicator line and crosshead was obtained. The engine was driven at 285 revolutions per minute, and it was therefore very important that this rigidity of connection should be secured. A smaller sector at the upper part of the larger one was the carrier of the cord, and the combination was thus a perfect means of reproducing the motion of the engine on the smaller scale required in working the paper barrel of the indicator. The "cord" was piano wire, a material much less liable to cause difficulty by stretching than any other that was available. Its free part was kept taut by a "spiral" (helical) spring, attached beyond the point of connection with the paper cylinder.

In the first of these experiments, as already described, Thompson indicators were used; in those about to be considered, Crosby instruments. It was hoped that the new Tabor indicator could be used also, but none were received in time. The instruments used



PLAN OF ARRANGEMENT FOR ENGINE TRIAL.

worked perfectly, and gave no trouble from beginning to end. The speed indicators were of several kinds. Hand instruments of two or three kinds were used to check the records of the automatic instruments. A "tachometer" was attached and belted to the engine shaft, and afforded a very convenient means of watching the momentary fluctuations due to variations of load, of steam pressure, and to accidental disturbances. A chronograph was also attached, connected with the standard clock in the physical laboratory, to beat seconds. A commutator was placed on the engine shaft, making contact at each revolution, and a key near the engine, for the purpose of breaking contact. A Brown mercury speed indicator served excellently well for a constant speed indicator. It exhibited instantly any variation of speed from the normal. The chronograph was set in operation when the indicator cards were taken, and thus gave the exact speed of the engine at that instant. Great care was taken to keep the instruments, and the engine as



well, in good order and well lubricated throughout the series of experiments. Some stiffness of the governor, however, the cause of which was not discovered until after the work had been completed, caused it to work less perfectly than in the engine first used, and the speed varied more than in that series of determinations. When the governor was in its most perfect adjustment, the engine was capable of holding the standard speed within a fraction of one revolution throughout a wide range of work, and nearly down to the lowest power that such an engine is at all likely ever to be called upon to supply.

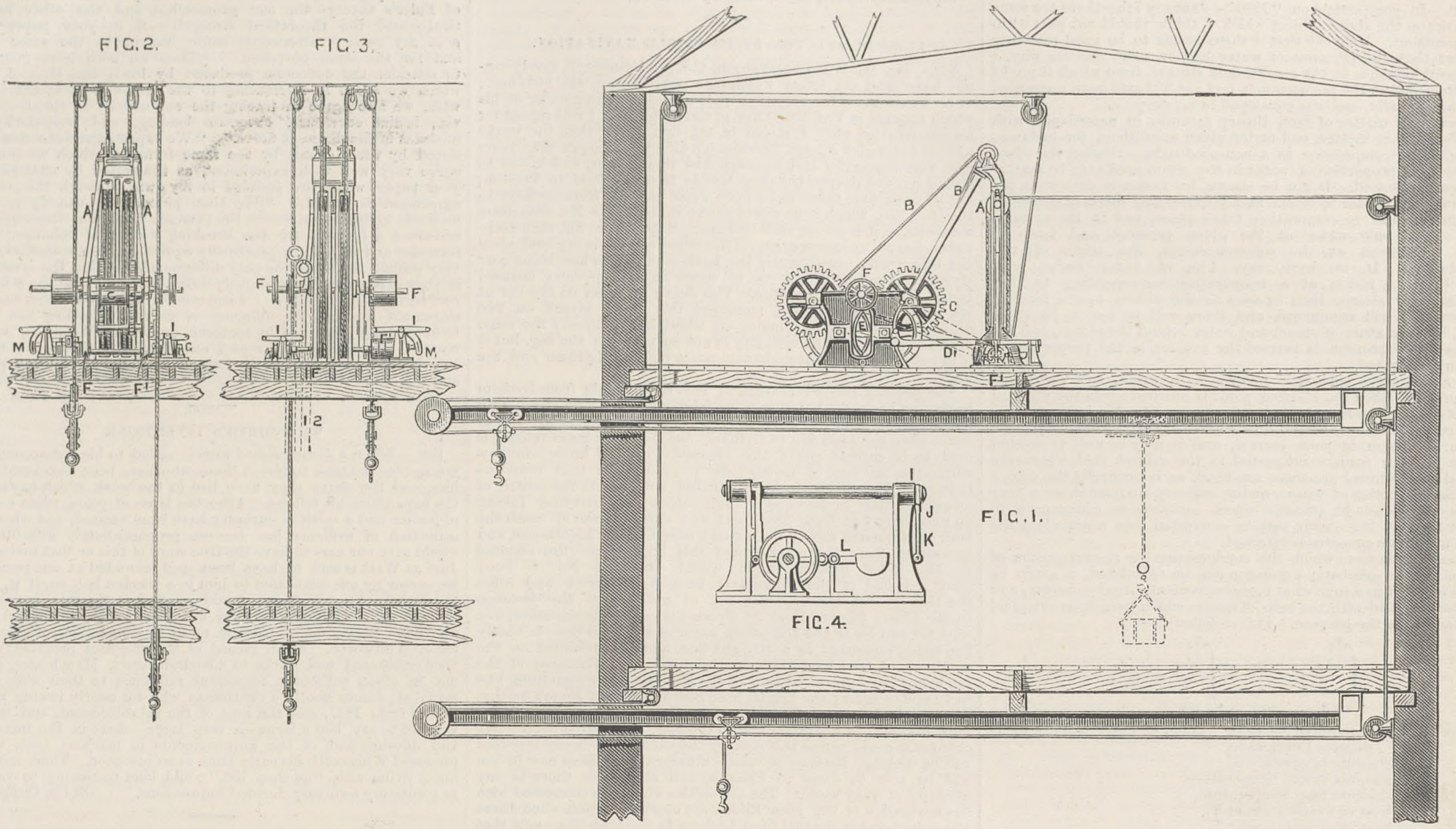
(*To be continued.*)

NAVAL ENGINEER APPOINTMENTS.—The following appointment has been made at the Admiralty:—W. E. Hosken, assistant engineer, to the Nelson.

THE LONDON ASSOCIATION OF FOREMEN ENGINEERS AND DRAUGHTSMEN.—It would appear from a circular just issued by the secretary to the members of this association that interest in its monthly meetings has diminished very much of late. This fact is not surprising, for the society has now, it would appear, no means of publishing its papers and proceedings, and that as its little organ, *The Foreman Engineer*, does not exist, the members know nothing of the future business of the society, nor of its present proceedings. It was a mistake to allow a publication so useful to it to be starved to death, and Mr. Joseph Newton, its proprietor, could not be expected to maintain it at a loss.

TRAVERSING WAREHOUSE CRANE.

MR. B. H. THWAITE, LIVERPOOL, ENGINEER.



THE THWAITE-NEVILLE WAREHOUSE CRANE.

FOR the different floors of warehouses or other buildings, the advantage of being able to hoist and traverse goods without the necessity of a complicated arrangement of machinery in the rooms themselves is very great, both from floor-space economy and from a safety point of view. The arrangement of crane, as shown in the illustrations above, has been designed by Mr. B. H. Thwaite to effect this purpose by the utilisation, with a comparatively simple alteration, of the ordinary form of winch-hoist placed in the attic or top storey of the building. A girder, with its traversing and hoisting carriage, is hung to the ceiling of each of the floors where it is required to be used, and, thus placed, it does not absorb any valuable storage-space.

Referring to the illustrations, it will be seen that the pulley-block A, sliding vertically on a stiff standard, is supported by the rope B working round the winch drum. The hoisting or lifting and lowering motion is effected by lifting or lowering the pulley B that winds round the winch-barrel C. If a considerable height of lift is required, the pulley C and the lower ones working on the traversing motion shaft F[1] are multiplied. The traversing motion shaft is driven from a shaft and drums *d*, arranged either for ropes or straps, and which are in duplicate for reversing the motion, and have a loose pulley on the traversing motion shaft for the stopping of the traversing motion. The lever D throws the friction gear and hoisting motion of the winch in and out of action.

One rope is used for both traversing and hoisting, and it is practically endless. The rope passes down to the underside of the floor, to which is hung the traversing girder, on which runs the traversing carriage or dog to which one end of the rope is attached; the other end passes from the pulley A to the opposite end of the traversing girder, passing over the suspended pulley on the traversing carriage and terminating with a ball and hook, so that as soon as suspended and the traversing motion is in action the carriage is drawn in either direction desired. The lowering of the hoisting pulley blocks A is compensated for by the fall of the hook and ball end of rope. This length is taken up by again hoisting the pulley-block A. The action of both transmission and hoisting is consequently simple in the extreme.

By pulling one of the actuating or controlling ropes of the brake lever I the traversing carriage is drawn in one direction; on releasing the rope the weighted lever of the brake falls, bringing the brake action into gear, instantly arresting motion; by pulling the other controlling rope the motion is reversed. On releasing the rope the brake arrests motion at once. The duplex winch shown in illustration is intended for two floors. The brake action is exceedingly simple; by pulling one end of the lever I the weighted brake arm is lifted up, lowering the friction band from out of touch with the periphery of the drum. The arrangement for shifting the driving belting is also simple. Attached to the lever I is a slotted quadrant M, this works the belt-shifting forks; by raising the arm the quadrant M is also raised, moving the forks right or left as may be desired. Instead of the winch, hydraulic power can be used on the Thwaite-Neville principle, as described in THE ENGINEER of 1885, p. 314. The hoist is being introduced by Mr. B. H. Thwaite, C.E., 37, Victoria-street, Liverpool.

COMPOUND EXPRESS ENGINE.

IN our impression for January 7th we illustrated a compound engine placed by Mr. Worsdell on the North-Eastern Railway nearly at the same time that he had an express engine built for working the fast trains between Newcastle and the North. This engine we illustrate on page 87. The cylinders are 18in. by 26in. by 24in., set on an incline of 1 in 60. The driving wheels are 6ft. 8in. in diameter. From the centre of the boiler to the rail is 7ft. 8in. The valve gear is Joy's; the working pressure 175 lb.

This engine has been at work only a short time, and so far it has more than realised anticipations, proving itself to be not only economical but very fast, keeping time with trains of far more than the normal weight. We shall give further particulars in a little time.

We may mention incidentally that the goods engine we illustrated shows a saving of about 16 per cent. in coal, with about 17 per cent. greater load hauled, as compared with the normal engines on the same work.

AMERICAN ENGINEERING NEWS.

THE following information concerning engineering works, and on industries relative to engineering trades, is from a New York correspondent:—

Railroad extensions.—Since 1884, when all railroad construction of importance was stopped owing to over-supply, general depression, and the extra depression due to the presidential campaign, the railroad world has been surely settling itself on a firmer basis, and the current year will be one of the busiest for railroad construction that have been experienced for several years past. Already contracts are being let and preparations made, and as soon as the season opens work will cemmence in earnest. The projected works whose construction is certain include several important trunk lines, as well as extensions of existing trunk lines and branches to open up new fields. There will be considerable work done in the South, the railroad facilities of which section were considerably improved last year and rendered more available for through transit, by the changing of the southern gauge of 5ft. to the standard of 4ft. 9in. adopted by the Pennsylvania Railroad and its allied lines. Cars built for the 4ft. 8½in. gauge can, of course run over these tracks. The bulk of the railroad work, however, will be west of the Mississippi river, in Texas, Colorado, Montana and the great North-west. Particulars of the new roads will be furnished hereafter.

Bridges.—The present will also be a great bridge year, not only for the ordinary bridges on new lines of railroad, but also several structures of exceptional importance. The great cantilever bridge at Poughkeepsie, N.Y., across the Hudson river, which will make the last link in a direct line from the Pennsylvania coal-fields to the New England mills and manufactories, is under construction. Work is being pushed rapidly on the foundations and piers, and the superstructure is in course of manufacture. The Baltimore and Ohio Railroad will build a large bridge from the mainland across the Arthur Kill to Staten Island, on the New York Bay shore of which the railroad company has acquired a large tract of land for freight yards and terminal purposes. Several bridges are projected to cross the Mississippi, including a large one at Fort Madison, Ia., for the Chicago line of the Atchison, Topeka, and Santa Fé Railroad, and a high-level highway bridge at St. Louis, Mo. A three-span cantilever bridge is also projected across the East River from New York City to Long Island City. This will give through railroad communication for Long Island. The existing Brooklyn Bridge can never be utilised for such communication.

A railroad weighing machine test car.—Messrs. Allen and Anderson, of Chattanooga, Tenn., have brought out a new form of car for testing railroad scales. The cars weigh 12,500 lb., and carry 12,500 lb. of test weights, some of which are to be used for testing depôt and platform scales. The cars are able, therefore, to test the weighing machines used for weighing loaded cars, &c., up to 25,000 lb. The firm will own and operate a number of these cars, sending a practical man with each one to make accurate tests and do the necessary repairs. Several Southern railroads have made a contract with the makers to keep all track and depôt scales in order during the current year.

An immense building enterprise.—In 1885 the directors of the Equitable Life Assurance Company decided to enlarge and improve the large building at 120, Broadway, New York City. The tenants vacated their offices by May 1st, 1886, and immediately work was commenced by tearing down the adjoining buildings. The excavations were cleared and strong foundations built, and then the new structure was built with wonderful speed, each day's progress being plainly noticeable. The work was carried on by day and night, but so carefully had the plans and arrangements been made that the gangs of men never seemed in a hurry, and not a hitch occurred. The structure is entirely fireproof, constructed of brick piers, iron columns and beams, with floors of the porous fireclay block arches, the same material being used to sheathe the ironwork. The front was built of huge granite blocks, weighing several tons each, and delivered on the work ready to be placed in position. Offices in the new structure will be ready for occupation by May 1st, 1887, the entire work of demolition, construction, alterations to the old building, adding new stories to the old building, and fitting up the interior, having been done in twelve months. The building occupies the entire block bounded by Broadway, Cedar, Nassau, and Pine streets, with the exception of the two Nassau-street corners, and its lengths of frontage are 167ft. 6in., 224ft., 46ft. 6in., and 224ft. respectively. The total depth from Broadway to Nassau-street is 308ft. A fine central court, 40ft. wide, runs between these streets, the centre 100ft. of which is 30ft. high, and covered with glass. From this court will run the marble staircases, and ten fast-running hydraulic passenger elevators will be provided. Shops will be opened on either side of the court, and there will be a restaurant in the basement. In the cellar are nine steel boilers, with an aggregate capacity of 900-horse power. There will be every improvement in heating, ventilation, electric lighting, telegraph and telephone appliances, letter-drops, &c. The tenants include a large number of lawyers. This company is the largest life insurance company in the world, its new business exceeding 100,000,000 dols.—£20,000,000—per annum. Mr. George B. Post, of New York City, was the architect.

Iron and steel products.—The following are the estimated amounts in gross tons for 1886 and 1885:—

	1886.	1885.
Pig iron	5,600,000	4,044,526
Bessemer steel ingots	2,000,000	1,519,430
Bessemer steel rails	1,500,000	959,470
Open-hearth steel..	200,000	133,375

During the past year the production of iron ore was about 10,000,000 tons, and about 1,000,000 tons were imported.

Nicaragua Canal.—The Congress Committee on Foreign Relations has recommended to Congress the incorporation of the Maritime Canal Company of Nicaragua. This company is to act under concessions granted by the Governments of Nicaragua or Costa Rica, and is to commence work in four years. The United States will have a controlling interest in the canal, and will limit the toll to 2·50 dols.—10s.—per ton. A resolution has been adopted recommending Congress to enter into negotiations with the Government of the Republic of Nicaragua with regard to the canal. The capital stock will be between a maximum of 100,000,000 dols. and a minimum of 50,000,000. Admiral Ammen, long known as an ardent advocate of this canal, is on the directorate. Meanwhile, Captain Eads has withdrawn his proposition to Congress to take up his Tehuantepec Ship Railroad enterprise; he will take it to prominent financiers to form a syndicate to manage it, and it is said that work will actually be commenced this year.

The iron market.—The prospects for the iron trade for the current year are eminently satisfactory. In consequence of a rise in prices for pig, and probable rises in the near future, several of the large firms are refusing to book large orders for several months ahead. The activity in railroad circles of course acts favourably on the market. Immense quantities of steel rails will be needed, together with splice bars, spikes, track bolts, switches and appliances, &c. There will also be large demands for structural iron, and for iron and supplies for locomotive and car manufacturers, &c.

Cable traction in New York.—Since the reduction of fares on the elevated railroads to a uniform rate of 5c., the Third Avenue elevated road has drawn so much patronage from the Third Avenue surface road, that the latter company has decided to institute some mechanical means of traction to replace horses. It is probable that the cable system will be adopted, as the company already has cable lines on Tenth Avenue and 125th-street, which work very satisfactorily. The cable system is in regular use now in several large cities, but up to the present nothing has been done to bring any but horse traction on the down-town portions of the New York street railroads—tramways. There is talk of operating some of the cross-town routes by electric motors. A plan has been invented to do away with the open slot in the street necessary for cable systems. The irons forming the sides of the slot are hinged at the bottom, their own weight causing them to fall together. The shank of the grip on each car would push the rails aside and obtain passage, while they would again fall together after the car had passed. How this would work with mud, dust or snow dropping in and clogging the working of the device, remains to be seen.

LETTERS TO THE EDITOR.

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

CYLINDER CONDENSATION.

SIR,—In your article on "1886"—January 7th—there are some remarks on the above subject which I think should not pass without comment. You say that "there seems to be good reason to believe that the presence of water has, in some obscure way, a powerful influence on the condition of steam;" from which it might be inferred that the phenomenon had not hitherto been accounted for theoretically, and was enveloped in mystery.

Now, as a matter of fact, theory is quite in accordance with practice in this matter, and under given conditions, for instance, expansion or compression in a non-conducting cylinder, the effect of a certain proportion of water in the steam used may be mathematically followed. It can be shown, for instance, that when the proportion of water to steam in the expanding mixture exceeds a certain amount re-evaporation takes place, and in the extreme case, when only water is present at the commencement and temperature is present at the commencement, the truth of this is obvious. If we have, say, 1 lb. of water under pressure behind a piston at a temperature corresponding to that pressure for steam, then as soon as the piston moves forward evaporation will commence, and there will no longer be water only, but a mixture of steam and water behind the piston, and the further the expansion is carried the greater is the proportion of steam evaporated.

If at any given point the process be reversed, and the steam compressed, when the starting point is reached again the whole of the steam will be reconverted into water. On this latter point—the compression of steam into water—there has recently been some discussion in your journal, and it may be well to remind those of your readers interested in the subject that where the initial and terminal pressures are fixed, as is generally the case, a certain proportion of water—under ordinary circumstances a very large one—must be present before compression commences, in order that all the steam may be converted into water when the final maximum pressure is attained.

The formula from which the condensation or re-evaporation of steam during adiabatic expansion can be calculated, is given by Rankine, and in a somewhat more convenient form by Zeuner, and is easily applied with the help of tables which have been compiled by Zeuner for the purpose. It is as follows:—

$$\int_{273}^{T_1} \frac{d\,q}{T} + \frac{x_1\,r_1}{T_1} = \int_{273}^{T_2} \frac{d\,q}{T} + \frac{x_2\,r_2}{T_2},$$

where q = heat required to raise 1 kilog. of water from 0 to T_c degrees Centigrade,
T = absolute temperature,
T_1 = absolute initial temperature,
T_2 = absolute final temperature,
r_1 = heat of evaporation at T_1,
r_2 = heat of evaporation at T_2,
x_1 = ratio of steam to water in 1 kilog.—by weight—at initial temperature,
x_2 = ratio of steam to water in kilog. at final temperature.

The quantities $\int \frac{d\,q}{T}$ for initial and final temperatures are taken from the table above referred to. On the assumption that the specific heat of water is constant for all temperatures, the value of $\int_{273}^{T} \frac{d\,q}{T}$ is represented by hyp. log. $\frac{T}{273}$.

r_1 and r_2 are taken from the tables generally used for saturated steam, and T_1 and T_2 are known for given initial and final pressures. If a certain value be assumed for x_1, then the only unknown quantity is x_2 which is easily calculated by means of the equation given.

$$x_2 = \frac{T_2\,r_1}{r_2\,T_1}\,x_1 + \left(\int_{273}^{T_1} \frac{d\,q}{T} - \int_{273}^{T_2} \frac{d\,q}{T}\right)\frac{T_2}{r_2}.$$

For any given initial and final pressures the above equation has the form $x_2 = Ax_1 + B$, A and B being constant for given values of T_1 and T_2. For the special case referred to above, where only water is present at the commencement of expansion, $x_1 = 0$—no steam—hence $x_2 = B$, which gives the amount of water evaporated in expanding to the final temperature.

The opposite extreme to the preceding is the case in which $x_1 = 1$—that is, before expansion commences, we have only pure saturated steam; expansion produces condensation, which goes on until the proportion of water reaches a certain amount, when re-evaporation sets in. Numerical examples will best illustrate the use of the formulæ, the results being given in the following table:—

Initial pressure	= 7 atmospheres		
Final pressure in atmospheres	4	1	0·5
Assumed value of x_1	0·513	0·513	0·513
Calculated value of x_2	0·515	0·513	0·509

It will be seen that in expanding from 7 to 4 atmospheres, re-evaporation takes place. On further expansion to 1 atmosphere there is re-condensation to the original value $x_1 = 0·513$; expanding still further to 0·5 atmospheres, continued condensation.

The following figures show the result of expanding from 7 to 4 atmospheres for various initial proportions (x_1) of steam to water:—

x_1 =	1	0·9	0·8	0·7	0·6	0·542
x_2 =	0·964	0·829	0·780	0·645	0·595	0·542

According to these results, when the initial proportion of steam sinks to 0·542, the final proportion at 4 atmospheres is the same as at starting, the value of x_2 having of course undergone variations at intermediate stages.

These calculations show that, at any rate as to the general principle, theory is in accordance with facts.

When we have to deal with cylinder walls which, as in practice, are *not* non-conducting, and consequently allow an abstraction or communication of heat, the mathematical conditions become less simple, and it would be necessary to know the law according to which the communication or abstraction of heat takes place in order to arrive at quantitative results. The general tendency, however, can be easily followed.

If Q be the heat communicated during expansion, then

$$\int \frac{d\,Q}{T} = \int_{273}^{T_2} \frac{d\,q}{T} - \int_{273}^{T_1} \frac{d\,q}{T} + \frac{x_2\,r_2}{T_2} - \frac{x_1\,r_1}{T_1}$$

Assuming that a communication of heat takes place according to some known law from the steam jacket to the steam in the cylinder, then $\int \frac{d\,Q}{T}$ can be calculated. Let us suppose its value to be C; then instead of as previously having the formula

$$x_2 = A\,x_1 + B,$$

we shall obtain

$$x_2 = A\,x_1 + B + C,$$

and according to circumstances we may have either condensation or re-evaporation or superheating. If $x_1 = 1$ and $A + B + C > 1$, then superheating would occur.

It is of course not possible, apart from further investigation, to obtain reliable quantitative results, but I venture to think that the phenomena referred to and their causes are not so obscure as you suppose. The influence of water in the cylinder can, as I have pointed out, be mathematically investigated by means of laws which are derived from the fundamental principles of the mechanical theory of heat.

G. R. BODMER.

14, Delahay-street, S.W., January 20th.

PRESTON AND THE RIVER RIBBLE NAVIGATION.

SIR,—Mr. David Alan Stevenson, C.E., of Edinburgh, surely cannot have read my letter which you published on the 14th inst., or he would never have written what he has done in a letter of his which appears in THE ENGINEER of the 28th inst. I will repeat for his information what I stated in my first letter, that the works carried out under Messrs. Stevenson's directions, begun fifty years ago, were successful and accomplished their object, which was to straighten and deepen the river Ribble from Lytham to Preston; but in those days there was a deep water channel from Lytham to the Irish Sea, which is no doubt shown in the books Mr. Stevenson mentions, as it is on our inch Ordnance Map. Now, Sir, that deep-water channel no longer exists; it has silted up, and is dry land when the tide is out; consequently the navigation works now being constructed cannot be of any use till there be a deep-water channel from Lytham to the Irish Sea. The depth of water on the bar at low-water spring tides—I measured this depth myself on two different occasions last summer—is about 4ft., I daresay the same depth as in 1838. The difficulty is not so much at the bar, but it is in getting a deep-water channel made between Lytham and the bar.

The present buoyed channel of the river Ribble from Lytham to the sea has eight buoys in it, each buoy about a mile apart, with not sufficient depth of water in it to bring a boat drawing 2ft. of water from the Irish Sea to Lytham, and how any improvement is ever to be carried out in this channel I do not know—anyhow where the millions of money are to come from that would be required. Sir, this channel is situated not quite in the centre of an open estuary surrounded on three sides by the Irish Sea. Taking an imaginary line from Southport due north, it would reach the land on the north side of the estuary near Lytham Lighthouse, and measuring from the point where this line crosses the channel of the river Ribble, which would be near No. 8 buoy (and the bed of the channel is here hard gravel, and when the tide is out there is not 2ft. of water, and the distance to the Albert Edward Dock at Preston is nearly eleven miles) due west till you reach the bar—deep water of the Irish Sea—is nearly five miles, measured in a straight line, and is surrounded on the north, south, and west sides by the open sea. The area of the sands and hard gravel estuary of the river Ribble is something like forty square miles; the length from Southport to St. Anne's-on-the-Sea is eight miles and the width five miles, measuring from No. 8 buoy due west in a straight line to the bar; and until a deep-water channel is made across this estuary the works now being executed will be useless. No class of vessels different from those now in use will be able to come to Preston, and at present there is any quantity of quay walls. The difficulties which are connected with the navigation of the river Ribble are enormous, even when there was a deep-water channel from Lytham to the Irish Sea—now that exists only on paper, on maps, and plans, and sections—they did all they could to make it a success, and now there is a deep-water channel to make nearly five miles long across an estuary with an area of forty square miles, and surrounded on three sides by the Irish Sea; and until this is done the works now being executed cannot be used, because as the channel is at present we have any quantity of accommodation.

I think Mr. David Alan Stevenson, C.E., will now be able to understand how it is that the works which Messrs. Stevenson designed fifty years ago accomplished their object; but the result has been to destroy the deep-water channel from Lytham to the sea, and no vessels any larger than come now—coasters—will ever be able to come, and the works now being constructed are for a class of vessel which cannot get over that five miles of sand and gravel. Southport would never allow great high walls to be built across the sands; it would destroy for ever the fishing trade on Southport sands, which trade is worth far more than the shipping trade at Preston is worth, and Parliament would never allow such an injustice to be done to a town as to make a seaport town into an inland town. All improvement of the navigation of the river Ribble applies between Lytham and Preston, and has been going on all this century, and the effect has been to fill up the estuary with sand and hard gravel and destroy the deep-water channel from Lytham to the Irish Sea; and this filling-up process is going on daily, and in another fifty years, if the sands rise as they have done during the last twenty-five years, it may become permanently dry land, and the Albert Edward Dock at Preston, of forty acres in size, would be surrounded with dry land. In those days the Irish Sea will not be able to get to Preston.

If Mr. D. A. Stevenson doubts the correctness of the statements in this letter, he can easily test them by going himself to Lytham, and taking a boat down the Channel, pass the buoys, out to the Irish Sea, and let the boat be on the bar at low-water spring tides.

G. HENRY ROBERTS, C.E.

87, Fishergate Hill, Preston, January 29th.

SIR,—At low water it is possible to walk straight across from Lytham to Southport. In one or two places the stream of the Ribble may reach half-way to the knees, not much more. That the walk may be taken I know, for I saw it done last summer. It seems to me that Mr. Roberts has hit the truth in his letter.

Liverpool, January 31st.

VIATOR.

THE LOCAL GOVERNMENT BOARD.

SIR,—Suffer me to raise my feeble voice in defence of the Local Government Board. If it were not for it we—the poor—should be at the mercy of assessors, overseers, and sanitary (?) inspectors. Some years ago a bootmaker built a large villa in the village where I lived, which he used as a sort of private hotel. He afterwards let it to a lady who is boss here. The house was let at a low rental, £35 per annum. During the shoemaker's time it was assessed at a fair estimate. When the lady had it the rateable value was put at £8, and the gross rent £10! Next door was a much smaller house, where a poor woman tries to make the rent by letting lodgings. This house was let to her at £15 per annum, the rateable value was stated at £14 10s., and the gross rent at £18. Well, I spoke to the assessor about the matter, and was defied and told to do my worst. I merely wrote to the Local Government Board, and the big house was assessed as £22 10s. rateable value, and the gross rent stated at £28. Even this is not in proportion to the smaller house.

In sanitary matters the Board does not seem to have so much power, yet they will help the poor man all they can. A lot of pigs and a horse were kept in a shed without a drain, close to a well, not many eet deep, in sand. After some months' correspondence with the Board the nuisance was removed. Many years ago a policeman told me that the sanitary laws are a dead-letter. I shall be pleased to send "C." a copy of the correspondence with the Local Government Board on the assessments alluded to in my letter if he likes to have one.

J. A.

Sizewell, January 31st.

THE STRENGTH OF STRUTS.

SIR,—Since the publication in your columns of our article on "Struts," based on the notes of four lectures given by one of us last spring to the students of the Finsbury Technical College, Mr. Fiddler has kindly drawn our attention to a communication of his own on "The Practical Strength of Columns," published as a selected paper in the "Proceedings" of the Institution of Civil Engineers issued last October. We think we cannot better point out in what way the investigations resemble one another than by quoting the following extracts from Mr. Fiddler's letter to us which accompanied a copy of his paper:—". . . . it is satisfactory to find the theory established by independent investigation; proceeding on parallel though not quite identical methods."

"Both papers commence with an independent demonstration of Euler's theory—the one geometrical and the other analytical—and the theoretical strength—β in your paper and ρ in my own—is afterwards made use of in the same way and for the same purposes." "Then we both have gone on to consider the deflection produced by loads less than β, and which we agree in attributing to the influence of excentricity; while we also agree in tracing the excentricity to three causes, viz., initial curvature, excentric loading, and irregularity of modulus in the different fibres." "We express the deflection produced by these causes by the same formula, which we find to agree very well with experiment, as illustrated by examples in your paper, which are omitted in my own, although the general agreement is stated." "We then proceed by exactly parallel methods to find the stress on the extreme fibre, and thereupon to construct a formula for the breaking weight of columns. The formulæ arrived at are practically equivalent to one another, and very similar in form—the only difference being that the symbol m in your expression has a slightly different meaning to the ϕ in my own formula." . . . . "I can readily understand Prof. Smith's statement—indeed, the influence of excentric loading has been treated many years ago by someone quoted in 'Weisbach,' whose name I forget; but so far as I am aware the theory has never before been worked out in the form which is common to your paper and my own."

W. E. AYRTON.
JOHN PERRY.

January 28th.

WHITWORTH'S INVENTIONS.

SIR,—When a distinguished man is called to his last account we are apt for the time to forget those who have been associated with him, and the share they have had in the work which has raised the hero above his fellows. After the lapse of years, when a sense of justice and a spirit of curiosity have been excited, and when the collection of evidence has become proportionately difficult, we would give our ears to have the true story of this or that invention. Just as Watt is said to have been well seconded at one period of his career by one who came to him in a wooden hat, so, if it were the fashion to seek them, should we find many men in wooden hats whose unobtrusive labours well deserve to be rescued from oblivion. Such a one I have in mind in connection with the late Sir J. Whitworth. A full record of the rise and progress of the once celebrated tool works in Charlton-street, Manchester, could not be given without a respectful reference to their able early manager, James Booth, a gentleman who for nearly twenty years, dating from 1837, was the soul of the establishment, and who, I venture to say, had a large—a very large—share in the inception and development of the improvements in machine tools which procured Whitworth his early fame as an inventor. There must be many living who, "an they list," could lend testimony to confirm or refute my own very decided impressions.

SUUM CUIQUE.

RAILWAY BRIDGE OVER THE RIACHUELO.

SIR,—Mr. Beyerhaus points out that he assumes (1) that the nodes are all hinged, and (2) that the end vertical is not able to resist a vertical force. Neither of these assumptions is correct. The nodes are rivetted joints, the bottom chord is a plate girder, and the end vertical is a braced column, all of them capable of resisting considerable stresses either direct or transverse. It is this capability in the bottom chord of resisting transverse stress which renders it so important that no compression should be possible in the end vertical. Professor Fitzgerald has shown that such a compression might occur, but I am glad to see he does not think it would amount to much. Still, considering the ambiguity of stress in all rivetted joints, it does not appear to me that the correspondence has gone to show a special utility in rigidity of connection for the end vertical, but rather the contrary.

January 26th.

T. GRAHAM GRIBBLE.

[We cannot publish more letters on this question. Our readers are no doubt quite satisfied that the member of the bridge upon which the discussion was raised is a tie, as Mr. Woodcock, under Mr. Wood, designed it to be.—ED. E.]

WAGES AT SWINDON.

SIR,—Having taken great interest in the wage lists appearing in your valuable paper within this last month, I noticed last week, among others, one for the Swindon G.W.R. Works. I noticed that rivetters, boilermakers—which I understand to mean boiler erectors or platers—smiths, and chargemen were rated as follows:—

	Standard. s. d.	Highest. s. d.
Boilermakers	28 0	30 0
Rivetters	26 0	28 0
Smiths	30 0	33 0
Chargemen	—	33 0

Now, this is certainly not correct. There are many kinds of smiths and also chargemen, some, of course, only chargemen of labourers; but the prices paid at present and for some years past very nearly, for boilermakers and their chargemen, angle iron smiths and general smiths, and rivetters, are as follows:—

	Standard. s. d. s. d.	Highest s. d.
Boilermakers	30 0—33 0	—
Chargemen	— 36 0	39 0
A.I. smiths	— 36 0	36 0
General smiths (this, I find, is correct).		
Rivetters	29 0—30 0	31 0

Now, I am a journeyman myself, and served my time here at this trade, and if at any time I leave here—which is not improbable—I consider that the figures stated in your paper would be injurious to me—very probably so—and not only me, but my fellow-workmen also.

I spoke to one of our head workmen about this, and he agreed with me that I should be justified in informing you how it really stood.

Certain I am that after the years I have striven, both practically and theoretically, I would not work at such a price. I would sooner by far take a meaner place, where there was not so much upon the mind as well as upon the hands.

I have given my name, but not for publication—not but what I can honestly vouch for the truth of what I have written, hoping you will give it space in your widely-known paper. You will oblige me and fellow-workmen.

SWINDONIANS.

Swindon, February 1st.

THE VYRNWY WATERWORKS.

SIR,—Allow me to observe that the gentleman who writes under the pseudonym of "Civil Engineer" knows very little of the subject upon which he presumes to discourse. I will briefly correct him upon several of the material points upon which he has committed grave mistakes.

(1) Neither Mr. Deacon nor I is or am entitled to the credit of pointing to the River Vyrnwy as a source of supply. Mr. Bateman gave it a prominent place in his scheme for the supply of the Metropolis, and proposed an embankment a short distance below the dam now being constructed. After him came Mr. Williams, who made surveys and suggested the Vyrnwy for Liverpool.

(2) I and my son, Mr. Charles Hawksley, took an active part in preparing the plans for Parliament, and I and Sir Frederic Bram-

well—not Mr. Deacon—carried the scheme through Parliament. By request of the Chairman—Mr. Bower—Mr. Deacon and I were recognised as joint engineers for parliamentary purposes, because those purposes involved no personal responsibilities.

(3) Mr. Deacon's agreement with the Corporation was not of the same date as mine, but of a later date. It made no reference to my agreement, which, indeed, it could not have varied if it had. By my agreement I was made engineer-in-chief, with the duty of designing, &c., and Mr. Deacon was made resident engineer, with the duty of supervising the constructions to be designed by me. There never was any joint engineership in the case. I was a professional engineer independently engaged *ad rem.* Mr. Deacon was a salaried officer of the Corporation, and so remains. It is true Mr. Deacon endeavoured on several occasions to hold himself out as joint engineer, but this I never permitted him to succeed in doing; and touching that matter, I hold a letter from the Town Clerk, dated 14th September, 1885, and written by direction of the committee, in which the Town Clerk distinctly states:—"I am instructed by the Water Committee to inform you that Mr. Deacon is not in the position of joint engineer with you, and further that there has not been any recognised departure from his position of resident engineer with the duties assigned to the holder of that office by the expressions used in your agreement." On this absurd claim of jointship, I may remark that I have expended about £15,000 in the discharge of my duties and obligations as "engineer-in-chief," towards which Mr. Deacon has not contributed a single shilling.

(4) As to the appearance of Mr. Deacon's signature on my drawings, and his name on the cover of my specifications, we were both engineers on the same work, I as chief, and Mr. Deacon as resident. The chairman requested me to permit the appearance of Mr. Deacon's name on the ground that "it would do that gentleman good and me no harm." I unwisely assented, and now see the improper use made of this act of kindness, which, however, neither creates nor implies any alteration of our relative positions. It is unnecessary to trespass further on your space, except to point out that the mis-statements to which I have referred and now disprove are in their nature libellous, as being injurious to the character and reputation of a professional man. T. HAWKSLEY.

30, Great George-street, Westminster,
February 1st.

DONKEY BOILERS.

SIR,—Referring to the late fatal donkey boiler explosion at Hull, the wonder is that we have so few of such accidents considering the many risks that are run; and I am tempted to give a few particulars concerning donkey boilers and their working in general. I may commence by saying that in most cases they are made far too small for the rapid loading and unloading of vessels, and consequently to attain those ends recourse has to be made to the main boilers, a proceeding I propose to touch later on. Let us take a vessel of 2000 tons, where the donkey boiler is too small for the simultaneous use of the winches. She comes into port grain laden, say, with, as is frequently the case, only two or three discharging days; meaning, in the case of grain during the winter season, eight to ten hours each day, or in all, about thirty hours for the cargo to be discharged in by steam, no matter from which source the latter comes. At the first starting of the cargo-discharging, with the boiler, water, and fires clean, steam can be kept, but the inevitable alteration of these circumstances renders unpleasant and dangerous phases certain.

It is superfluous here to follow the various changes that take place in the working of the boiler from the time steam is raised to the disappearance of the water out of the glass gauge These are but too well known to the experienced marine engineer, one of the results is frequently to be seen in bulged and blistered furnace plates, through the extreme density of the water used, and I may add, too narrow water spaces. Also it is very noticeable that the errors in the sizes of the boilers are mostly on the side of inefficiency for sufficient steam. This matter is often left to chance, or precedent takes the place of judgment in the choice of the boiler. But it does not at all follow that because a certain sized boiler supplied sufficient steam for one vessel's winches that a similar kind would answer for another vessel. It is a matter for regret that this most important item in a new vessel's furnishings is very often looked at in the light of first cost, or does not receive the practical attention it should have.

I do not wish to condemn reasonable economy in the choice of the boilers and their fittings, but I condemn most emphatically that short-sighted economy which in the end courts nothing but disappointment and possible disaster.

A word or two on donkey boiler safety valves. Generally the boiler is put into a dark recess in the stokehole bulkhead, with safety valves hard to get at for overhauling. Hard to steam boilers are, in nearly all cases, easy to prime. The result in that case is that safety valves get set through the dirt given off in priming, and more especially in the case of dead weight valves, where the weights are of too nice a fit for the chamber. But in general the gearing of safety valves is too closely fitted.

Taking up the subject of the use of the main boilers for cargo-discharging purposes:—It is ruinous in this way, that comparatively so little fire being required in the main boiler furnaces to supplement the donkey boiler furnace, the earthy matter from the new compensating water is precipitated unequally on the heating surfaces, resulting in cracked and blistered tube and furnace plates. Then comes trouble for those who are at all anxious for the preservation of their boilers.

What I have just said may not be new to many, but being a fact of such importance, does not decrease in value by an insertion in your valuable and influential columns. In a vessel where a frequent change of engineers occur, things connected with the donkey boiler and winches are sure to be neglected or receive secondary attention. This fact is unfortunately not too widely known. In concluding, I am sure, Sir, that you will agree with me that the exigencies of the present circumstances in trade demand that a far healthier state of things should exist, not only to meet the present keen competition, but also for common safety. JAS. W. BECK.

Bristol, January 28th.

THE STRENGTH OF STRUTS.

SIR,—In some investigations of the strength of struts, it is assumed that homogeneous beams will acquire a double or reversed deflection, the beam under end thrust assuming curves like that of an S. May I ask Professors Ayrton and Perry to refer me to any experimental investigation which proves that such deflection takes place? In some experiments I have carried out with wood and wrought iron, I have entirely failed to get any curve but one, unless I used special appliances to deflect the strut right and left. I assume that the investigations of Professors Ayrton and Perry are based on facts, and I shall be obliged, as I have said, for instruction as to the mode of making an experiment which will secure the double flexure. My experiments were made both with flat, square, and round bars with squared flat ends unfixed.

Bristol, January 31st, 1887. J. WALKER.

ENGINEERING SOCIETY, KING'S COLLEGE, LONDON.—At a general meeting held on Tuesday, January 25th, the President in the chair, Mr. G. L. Hodgson read a paper on "The Characteristics of Dynamos," which was adjourned from November 16th last. The author commenced with a comparison of the characteristic curves of dynamos with the indicator diagrams obtained from steam engines, though there are certain differences which cause the analogy not always to hold good. The distinctive curves obtained from the various types of machines were then discussed, and the methods by which they may be constructed. The characteristics of motors were then briefly alluded to. The paper was illustrated by wall diagrams and hand sketches. After a vote of thanks had been passed the meeting adjourned to February 1st.

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

(*From our own Correspondent.*)

THE check which has occurred in the trade revival in the Scotch and North of England markets is leading to a little hesitancy here. A tendency is noticeable among buyers to hang back, and only where early supplies are needed will consumers consent to place orders at the moment. Makers, however, refuse in their negotiations with buyers to attach great importance as yet to the change in the Northern markets. They believe that it is only a natural rebound from the too rapid advances which were taking place, and that the markets will again right themselves.

The demand expressed in Wolverhampton yesterday and in Birmingham to-day (Thursday) for finished iron was restricted in nearly all branches except sheets. Of these latter the local consumption continues very large on account of galvanising and working up purposes. Some of the Eastern markets and those of South America are sending in better orders for merchant iron, but the requirements of the Australian markets outside galvanised sheets are under the average of the season.

It is a gratifying indication to some makers of merchant iron, who for several years past have been trying unsuccessfully to get back into foreign markets with which they once did a fair business, but which have of late been passing into the hands of German and some other foreign competitors, are now again receiving orders from them. Certain of the Mediterranean markets may be mentioned in this connection.

Prices of sheets keep at £6 upwards for singles; £6 10s. to £6 12s. 6d. for doubles; and £7 10s. for lattens. In the galvanised state corrugated sheets are quoted £10 10s. to £10 15s., delivered Liverpool. A report is current this week that the Bradley Sheet Ironworks, Bilston, which were recently put to stand by the Birchills Hall Iron Company, are to be early re-started by a new proprietory, under experienced management. Certainly there is abundant room for an increase in the out-turn of sheets at the present time. The galvanised iron roofing manufacturers have plenty of orders in reserve, and they still quote the lately advanced prices. For galvanised tanks there are a few better inquiries, and manufacturers ask more money.

Messrs. E. P. and W. Baldwin, of Swindon and Wilden, are very busy in their tinning department, which they have lately enlarged. The firm also contemplate the adoption of other modern and improved appliances. The heavy demand for their charcoal tin-plates—of which they are the largest manufacturers—keep all their charcoal fires on regularly. This is accounted for by the fact that users of goods made from steel tin-plates find that the tin wears off steel sooner than off charcoal tin-plates.

Some of the marked bar firms are receiving an increased number of orders, and declare prospects are improving. Boiler and other plates are quoted by the New British Iron Company as follows:—£8 for best Corngreaves, £9 for Lion, £10 for best Lion, £11 for double best scrap Lion, £12 for treble best Lion, and £13 for extra treble best. Sheets of 20 gauge are quoted £8, £9, £10 10s., and £11 10s., according to quality; and best charcoal sheets £13. Ship and tender plates are £7 10s. to £8 10s. Slit rods the New British Iron Company quote £6 5s. for Corngreaves, £7 C. G. C. brand, £7 10s. Lion, £9 best Lion, and £11 10s. best charcoal. Steel rods are £8, and iron horseshoe rods £6 10s., £7 10s., and £9, according to quality. Hoops the company quote £7, £8, and £9 10s. Steel hoops are £8 10s., and best charcoal, £8. The price of common bars keeps at £5 to £5 5s.; gas tube strip, £5 upwards; and hoops, £5 5s. to £5 10s. Nail rods are also £5 5s. to £5 10s. Puddled bars are quoted by some strong firms at £3 10s. to £3 12s. 6d.

The demand for steel is steadily increasing for almost every purpose to which iron can be applied. The quality of some of the mild steel now being produced in this district is good enough even for smithy bars, and where careful working by the smiths can be guaranteed, is being used instead of bar iron. Plating bars for use by the edge tool makers are being purchased from Sheffield works at £6 to £6 10s. per ton, delivered here—prices which are about the same as those for iron plating bars, and it is eloquent of the quality of the steel supplied that makers declare that they prefer to use it instead of iron at the same price. Cast steel prices show no alteration upon the rates which have ruled for years past. Some local buyers who have recently sought quotations for cast steel of a ductile nature, for the manufacture of ships' tackle and other special work, received in response prices varying from £37 to £42 per ton, while for steel of a yet higher quality for horseshoe best studs, &c., the quotation was £65 per ton.

Prices of steel supplied by certain of the Welsh steel makers to local buyers are increasingly firm, in consequence of the manner in which order books at the Welsh works are filling up. Offers by local consumers to buy steel tin-plate bars for rolling down into sheets are this week met by exceptional salesmen with a demand for a further 5s. advance, making the figure £5 5s. delivered here.

The condition of the pig iron market is not of a reassuring character, but sellers maintain a decided front. Most vendors of Midland brands decline to make any concession in prices, notwithstanding the fall in the North of England. Vendors prefer to wait before departing from recent advanced quotations, urging, as they did last week, that makers have abundance of forward orders upon the books. Northampton pigs remain at 40s. to 41s. per ton delivered here, and Derbyshires and Lincolnshires 42s. 6d. per ton.

Hematites keep strong. The demand is scarcely so large as two or three years back, when steel blooms and billets were in less favour; yet there is a considerable sale, particularly of foundry numbers. Good forge hematites are quoted at 60s. delivered from the West Coast and Lancashire, and foundry numbers 1s. 6d. to 3s. per ton additional. The Barrow Company again quoted this week 62s. 6d. for forge nominal. Local pigs are named at 52s. 6d. for all-mines, 37s. 6d. to 40s. for part-mines, and 30s. to 32s. 6d. for common cinder qualities. The demand keeps up capitally.

The large American demand for iron and steelmaking materials is running up prices considerably, to the inconvenience of local consumers. Purple ore from Runcorn cannot this week be bought at less than 15s. 6d. per ton delivered to consumers' works. The last contracts of some local buyers were concluded at 11s. 9d., showing a rise of 3s. 9d. per ton. Red hematite ore has advanced to 20s. 6d., delivered from Saltney into this district, and even at this figure—which means to the raisers 15s. f.o.b. Saltney—there is but little desire to make sales.

Common ironmaking materials are also in rather better request here in consequence of the larger business doing at the blast furnaces. Northampton stone is selling at 5s. to 5s. 6d. per ton delivered hereabouts. Ironworks coal is going off rather better, and for contracts some owners are getting an advance of 6d. per ton.

The engineers and machinists are fairly well situated for work; in several leading establishments orders are accumulating.

Orders in the lock trade are not vigorous. Indeed some of the largest Willenhall makers of rim and mortice have less for their machinery and hands to do than for a long time past, the Australian demand being abnormally quiet. Wolverhampton brass cabinet makers, however, are fairly well engaged. Increased success is attending the action of those makers in getting out locks to compete with the German importations in the London market. The low prices which the adoption of machinery is enabling them to accept are serving them in good stead.

Consideration is being given to the question of again calling out those Cradley Heath chainmakers, numbering about 300, who have resumed work at the advanced terms. The men have just completed the twenty-fifth week of the strike, and they are determined to hold out to the last.

The Walsall Chamber of Commerce are about to bring before the War-office authorities the advisability of contractors being empowered to have their goods forwarded to Woolwich at the reduced rate of 22s. 6d. per ton, charged by the railway company for Government stores.

The brick manufacturers of Oldbury have unanimously resolved to advance the price of common bricks 2s. per thousand.

NOTES FROM LANCASHIRE.

(*From our own Correspondent.*)

Manchester.—The iron trade of this district remains in much the same condition as reported last week. The continued downward tendency of prices in the iron centres of Scotland and the North of England necessarily has a depressing effect upon the market here, and although local and district makers still hold nominally to late rates, they are more disposed to entertain offers at under their full list prices. So far as common pig iron is concerned, there is little or no business doing to really test prices, but buyers are unquestionably now in a position to place orders on much more favourable terms than was possible a week or so back, and there is iron in second hands which is offered at considerably under the nominal current market rates. Hematites remain very firm, and, so far as makers are concerned, there is little or no giving way. As regards manufactured iron, it can scarcely be said—except it is in sheets—that any very material advance has been established upon the late low rates. Makers in some instances hold out for better prices, but merchants and dealers who bought before the recent advance are offering at prices almost as low as ever.

There was a fairly good attendance on the Manchester iron market on Tuesday, but business was extremely slow. For local and district brands of pig iron prices were rather easier, Lincolnshire makers quoting about 39s. 6d. to 40s. 6d., less $2\frac{1}{2}$ per cent., for forge and foundry qualities delivered equal to Manchester, with Lincolnshire brands to be got at about the same figure, but no sales of any weight were reported. Scotch and Middlesbrough iron was also to be got at lower prices than last week. For hematites quotations remained at about 60s. to 61s., less $2\frac{1}{2}$ per cent., for good No. 3 foundry qualities delivered into the Manchester district, but buyers could have placed out orders at under these figures. Finished iron prices average about £5 to £5 2s. 6d. for bars, £5 7s. 6d. for hoops, and £6 10s. to £7 per ton for sheets delivered into the Manchester district.

There is nothing very encouraging to report with regard to the condition of the engineering trades; the improvement which has been looked forward to in some quarters still shows no real sign of development, and I continue to hear complaints from important sources that, if anything, trade is getting worse rather than better.

At the meeting of the Manchester Association of Engineers, held on Saturday, special reference was made to the great loss which had been sustained by the death of Sir Joseph Whitworth, and on the motion of Mr. Thomas Ashbury, C.E., seconded by Mr. R. Rawlinson, it was resolved—"That this meeting of the Manchester Association of Engineers, whilst regretting to hear of the death of Sir Joseph Whitworth, Bart., feels it an honour to place on record its high and keen appreciation of the invaluable and distinguished services and benefits rendered by him during the course of a long and eminently active life in promoting the advancement of the practice and teaching of mechanical science, and who, by his great ability and skill, achieved the great result of laying down a fundamental basis of truth, accuracy, and trustworthyness upon which he has founded with unparalleled success the construction of ordnance and engineering and mechanical structures. This meeting also gratefully acknowledges the great impetus given to technical education by the noble generosity and patriotism of one of the most illustrious and honoured citizens of Manchester, whose name is indelibly stamped as the prince of mechanicians and the originator of absolute accuracy and system in mechanical construction, and wishes to convey to Lady Whitworth its deep sympathy in the great loss she has sustained." The remains of the deceased baronet were brought from Monte Carlo on Tuesday, and were interred on Wednesday at Darley Dale, Derbyshire, Mr. Thomas Ashbury and Mr. Rawlinson attending the funeral as representatives of the Manchester Association of Engineers.

The question of the waste of energy in the steam engine was also discussed at the meeting of the Manchester Association of Engineers on Saturday. Mr. H. Guthrie, C.E., read a paper on "The Thermodynamic Analysis of the Steam Engine," in the course of which he observed that in order to deal with the motive-power of the steam engine we were content to accept 20 per cent. and throw away 80 per cent. of the energy developed in the furnace, whilst, so far as this energy was utilised by the steam engine, it was quite a common thing to realise no greater efficiency than about 4 per cent.; and with the very best of engines, with all the latest improvements, it was not possible to realise more than $12\frac{1}{2}$ per cent. on the gross or potential energy of the fuel. In the discussion which followed, objection was raised to the great waste which was occasioned by the use of long chimney stacks to create a draught; but, on the other hand, it was urged that even this was more economical than a mechanical draught, and gas firing was suggested as probably the most feasible means of securing the best results, whilst one member expressed the opinion that gas engines would prove to be the motor of the future. The only really practical means of securing greater economy under the present system which was suggested was in providing plenty of boiler room, and thus securing slow combustion of the fuel.

The Manchester Ship Canal project has just passed through what may well be termed a crisis in its history. Mr. Daniel Adamson who has been the predominant figure in the undertaking all through the long struggle which the promoters have had to fight, has retired from the board of directors and some other guiding hand will now have to carry on the scheme to its further development. The private meeting of shareholders held in the St. James's Hall, Manchester, on Tuesday, laid bare the fact that there has been very considerable friction on the board of directors, but it seems scarcely possible to conceive that Mr. Adamson, after all he has done, and the intense interest which unquestionably he still takes in the ultimate success of the ship canal scheme, will allow any personal feeling to stand in the way of what the shareholders may consider the best policy to be pursued. The independent committee who thoroughly investigated the whole matter after the recent unfortunate failure to raise the required capital, recommended a re-constitntion and strengthening of the board of directors as essential for the successful carrying out of the scheme. This recommendation of the committee is now being acted upon, and it is a matter of deep regret that Mr. Adamson has, at this point, felt himself compelled to sever his active connection with a project with which his name, whatever may be the ultimate issue of the efforts now being put forward, must always be pre-eminently identified.

In the coal trade the month has opened with a slight easing down in prices. With the recent mild weather there has been a decided slackening off in the demand, which has necessitated a resort to short time at a good many collieries, and the leading colliery firms in the Manchester district who have found that they were being undersold, have reduced their pit, wharf, and delivered prices for house-fire coal 10d. per ton; in other districts, although there is no quoted reduction, there is also some little giving way. Steam and forge coals and engine classes of fuel are also again beginning to hang in the market, but in these there is no change in price. At the pit mouth best coals average 9s.; seconds, 7s. 6d.; common house-fire coal, 5s. 9d. to 6s. 3d.; steam and forge coals, 5s. to 5s. 6d.; burgy, 4s. 6d. to 5s.; best slack, 3s. 6d. to 4s.; and common, 2s. 6d. to 3s. per ton.

For shipment there has been a fairly good demand, and for steam coals, delivered at the high level, Liverpool, or the Garston Docks, sellers have had no difficulty in getting about 7s. 3d. to 7s. 6d. per ton.

The annual general meeting of the subscribers to the Manchester Coal Exchange was held on Tuesday, Mr. John Rawcliffe, the chairman, presiding. The report and balance-sheet, of which I gave an abstract last week, was adopted, and the following gentlemen were elected officers for the ensuing year:—President, Mr. Edgar Storey, Leigh; vice-president, Mr. John Platt, Liverpool; treasurer, Mr. R. Peters, Tyldesley; four members of the committee, Messrs. W. Allton, Derby; J. Carter, Blackburn; T. Lymm, Wigan; and G. Pearson, Ashton-under-Lyne; auditors, Messrs. E. Neville, Preston; and H. Nield, Lees, Oldham.

Barrow.—The demand for hematite qualities of pig iron is very steady and brisk, and the work in the hands of makers is very considerable. The demand is largely represented by orders on foreign account, in which America and the colonies take an especial share. On home account there is also a growing trade, particularly for Bessemer samples. The orders recently booked have been at prices at about 50s. per ton net f.o.b., but the largest makers are asking 52s. per ton net, and as they are favourably situated for orders they are declining business at lower values than these, while for forward deliveries still higher prices are asked. The outlook in the iron trade is more satisfactory than it has been, and it is evident that a degree of permanency is established in the improvement which set in some few months ago. The output is being increased on every hand, and makers are very fully sold forward. Large deliveries have been contracted for, and there is an undoubted assurance of activity for a greater part of the present season. Stocks of iron are large, but they are held by makers and speculators who are sanguine that higher prices will soon be realised. The steel trade is steady. Rails are in very full inquiry, and orders are largely placed, while from America and the colonies, as well as from the Continent, the known requirements of consumers are such as to justify the belief that large orders will be placed during the season. Prices are steady at £4 5s. per ton net at makers' works f.o.b. for ordinary heavy sections of rails, prompt delivery. There is still a very busy trade in blooms and billets, and prices are better than they have been for a considerable time. Steel wire is quiet, and very little is doing in wire nails, but hoops show a good trade. Steel forgings are quiet, and there is only a poor trade in tires and steel castings. In the shipping trade there is no change to note. No new orders are reported, but there are numerous inquiries for steamers, which, it is believed, will lead to good contracts being booked. Engineers are not busy either in the marine or the general departments. Iron ore is in good demand at full prices of 12s. per ton net at makers' works, but purchases are difficult to make for large parcels. Coal and coke steady. Shipping busier.

THE SHEFFIELD DISTRICT.

(*From our own Correspondent.*)

THE Government contract for cutlery for the Army has this year been given to one firm, Messrs. Atkinson Brothers, Milton Works, who have held contracts for the Government for the last thirteen years. This is the first time, however, that the entire order has been placed with one establishment. The quantity is 250,000 table knives, 240,000 forks, and 7000 clasp knives. The order is now being completed at the rate of 120 gross per week.

"Fair-Trade" is again being brought to the front. Mr. J. E. Bingham, J.P., the senior member in the extensive silver and electro-plating firm of Messrs. Walker and Hall, Howard-street, is the President of the Sheffield branch of the National Fair-Trade League, which has several sub-branches in the town. A meeting, almost entirely composed of working-men, was held by the Hillsbrough branch on Monday night. I was present, and was struck by the attention which was given to Mr. Bingham, who spoke ably and earnestly for an hour. At the close a resolution condemning "unnatural Free Trade" as injurious to the nation, and especially to the interets of working-men, was passed unanimously. Usually there has been strong opposition, and occasionally an adverse vote carried. In the course of his address Mr. Bingham incidently mentioned that he had been solicited that day to assist in sending a man to the United States. The reason given was that a large steel and iron company in Cumberland, employing about one thousand hands, intended starting a branch establishment at Washington County, U.S., and that he had to follow them. This migration of capital is a serious feature of industrial affairs.

Messrs. John Brown and Co., Atlas Steel and Ironworks, had some most successful blasting operations done for them last Saturday by Mr. W. Liversidge—Messrs. R. Roper, Son, and Co., Sheffield. A solid mass of metal, composed chiefly of iron and spiegeleisen, 3ft. or 4ft. in depth and 9ft. in diameter, was rent asunder in spite of its strength and tenacity. The first shots were extremely successful, not a scrap of the metal being lodged beyond a distance of eight yards from the seat of the explosion. This is an important undertaking for large works, and it necessitates effective barricading of the furnaces, as well as able superintendence on the part of the experts engaged in the blasting operations by means of dynamite.

In the death of Mr. Benjamin Sykes, at the mature age of eighty-four, passes away one who was familiarly known as the "Father of the File Trade," and amongst his colleagues as the "Father of the Cyclops Works." More than fifty years ago Mr. Sykes was engaged by Messrs. Johnson, Cammell, and Co., as their file manager, on the firm deciding in 1836 to commence the business of file manufacture. Prior to that date he had been in the employment of Messrs. W. Ibbotson and Co., at the Globe Works, as file forger. Soon afterwards Messrs. Johnson, Cammell, and Co. found their business increase to such an extent that extensions had to be made which led to the great Cyclops Works of to-day. In 1883 Mr. Sykes retired from active work, having been with Messrs. Cammell and Co. and their predecessors more than forty-six years. He was one of the ablest of file managers Sheffield ever produced, and was respected as much for his excellent qualities as for his skill as an artisan and a manager of artisans.

THE NORTH OF ENGLAND.

(*From our own Correspondent.*)

THE Cleveland iron market held at Middlesbrough on Tuesday last was well attended, but the tone was flat, and but little business was transacted. The value of pig iron has been falling steadily for a fortnight, and is now 2s. per ton less than the maximum figure lately reached. Makers have made no alteration in their quotations, but merchants are offering for prompt delivery at 36s. 3d. per ton for No. 3 g.m.b., and 35s. for forge quality. A week since 37s. was the lowest price taken for No. 3, and 35s. 6d. the lowest for forge. The strike which has commenced at the Eston steel works has undoubtedly had a depressing effect upon the market, for the Cleveland pig iron which would otherwise have been used in the steel converters will now appear in the market or be put into stock. The uncertainty as to its duration has had the effect of discouraging both buyers and sellers, and in the meanwhile but little business is proceeding,

Messrs, Stevenson, Jacques, and Co.'s current quotations are:—"Acklam hematite," mixed numbers, 50s. per ton; "Acklam Yorkshire—Cleveland—No. 3, 39s.; "Acklam basic," 40s.; refined iron, 54s. to 64s. per ton.

The current price of Cleveland warrants, which depends mainly upon the sales made at Glasgow, is from 36s. 4½d. to 36s. 6d. per ton.

On the 31st ult. Messrs. Connal and Co. had in their store at Middlesbrough 309,682 tons of pig iron, that being an increase of 340 tons during the previous week. At Glasgow on the same date they held 841,959 tons.

The quantity of pig iron shipped during January was 51,872 tons, whereof the principal items are as follows, viz.: to Scotland there went 26,825 tons; to America 6950 tons; to Holland 3810 tons; to France 3085 tons; to Belgium 2101 tons; and to Italy 1977 tons. The shipments of the previous month only reached 63,777 tons.

The manufactured iron and steel exported during January amounted to 32,770 tons, against 45,194 tons during December. The principal destinations were: India, which took 14,162 tons; America, 2950 tons; Burmah, 1750 tons; Japan, 1264 tons; and Egypt, 2105 tons.

With respect to the Northumberland colliery dispute, it cannot be said that any real progress has been made towards a settlement. About 14,000 men are idle, and the ponies and working gear have been brought to bank. Meanwhile, Mr. John Morley, M.P., has, at the request of Mr. B. C. Browne, Mayor of Newcastle, offered his services as arbitrator. He has been courteously received both by the employers and the colliers, but there is no present appearance of any advantage being taken of his good offices. The mania for striking has now extended to the Durham collieries. Those belonging to the Wardley, Usworth, and Felling collieries have some grievances which, if not immediately removed, they think ought to involve a strike. They have passed a resolution accordingly.

NOTES FROM SCOTLAND.

(*From our own Correspondent.*

THE pig iron market has been much depressed during the greater part of the present week. Prices have been steadily declining with scarcely a break, and it seems as if all confidence in a revival of business had gone out of the market. It seems evident that the wants of consumers have been pretty well met for the present, and those who were induced to purchase as a matter of speculation are reported to be following the usual course of parting with their iron in a falling market. The shipments are larger in amount than they were when prices were steadily advancing, and the shipments of Scotch pigs to the United States to date since Christmas are 8135 tons, as compared with 3729 in the same period of last year. Italy is also a very good customer, having taken 8612, against 2942 tons last year. The shipments altogether are fully 9000 tons ahead of what they were at this date last year, and as the weekly output of pigs is less now by about 4000 tons, and the deliveries into store comparatively small, there does not seem much apparent reason for the steady fall in prices. No doubt it is explained by the fact that the upward movement was more rapid than was fully warranted by the circumstances of the trade.

Business was done in the warrant market on Monday at 45s. to 44s. 7½d. per ton. On Tuesday transactions took place at 44s. 6d. to 44s. 8d. and 44s. 2d., closing with buyers at 44s. 3d. cash. Business was done on Wednesday at 44s. 2½d. to 43s. 11d. cash. To-day—Thursday—transactions occurred up till 44s. 9d., closing with buyers at 44s. 5½d. cash.

The current values of makers' pigs are reduced in sympathy with the state of the warrant market. Free on board at Glasgow, Gartsherrie No. 1 is quoted at 52s. 6d. per ton; No. 3, 45s. 6d.; Coltness, 59s. and 47s. 6d.; Langloan, 55s. and 47s.; Summerlee, 57s. 6d. and 45s. 6d.; Calder, 52s. 6d. and 44s. 6d.; Carnbroe, 49s. 6d. and 44s. 6d.; Clyde, 49s. 6d. and 44s. 6d.; Monkland, 46s. 6d. and 42s. 6d.; Govan, at Broomielaw, 46s. 6d. and 42s. 6d.; Shotts, at Leith, 52s. and 46s. 6d.; Carron, at Grangemouth, 52s. 6d. and 44s. 6d.; Glengarnock, at Ardrossan, 52s. 6d. and 45s.; Eglinton, 46s. 6d. and 42s. 6d.; Dalmellington, 49s. and 44s. 6d.

The steel trade continues active, although contracts are not yet reported at the recent advance in prices.

Some of the makers of malleable iron have run short of coals, in consequence of the colliers' strike, and a proportion of the furnaces at certain works have had to stop in the meantime.

There was shipped from Glasgow in the past week machinery to the value of £3222; sewing machines, £783; steel goods, £12,970, of which £6140 was bridge work for Kurrachee, and £3410 billets and slabs for Baltimore; £22,000 general iron manufactures, embracing £4020 pipes, bars, &c., for Bombay, £3220 ditto for Japan, £2850 bars, sheets, pipes, &c., for Kurrachee, and smaller quantities of goods to numerous other places.

The shipments of coals have been materially reduced, in consequence of the miners' strike. There was shipped from Glasgow, 17,779 tons; Greenock, 42; Ayr, 3842; Irvine, 1194; Troon, 4879; Burntisland, 11,871; Leith, 1000; Grangemouth, 8170; and Bo'ness, 4139; total, 52,916 tons, being 3768 less than in the same week of 1885.

There is a dearth of coals in various directions, as may well be imagined, seeing that a large proportion of the colliers have been idle more than a week. As regards their constant customers, who take coals under contract, the coalowners are released from the obligation to supply them during a strike by special clauses in the contracts. But for the steamers and the factories supplies have to be found, if at all possible, at advanced rates, the difference being paid by the customers. Coals have accordingly advanced in some places as much as 1s. 3d. a ton within the last week, although it is expected that when a proper supply of coals is available the prices will revert to the former level.

The coalowners of Lanarkshire, Stirlingshire, and Ayrshire have agreed not to give the colliers the advance of 6d. a day for which they have struck. Early in the week the colliers were out almost everywhere in the principal mining districts of the west, after being idle the whole of last week. The policy of restricted output has not been successful to keep the men, as it could not possibly be unless the restriction were general all over the country. Adopted in one district, it simply has the effect of sending shippers to other ports where coals can be had at the old rates, and restriction in this shape is a misfortune to both masters and workmen.

During the past month ten vessels of an aggregate of 15,980 tons were launched from the Clyde shipyard, as compared with five of 9150 tons in January, 1886.

WALES AND ADJOINING COUNTIES.

(*From our own Correspondent.*)

THERE is a slight stiffening of prices in the coal trade. Best steam may be regarded as firm at 8s. 6d. This is a poor price at the best, f.o.b. at port, but coalowners are beginning to be thankful for small mercies, and this little improvement is hailed with satisfaction.

At each port—Newport, Swansea, and Cardiff—the shipments during the week have been sustained. It is evident that the coaling ports are being well looked after, in case of emergencies. On Saturday last three steamers alone took from Cardiff 10,000 tons, and the total of eight steamers was 17,750 tons. Big steamers and large collieries will be the leading features of the future. I note many of the smaller collieries closing up or sold. Garw, a small but good colliery, was sold by auction last week to Mr. Crockett, of Pontypridd, for £1500. The Albion, the latest of the large collieries, is soon expected to strike the 4ft. The 3ft., I hear, has not proved so well as expected, but the 4ft. will make amends. I am glad also to report more favourably of the great majority of the Rhondda collieries.

Latest colliery quotations are:—Small steam, 4s. 3d.; large seconds, 8s.; best, 8s. 6d.; No. 3 Rhondda, 8s. 9d. This is one of the most valuable of coals, and as it is being rapidly worked out, will certainly be one of the first coals to rise in price. As for the 4ft., the area is still a large one. Coke is in good demand, and large quantities are being sent away by rail and ship. Quotations this week are:—Foundry coke, 16s.; furnace, 14s. Hitherto Cyfarthfa has been a large buyer as well as maker, but this week a contract has been obtained from the Messrs. Crawshay by Evance, Coppee, and Co., of Cardiff, to construct eighty coke ovens on the latest scientific principles. This firm has made good headway in Wales, having, I understand, constructed for the principal ironworks, excepting, if I am not mistaken, Tredegar.

The mystery to me is that the owners of coke ovens in Wales do not go in for bi-products. The saccharine results theory from coal tar is now a dead letter here.

There is more rumour in the reported prosperity of the iron and steel trades of Wales than one cares to know. A few days ago it was announced that Dowlais and Cyfarthfa had accepted orders which would take more than twelve months to complete. The report, I am assured on the best authority, is incorrect, and most certainly was an injudicious one, as it aroused hopes in the minds of ironworkers which are not likely to be realised. Both works are going on with tolerable regularity, but steel bar is the principal make, and rail orders are by no means plentiful. The price is now over £4. Steel sleepers for the colonies are a little in demand. Home railways are yet undecided. The fact is that the humidity of the climate and the ballast are against them. Some good judges tell me that they fear that the steel sleepers will never replace the wooden generally. Steel oxidises even more rapidly than iron, as seen in the rail stacks in the neighbourhood of ironworks. This should comfort ironmasters, as it tends to lessen the life of a rail a little.

Tin-plate continues in its old state; Monmouthshire, semi-stagnant; Glamorganshire, prosperous.

Many works in Monmouthshire are stopped, some hopelessly, others on strike, a few temporarily.

On the Ebbw river the stoppages have told a tale, the water being now so pure that salmon have again come up the Bassaley.

The export from Swansea of tin-plate last week was again a large one. Quotations remain as last week, but perceptibly hardening, Bessemers touching 14s., and Siemens as much as 14s. 6d. Wasters are eagerly picked up, and an ordinary quotation now is 12s. 9d., best fetching 13s.

I note that several of the Monmouthshire tin-plate masters are making a strenuous effort to have a slice of this prosperity, and next week I expect to record a few compromises between them and their men. Nettlefolds, who are starting Rogerston as well as Tydee, are turning out work from the latter place.

A few colliery disputes are on the carpet. The management at Harris's Navigation is pressing for an alteration of payment for certain work, and a partial antagonism seems likely.

Bilbao ore is selling at 13s.; pitwood, 16s. 6d.; pig iron slightly receding.

A meeting at Bridgend next week, to decide upon abandoning or not the Ogmore Dock and Railway, is called officially.

NOTES FROM GERMANY.

(*From our own Correspondent.*)

SINCE last report the iron markets have maintained their buoyan physiognomy, and with it prices have, in several instances, made a further advance, but there is not the same rush to place orders which characterised the trade last month. Buyers begin to show confidence in the permanence of the present situation, as the prices asked by sellers are now willingly accorded. The buyers are no longer keeping back their specifications, but when the orders are placed, in most cases a very short time for delivery is de manded, so no doubt they have been kept back to the last moment. In Silesia too, the trade is looking very healthy, and since there is every chance of a comprehensive iron convention being arranged, with a common office at Berlin for the sale of the manufactured products and the distribution of the orders received at the several combined works, prices have become very strong. Forged pig has been put up to M. 48, foundry pig to 50, and rolled iron to 107·50 for inland consumption, and 97·50 for export, and both foundries and rolling mills are much better employed than is usually the case about new year's time. The Western group of works has also been able to raise its iron prices considerably under their new convention, and the reports from all neighbouring foreign markets are excellent; so, on the whole, a cheerful feeling prevails. Ores are still in increasing demand, and both native and foreign have advanced a trifle in price; natives run from M. 9·20 to 13·00 p.t. at mines. Every kind of crude iron is on the rise. Spiegel is more and more in request for export and also home use, at enhanced prices, which now go up to M. 60, though inferior brands may be bought from 50 p.t. upwards at works. Forge pig is equally in brisk demand everywhere; good brands of Siegerland pigs fetch up to M. 50, whilst Rhenish stand at 47, and a less good quality may be had at 45½ p.t. Foundry iron does not keep pace in demand with the other sorts, but the price has nevertheless got up to M. 56 nominally, tapering down in the 3 Nos. to 49 p.t. Bessemer and basic pig are now participating in the general better demand, the first being quoted at M. 51 to 52, the second at 42 p.t.; and Luxemburg at 40f. free on trucks at works. In rolled bars, girders, and angles, the orders are almost overpowering the capabilities of the mills to deliver at the stipulated date, and gradually the prices are rising to be more in conformity with the enhanced prices of the raw materials; so under the circumstances of such abundant work the prices must soon rise to a remunerative point. Indeed, sales of bars have already been made at M. 110, whilst the list prices are 102 to 108, girders 108 to 110, and angles 105 to 112 p.t. Boiler plates are still the dullest of sale, and though the price has been raised by the convention to M. 145 p.t., it does not compensate for the heightened value of the raw materials. There is no slackening of the great demand for sheets of all sorts and thicknesses, which stand at M. 140 to 145 p.t. The rise in these is so frequent, as the order books get filled up, that constructive works requiring them are quite embarrassed in forming their estimates where the lowest tendering prices are imperative. The wire rod mills are all fully supplied with orders many of which are for foreign account, and the price for steel as well as iron rods is M. 112 to 115 p.t. Steel and iron drawn wire are quoted at M. 130 p.t. As remarked last week the steel branch is looking up here, partly because no more foreign competition in rails for the State is to be tolerated, and partly through large orders for wire rod billets having come in from America and more railway material for home requirements having been given out. Steel rails are quoted at M. 125 and sleepers at M. 120 p.t. The machine shops, foundries, and boiler shops are a little busier, but better prices cannot as yet be obtained for the work; pipes, for instance, are in good request, but do not realise their cost of production. A convention to prevent the unnatural competition which produces the state of things has been proposed by thirteen principal foundries; but one large one holding aloof, the consequence is the ruinous prices accepted. The galvanising works are pretty well employed on buildings and roofings, as also on work of various descriptions for the War Departments, including galvanised pontoons and corrugated shields for fortification work. The wagon works have lately finished up all the old work on hand, and now they have almost come to a dead standstill.

Coal is firm, and coke is rising in price from last quotations, and the demand is larger now than last year at this time. The Westphalian coal field—Dortmund mining district—produced last year 28,497,293 tons of coal, 1000 kilos. to the ton.

Both in Belgium and France iron is going up in price, and in the latter country the works are very full of orders, merchant bars standing at 140f., girders at 145f., and boiler plates at 185f. p.t., whilst the Belgian trade has had a fillip through large orders for steel in various shapes for America having lately been placed there. Bar iron costs for home use 110f.; for export, 100f.; girders, 100f., and steel plates, 165f. per ton, and a rise of 5f. all round is in near prospect.

The administration of the newly-established steel department of the Torni Works has obtained permission from the State to lay down lengths of its own and the same of English and German manufactured steel rails on the Mediterranean Railway, in order to compare the qualities of each different make. As formerly noted in this place, the capacity of the Torni Steel Works is estimated for 100,000 tons per annum.

AMERICAN NOTES.

(From our own Correspondent.)

NEW YORK, January 20th.

THE latest telegrams from the interior show a rather unsettled condition of the iron and steel markets and of the ore and fuel markets. A serious strike among coal handlers at the distributing point below New York City has unsettled deliveries, and speculative values are obtained for small supplies of coal. The disturbance will be terminated in a few days. The production of anthracite is largely fallen off in consequence. The combination will meet in a few days and renew their annual agreement to restrict production within given limits. The upward tendency on the iron and steel trade is observable at all points. Old car wheels have sold at interior points at 21·50 dols., and old rails have sold at 29 dols. to 29·50 dols. at Pittsburgh. Tide water quotations are 25·50 dols. to 26 dols. Interior quotations for blooms and billets are 34·50 dols. to 35·50 dols., and nail slabs 35 dols. Steel rails are quoted at interior mills at 39 dols., and merchant tool steel 8c. per lb.; crucible sheet steel, 9c.; Bessemer and open-hearth slab steel, 3c. All of the wrought iron pipe mills throughout the country are running full time during the dull season. Puddled bars have advanced to 34 dols. to 35 dols. in Eastern and Western Pennsylvania mills. Lake copper is quoted in this city at 12c.; Baltimore, 10½; crop ends, 23c.; crop iron, 24 dols. to 25 dols. Steel wire rods are in active demand at 40 dols. to 41 dols. Tin-plates are moving freely, and prices are advancing in sympathy with rumours from the other side that the market is a little stronger. Western mills are holding steel rails at 40 dols. and Eastern mills at 39 dols. The entire market is very strong, and both buyers and sellers are waiting for an advance.

NEW COMPANIES.

THE following companies have just been registered:—

Box and Packing Case Manufacturing Company, Limited.

This company was registered on the 26th inst., with a capital of £20,000, in £1 shares, to acquire the business of the Patent Package Company, Limited, and to manufacture and import all kinds of boxes, packing and sample cases. The subscribers are:—

	Shares.
F. J. Moggeridge, 20, Arlington-road, Camden Town, engineer	1
W. J. Breach, 7, Campbell-terrace, Clyde-road, Tottenham, chemical manufacturer	1
J. Parrett, 216, Wick-road, E., commercial traveller	1
R. Boley, Clarendon House, Ealing, clerk	1
J. F. Boley, Clarendon House, Ealing, engineer	1
J. B. Boley, M.D., Clarendon House, Ealing	1
S. Boome, 12, Buckingham-street, Strand, secretary to a company	1

The number of directors is not to be less than three, nor more than seven; the subscribers are to appoint the first four; qualification for subsequent directors, 100 fully-paid shares; remuneration, £1 1s. for each meeting attended, provided that no director receive more than 50 guineas per annum. The board will be further entitled to 5 per cent. of the net profits after the shareholders have received a dividend of 7½ per cent.

Burrell's Hiring Company, Limited.

This company was registered on the 26th inst., with a capital of £10,000, in £20 shares, to acquire machinery, tools, implements, &c., and to let the same on the hire-purchase system. The subscribers are:—

	Shares.
*C. Burrell, jun., Thetford, engineer	1
*R. G. Burrell, Thetford, engineer	1
*F. J. Burrell, Thetford, engineer	1
T. Lumley, Thetford, engineer	1
S. Peebey, Thetford, clerk	1
W. Burrey, Richmond, Surrey, solicitor	1
E. Bird Foster, Cambridge, banker	1

The number of directors is not to be less than three, nor more than seven; qualification, £100 in shares or stock; the company in general meeting will determine remuneration. The subscribers denoted by an asterisk are the first directors.

Carbonic Oxide Gas Company, Limited.

Registered on the 25th inst., with a capital of £10,000, in £100 shares, for the purchase of the rights of A. Fritschi, of 43, Rue St. George's, Paris, to a certain invention relating to the production of carbonic oxide gas. The subscribers are:—

	Shares.
W. Palmer, 36, Huntingdon-street, Kingsland-road	1
C. Gregory Lennery, 3, George-yard, Lom-street, mineral broker	1
C. de Valhermey, 37, Ladbroke-road	1
A. P. Kent, 3, George-yard, solicitor	1
L. A. Groth, C.E., 5, Crosby Hall-chambers	1
A. J. Robins, 112, Deptford Lower-road, clerk	1
A. Wilkin, 34, Great St. Helens	1
F. Platt, 4, Hanover-square	1

Registered without special articles.

Economic Contract Company, Limited.

This company was registered on the 25th inst., with a capital of £20,000, in £1 shares, to acquire the business, property, and liabilities of the London and Spanish Company, Limited, and to acquire concessions or contracts for public or private loans and public works. The subscribers are:—

	Shares.
G. E. Holloway, 1, Ashstead-villas, Croydon, clerk	1
G. H. Repp, 3, Strahan-road, Bow, clerk	1
J. E. K. Wyman, 54, Sutherland-road, Bow, clerk	1
F. J. Bassil, 105, Sandringham-road, Dalston, clerk	1
J. Owen, 11, Young-street, Kensington	1
A. Stein, 17, Great Winchester-street, secretary to a company	1
E. G. Fisher, 5, Lulworth-road, Peckham, clerk	1

The number of directors is not to be less than three, nor more than five; the subscribers are to appoint the first and act *ad interim*; qualification, 100 shares; remuneration, £1 1s. each per meeting, to be increased to £4 4s. in any year in which 10 per cent. is paid.

Lock Washer and Composite Rail Key, Limited.

Upon the terms of an agreement of the 14th inst., this company proposes to purchase from Joseph Hy. Betteley, of 42, Old Broad-street, the English letters patent dated 9th June, 1885, No. 7026, granted for improvements in securing the permanent way of railways, and which may be made applicable to other purposes; and also the French patent for the same invention. It was registered on the 20th instant, with a capital of £10,000, in £1 shares. The purchase consideration is £6000, in fully-paid shares. The subscribers are:—

	Shares.
R. J. Rastrick, Southsea, pharmaceutical chemist	1
J. Hobden, Lea Bridge, Grocer	1
R. J. Lightfoot, 2, Boston-villas, Finsbury Park, clerk	1
J. H. Betteley, 42, Old Broad-street, engineer	1
E. V. Hall, Allerton, Forest Hill, merchant	1
C. W. Smith, 76, Gresham-road, clerk	1
G. Evans, 17, Highbury-place, newspaper publisher	1

The number of directors is not to be less than three, nor more than five; the subscribers are to appoint the first; qualification, 100 shares, or £100 stock; remuneration, £1 1s. per meeting to each director.

Northern Engineering Company, Limited.

This company was registered on the 22nd inst., with a capital of £10,000, in £10 shares, to carry on business as mechanical engineers, tool makers, and machinists, and to purchase from Walter Schischkar and Francis Fleming their patent rights in respect of an improved frictional racket applicable to revolving the capstan heads of lathes, the dividing apparatus of milling machines, and to feed motions of machine tools; and also an invention for improvements in lathes. The subscribers are:—

	Shares.
G. F. Priestly, Halifax, card maker	1
H. Booth, C.E., Halifax	1
J. Bairstow, Halifax, woollen merchant	1
W. Schischkar, Halifax, engineer	1
A. Broughton, Brighouse, engineer	1
H. Campbell, Halifax, engineer	1
G. Harrison, Halifax, engineer	1
F. Fleming, Halifax, card manufacturer	1
G. Broughton, Brighouse	1

Registered without special articles.

Plymouth Alpine Mining Company, Limited.

This company proposes to acquire land in California, for mining and other purposes, and with a view thereto will carry out an agreement of the 21st inst., between Alfred E. Ann and Frank Fuller. It was registered on the 25th inst., with a capital of £65,000, in £1 shares, with the following as first subscribers:—

	Shares.
*J. P. Moodie, 1, Sussex-place, Hyde Park	200
*A. Thomson, 66, Cozenove-road, Stamford Hill	200
*J. Allen, 99, Cannon-street	200
S. Crowder, Mansion House-chambers, acting chairman to the Transvaal Exploration Company, Limited	200
A. E. Ann, 63 and 64, New Broad-street, merchant	200
F. Fuller, Plym-villa, Wallwood-road, Leytonstone, secretary	200
C. F. Branton, 15, Prole-road, Finsbury Park, accountant	200

The number of directors is not to be less than three, nor more than seven; qualification, 200 shares; the first are the subscribers denoted by an asterisk, and, after the allotment, Mr. Alfred E. Ann; remuneration, £100 per annum each, and also 5 per cent. of the net profits of each year in which at least 15 per cent. is paid to the shareholders.

Rowley Horseshoe Company, Limited.

Upon terms of an agreement of the 9th ult. this company proposes to acquire the patent rights of Mr. Michael John Rowley for the improved construction of shoes for horses (No. 4627, of 1881). It was registered on the 25th inst., with a capital of £12,000, in £1 shares. The subscribers are:—

	Shares.
*W. Robertson, Avenue-road, Crouch End, accountant	1
W. Sampson, Harvey-road, Leytonstone, clerk	1
A. C. Tiley, 39, Arlington Park-gardens, Chiswick	1
G. O. Woods, Mottingham, S.E., clerk	1
*M. J. Rowley, 14, Blandford-street, Portman-square, engineer	1
*J. J. Michael, 23, St. Quintin-avenue, W., secretary to a company	1
E. H. Stevens, 119, Chesterton-road, Notting Hill, clerk	1

The number of directors is not to be less than three, nor more than five; qualification, 50 shares; the first are the subscribers denoted by an asterisk; remuneration, £20 per annum each, and 20 per cent. of the net profits after payment of 5 per cent. dividend.

William Edgecumbe Rendle and Company, Limited.

This is the conversion to a company of the business of contractors, glaziers, builders, and engineers, carried on by the firm of William Edgecumbe Rendle and Co., the purchase including the goodwill, trade marks, stock-in-trade, and other assets of the said business. It was registered on the 21st inst., with a capital of £60,000, in £5 shares, 10,000 of which are £7 per cent. cumulative preference shares, and are also entitled to one moiety of the surplus profits after £10 per cent. per annum has been paid on the ordinary shares. The subscribers are:—

	Shares.
*Captain J. W. Clarke, 16, Beaufort-gardens, S.W.	1
*T. W. Allen, 77, Vincent-square, S.W., manager	1
*J. H. Andrews, 48, Arcade-chambers, Manchester	1
*J. Edgecumbe Rendle, 3, Westminster-chambers, contractor	1
F. E. Hamilton, 33, Frederick-street, W.C., clerk	1
W. Poole, 243, Commercial-road, Peckham, clerk	1
J. F. Little, 1, Chase-side, Enfield	1

The number of directors is not to be less than three, nor more than seven; qualification, £500 in shares or stock (the first directors excepted). The first directors are those subscribers marked with an asterisk; remuneration, 50 guineas per annum to each director, with such additional amount as may be voted in general meeting, after dividends at the rate of £10 per cent. per annum have been paid on the preference shares.

THE PATENT JOURNAL.

Condensed from the Journal of the Commissioners of Patents.

Application for Letters Patent.

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

24th January, 1887.

1098. BOILERS, A. Donneley, London.
1099. WASHING MACHINES, T. E. Thickpenny, London.
1100. ELECTRICITY, C. E. Lewis, London.
1101. WHEELS, C. D. Abel.—(*F. Astöwer, Prussia.*)
1102. HANDLES, J. Ashbury, London.
1103. WEIGHING SUBSTANCES, W. B. Avery, London.
1104. BAGS, B. G. D. Cooke, London.
1105. GUNS, E. W. I. Peterson, London.
1106. PRODUCING FERMENTATION, J. G. Tongue.—(*B. Drenckman and W. Hildebrand, Germany.*)
1107. BOXES, H. Campbell, London.
1108. PURIFIERS, H. H. Lake.—(*W. H. Likins and A. A. Atterbury, United States.*)
1109. VEHICLES, J. D. Greene, Michigan.
1110. STOVES, A. E. Clements, London.
1111. FIRE-PLACES, J. B. Colbran, London.
1112. DECORTICATING APPARATUS, J. Johnson and C. D. Greenland London.

25th January, 1887.

1113. SEWING MACHINES, M. Lachman, London.
1114. BUFFERS for GAS COMPRESSOR VALVES, H. J. Allison.—(*The De La Vergne Refrigerating Machine Company, Incorporated, United States.*)
1115. VELOCIPEDES, W. Phillips, Coventry.
1116. SECURING SCREW STOPPERS in BOTTLES, G. D. Laing, Nottingham.
1117. SPOKE BRUSH, T. Thompson, Edinburgh.
1118 LOOMS for MANUFACTURING CHENILLE, &c., R. Boyd, jun., and E. Lepainteur, Glasgow.
1119. VELVET or VELVETEENS, J. Cook, Lancashire.
1120. ORNAMENTAL METALLIC TUBES, G. J. Williams, Birmingham.
1121. READY TICKET HOLDER, G. G. Campbell, London.
1122. LOCK for CASH, &c., BAGS, W. H. Crouch, Birmingham.
1123. MIXING TEA, &c., E. Burke, Dublin.
1124. TABLES for PLAYING GAMES of CARDS, &c., H. J. Gill, Dublin.
1125. AUTOMATIC HELP YOURSELF CIGAR-BOXES, J. Parker, Hull.
1126. KNITTED FABRICS, J. Booth, Halifax.
1127. ELONGATING FISHING-ROD, W. and J. J. Hardy, Alnwick.
1128. REVOLVING ADVERTISEMENTS, &c., C. H. Guest and L. Barrow, Birmingham.
1129. STEREOGRAPHIC PRINTING by a PLATEN HAND PRESS, W. Whitehead, Leeds.
1130. FERTILISER, W. Thompson, Stratford-upon-Avon.
1131. NON-ALCOHOLIC MEDICATED LIQUORS, J. Foulis, Musselburgh.
1132. GAS for USE in GAS ENGINES, F. Windham, London.
1133. PEELING OSIERS, J. Brown, Earith.
1134. BLOCKS of FUEL for SMELTING, J. A. Yeadon and R. Middleton, Leeds.
1135. IRON SHIPS, H. McC. Alexander, Cheltenham.
1136. TONIC LOZENGE for INDIGESTION, &c., T. Needham, Halifax.
1137. CRUET, C. Fieldon, Birmingham.
1138. STRENGTHENING CAST STEEL CARD TEETH for DRESSING SILK WASTE, L. E. and G. F. Priestley, Halifax.
1139. PREPARING COKE for use in SLOW COMBUSTION STOVES, J. J. Royle, London.
1140. AUTOMATIC SATURATOR for CONDENSING CYLINDERS employed in the MANUFACTURE of AERATED WATERS, J. McEwen, London.
1141. PROTECTING VELOCIPEDES from ATMOSPHERIC EXPOSURE, T. Kendrick, London.
1142. TAPS, R. Bateman, Birmingham.
1143. WINDOW FASTENERS, A. S. Butt, London.
1144. CONSTRUCTING PAPER KNIVES, C. E. Marr, London.
1145. INDIA-RUBBER TIRES, W. Oliver, Manchester.
1146. SHEAVES for PULLEY BLOCKS, P. M. Justice.—(*F. B. Torrey, United States*).
1147. ESCUTCHEONS for KEYHOLES, J. and G. Shelvoke, Birmingham.
1148. LIFT or HOIST, F. A. Egleton and J. Robbins, London.
1149. SOLID DRAWN METALLIC CARTRIDGE CASES, T. R. Bayliss, London.
1150. LIGHTING by the CONSUMPTION of GAS and AIR, J. S. Sellon, London.
1151. PLATE GLASS, C. M. Pielsticker, London.
1152. ROTARY ENGINES for COMPRESSING FLUIDS, &c., W. A. Granger, London.
1153. DESTRUCTIVE IMPLEMENTS to be used in WAR, R. Atkin, London.
1154. BLOTTING-PAD, B. Bradford, London.
1155. BATTERIES, W. A. Phillips, London.
1156. INSULATORS, W. D. Ingall, London.
1157. BOTTLES, J. L. Westrus and R. Schols, London.
1158. RAISING the FIBRE of CLOTH, F. Laycock, London.
1159. CANDIES, J. C. Mewburn. — (*W. E. Coleman, United States.*)
1160. MACHINES, J. Y. Johnson.—(*The Shoe Lasting Machine Co., United States.*)
1161. TOYS, P. Ward, London, and H. Ledeboer, Anerley.
1162. TOOL, W. P. Thompson.—(*D. C. Wilgus and R. C. Woodworth, United States.*)
1163. LEATHER DRESSING, J. H. G. Langenhagen, Liverpool.
1164. GRIPS, A. J. Boult.—(*E. D. Dougherty, United States.*)
1165. TENSION DEVICES, A. J. Boult.—(*E. D. Dougherty, United States.*)
1166. MACHINES, S. B. Stine, London
1167. GAS-BURNERS, A. J. Boult.—(*A. T. Smith, United States.*)
1168. GAS-ENGINES, J. Charter, T. A. Galt, and G. S. Tracy, London.
1169. VENTILATING FANS, A. J. Boult.—(*J. E. Barney, United States.*)
1170. SHOES for HORSES, &c., A. J. Boult.—(*H. M. Haar and J. Kress, United States.*)
1171. MANUFACTURE of NAPTHALINE, G. H. Fenner, London.
1172. VALVES for PUMPS and ENGINES, W. Lockwood, London.
1173. VESSELS for CONTAINING LIQUIDS, &c., M. Mackay and C. J. R. Scudamore, London.
1174. COLLAPSIBLE PACKING CASE, A. M. Clarke —(*The Firm of Les fils d'Ulrich-Vivien, France.*)
1175. MUSICAL INSTRUMENTS, J. Harrington, London.
1176. MUSICAL INSTRUMENTS, &c., J. Harrington, London.
1177. FACILITATING the VENTILATION of GAS BURNERS, J. F. Woods, London.
1178. SPIRAL STAIRCASES, W. Sinclair, London.
1179. SEWING MACHINES, G. H. L. Gundelach, London.
1180. DEVICE for SEWING MACHINES, H. Grossmann, London.
1181. REFRIGERATING MACHINES, A. Conacher, London.
1182. AERATED WATER CASES, S. E. Davies, Birmingham.
1183. METALLIC CASES, &c., E. A. Jahncke and H. W. Herbst, London.
1184. GRAPPLING, J. H. Lancaster, London.
1185. ACTION for HORIZONTAL PIANOFORTES, W. G. Eavestaff, London.
1186. TRICYCLES, &c., J. Farran, Manchester.
1187. DRILL CHUCKS, H. H. Lake.—(*J. N. Skinner, United States.*)
1188. HYDRAULIC LIFTS, E. B. Ellington, London.
1189. GAS MOTOR ENGINES, C. D. Abel.—(*The Gas Motoren-Fabrik Deutz, Germany.*)
1190. HYDRAULIC LIFTS, E. B. Ellington, London.
1191. SECURING WOOD FLOORING BLOCKS, R. Walker and F. Mills, London.
1192. BUTTON LOCATING, &c., MACHINES, T. E. Keavy, London.
1193. VENTILATORS, W. Eckstein, London.
1194. LOCKING SCREW NUTS, J. E. H. Gordon.—(*J. P. Ball, N. M. Bennett, and M. E. Bases, United States.*)
1195. SWITCH BOARDS, S. Pitt.—(*D. Dewar, Belgium.*)
1196. THROTTLE VALVES, B. W. Davis, London.
1197. PENCIL CASES, M. Oppenheim, London.
1198. BOXES for MATCHES, &c., G. F. Lloyd, London.
1199. TELEGRAPH CONDUCTORS, D. Nicoll, London.

26th, January 1887.

1200. PIPES, A. Westwood, Birmingham.
1201. PACKING, A. MacLaine, Belfast.
1202. PUZZLE, J. H. Stone, Nottingham.
1203. CAPSULES, F. Wheeler, Belfast.
1204. SIFTING TEA, E. Burke, Dublin.
1205. BOXES, W. Washing Manchesterton.
1206. STEAM-ENGINES, F. B. M. Harman, Glasgow.
1207. SLEEPERS, A. Murray, Glasgow.
1208. STEAM-ENGINES, F. B. M. Harman, Glasgow.
1209. LAMPS, J. Fyfe and W. McCutchon, Glasgow.
1210. PREVENTING OVERWINDING in COLLIERY ENGINES, A. Johnson and J. S. Critchley, Bradford.
1211. BOILERS, J. Barber and J. Fortune, Manchester.
1212. BOXES, S. Basnet, Birmingham.
1213. SLIPPER, J. Blakey, Yorkshire.
1214. LAMPS, H. Lucas, Birmingham.
1215. LOOMS, H. Preston, J. Bennet, J. Lewis, and F. W. Jepson, Halifax.
1216. LAMPS, J. E. Wallis, Hampshire.
1217. MEASURING FABRICS, J. Elliott and E. J. Arnold, Leeds.
1218. JOINTS, H. A. Phillips, Hull.
1219. FINGER-PLATES, W. W. Lunt, Wolverhampton.
1220. SEWING the BOTTOMS of BOOTS, F. D. Allen Bristol.
1221. COMBING MACHINES, A. Smith, Bradford.
1222. DYEING, A. Smith, Bradford.
1223. FLUSHING APPARATUS, S. H. Wright, Liverpool.
1224. FLUSHING CISTERNS, H. Roberts and T. Osborne, Sheffield.
1225. AXES, J. C. Bell, Sheffield.
1226. VESSELS. M. H. Dement, London.
1227. LAMPS, A. J. Nash and F. L. Saunders, Birmingham.
1228. LOOMS, J. Lowe, Manchester.
1229. PIPE, J. Barker, Yorkshire.
1230. TENTS, W. Burgess, Malvern Wells.
1231. HEATERS, M. H. Dement.—(*G. W. Le Vin, United States.*)
1232. BEDSTEADS, A. E. Bingemann, London.
1233. GEARING for VELOCIPEDES, R. Caswell and J. C. Goslin, London.
1234. SIGNALLING, E Ducretel and E. Pinel, London.
1235. STEAM ENGINES, C. Silver and H. Thompson, Nettlebed.
1236. FASTENING for CARRIAGE WINDOWS, W. Fisher, London.
1237. SPANNER, C. Church, London.
1238. PRINTING SINGLE LINES, P. Ellis, Wallington.
1239. NOVEL MARKING, &c., for WHIST, &c., G. Bedford, London.
1240. CORKS, J. Lowman and J. Howard, London.
1241. GETTING COAL, R. Thompson, London.
1242. REMOVING STONES, &c., J. I. Booker, Liverpool.
1243. MONOCYCLES, Z. J. Francis, C. Francis, and F. D. Barritt, London.
1244. TORPEDO, H. N. Morgan, London.
1245. BRACES, W. H. Chignell, London.
1246. REMOVING SNOW, H. N. Morgan, London.
1247. BOILERS, T. Marshall, London.
1248. THRASHING MACHINE, J. Marshall, London.
1249. PURIFYING WATER, &c., W. L. Cooper, London.
1250. ILLUMINATION, G. Gritton, London.
1251. MACHINE TOOLS, J. J. Miller, London.
1252. PERAMULATORS, W. J. Parker, London.
1253. ROVING FRAMES, E. Dervieu, J. V. der Zée, and J. Fayollet, London.
1254. SAFETY BALL BURNER, &c., W. G. Cloke, London.
1255. WATERPROOF FABRICS, G. C. Mandleberg, H. L. Rothband, and S. L. Mandleberg, London.
1256. WATERPROOF FABRICS, G. C. Mandleberg, H. L. Rothband, and S. L. Mandleberg, London.
1257. PREPARING CHEQUES, C. L. Hindle, London.
1258. OBTAINING METALLIC ZINC, W. S. Squire and S. C. G. Currie, London.
1259. SELF-TURNING STEAM PLOUGH, J. Chew, Woodford.
1260. TOOLHOLDERS, G. L. Anders, London.
1261. STOPPERS for STEEL, D. McCorkindale and G. Dougall, Glasgow.
1262. HOT-AIR ENGINE, L. Bénier, London.
1263. WASHING WOOL, W. Cook, London.
1264. COMPOUNDS for BIRDS, T. Monk, London.
1265. CLEANING FISH, H. J. Haddan.—(*E. Bruère, France.*)
1266. MOTORS, G. Adam, London.
1267. BOOTS, J. T. Gray, London.
1268. LAMP, J. M. Richards.—(*F. Frölich Vienna.*)
1269. LAMPS, A. Gough, London.

27th January, 1887.

1270. PULVERISING, H. H. Lake.—(*G. and A. Raymond United States.*)
1271. VELOCIPEDES, H. W., G., and F. W. Turner, London.
1272. LOCKS, E. Gietaert, London.
1273. HEATERS, A. H. Crockford, London.
1274. FIRE-ARMS, J. Schulhof, London.
1275. PIPES, F. W. Klever and C. A. G. Storz, London.
1276. ALLOYS, E. Cleaver, London.
1277. FIRING MINES, C. A. McEnvoy, London.
1278. ENGINES, S. Pitt.—(*A. W. Browne, United States.*)
1279. MINERS' SAFETY LAMPS, W. Patterson, Durham.
1280. LUBRICATING STEAM ENGINE, &c., CYLINDERS, J. Fletcher, Ashton-under-Lyne.
1281. SMALL-ARMS, J. W. Smallman, London.
1282. WOVEN and other DRIVING BELTS, &c., J. Higginbottom, Liverpool.
1283. TAPS for BOTTLES, &c., J. A. Schofield and J. Brierley, Manchester.
1284. SPINNING TOP, A. H. Valda, Chiswick.
1285. ROTARY DISC ENGINES, F. Pragst, Manchester.
1286. KNURR and SPELL TOYS, G. Humphrey, Sheffield.
1287. HAND-MADE and other LACES, A. M. Hart, London.
1288. LOCKS, J. Buchanan, W. Wilson, and T. Dykes, Glasgow.
1289. LOOMS, J. Hanson, Bingley.
1290. MAKING IRON or STEEL, F. W. Paul, Glasgow.
1291. TREATING PARAFFINE WAX, N. M. Henderson, Glasgow.
1292. DELIVERING BOXES of MATCHES, &c., F. J. J. Gibbons and H. Osborne, London.
1293. CONVERTING ORDINARY SERVICE TARGETS into VANISHING TARGETS, G. C. Thorne-George, London.
1294. RAISING, &c., SASHES, T. B. Brown, Taunton.
1295. LINING of SADDLE NUMNAHS, &c., H. S. Wilton, London.
1296. PICKING BANDS and STICKS for POWER LOOMS, W. Wilkinson and L. Holden, Preston.
1297. INFLAMMABLE GAS from OIL, F. A. McMinn, London.
1298. SKIVING SKEINS for BASKET WORK, E. Marston, South Wigston.
1299. LOCK FASTENER for GLOVES, &c., J. B. Small, Glasgow.
1300. VENT PEG for CASKS, &c., C. Fielden, Birmingham.
1301. STOCK POTS, &c., S. J. Fellows, Birmingham.
1302. AMALGAM, W. T. Whiteman.—(*G. A. Wilkins United States.*)
1303. SHARPENING LEAD and SLATE PENCILS, H. Theising, London.
1304. VELOCIPEDES, W. Golding, Manchester.

1305. Alloys of Aluminium and Chromium with Iron and Steel, E. H. Cowles, London.
1306. Kitchen Ash-pans, R. Rowbotham, London.
1307. Lubricators, F. Bosshardt.—(*W. Lauke, France*)
1308. Portable Stoves, G. Johnson, London.
1309. Instruments and Tools, G. V. Frankish, Sheffield.
1310. Division of an Angle or Arc, I. J. Murphy, Belfast.
1311. Rails for Railroads, Tramways, &c., W. E. Heath, London.
1312. Pianofortes, G. Green and C. Savage, London.
1313. Devices Connected with Ploughs, T. Scott, Glasgow.
1314. Swivelling or Revolving Chairs, A. and A. Weir, Glasgow.
1315. Separating Fluids, W. Bergh, London.
1316. Split Drums or Pulleys, A. C. Wells, London.
1317. Affixing Tickets to Goods, W. Foxcroft, London.
1318. Stretching Trousers, J. G. Hatchard, London.
1319. Extinguisher for Mineral Oil Lamps, H. Nicoll, London.
1320. Braid or Cord Trimming, B. Ball and B. Ball, jun., London.
1321. Self-fitting Joint Pins, H. D. Cunningham, London.
1322. Iron and Converting Iron into Steel, W. H. Tooth, London.
1323. Gas Cocks, S. Chandler, sen., S. Chandler, jun., and J. Chandler, London.
1324. Registering Mechanism for Barometers, &c., I. Josephs and J. Davis and Co., London.
1325. Sewing Machines, F. O. Pol and L. F. Triebe, London.
1326. Driving Separators, &c., E. Seger, London.
1327. Covering Ironwork with Fireproof Encasements, &c., C. S. Williams, London.
1328. Railway Wagons, H. H. Lake.—(*A. C. M. Auquin, France.*)
1329. Holdfast Nuts, J. A. McLaren and H. M. Sherratt, London.
1330. Printing Type, &c., F. Kammann and F. Jurschina, London.
1331. Commutator Brushes, D. Halpin and I. A. Timmis, London.
1332. Chairs, &c., C. D. Abel.—(*Die Fabrik für Möbel aus massiv gebogenem Holze der Ungarischen Landesbank Actien Gesellschaft, vormals Charles Chevallier.*)
1333. Decomposing Organic Matter, &c., W. Webster, jun., London.
1334. Tulle Frames, E. Davenière and J. R. Hancock, London.
1335. Locking and Unlocking Delivery Boxes, W. S. G. Baker, jun., London.
1336. Maintaining a Proportional Flow of Fluids through Pipes, C. C. Barton, London.
1337. Galvanic Cells, N. W. Perry, London.

28th January, 1887.

1338. Hoisting Apparatus, T. H. Ward, Tipton.
1339. Producing Transparencies on Coloured, &c., Glass, H. R. Yeo, Plymouth.
1340. Fly Frames in Card Room, A. Perry, Ashton-under-Lyne.
1341. Balancing Pressures on Bearings of Quick-speed Machines Driven by Belts, W. E. Ayrton and J. Perry, London.
1342. Locking Drawers of Cabinets, R. G. Murdoch, Edinburgh.
1343. Locking Interchangeable Loose Covers for Books, E. Taylor, Birmingham.
1344. Sash Pulleys or Frames, W. H. Blackwell and J. Lowe, London.
1345. Cranks for Velocipedes, J. E. Holloway, London.
1346. Board or Table to Play Games upon, H. Stevens, Southampton.
1347. Double-acting Spear Pump, G. Smith and W. Herod, Southwick.
1348. Latches for Locks and other Fastenings, J. Cornell, Birmingham.
1349. Shoulder Slide Type, T. A. Livesey, Springfield.
1350. Cutting Velvets, &c., G. Roger, Manchester.
1351. Machines for Washing, &c., W. Birch, Manchester.
1352. Air Gun and Pump Combined, J. W. Johns, Edinburgh.
1353. Castors for Furniture, A. W. J. Littley, Birmingham.
1354. Lubricators for Lubricating Crank Pins, J. Smith and J. Haigh, Halifax.
1355. Enemas, J. Smithers, Kingston-on-Thames.
1356. Portable Camp Bedstead, F. W. Laurie, London.
1357. Rails for Preventing the Jolting on Railways, W. Cluse, London.
1358. Lock-stitch Sewing Machines, J. Jackson and P. A. Martin, Birmingham.
1359. Holding and Releasing Side Levers on Railway Wagons, T. Williams, Stockton-on-Tees.
1360. Pocket for Holding Needles, R. Wheatley, jun., Birmingham.
1361. Loop Lock-stitch Sewing Machine, J. Moss and C. B. Hunt, London.
1362. Kitchen-ranges, J. Macintyre and A. and T. Buchan, Glasgow.
1363. Gathering up Corn Lying on the Ground in Sheaves, N. Rix, Hertfordshire.
1364. Gauge for Obtaining Lines, &c., on Stone, W. T. Farrell, New York.
1365. Gloves, M. Biggin, Sheffield.
1366. Affixing Almanacks, &c., to Penholders, E. G. W. Packer, London.
1367. Bearing, W. J. Payne, London.
1368. Pivotting of Swing Glasses, F. Pickford, London.
1369. Plane Knife, J. Knott, London.
1370. Bevelling Small Pieces of Glass, E. H. Pearce and J. Hulls, Birmingham.
1371. Engines, J. C. Sellars, Liverpool.
1372. Sprinklers for Extinguishing Fires, W. Mayall, London.
1373. Argand, &c., Burners, W. Richardson, London.
1374. Tanning Leather, A. Tissot, London.
1375. Looms for Weaving, E. Brook, London.
1376. Lighting and Heating, E. Davies, London.
1377. Packing for Stuffing-boxes, J. T. Davis, London.
1378. Horseshoes, W. G. R. A. Cox and G. Collier, London.
1379. Double Tent Camp Bedstead, W. E. G. Forbes, London.
1380. Candles, A. B. Calder, London.
1381. Album Stands, S. Bromberger, London.
1382. Varnishing Composition, E. Page and G. Brayfield, London.
1383. Collapsible Baskets, R. Spear, London.
1384. Lubricating Piston Rods, R. Peacock and J. Bird, London.
1385. Flyers, T. K. Hattersley, London.
1386. Casks, J. Spencer, London.
1387. Night Dress, J. Dawson, London.
1388. Utilising Old Railway Rails, W. G. Olpherts, London.
1389. Igniting Matches, T. E. Ware, London.
1390. Electro-magnets, &c., R. C. Jackson, London.
1391. Indicating the Position of Valves, A. J. Boult.—(*J. S. Hall, United States.*)
1392. Velocipedes, W. Smith and G. Hicking, London.
1393. Conduits, A. J. Boult.—(*J. F. Munsie, United States.*)
1394. Sheaves, &c., J. Aitken, Liverpool.
1395. Wringing, &c., Fabrics, J. Hawthornthwaite, Liverpool.
1396. Stud Wrenches, J. D. Bowman, London.
1397. Garden Pots, &c., B. Looker, London.
1398. Stoppering Bottles, F. Wheeler, London.
1399. Coupling and Uncoupling Railway Rolling Stock, T. Grace, London.
1400. Automatic Apparatus for Subjecting the Person to the Action of Electric Currents, A. Loiseau and O. Pierrard, London.
1401. Knitting Machines, O. Pommrich, London.
1402. Sewing Machines, F. A. Hertel, London.
1403. Vehicles and means of Lighting the Same, C. Naneveau, London.
1404. Repairing Broken Axles, &c., M. A. O. A. Apercé, London.
1405. Umbrellas, A. A. Heise, London.
1406. Sifting Machines, A. P. S. Jones, London.
1407. Washing Machines, H. J. Haddan.—(*W. Lane, A. Doney, and J. C. Kellow, United States.*)
1408. Magnetic Attachment, S. J. H. Row, London.
1409. Grass Collecting Apparatus for Lawn Mowers, H. H. Lake.—(*O. Zistel, United States.*)
1410. Aerotherapeutical Apparatus for Promoting Respiration, &c., C. Breuillard, London.
1411. Tickets, Labels, &c., and Machinery for the Same, H. H. Lake.—(*H. C. Hall, United States.*)
1412. Spring Mattresses, H. H. Lake.—(*La Société de Berg et Cie., France.*)
1413. Holding Cop Tubes upon the Spindles of Spinning Machines, A. Debargue, London.
1414. Paint and other Brushes, W. L. Barnes, T. Gerehart, A. S. Gookin, and E. F. J. Gaynor, London.
1415. Wagonettes, &c., S. Hart, London.
1416. Brake for Perambulators, T. W. Haus and A. C. Hettler, London.
1417. Driving Gear of Traction and other Engines, R. H. Fowler, R. H. Shaw, and T. Benstead, Leeds.
1418. Conveying Ammunition to and for Loading Heavy Guns, C. H. Murray, Newcastle-upon-Tyne.
1419. Conveying Ammunition to Heavy Guns, C. H. Murray, Newcastle-upon-Tyne.
1420. Mounting Heavy Guns by Hydraulic Power, R. T. Brankston, Newcastle-upon-Tyne.

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1421. Rolling Mills, C. Roy, London.
1422. Carpets, T. F. Naylor, Manchester.
1423. Boot Trees, &c., W. Beasley, London.
1424. Shelter, Packing-case, and Easel for Painters, K. Mackenzie and T. Wilkins, London.
1425. Printing Machines, H. P. Trueman and J. G. New, Birmingham.
1426. Self-acting Mules, J. and W. France, Manchester.
1427. Carding-engines, J. Elce and T. S. Whitworth, Manchester.
1428. Metal Angle Clamps, H. Stevenson, Manchester.
1429. Extinguisher, F. R. Baker, Birmingham.
1430. Locking Mechanism of Fire-arms, B. J. B. Mills.—(*The Waffen Fabrik Mauser, Germany.*)
1431. Blowing Bottles, &c., D. Rylands and B. Stoner, Barnsley.
1432. Automatic Adjustment, J. Oliver, Chesterfield.
1433. Tandem Bicycles, M. J. Schulte, London.
1434. Gauge, J. McDonald, Glasgow.
1435. Lamp, &c., Shades, J. S. and G. Browne, London.
1436. Supplying Fuel to Furnaces, A. W. Bennis, Liverpool.
1437. Ring, &c., Apparatus, W. H. Bramall, J. Wolstenholme, and W. Napier, Manchester.
1438. New Solid Steel Shafts, W. A. Colclough, London.
1439. Forging Nuts, E. Davies, London.
1440. Aerated Water Syphon Filling, M. L. Orr, London.
1441. Bent Plates for Floors, &c., R. C. Braithwaite and W. Kirk, Birmingham.
1442. Movable Points of Crossings, A. Dickinson, Birmingham.
1443. Composition from Cellulose, R. Eisentraut, London.
1444. Hollow Clay-ware, &c., P. Graham, Glasgow.
1445. Tapered Slips for Ship and other Plate Work, T. White, Glasgow.
1446. Adjustment of Bicycle, &c., Saddles, G. Ursinus, London.
1447. Anti-intemperance Mixture, A. R. Lowenthal, London.
1448. Chimney Cowl or Ventilator, J. Bidder, London.
1449. Lamp Chimneys, D. C. Defries.—(*L. Sepulchre, Belgium.*)
1450. Pea or Dart Gun, J. Hope, London.
1451. Combined Trucks and Step Ladders, J. Hill, Washington, U.S.
1452. Unstoppering Aerated Water Bottles, A. Ballard, London.
1453. Controlling a Ship's Rudder, T. G. Stevens, Dartford.
1454. Hydro-carburetted Air Engines, W. D. and S. Priestman, London.
1455. Martingales, W. Kennedy, London.
1456. Fish-hooks, R. S. Bartleet, Middlesex.
1457. Fasteners, E. Tonks, Middlesex.
1458. Doubling Materials, E. Edwards.—(*G. and H. Ulbrich, Germany.*)
1459. Tramways, M. H. Smith, Middlesex.
1460. Fountains, C. J. Galloway and J. H. Beckwith, London.
1461. Purifiers, H. Simon, London.
1462. Grinding Grain, J. Römheld, London.
1463. Closing Doors, B. Bancroft, London.
1464. Separating Fat, H. M. Roberts and A. W. Doery, London.
1465. Cameras, W. and K. L. North, London.
1466. Bracket, A. W. Koch, London.
1467. Harrow, R. and H. Cox, London.

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1468. Cloths, J. Benn, Bradford.
1469. Valves, A. Johnson, Bradford.
1470. Nails, J. Moore, London.
1471. Engines, F. Pragst, Manchester.
1472. Lock, A. Butler, Leeds.
1473. Lamps, C. Retallack, Birmingham.
1474. Restrictor, E. C. S. Moore, Kent.
1475. Cork, G. A. Goodwin and M. Broadbent Manchester.
1476. Shirt Fronts, E. and G. Slatter, Nottingham.
1477. Toy, J. A. de Macedo, Leeds.
1478. Ventilator, S. Wilkinson and J. Clarkson, London.
1479. Hydro-carbons, A. G. Meeze, Surrey.
1480. Gutters, C. Stroud, Wolverhampton.
1481. Level, J. Hayes, Maryport.
1482. Vapours, H. J. Allison.—(*The Gas and Power Company, United States.*)
1483. Pulleys, W. S. Johnston, Glasgow.
1484. Bats, J. Browning, Bristol.
1485. Carts, F. Blanks, London.
1486. Sunshades, &c., G. Preston, Glasgow.
1487. Horseshoes, C. Howieson, Glasgow.
1488. Fixing Lines to Sashes, G. White, London.
1489. Safety Lamp, H. O. A. E. Grünbaum, London.
1490. Charging Gas Retorts, J. Atterton, Suffolk.
1491. Carriage Frames, J. E. H. Colclough, London.
1492. International Joiner and Cabinet-maker, A. Telfer and E. George, Newcastle-upon-Tyne.
1493. Feather Cowl, J. S. and J. T. Wilson, South Shields.
1494. Tubes, Shafts, Axles, Rods, &c., P. M Parsons, Blackheath.
1495. Bevelling Glass, E. H. Pearce and J. Hulls, Birmingham.
1496. Revolving Knives or Cutters, J. H. Newton, Sheffield.
1497. Felt Hats, J. H. Neave, Liverpool.
1498. Fastener for Wearing Apparel, E. J. James, London.
1499. Laying, &c., Underground Wires, T. O. Callender, London.
1500. Miners' Cages, T. and A. E. Penn, London.
1501. Water Motor, P. de Nagy, London.
1502. Tennis and other Bat Handles, J. Neville, Enfield.
1503. Connecting Parts of Bedsteads, &c., C. Hass, London.
1504. Extinguishing Fire, J. C. Merryweather, London.
1505. Cotton Fabric, A. Fiquet, London.
1506. Dynamic or Energy Balances, J. Gamgee, London.
1507. Pencil Sharpeners, B. S. Cohen, London.
1508. Cords for Pictures, &c., G. Hookham and W. Tonks, London.
1509. Money-boxes and Tills, H. C. Symons, London.
1510. Cannon Shell, T. James, London.
1511. Producing Light, P. Ward and W. S. Oliver, London.
1512. Fire-extinguishing Apparatus, F. Grinnell, London.
1513. Indicating Names of Stations, R. E. Middleton, London.
1514. Synchronous Time-keepers, R E. Middleton, London.
1515. Lighting by means of Gas, H. Schlichter, London.
1516. Treating Brewers' Wort, W. Adlam and F. Faulkner, London.

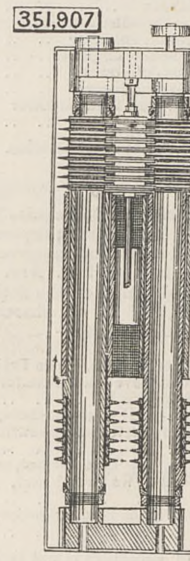
SELECTED AMERICAN PATENTS.

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

351,907. Device for Taking Electric Currents from or to Moving Surfaces, *Rudolf Eickemeyer, Yonkers, N.Y.—Filed December 3rd*, 1885.

Claim.—(1) The combination, substantially as hereinbefore described, of one or more disc-shaped electric conductors, a rotative shaft on which said conductors are mounted, and gearing by which said shaft and the brush-conductors are positively rotated. (2) The combination, substantially as hereinbefore described, of one or more disc-shaped electric conductors, a rotative shaft on which said conductors are mounted, gearing by which said shaft is positively driven, and a mercury-bath for lubricating each conductor. (3) A disc-shaped electric brush conductor composed of a series of laminations or plates, each affording at or near its periphery a surface for electric contact in a plane substantially at right angles to the axis of said disc. (4) A disc-shaped electric brush conductor composed of two series of laminations or plates, each plate affording at or near its periphery a surface for electric contact in a plane substantially at right angles to the axis of said disc, and having the contact surfaces of the two series of plates coincident with each

351,907

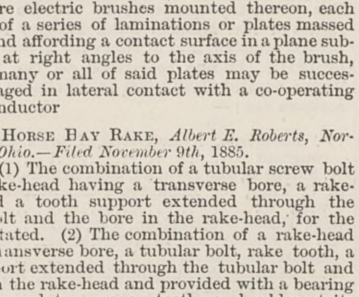


other, substantially as described, whereby a conductor with which said brush is to operate can be embraced between said two series of plates at or near their peripheries. (5) A disc-shaped electric brush conductor composed of laminations or plates having an axial opening, a radial slit, and a portion thereof cut away on excentric lines, substantially as described. (6) The combination, with a disc-shaped brush conductor composed of laminations or plates and axially mounted, of a mercury-bath for lubricating said plates, substantially as described. (7) The combination, substantially as hereinbefore described, of a rotative shaft and one or more electric brushes mounted thereon, each composed of a series of laminations or plates massed together and affording a contact surface in a plane substantially at right angles to the axis of the brush, whereby many or all of said plates may be successively engaged in lateral contact with a co-operating electric conductor

352,205. Horse Hay Rake, *Albert E. Roberts, Norwalk, Ohio.—Filed November 9th*, 1885.

Claim.—(1) The combination of a tubular screw bolt with a rake-head having a transverse bore, a rake-tooth, and a tooth support extended through the tubular bolt and the bore in the rake-head, for the purposes stated. (2) The combination of a rake-head having a transverse bore, a tubular bolt, rake tooth, a tooth support extended through the tubular bolt and the bore in the rake-head and provided with a bearing at its lower end to engage a tooth, a shoulder at its central portion, and a screw threaded top end, a nut on the said screw threaded top end, and a spring

352,205

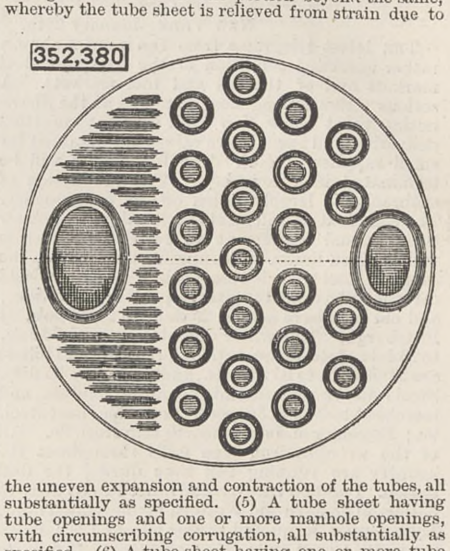


resting upon the shoulder of the tooth support, to operate in the manner set forth, for the purposes stated. (3) A rake-head having a transverse bore, a tubular bolt or bushing, B, a rake tooth, a tooth support, F G, extended through the tubular bolt and the bore in the rake-head, a spring H, and a nut J, arranged and combined substantially as shown and described, for the purposes stated.

352,380. Tube Sheet for Steam Boilers, &c., *Henry Warden, Philadelphia, Pa.—Filed August 23rd*, 1886.

Claim.—(1) A tube sheet one or more of the openings of which has a circumscribing corrugation, with elastic portion beyond the same, all substantially as specified. (2) A tube sheet the tube-carrying portion of which comprises a number of divisions, each with one or more tube openings, a circumscribing corrugation, and an elastic portion beyond the latter, all substantially as specified. (3) A tube sheet each of the tube openings of which has a circumscribing corrugation and an outer elastic portion beyond the latter, all substantially as specified. (4) The combination of the tubes with a tube sheet, one or more of the tube openings or tube spaces of which has a circumscribing corrugation and an elastic portion beyond the same, whereby the tube sheet is relieved from strain due to

352,380

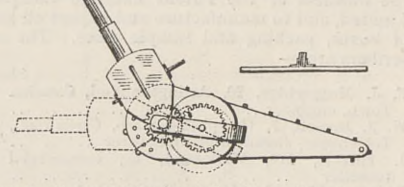


the uneven expansion and contraction of the tubes, all substantially as specified. (5) A tube sheet having tube openings and one or more manhole openings, with circumscribing corrugation, all substantially as specified. (6) A tube sheet having one or more tube openings or tube spaces with circumscribing corrugation and elastic portion beyond the same, and one or more manhole openings with circumscribing corrugation, all substantially as specified. (7) A tube sheet having one or more tube openings or tube spaces with circumscribing corrugation and elastic portion beyond the same, and having corrugations in that portion in which there are no tube openings, all substantially as specified.

352,332. Painting and Whitewashing Machine, *Charles P. Lancaster, Fairmount, Ind.—Filed August 3rd*, 1886.

Claim.—In a device for applying paint, whitewash, or other substances to surfaces, the combination of a receptacle having a slot for the emission of the paint

352,332

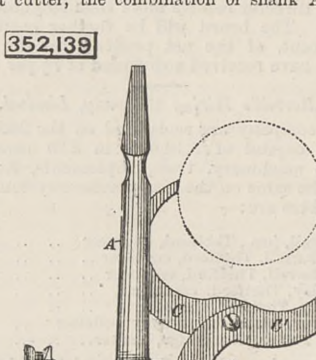


or wash, the movable frame having rollers carrying a moving belt provided with brushes, and the mechanism for driving the belt to apply the paint or wash, substantially as specified.

352,139. Washer or Gasket Cutters, *John Leuenberger, Camden, Ohio.—Filed July 30th*, 1886.

Claim.—(1) In a washer or gasket cutter, the combination of main shank A, calipers C C^1, sliding bar B, and a graduating device or attachment, substantially as and for the purposes specified. (2) In a washer or gasket cutter, the combination of shank A, calipers

352,139

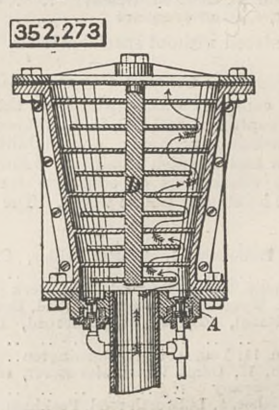


C C^1, provided with graduating slot C^2, sliding bar B, and screw B^2, substantially as and for the purposes specified. (3) In a washer or gasket cutter, the combination of shank A, calipers C C^1, provided with graduating slot C^2, screw B^2, sliding bar B, knife D^1, screw S, and pointer D, substantially as and for the purposes specified. (4) In a washer or gasket cutter, the combination of shank A, calipers C C^1, provided with graduating slot C^2, screw B^2, sliding bar B, slot B^1, knives D^1 D^2, screw S, and pointer D, substantially as and for the purposes specified.

352,273. Steam Muffler, *Renaldo Solano, Brooklyn, N.Y.—Filed August 14th*, 1886.

Claim.—A muffler attachment for the escape nozzles of vacuum brake ejectors or other steam escapes, consisting of an annular chamber formed of a separate casting A, having a series of inwardly-projecting

352,273



annular flanges, and a central core or casting D, having a series of outwardly-projecting flanges arranged alternately, as described, for diverting the course of the passing steam, said chamber communicating openly with the steam escape and with the atmosphere through a perforated or gauze covering, and fitted with suitable drip valves, as set forth.