ITALIAN INDUSTRIES.

(By our Special Representative.)

No. VIII.*—TEXTILE INDUSTRIES.—PART I.:—SILK.

IN my first article on the power stations of Italy, I called the science of hydraulics here the "great mother-science," from which our industries derived their being, their nourishment, and their present vitality. I should have said, perhaps, with more exactness "mother to a large number of our industries, and foster-mother of them all." And among the many daughters which she has adopted, the Italian textile industry is the oldest and the most healthy, and day by day is making itself more felt as a factor to be reckoned with in the commerce of the world. Putting aside the general causes of this prosperity, causes which have been already referred to, a primary reason is to be found in the fact that Italy, in the matter of the raw product to which the textile industries owe their life, is the country most favoured by Nature in the whole of Europe.

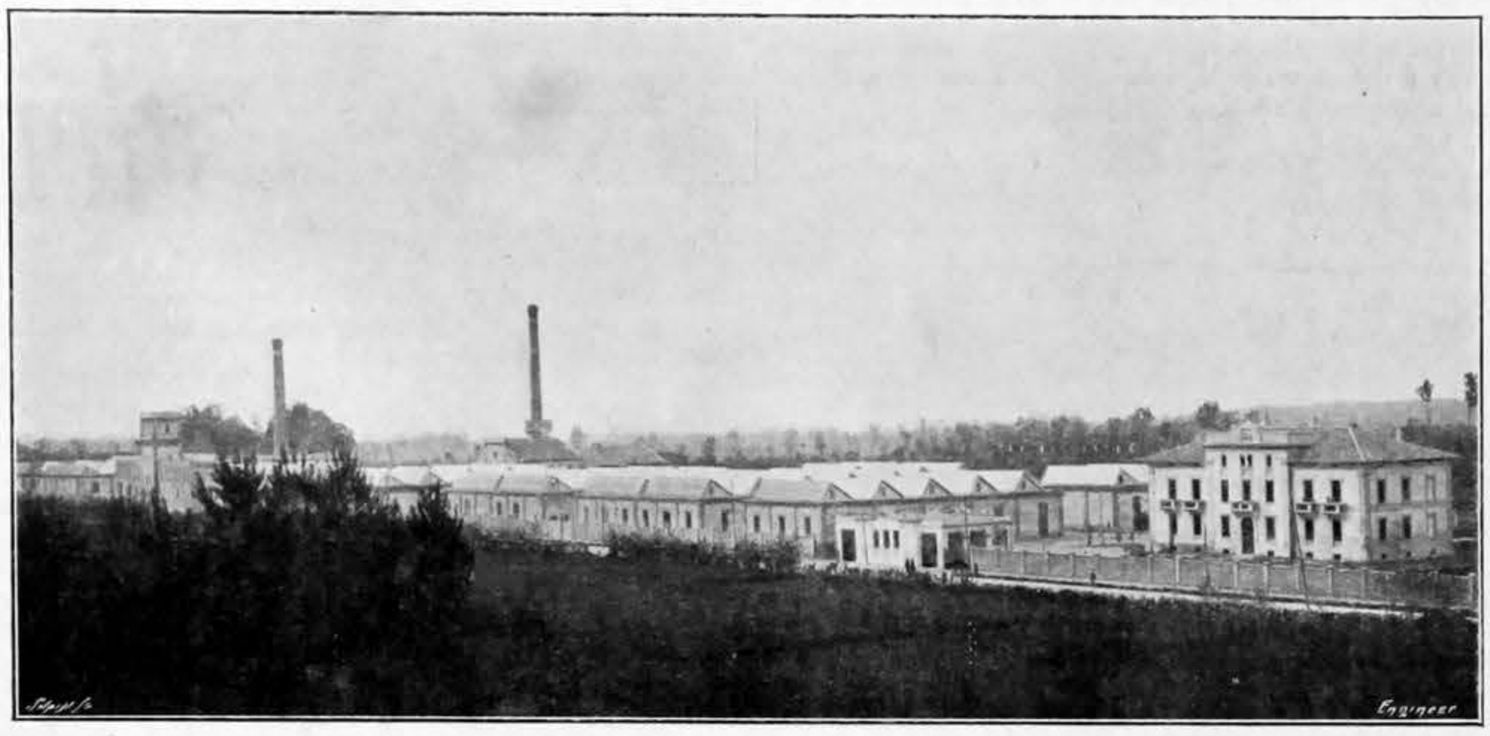

Fig. 1 WORKS FOR THE MANUFACTURE OF ARTIFICIAL SILK

Whilst other nations depend almost entirely—viz., with the exception of a negligible quantity of home-grown wool—on foreign countries for their raw material, Italy is responsible for five-sixths of the total crop of all the silk-producing countries of Europe; besides this she has a large and ever-increasing production of flax, hemp, and jute, which, though as yet not great enough to permit the exportation of the raw material, still does much to account for an export, under these three heads, of 40,000,000 kilos. of the finished article.

In the northern provinces, and especially in Lombardy, the silkworm represents the principal riches of the peasant. It is considered by him as his first "crop." Thirty days of very hard work and of self-denial—and it is self-denial, for the Lombard peasant in this interval gives up his whole house to the silkworms, and sleeps for the few hours in which sleep is allowed him in the hayloft—and then the reward is gained. The money is forthcoming which enables him to provide for the exigencies of the tax collector, and to have something in hand until the moment in which he is able to realise his other products.

The silkworm in Italy not only yields enough to supply the home market, but also enables the country to export raw and spun silk to the value of 300,000,000 lire, and woven silks to the value of 100,000,000 lire yearly.

This industry is not a new one, as so many other Italian industries are. For its age it may be compared to the celebrated glass-blowing industry of Murano, whose artificers were considered by the Venetian Republic worthy husbands for the daughters of the highest nobility of the "Queen of the Adriatic." It is well known how the Chinese kept for 3000 years the monopoly of the precious insect, and how they punished by death anyone who revealed the secrets of the trade or who gave to a foreigner the eggs from which their riches were so much derived. It is also well known how the Emperor Justinian obtained these eggs by means of two missionaries sent out on purpose, who returned with their hollow sticks full of the precious "seed." From that time the industry was established in the Peloponnesus.

The first place in Italy where the cultivation of the silkworm was established was Sicily, and it is probable that the new industry was due to the military expedition of King Roger of Sicily into Greece. From Sicily the lately discovered fount of riches extended itself into Calabria, and almost at the same time we find it springing up in Venice and in Genoa, for the identical reasons for which it had already brought itself to light in Sicily, namely, in consequence of naval expeditions to the Oriental Empire.

From that moment the silk industry of Italy has made ever increasing progress. In the Middle Ages the country may be said to have possessed almost a monopoly of this branch of trade, and at the present day the production and export of Italian raw and worked silk is one of the most important items in the general commerce of the entire globe.

Never has this industry enjoyed such prosperity as it does at the present moment, and this fact is undoubtedly due to the new system of selection of the eggs. In consequence of the terrible scourge of the *Pebrina*, which passed like a wave of destruction over the country in the latter part of the last century, and nearly ruined all who had to do with the silk industry, the Government appointed a commission of experts to inquire into the means whereby this dreaded plague might be averted in the future. They came to the conclusion that the seat of the disease lay in the egg itself, and Signor Cantoni, together with M. Pasteur, of Paris, devised the system of the cellular segregation of each female moth, now so universally adopted here. This measure, combined with the establishment of trustworthy commercial houses, which only put on the market healthy eggs, has worked wonders to eradicate the evil, and as the peasants year by year begin to understand that it is to their interest to buy their eggs from one of these large dealers instead of producing their own stock, it is to be hoped that in the near future the *Pebrina* will be stamped out altogether. Another reason for the immense production of the last few years is an interesting one. I owe the theory to the courtesy of Commendatore Erasmo Mari, of Ascoli Piceno, one of the chief houses to which I referred above for the sale of silkworm eggs—see Fig. 2—and one whose success in his trade may fully warrant him in saying that the theory has passed into the realm of practice.

Signor Mari's experience led him to conclude that the cause of the general weakness of the insect, and its consequent propensity to catch diseases, lay in the fact of too much interbreeding. He therefore ordered consignments of eggs from China and Japan, and the results of this introduction of new blood were so satisfactory that he continues year by year on the same system, crossing and recrossing the Italian indigenous breed with the foreign stock, and acclimatising the cross-breeds for two years before putting the product on the market. The cocoons selected for stock are placed each in a separate compartment, and in tiers of shallow trays, the male cocoons, known by their slighter weight, being separated from the female cocoons in order to facilitate operations later on. Then, as the moths emerge, they are taken by a specially skilled man, who gives to each female her male. This operation requires great quickness of eye and lightness of hand, as, of course, in a large establishment scores of moths are bursting from the cocoons at the same moment. Each female is then taken and placed separately in a little paper bag—the cellular segregation system above referred to—where she lays her eggs and dies. These little bags are then hung up in long strings in an airy room to await further manipulation—see Fig. 3, page 647, the reproduction of one of the rooms destined for this purpose in Signor Mari's factory. The bags are then handed over to the crushers, who take out each dead moth, crush them one by one in a little mortar, and pass them on to the microscopical examiners, who again in their turn hand them over to the controlling experts for a second microscopical examination. If any germs of infection are found in the fluid that comes from the body of the dead moth, the little bag from which she was taken and which contains her eggs is immediately burnt. The sterile eggs, known by their bright yellow colour as against the greyish tint of the fertilised eggs, are then destroyed, and the rest are ready for the crop of the future year.

I have gone somewhat at length into this industry on account of its wonderful development in the last decade, and of the pitch of scientific perfection which it has attained in the hands of these expert specialist firms.

In Fig. 4 will be seen a reproduction of the department in which the dead moths are crushed and the first selection takes place. Fig. 5 represents the first microscopical examination, and Fig. 6 the last controlling examination, also microscopical. The above photographs are all taken in the works of Commendatore Mari, of Ascoli Piceno.

The life and metamorphoses of the silkworm are too well known, from futile experiments made in that direction in our childhood, to warrant my going into the matter at any length. The principal centres of production here are Lombardy, Piedmont, and Liguria. The industry is, however, also very flourishing in Tuscany, and is beginning to lift up its head successfully in the southern provinces, where the cocoon, though produced in smaller quantities, is nevertheless, for climatic reasons, of perhaps superior quality for hardness and silk-producing properties.

The industry of the rearing of the silkworm is practically in the hands of thousands of peasants throughout the whole of Italy, and the success of the crop depends almost entirely on the capacity of the individual. The precautions to be exercised are without number, and the care must be never-ceasing. It may be truly said that few peasants in the Como district ever sleep in their beds during the first two weeks of June.

The cocoons, when sold, are put into huge ovens, where, by means of baking or steaming, the chrysalis inside is shrivelled up, because to allow the moth to escape from the cocoon would mean spoiling the silk. There are many ingenious kinds of apparatus for this operation, among the best known for efficacy and celerity being the ovens of Signori Bianchi-Dubini, of Milan. After the cocoons have been baked, they are taken to the spinning factories, where they are put into basins containing boiling water, and the silk is drawn off from them on wooden frames revolving by water or steam power. From these frames it passes on to the spindles, and, after several processes, is twisted into the hanks, about a foot long, so well known in commerce, and is made up in packets to be sold to the dyers and weavers.

The number of basins for drawing in this country are about 63,000, of which 45,000 are in Lombardy, Piedmont, and Liguria, and there are about 200,000,000 silk spindles. These data are only approximate, and are considerably below the real figures, which would be very much increased if it were possible to arrive at any sort of just estimate of the immense number of hand spindles in the country. These, together with the innumerable hand looms, of which the Romagna district is full, constitute thousands of little "family industries," and any information about them is courteously mis-stated by the peasant proprietor, for fear that his dreaded enemy the tax-collector, should bring him to account for the small gain derived from them.

To have an idea of the importance of the raw silk industry in Italy, it is enough to say that the country produces the greatest amount in the world after China and Japan that out of the total mass of silk of Europe and Asia, which is poured every year on the European and American markets, Italy produces almost the quarter, and that the average crop of cocoons between 1900 and 1904 was about 55,000,000 kilos. a year. The crop of 1904 was an exceptionally large one, being between 60 and 65 millions of kilos. for an approximate value of 200 million lire.

Fig. 2—COMM. ERASMO MARI'S ESTABLISHMENT AT ASCOLI PICENO

Our production in the raw silk market of Europe may be gauged from the following table:—

	Kilos.		Kilos.		Kilos.
1885.—Italy,	6,000,000 ...	France,	4 500,000 ...	Germany,	800,000
1895.— ,,	9,500,000 ...	,,	7 000,000 ...	,,	1,200,000
1905.— ,,	11,000,000 ...	,,	9 000,000 ...	,,	1,000,000

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And here it may be well to note that, for the hundreds of accessories, great and small, necessary for the trade, from the coming to life of the little grub up to the mechanical weaving of the silk, Italy is, and has been always, dependent on herself. The process of drawing and spinning, once effected entirely by hand, has progressed with modern science, and the firm of Giovanni Battaglia, of Luino, produces electrically-driven machines for these purposes, which save an immensity of time and labour. Their spinning and twisting machines are especially remarkable, not only from the point of view of their celerity, but from the fact of the extremely ingenious automatic arrest of any particular reel in which a breakage of one of the threads of silk may occur.

For the scores of delicate little blown glass accessories, fine enough to be able to conduct, to thread, and to twist a product of the gossamer strength of silk, Fratelli Bettini, of Lecco, hold, perhaps, the first place.

The great silk-spinning industry of Italy was, until not long ago, in the hands of thousands of peasants' families, who worked in detail with their wooden hand spindles; but modern appliances combined with the industrial trend towards enterprises conducted on a large scale, have contributed to the formation of companies, and to the introduction of the most perfect mechanical looms, each of which corresponds, in its output, to that of three hand looms. These large companies seem hitherto to have only had the happy effect of increasing the production and export, without interfering with the gains of the small proprietor. Among the spinning companies may be noticed Banfi, of Milan; Dubini, of Milan; the "Setificio di Vimercate," and Craponne and Co., of Milan; while among the spinners of waste, one of the most powerful companies is the "Società per la Filatura di cascami di seta," of Milan.

For the dyeing of the raw silk, Italy was, until not many years ago, entirely dependent on the foreigner, but the art has made immense progress lately, and firms like the "Unione Industrie Seriche" of Como, Noseda of Como, Allamel of Cernobbio, the "Tintoria e Stamperia Comense," Malizia of Milan, Rusconi of Milan, and many others can now vie in the excellence and permanency of their colours with any French or German houses. As an illustration of the pitch of perfection to which the dyeing industry has arrived in Italy, the visitor to the Milan Exhibition may observe the frieze which runs round one of the large rooms, a frieze made entirely of silk, and containing in all no less than 65,280 different grades of colour.

The silk weaving business in Italy is only less important than the production of the raw silk itself, but, unlike the latter, the various phases of the industry are so well known that it would be superfluous to go into detail. There are about 25,000 looms, employing about 30,000 hands, while among the best known weaving companies may be mentioned the "Tessiture Seriche Bernasconi" of Cernobbio, the "Unione Industrie Seriche" of Como, and many others, especially in the Como district, where the heart of the industry may be said to lie.

In the weaving branch of the silk trade, however, Italy has not, as yet, been able to emancipate herself from foreign help, as her machine looms are almost entirely of Belgian or German manufacture.

But this subject would not be complete without noticing the fact that the art of making brocades, damasks, and the finest silk coverings for furniture and walls, the art for which Italy was so justly famed in the Middle Ages, still lives and prospers in the country. The firms of Carrugo and of Osnago Civelli, of Milan, working as their fathers did before them with wooden hand looms—machine looms being useless on account of the complicacy of the patterns and the thousands of different coloured threads—may be justly said to rival any of the mediæval artists whose gorgeous stuffs may still be seen in the palaces of Venice and of Genoa.

To all these old branches of the great silk industry of Italy may be added now a new branch, that of the making of artificial silk from cotton waste, an industry originating in Frankfort, and which has now made its appearance at Pavia, where the company's works—see Fig 1—cover 65,000 square metres.

Such is the present state of the great silk industry of this country, an industry which employs more than 200,000 hands, and which last year was responsible for an export trade for the worth of 573,000,000 lire—an industry which, in 1905, exported into the United States alone, goods to the value of 16,630,000 dols.—an industry which has been in times past, which is, and which will ever be more so, one of the principal factors of the prosperity of the country and the glory of the Italian nation.

THE COMMERCIAL ORGANISATION OF ENGINEERING FACTORIES.

By HENRY SPENCER.

No. IX.*—COSTS DEPARTMENT *(continued)*.

Finished stores.—Before passing from the question of materials, reference must be made to the record of parts delivered to "finished stores" room from the various manufacturing departments, for if an accurate record is to be kept as to the stock of finished parts on hand, and which do not come under the head of "work in progress," it will be necessary to keep a similar account to that furnished by "Finished Stores Received" sheet—Fig. 70. But while it is obvious that car details of such value as is represented by finished stores should be under close observation and control, it will also be readily conceded that, for the sake of convenience, there are certain units and fitted-up sections that may advisedly be permitted to remain outside the store room. Under such circumstances even, the storekeeper should be acquainted with the facts, and be nominally responsible for the records as to their subsequent disposition, as otherwise there is a real and grave risk that such parts will unaccountably disappear. Undoubtedly a lax system of stores control will result in such disappearances, which, traced to their source, would probably be found to arise from a car repair job, and the penalty paid for the laxity in this connection may be the gratuitous replacement of some very costly part. Only they who have actual experience can know how important this question is, and a conscientious, experienced employé may easily save the amount of his salary by maintaining a keen look-out for leakages of this nature. But this record of "finished stores" received from the various departments has another important function, for the value of cost records depends entirely upon the necessary information as to what quantities are represented by the labour costs shown on the job cards. Reference to the latter will show that provision is made at the foot of the card for recording deliveries to the stores room, and in this way the parts actually finished are compared with the rough material issued against each job.

FIG. 70.—*Finished Stores Received Sheet. Size, Foolscap.*

FINISHED STORES RECEIVED.

Month of.....19.....

Date.	ex Factory Order No.	Card No.	Description.	Stores Ledger.

Labour costs.—The question as to how the actual time spent on the various batches of details may be correctly ascertained is as complex as it is important, and the difficulties are all the greater when the task is to ascertain the labour costs on such numerous small jobs as come under the head of drilling, key-waying, slotting, &c. With a bonus or premium system in vogue and running concurrently with the time rate system of pay for such jobs as cannot conveniently be given out on a bonus job note, the necessity for a reliable record becomes more acute, for it cannot obviously be permitted that a man may make capital out of one at the expense of the other job. Yet this is what may often occur unless the time charges are carefully checked. In some factories the foreman or his clerk have to perform the clerical work that is inevitably involved, while in others a clerk from the costs office makes a round of the shops once each day to collect the figures. Some shop accountants permit the workman to write up his own record on a weekly time sheet, and others prefer to have a time sheet for each day. But a foreman is better employed when unfettered with this responsibility, and the figures are more satisfactorily obtained by a man not under his direction. To send a clerk on a daily patrol of the shops simply duplicates the work without ensuring even reasonable accuracy. The daily time sheet lends itself to veiled inaccuracies, while to put a weekly time sheet into the hands of a workman reveals a palpably unreliable system that merely results in a collusive, neglected compilation of figures that are intended to obscure his incompetence and delay the collection of the desired data. How, then, can the work be satisfactorily carried out, without placing too great a drag on the first duty of the factory, *i.e.*, maximum production. One instinctively turns to the mechanical time recorder for a solution of the matter, and there is certainly much to be said in favour of the "Rochester Card Recorder." This machine is in many respects similar to the "Bundy" machine already referred to, and will serve 100 men admirably, showing results which make for both efficiency and economy, provided the department is not a scattered one. In the case of fitters, for example, of whom 100 may be employed in very close proximity to each other, the time of the squad could be ascertained by the use of this recorder with absolute accuracy by purely mechanical means, and with the minimum amount of clerical co-operation.

Time slips.—For a more scattered department, such as the machine shop or the erecting shop, the periodical visits to a time-recording machine would absorb too much time, and the work would be disposed of much quicker if a written time sheet be adopted. The form shown by Fig. 71 is one that has been found more uniformly satisfactory in actual practice than either the weekly or daily sheets previously referred to. The clerical work may be done by a job clerk in each department if desired, but, as a rule, it will be found that the turner or machinist has ample time for this after setting up his job. Each man is provided with a pad of fifty time slips, cheaply bound and perforated for tearing off, which he hangs up close at hand. They are issued to him from the Costs Department, bearing his name and shop number—the work of a boy with a rubber stamp outfit.

The first job of the week would be entered in the above form, the order number and card number—if any—written on the upper portion of the next slip immediataly underneath before tearing off the top slip for the foreman's signature. The slip is then placed in a box as the workman goes out for breakfast or lunch, as the case may be, and the box is afterwards cleared by a boy from the Costs Department. On finishing the shafts, the order number, &c., of which the workman entered on his time-slip beforehand, while his tool was taking its first cut, he will enter the time and date, and set up his next job. His foreman will tell him the name of the job and its

FIG. 71.—*Time Slip. Size, 5in. by 3½in.*

Date, 20th July, 1906.

Mr. Adams. *No.* 336.

Stopped work on

Order No...... ..... *Card No.*..... ..... *at* .....*o'clock, and started to Rough Turn Shafts.*

.....

For Order No. 3230. *Card No.* 571.

E. H., Foreman.

order number, and it is the work of a moment to note the same on his slip. In this way he reports the work of the week, and at stopping time on Thursday—which is usually recognised as week-end in the wages department—each workman places a time-slip in the box showing the number of the job he had in the machine at stopping-time, which is identical with that on his next slip, which commences a new week. How readily the man grasps the idea will be proved by trial, and one prominent feature is that no mental calculation is asked for. Seeing that each slip is signed by the foreman, it will be a risky venture to attempt a false time charge, and the manner in which the slips are linked to each other is unmistakably a good guarantee that jobs will not be omitted.

Date calendars.—It is very essential that the correct dates shall appear on the time slips, and as an aid to the man, light wooden racks are fixed in a conspicuous position, and arranged to exhibit numbered cards, printed black on a white ground, to serve as date calendars, being changed each morning by a shop apprentice.

Management of workmen.—In a work that is so closely akin to the internal administration of the factory, it will not be considered an act of trespass to refer to the efforts made in some establishments to raise the tone and standard of intelligence of the men by encouraging them to co-operate with the management by suggesting improvements in the shop system and equipment. Such suggestions are made in writing, and, in strict *incognito* as to their origin, referred to a shop committee for criticism. If adopted, their value is assessed by the committee, and money prizes paid each month for the best suggestions. Reading rooms for the use of the men during the lunch-hour, and equipped with suitable periodicals, of which there is always a plentiful supply in the offices, are always appreciated under proper direction, and tend to enlist the interest of the men in questions of a practical character.

Technical education of apprentices.—The author has in mind a well-known successful firm, which is raising up an educated class of workmen, who will bear comparison with the *personnel* of any contemporary firm, either at home or abroad, and, judiciously handled, will remain one of its most valuable assets. The apprentices are encouraged to attend the local well-equipped technical school, their fees and the cost of text books, &c., being paid by the firm, prizes being offered to all who achieve success at the annual examination. The keenness and friendly spirit of rivalry on the part of the apprentices is very pronounced, their work of a very high order, and the well-meant intentions of the firm are appreciated very greatly. Undoubtedly, it bespeaks an admirable spirit, and the mutual reward must follow as a natural sequence.

FIG. 72.—*Weekly Time Sheet. Size, 8½in. × 10½in.*

Name..... *No.*.....

Rate..... *Dept.* .....

.....*Ltd., London.*

Workman's Time Sheet, Week ending.....190.....

Factory Order No.	Card No.	Description of Job.	Machine Tool Nos.	Ordinary Time. F	S	M	T	W	Th	Total.	Overtime. Th	F	S	S	M	T	W	Added Time.	Total Over-time.	Gross Total.	Amount.

Official labour records.—Following the collection from the factory of the various time charges against the current jobs in hand, the time clerk prepares the official records of the same for posting against the respective costs accounts. In this connection the time sheet shown in Fig. 72 is recommended as a convenient, successful method of collecting each day's jobs in a weekly summary, preparatory to checking the total time charges with the timekeeper's record and the wages earned on each job with the total amounts appearing on the pay-roll, so that there need be little fear of incorrect postings in the costs records with the attendant difficulty in balancing. They who have experience of the worry and loss of time incurred in tracing such incorrections will appreciate the assistance that is afforded by this preliminary precaution. Bonus balances will be shown on the time sheet against the various order numbers referring thereto, as also the time charges against outdoor jobs with railway fares, board allowances, &c., so

* No. IX. (*continued*) appeared June 22nd.

that a complete statement appears as to the time worked by each man and the amount of wages earned.

The use of loose sheets is far more advantageous than a book record of this character, in that the work can be distributed among two or more clerks, not only in the course of writing up from time slips, but also for comparison with the timekeeper's record of the readings taken from the "Bundy" recorder, and with wages book. Then when this balancing is found correct, posting into costs accounts is greatly facilitated by the suggested distribution of the work.

Job slips—The loss of time that is occasioned in a large office in consequence of the wrong order numbers that are repeatedly appearing on time slips and kindred records is so considerable as to render the "job slip"—Fig. 73—almost indispensable. The trouble of writing this is very insignificant as compared with that of clearing up such inaccuracies, and as the slip accompanies the job when given out by the foreman, the possibility of any misunderstanding between him and his men regarding the correct order numbers is very remote.

FIG. 73.—*Job Slip. Card 5in. by 3in.*

JOB SLIP.

Shop Order No. .....

Card No. .....

For .....

Class .....

Drawing No. .....

Pattern No. .....

Men's Nos. .....

Dates .....

Date completed .....

This Card must be held by the workman who is doing the job. When he finishes the work he will hand this back to his foreman, along with the job to be checked.

But the foregoing considerations do not exhaust its utility as an aid to the foreman, taking the machine shop as an example. The "Job Slips" are placed vertically in a wooden drawer of suitable capacity, and arranged by the foreman behind guide cards bearing the names of the various operations on machine tools, *e.g.*, automatic lathes, boring, drilling, grinding, milling, &c. They enable him to see at a glance whether he has sufficient work in hand to meet the demands that will be made upon him during the day, and to make due provision, and assist him to keep in touch with the many parts both in hand and in abeyance. On the completion of the work to which a job slip has reference, its return to the costs department will be followed by due reference to the cost card, which is added and ruled off.

Cost cards.—Referring to the schedule of parts that is issued for the guidance of departmental foremen, it will be remembered that each batch of parts is allied to a card number, which is referred to also in the job slips and the time sheets. In thus dividing up the sectional details of the cars, and marking the distinction between the different batches of parts, we are enabled to determine the cost of the various component details, and distinguish hubs from axles, gear wheels from their pinions, engine casings from cylinders, and so on; and from this subdivision to compile comparison costs with a view to throwing up into prominence any excessive or decreased costs that are disclosed by the cost cards, Fig. 74.

FIG. 74.—*Cos Card. Size, 5in. × 8in.*

Ca d..... *Pattern*..... *Description*..... *Class*

Shop Order ..... *Drawing* ..... *Quantity*..... *Material*.....

Date.	Operations.	Time charges.			Labour dissection.									Labour Cost.		
		No.	Hours.	Rate.	Lathe.	Drill.	Slotting.	Planing.	Wheel cutting.	Fitting.		Mark off.	Forge.			
Received Finished Stores	Date															
	No.															

FIG. 74.—*Cost Card, reverse side.*

MATERIAL FROM STORES.

Date.		Reference.	Description.	Weight.	Rate.	Value.		
Selling Price:	Agency User		Material Cost Labour ,, E.C. Total Cost					

These cards are filed vertically in a cabinet of drawers, each of which is sufficient to contain 1000 cards, and guide cards are used for a numerical classification in the order of the card numbers. It will be noticed that the cost of material, taken from the storekeeper's records of stores issued and returned, appears on one side of the card and the labour costs on the other, being posted from the time sheet—Fig. 72. There are also columnar dissections for the various operations, showing the number of hours represented by each, as a first step towards the allocation of departmental establishment expenses, and the record as to deliveries to finished stores room shown at the foot of the card, is obtained from the sheet referred to by Fig. 70. The cost cards in any one drawer constitute a full and complete record of the production costs of one batch of cars, not only as to details referred to in the shop lists, but also as to subsequent fitting and erection in accordance with schedule requisitions, the whole of that batch of costs being collected in the "car costs" book to be described later. The left-hand side of this book is virtually a specification in detail prepared similarly to the shop lists, the costs of manufacture being copied from the cost cards, and the remaining costs of parts procured from outside sources obtained from a card index precisely similar to that referred to in Fig. 32. A final summary of the sections of "car costs" serves the purpose of an index to the folios on which the various car sections are set forth.

SUBMARINE VERSUS SUBMERSIBLE BOATS.

By SIMON LAKE.

THE numerous fatal accidents to submarine boats during the past two years have led many people to the conclusion that the submarine is more dangerous to its navigators than to a possible foe.

Considerable criticism has been poured upon the heads of departments and those responsible for the construction of this class of vessel. Such criticism may or may not be justly due.

Submarine navigation in its modern aspect is comparatively a new art, and only by practical trials and the gradual elimination of weaknesses can a standard type be developed capable of safe control and yet able to inflict the greatest possible measure of injury upon the enemy.

The modern automobile torpedo is the primary reason for the existence of submarine vessels; and the ability of the submarine to intercept the foe with this proved weapon of destruction before the enemy can reach our harbours by gun-fire is sufficient warrant for its development apart from any other advantages that may follow in the train of its evolution.

Numerous trials with submarine vessels have shown that such boats can be run, in peace-time manœuvres, either under the water or in various stages of part submergence with a variable measure of success. It was only to be expected that there should be risks run and failures encountered with possibly serious consequences. Each one of the accidents, however, has brought substantial enlightenment, even though purchased in some cases at a grievous cost of life; and with this emphasis upon certain weaknesses it is now possible to predict the lines along which further progress in the art may be made with a reasonable assurance of immunity from dangerous mishap. Such have been the lessons to the technical student of the submarine.

An unfortunate condition of affairs has existed which has prevented a full understanding of the subject on the part of those responsible for the purchase of many of the submarine boats now extant. This has been the veil of secrecy cast about the submarine question by most of the inventors and builders of under-water craft. The inventors and builders have been compelled to keep secret many things which they have learned—perhaps by costly experimentation—at least until such time as patent protection could be secured. Many other features, the fruit of experience, but on which no such protection could be secured, have been kept secret for the soundest of business reasons. The writer has been no exception in these particulars. The fatal accidents of the past two years, however, have prompted him to make public the results of certain experiences and investigations, with a view to contributing, as far as lay in his power, to the prevention of disasters kindred to those that have so shocked the civilised world, and which, in the eyes of the general public, have cast discredit upon the art of submarine navigation.

Submarine vessels are broadly distinguished to-day by the two denominations of "submarine" and "submersible." The difference between these terms has not always been well defined. Boats of each type naturally are submarines in the common understanding of that word. The term "submersible" was first given to the Narval built in France in 1899. The earlier types of French boats were of the diving or plunging class originally, while the Narval was the first of the French boats primarily designed to submerge or be submerged bodily by the down-pull of hydroplanes, rather than to plunge or dive by the head, as is common in the diving type. It is in these distinctions that lie the most important differences among the present types of under-water boats.

France, to whom we are thus indebted for the term "submersible," is the only country in which the study and the development of submarine craft has been entirely under governmental auspices. There has been an entire absence of a spirit of commercialism in that investigation, and the conclusions of the French Admiralty to-day in favour of the "submersible" are based upon serious, painstaking, and practically exhaustive researches which have candidly considered submarine craft of all forms and types.

Russia, under the stress of war, being uncertain as to which was the type most to be desired, purchased boats of several sorts, in order to determine practically the class best fitted to meet the demands of actual conflict. None of the boats ordered were delivered in time to be factors during the period of hostilities; but the circumstances of war taught its lessons and showed the Russians the conditions that must be met by a successful submarine craft. Manœuvres and operations since undertaken in the light of these lessons by her active submarine flotillas have served to verify the conclusions of the French and to add Russia's decision in favour of the "submersible" as that term is understood in this article.

England and the United States have tried only one type—that of the diving order; and it is the diving submarine that has met with so many of the accidents—some of them fatal—during the past two years. Let us see if the reasons for these mishaps cannot be made clear.

The *sine quâ non* to the successful working of the diving boat is extreme sensitiveness in a fore-and-aft direction when submerged, or in other words, lack of longitudinal stability. Without this tenderness it is practically impossible, at the speeds so far attained, to control such a vessel when running submerged.

It is not necessary here to discuss either the administrative or the military aspects of this lack of longitudinal stability. The accidents that have occurred make a more direct and human appeal by emphasising the dangers faced by their crews even in times of peace.

The submerging or "submersible" boat requires no such hazardous limitation in the direction of safety in order to make her operatively a success. In the "submersible" it is possible to secure a far greater measure of longitudinal stability than is possible in the diving class. This greater longitudinal stability which may be secured in the "submersible" does not in any sense affect the speed and precision of action either in submerging or in maintaining a uniform degree of submergence when once under the surface. All that this may mean from a military or an administrative point of view has been thoroughly discussed elsewhere. Let us see, however, what are the physical conditions operating when a boat is submerged and against which those in control of a "diving submarine" must effect a balance by skill either in the form of deftness of handling or nicety of adjustment in one direction or another.

The loss of the British submarine A 8, therefore, may be taken as a case exemplifying in the plainest and most startling manner the dangers peculiar to the diving submarine. The testimony taken during the court martial showed that that boat when running in light condition had a normal reserve of buoyancy of about 16 tons. This had been reduced to six tons, and she was so trimmed that she was down 4 deg. by the stern at the time of the accident. The boat was running at a speed of 10 knots under her gasoline engines. It was further shown, by the testimony of Captain R. H. Bacon, R.N., that a moment to change trim of no less than 132 foot-tons would be required to bring the boat horizontal or on an even keel when trimmed in the condition described, and that a still greater moment to change trim would be required to bring the vessel down by the head so as to make her plunge. The practical proof that sufficient force was exerted in some manner to effect this very end was given by the sudden and disastrous manner in which that boat dived.

Both Sir William White and Captain Lees, R.N., have recorded their belief that the form of hull of the A 8, combined with her limited longitudinal stability, was in itself the prime reason for the sudden plunging of that vessel. Model experimental trials both in the United States and in Germany have only served to confirm that assumption. As far back as 1897 towing experiments with my boat Argonaut I., in her original form, made plain this tendency of the cigar-shaped hull, even when united with great fore-and-aft stability, to bury or to run under by the bows. The Argonaut I. was subsequently modified by the addition of a ship-shaped superstructure which eliminated completely the down pull at the bows previously so markedly present.

Without referring to the detailed results of my model tank experiments, the elemental difficulties can be shown in a graphic manner, with sufficient accuracy to demonstrate the forces at work tending to unbalance or upset a craft of the diving type, already more or less unstable in a fore-and-aft direction, and in which the reserve of buoyancy is needfully reduced to a dangerous degree in order that the boats may be made operative at moderate speeds.

The following diagrams will help to make the circumstances clear to the general reader. In Fig. 1 we have a

boat of the diving type running submerged in the usual manner—that is, with a trim of from two to four degrees by the head, in order to enable the vessel to remain under water. In the diagram, A represents the position of the centre of buoyancy, B the centre of gravity of the vessel, and C the horizontal rudder which is to overcome the righting moment of the short arm between A and B.

Experience and model experiments have shown that the down-pull at the bow in a cigar-shaped craft is much greater at or near the surface and at or close to the bottom; and it has been found that this down-pull changes with the depth below the surface, or the distance above the water-bed. To run "awash," therefore, it is necessary to trim by the stern, and, still further, to offset any tendency to plunge by setting the horizontal rudder a number of degrees "to rise," as was the case with the A 8.

To dive, additional water is admitted into what is called the forward trimming tank, the horizontal rudder C is set to "dive," and the vessel plunges under, head first, like a porpoise. Now, the trick in handling a diving boat is to allow her to reach a depth of several feet below the surface—where the down-pull at the bow is less—and then to catch her and hold her at that submergence by the continual manipulation of the horizontal rudder C.

The difficulties of the problem may be better understood by referring to Fig. 2, in which the conditions prevailing are diagrammatically likened to a balanced beam, for which the pivotal point A corresponds to the centre of buoyancy of the vessel, and the weight centred at B, acting as a short pendulum, corresponds to the weight of the vessel as a whole. B, then, is the one force tending to hold the beam horizontal. H is a float, representing the amount of reserve buoyancy statically in the craft when trimmed to run submerged, and bears to the total displacement of the boat the ratio of only about 1 to 560 in the case of vessels of the "A" class of 200 tons. It must be plain that this very small reserve of buoyancy can add practically nothing to the stability of the beam, which we assume is floating. F is a weight applied at the short arm of the beam, and represents the downward pull at the bow graphically, but not relatively, because this weight or force is a continually changing quantity, which must be as continually checked or counterbalanced by the force of the stream lines impinging against the horizontal rudder C—in the direction of T^1—which must equal, in effect, a counterbalancing weight placed at G and acting in the direction of T. With expert steersmen, and by fine adjustments of water ballast, a certain measure of success has been won after experimenting with vessels of this particular type for a period of half a century. But this success is at the expense of constant vigilance, and with so many restrictions, that under some conditions it is still impossible or dangerous to navigate submerged in this manner.

Again referring to Fig. 1, it will be seen that when the boat once reaches the position shown, she is running with a slight downward inclination by the bow, which is required to balance the upward pull of the reserve buoyancy of the vessel. In smooth water and with the vessel running at an angle of only a few degrees, the stream lines D and E are parted at the bow easily and sweep around the vessel in an approximately uniform manner. In this condition the boat moves forward in a plane parallel to the surface of the water, but not with the axis of the craft parallel to the surface. In other words, the boat does not follow the true direction of her axis, but moves forward at an angle, and her course is a mean between two opposing forces:—First, that of buoyancy, which is continually tending to bring the vessel to the surface; and, secondly, that force due to the downward thrust of the screws in line of the axis of the boat. These opposing forces can be balanced only by exceptional skill on the part of the man at the diving rudder, otherwise the maintenance of a uniform depth in a diving boat becomes impossible.

In addition to the two forces just mentioned, there are others which tend to destroy the trim of the boat. The first of these is the righting moment of the pendulum A-B, which tends to bring the vessel on an even keel. This may be considered as a constant force, but for the shortness of its arm it can have, of necessity, but a relatively slight effect. It is, however, the one constant force, and the only one which prevents the craft from swinging like a pin wheel around its fulcrum at the centre of buoyancy A. The next disturbing influence is that of the down-pull at the bow, already noted, which varies according to the speed of the boat and the depth of submergence. The fifth element of disturbance is that of the sub-surface effects of wave motion, which gives a varying head, and, consequently, intermittent change of pressure or down thrust on different portions of the boat. The sixth force is one within the craft herself, and is the result of shifting weights in the form of surging water ballast, changes in position of the crew, or the transfer fore or aft of other masses.

It will thus be seen that there are six disturbing forces to be taken into account, and of these four of them are continually fluctuating. These opposing forces must be harmonised by the manipulation of the horizontal rudder C, which, by the exercise of great skill and control and within prescribed limits, it has been found possible to do under certain chosen conditions. A moment's inattention, however, on the part of the helmsman or the failure of the horizontal rudder to respond with sufficient quickness may lead at once to loss of control, and the vessel will either break for the surface and broach or plunge toward the bottom, with the risk of disaster under the impulse of her driving engines and the rapidly increasing inclination of her bow. If the engines can be stopped before the vessel has struck the bottom, then the two constant forces—those of the righting moment of the pendulum A-B and that of the reserve buoyancy—will combine to bring the vessel back to her normal horizontal position and to draw her again to the surface. It should be plain from this what must be the task of the operator at the diving rudder and to what degree his skill must be developed to meet the conditions thus confronting him even in time of peace and amid surroundings and circumstances carefully chosen. How much greater then must be his task when operating amid the environments of warfare and under the nervous stress of actual conflict! Sub-Lieutenant Godfrey Herbert, one of the officers aboard the A4 when she sank, testified—as stated in the *Naval and Military Record*:—"The boat sank to a depth of 90ft. before starting to rise. During this time water was coming down the ventilator with considerable force, which increased as the depth got greater. In about a minute the lights went out, and it was with great difficulty that the captain's order to put the 25 horse-power pump on to the fore bilge was attempted. Just before the lights went out the boat had an inclination by the bow of 40 deg., and all small gear and the cloth covering the batteries were washed forward. . . . The gauge was shown at 90ft. It could not show more." From an editorial in the same paper we find the following:—"They are liable, says Sir William White, to unexpected dives, and this again is confirmed in the case of the A4 by the testimony of the coxswain."

Fig. 3 represents a boat of the diving type and of the "A" class, submerged and inclined at just half the angle assumed by the A 4 when she sank. It will be seen from this diagram how considerably the down-pull at the bow is augmented by every change of trim on the part of the cigar-shaped craft; and it is not difficult to understand how a very rapid increase of inclination may render less effective the counterbalancing factor of the horizontal rudder C. This has been borne out by numerous official reports.

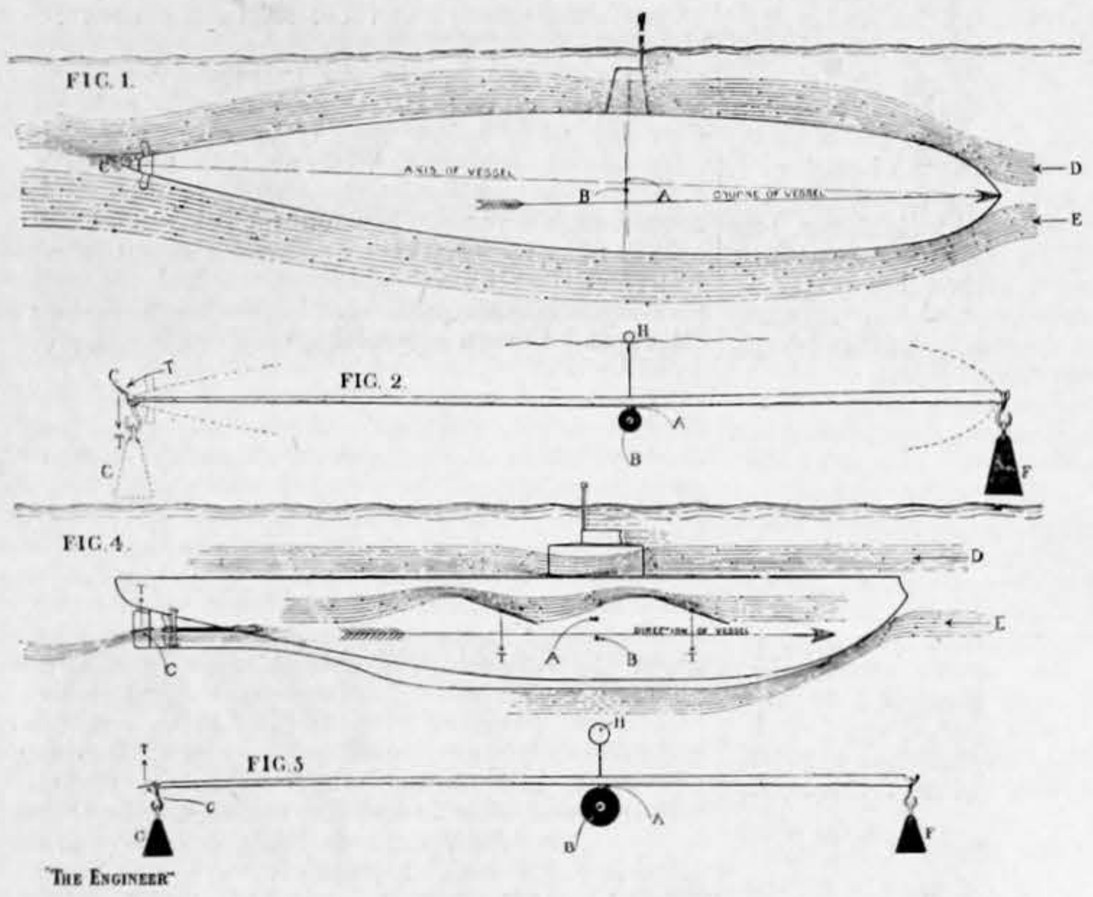
In the case of Fig. 3, it is assumed that the boat has started in the condition primarily required—with trim by the head—as indicated in Fig. 1, and that the vessel was then moving forward in a plane parallel to the surface. By reason of some of the causes or forces heretofore described, the craft now takes a further inclination or dip by the bow. Fig. 3 shows graphically what occurs when the momentum of the vessel tends to maintain her on her forward course in a plane parallel to the surface. The stream lines, instead of parting fairly on each side of the bow, come with greater force against the forward upper half of the vessel, and impart, by reason of this, a strong downward thrust at that point, while the supporting resistance on the under side of the hull at the bow is considerably lessened. Consequently, the balance is destroyed and a very much larger angle of the horizontal rudder C is called for. There is, of course, a limit to the effectiveness of the horizontal rudder C. A horizontal section drawn through L-K, and another drawn through M-N, each equally distant above and below the centre of buoyancy when the boat is inclined as shown in Fig. 3, give the relative areas of resistance, and illustrate how much more rapidly the forward or lower area increases than the after or upper area. It will be seen from these sections how much more difficult the lower one is to move forward through the water than the after or upper section. This, of course, is due to the very bluff character of the lower section and its greater tendency to produce eddying, back pressures, &c., when driven at a considerable speed. Therefore, the condition becomes as follows:—The vessel moves forward first in a horizontal plane, and then for some of the reasons previously stated additional inclination occurs; resistance to progress of that part of the vessel below the swinging point O—*i.e.*, a line intersecting the centre of buoyancy—increases and retards the bow, while the momentum of the craft carries the upper and less resisting section—now the tail-end or after-body of the boat—forward; any shifting weights, providing the angle has become great enough, would move forward, as in the case of the A4; the horizontal rudder even when given its maximum angle of rise proves ineffective, and the boat continues to dive with a rapidly increasing inclination unless the machinery is stopped and the vessel's momentum arrested. If the vessel during this interval has not been brought to a standstill by the bottom she may continue to plunge to a depth where the pressure may prove sufficient to cause her collapse.

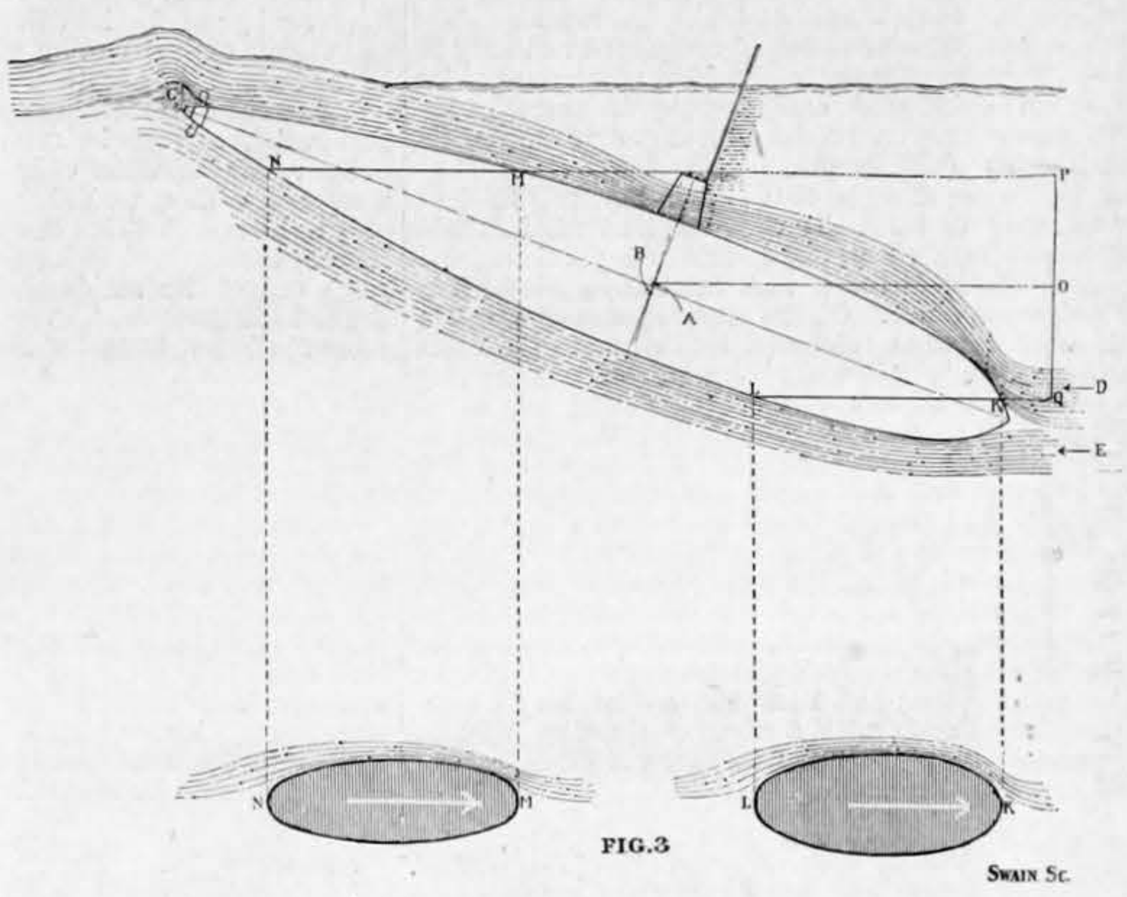
Fig. 4 illustrates a "submersible" of the latest type, which will be explained in connection with Diagram 5, so that a direct comparison may be drawn with the working principles of the diving boat, as shown in Figs. 1, 2, and 3.

In Fig. 4 the "submersible" is shown running on a level keel—the position normal to boats of this type—instead of being several degrees down by the bow, as is necessary with the "diving" type. The reason why it is thus possible to run the "submersible" on an even keel is as follows:—It will be observed in the first place that the hull is quite different in form. This raises the centre of buoyancy to a point much higher than it is possible to do in the regulation cigar-shaped craft of the "diving" type. The vessel is also provided with a heavy keel, which lowers the centre of gravity. Therefore, the arm of the pendulum A-B becomes longer and its righting moment correspondingly greater. This is a most important feature, as it contributes directly to securing the greatest possible measure of longitudinal stability under the circumstances. As the boat does not need to be inclined to submerge her, there is no limit—by reason of operative requirements—to the longitudinal stability that may be given the submersible; and in practice it is desirable, of course, to have the longitudinal stability as great as the form of hull and the arrangement of weights will permit.

To run "awash," or submerged, the vessel is trimmed by adding water ballast until only the desired amount of reserve buoyancy remains which will ensure the boat resting on an even keel, with her conning tower in an awash condition in relation to the normal surface. In other words, the beam or balance represented by Fig. 5 is brought to a horizontal position by adding fixed weights at both ends, so that G and F are equal. In this condition the "submersible" can be run without risk of, or impulse toward, a sudden dive.

The official reports and the testimony given during the court-martial following upon the loss of the A8 confirm the belief that it is either impossible or dangerous to run "diving" boats upon the surface on a level keel, even when retaining a very considerable reserve of buoyancy. This hazard is primarily due to the down-pull at the bow, characteristic of the cigar-shaped form of hull, and lacking longitudinal stability of vessels of the "diving" type. With the "submersible" of the type illustrated here there are none of the tendencies to dive so characteristic of the other order of boat under these circumstances. The reasons for this are the great longitudinal stability and the structural form, which completely off-





THE STABILITY OF SUBMARINE BOATS

COMM. ERASMO MARI'S FACTORY FOR THE PRODUCTION OF SILKWORM EGGS

(For description see page 643)

Fig. 3—CELLULAR SEGREGATION OF SILKWORM EGGS

Fig. 4—CRUSHING DEAD MOTHS FOR FIRST SELECTION

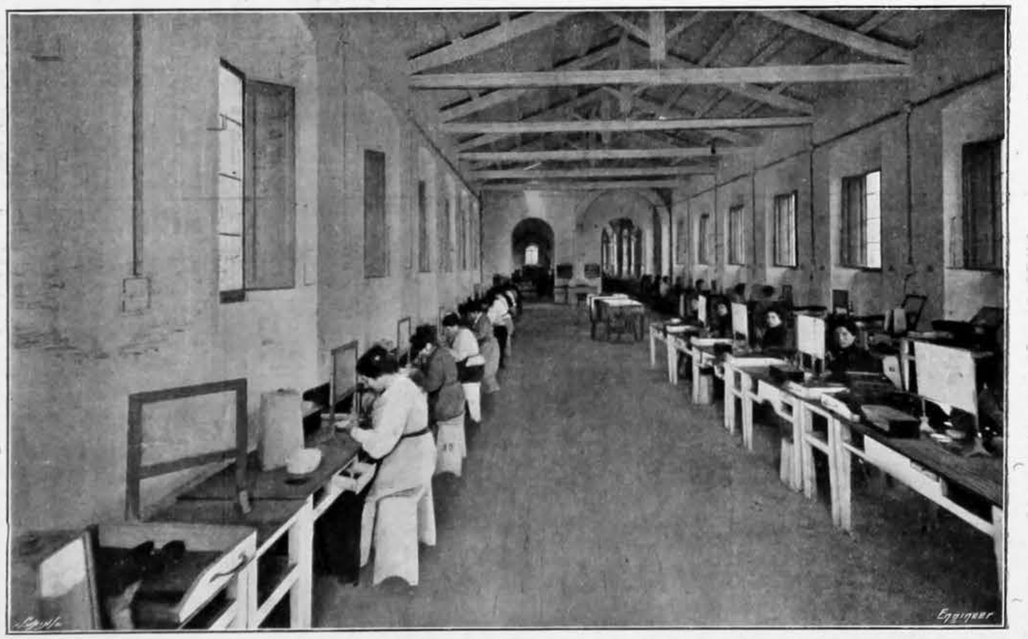


Fig. 5—MICROSCOPICAL EXAMINATION OF SILK MOTHS

Fig. 6—FINAL EXAMINATION OF SILK MOTHS

set the development of a downward pull. The vessel being in the "awash" condition just described is given headway, and it is soon noticed that there is a slight tendency to change trim by rising at the bow—due to the thrust against the large conning-tower—and this is at once corrected by a permanent angle of the horizontal rudder C intended for this particular purpose. It will be observed, of course, that this horizontal rudder is placed aft, as in the "diving" boats, but it is used for the very opposite purpose of keeping the vessel in a horizontal position, rather than to cause her to take a dip or plunge, as is the case with the "diving" type. A downset of the horizontal rudder of only two or three degrees is usually sufficient to balance the tendency of the bow to rise in boats of the "submersible" type herein illustrated. A level keel being thus secured, the angle of the horizontal rudder remains constant for a given speed.

The "submersible," still running in the "awash" condition, but ready for instant submergence, is quickly brought completely under the water—without change of trim—by depressing the forward ends of the hydroplanes. This causes the stream lines at the side of the boat to impinge against the upper surfaces of the hydroplane and to give a resultant downward thrust, as indicated by T T, in Fig. 4. The hydroplanes, being four or more in number, and symmetrically disposed in regard to the centre of buoyancy or fulcrum, the thrust against their upper faces causes the boat to sink on an even keel. It will be observed that the stream lines at the bow are not affected in the same manner as those at the bow of the "diving" boat of cigar-shaped form. There are none of the disturbing eddies developed peculiar to the spindle-shaped hull; and the vessel moves forward along the line of least resistance instead of at an angle. The thrust of the screws or the momentum of the vessel, when the machinery is stopped, impel her in the direction of her major axis, which is in the plane of the course desired.

When the vessel has reached the depth desired, the hydroplanes are brought back to an angle which will yield just pressure enough to counterbalance the upward pull of the reserve buoyancy statically in the craft, and indicated by H. Because of the buoyant character of the superstructure and the greatly increased buoyant moment of the conning-tower in vessels of this class, the righting effect of this force is very much greater than can possibly be the case with boats of the "diving" type. The reserve buoyancy is the only force which it is necessary to counteract in "submersibles" of the type under discussion; and this force is a constant one, and so easily balanced or neutralised that the writer has frequently left the controlling mechanism of the hydroplanes—situated in the conning-tower—and has gone below into the engine-room for periods of several minutes at a time, and has returned to the conning-tower and found the boat running still at substantially the same depth as that at the instant of his departure. The reason for this is the fact that in the "submersible" we thus do away with four fluctuating forces which are inherent or peculiar to boats of the "diving" type and spindle form of hull.

The practical results thus secured by the "submersible" are:—

(1) Safety in submerged control.

(2) Facility in handling that calls for no special training or rare dexterity on the part of a single member of the crew.

(3) Easy maintenance of a uniform depth on an even keel in waters of variable depths, thus making it safe and practicable to operate either in deep or shallow waters.

(4) The removal of restraint to free movement on the part of the crew in the very fullest discharge of their duties.

(5) By preserving an even keel, ensuring the effective operating of the observing instrument the moment it appears above the surface, and thus affording that measure of safety and efficiency following in the train of rapid observation of the entire horizon.

(6) The ability to discharge torpedoes with the vessel always on an even keel, thus ensuring the maximum probability of making a successful target.

These advantages have appealed with convincing force to both the French and the Russians, who have examined and tested exhaustively these rival methods of operating, and the practical reasons for this decision are not to be denied while the records of so many serious accidents to "diving" boats in the hands of skilled crews give us cause for pause and question.

LAUNCH OF H.M.S. AGAMEMNON.

THE first-class battleship Agamemnon was launched from William Beardmore and Co.'s Naval Construction Works at Dalmuir on the 23rd inst. With the sister ship Lord Nelson, being built by the Palmer Company, at Jarrow-on-Tyne, the Agamemnon is the first battleship designed by Sir Philip Watts since his appointment as Director of Naval Construction. The Agamemnon is shorter than the ships of the King Edward class, being 410ft. in length, as compared with 425ft., but the beam is 18in. greater, being 79ft. 6in. These dimensions are more suitable for existing docks than those of her predecessors, as well as of the Dreadnought, a somewhat later design of Sir Philip Watts, built with great celerity, and now being fitted out at Portsmouth. At 27ft. draught the Agamemnon will displace 16,500 tons. The speed is to be 18 knots, the twin engines, supplied with steam from fifteen Yarrow water-tube boilers, giving 16,750 indicated horse-power.

In many of her details, as well as in the broad principles of design, especially as regards her armament, the Agamemnon embodies departures from previous practice, and marks the intermediate stage between the King Edward and the Dreadnought classes. The former is equipped with four 12in. and four 9·2in. guns on the upper deck, and ten 6in. guns, most of them on the main deck. The Dreadnought has ten 12in. guns, while the Agamemnon has four 12in. guns and ten 9·2in. guns, all above the upper deck. The guns have thus a higher platform, being about 9ft. further above the water-line than many of the guns in earlier ships of the line. The guns, too, are more concentrated in the centre of the length of the ship, and over 30ft. above the water-line, so that they have a great command of the water around the ship on all sides, and to this extent are better able to check torpedo-boat attack. The large guns are all covered in, excepting the muzzles, and they have not only a great height of platform, but considerable arc of training. The 12in. guns are mounted in pairs in barbettes fore and aft; while eight of the 9·2in. guns are in twin barbettes, the remaining two being in single-gun barbettes in the centre of the broadside. Four 12in. and 9·2in. guns constitute the broadside fire, while ahead or astern two 12in. and four 9·2in. guns can be used. In addition to these weapons, there are thirteen 12-pounder quick-firers, twenty-three 3-pounders, and two Maxim guns, with two guns for boat or field use. The ship has five submerged tubes for firing torpedoes, two on each broadside and one at the stern.

In protection, too, the Agamemnon has more powerful provision than preceding ships, and in this respect is probably quite equal to the Dreadnought. The water-line belt amidships is 12in. in thickness, reduced towards the stern to 4in., and towards the bow to 6in. Above this, in the central part of the ship, the broadside to the upper deck is of 8in. armour, and the thwartship bulkheads to protect against raking fire from before as well as from abaft the beam are of 12in. in thickness. The same thickness of armour is also used for the conning tower.

The Agamemnon, whose hull has been built on very fine lines, will be propelled by twin screws. The bow has the usual ram formation, but the stern differs from earlier ships, representing somewhat the type of the Elswick model, with the balanced rudder partly suspended rather than supported at the bottom. This, it is claimed, improves the turning movement of the ship. A deep bilge keel extends for almost two-thirds the length amidships. The machinery is of the usual naval type, with four cylinders for each set, working on the three stage compound system. The high-pressure cylinder in each set, taking steam direct from the boilers, is 32¾in. diameter, the next in the series is 53¾in. diameter, and from this latter the steam passes to two low-pressure cylinders, each 60in. in diameter, the stroke in all cases being 48in. The engines will develop their full power of 16,750 indicated horse-power with 120 revolutions, equal to a piston speed of 960ft. per minute. These engines have been constructed by Hawthorn, Leslie and Co., of Newcastle-on Tyne, the extensive new works of William Beardmore and Co. not being in a position to justify the firm undertaking the contract, lest they should not be able to complete it within the stipulated time. The normal coal load of the vessel will be 900 tons, but space has been arranged for carrying 2500 tons, which will give the Agamemnon a very considerable range of action.

Quite apart from the fact that the Agamemnon is so notable an example of the modern trend of naval development, and the largest warship yet built on the banks of the Clyde, the launch was of quite exceptional interest. This was not so much on account of the heavy weight to be transferred to the water—the launching weight being between 6500 and 7000 tons—considerably less than half that of the Lusitania. sent off the stocks of the neighbouring establishment at Clydebank the other day—but because the event was practically the opening ceremony of what is, or has every promise of becoming, one of the largest and best equipped naval establishments in the country. Platforms at the bow and alongside the vessel were crowded with spectators, the guests of the firm, and the yard generally was occupied by a vast concourse of workpeople and local residents. Amongst the guests on the bow platform were the Earl and Countess of Aberdeen, the latter of whom named the vessel, while the religious service, usual at launches of ships for the British Navy, was conducted by the Rev. William Swan, minister of Old Kirkpatrick parish.

Built on a line of declivity of $\frac{7}{16}$in. per foot the Agamemnon's bottom was unusually high above ground level, the height of the cross timbers underneath the standing ways, about the forward part of hull, being quite 15ft. or 16ft. While this entailed an unusual amount of timber support, the advantages of the extra head-room for workmen, and for the passage of material underneath the structure, far outweighed any saving in timber make-up, which only a usual height of keel or bilge blocks might have conferred. The thoroughness and substantiality in evidence here also marked the launching make-up, both as regards standing and sliding ways, and the cradle poppets or uprights. The heads of the latter abutted against a steel shelf securely fixed to the shell forward and to the under side of propeller bosses aft, the shelf on each side, for the whole length almost, being tied by broad belts of plating and wood packing crossed under the vessel's forefoot, forming a strong sling in which the vessel was supported. There were two releasing triggers, of special design, interposed between the standing and sliding ways on each side near the fore end of the cradle, and at the proper moment these were instantaneously and simultaneously disengaged by an electric current. A powerful hydraulic ram was stationed at the fore end of the sliding ways on each side, but these did not require to be put into operation. About eight minutes past one o'clock the last of the blocks supporting the vessel at the bilges was knocked away, and shortly thereafter the christening bottle was sent against the ram of the vessel by the turn of a miniature steering wheel on the ceremonial platform by Lady Aberdeen. Almost instantly, but very gradually at first, the huge vessel began to move. Until mid-distance was reached motion was slow, but the vessel rapidly gathered way thereafter and entered the water with remarkable smoothness, only a suggestion of frictional heat and smoke from the ways occurring just when the vessel was near the dipping stage. One minute fifty-one seconds after the release the vessel was completely water-borne, with singularly little disturbance on shore or afloat, the checking by three wire check-ropes attached to the vessel's sides and to piles of chain-cable on the ground alongside the berth—as is now the arrangement most in favour—being prompt and effective. Tugs in readiness took the Agamemnon in tow, and she was in a very short time safely berthed in the company's tidal fitting-out basin.

At the luncheon provided for the large company of specially invited guests, Mr. Wm. Beardmore, the chairman, in proposing "Success to the Agamemnon and the Health of Lady Aberdeen," said that there was a double interest in the launch that had taken place that day. The Agamemnon was the first ship designed by Sir Philip Watts, the present Director of Naval Construction, and not only did she differ from the ships designed by Sir William White, but also from ships designed by Sir Philip Watts a few months later. The ships which composed the fleet to-day were very inferior in armament to those which were now being built. The ships of the Majestic class, for instance, had only four 12in. guns. The remainder of their weapons were 6in. and 7in. guns. The Dreadnought had ten 12in. guns. This showed the enormous difference there was between the Dreadnought and the ships of which the fleet was at present composed. Not only so, but gun manufacturers had made so many improvements in the type of guns that a new 12in. gun was to-day about 50 per cent. more effective than the 12in. guns at present in the fleet. Were the Dreadnought and the Majestic to face one another, the Dreadnought, he ventured to think, would put the Majestic out of action in a very short time. The range of the guns was much greater in the later type of vessel. He had, indeed, heard it stated that the Dreadnought was equal to any three battleships now in the British Navy. Comparing the Agamemnon with the Dreadnought, the difference was mainly in the armament. The former had four 12-inch guns and ten 9-inch guns. It remained to be seen which design would prove the more effective, but he thought that probably there would in future ships be a combination of the best points of both. Not only had there been a great improvement in armour. The 8in. armour of to-day, he believed, was more than equal to the 12in. armour of four years ago. These things made an enormous difference in the power of the fleet. It simply meant that as things were now progressing, the fleet became obsolete in four or five years. This was a serious matter for the taxpayer, who had to keep up the fleet, but he was afraid it was true. The second point of interest to which he wished to refer was the fact that that launch was practically the opening ceremony of their new yard, which he ventured to think was one of the best equipped naval establishments in the country. The river frontage was over a mile in length, the dock was 1000ft. in length, and 350ft. in breadth, and the workshops were all of the largest dimensions, and contained the most modern and up-to-date tools. The yard was also unique in this respect, that it was the first establishment of such proportions in which steam as a motive power had been entirely discarded. All the machines were driven by electric motors, and those motors were worked by electricity generated by internal combustion gas engines. There was not a steam boiler in the whole place. In this he thought they might claim that they had done something wholly new. The gas they used for power purposes they first of all chemically treated, so as to extract from it the nitrogen, which was of no use for heating purposes, but was of great value for fertilising purposes. The result was that by taking from the gas that nitrogen and forming it into sulphate of ammonia, they found that when they came to square their accounts that their coal bill was entirely paid by the money received for sulphate of ammonia. In concluding, and speaking on behalf of the firm, he had pleasure in presenting Lady Aberdeen with a silver model of a full-rigged antique man-of-war.

Mr. Edmund Sharer, in responding to the toast of "The Builders," proposed by Lord Aberdeen, said that he did not think any other shipbuilding yard in this country ever had the honour of commencing its career by building a battleship for the British Government. The Agamemnon was the first battleship to be launched on the Clyde all the armour of which was manufactured by the builders themselves. She was also the first battleship ever built without the use of steam. She was the first of her class to be launched, while she had been brought to the launching stage in nine months and twenty working days. In speed of construction the credit lay with the Dreadnought, but if Beardmore's got a repeat order they would beat the Dreadnought's record. He wished to express the indebtedness of the firm to the Admiralty officials, and to their own workmen for the hearty support they had all given them in the construction of the vessel.

ROYAL METEOROLOGICAL SOCIETY.—The final meeting of the session was held on Wednesday afternoon, the 20th inst., at the Society's Rooms, 70, Victoria-street, Westminster, Mr. Richard Bentley, F.S.A., president, in the chair. Mr. F. J. Brodie read a paper on "The Mean Prevalence of Thunderstorms in Various Parts of the British Islands during the Twenty-five Years 1881-1905." The author gave the mean number of days on which thunderstorms or thunder only occurred in each month, each season, and in each year at fifty-three stations situated in various parts of the United Kingdom. July, he said, was the month with the largest number of thunderstorms over Great Britain as a whole, and August at some places in the North of Scotland and North-west of England, while June is the stormiest month at nearly all the Irish stations. Mr. W. H. Dines communicated a paper on a "Typical Squall at Oxshott, May 25th, 1906."

ROYAL AGRICULTURAL SHOW.

No. I.

AFTER a break in the itinerary show system extending over three years, and a disastrous experience at Park Royal, the Royal Agricultural Society has this year resorted again to its former practice, and is holding its sixty-seventh annual exhibition on a plot of land known as Osmaston Park, Derby, lent by the Midland Railway Company, and as far as can be gathered the prospects are distinctly brighter than in recent years. The entries show a decided improvement over those of late years, and particularly upon the entries received at the London shows. In the implement section the number of stands at Derby is 424 compared with 289, 350, 456, 340, 358, 412, 395 in the seven preceding years, and 377 at the last Derby Show in 1881. The increase in the live stock entries is equally satisfactory, demonstrating—if demonstration were necessary—the folly of fixing on a permanent showground near London. Although not so large as some previous showyards, the present ground, covering 84 acres, is ample, and obviates much unnecessary perambulation on the part of visitors as regards the implement section at any rate. The usual method of placing the machinery exhibits between the main entrance gate and the live stock exhibits has been followed, as it ensures visitors passing by the machinery, which is thus brought under the observation of all. The special features of advantage that have been introduced are that, instead of an exceptionally wide central avenue along which the majority of visitors passed, the fan-shaped setting out of the ranges of shedding distributes the public more widely. Much of the improvement has been rendered practicable because the large open space near the entrance, which has been a feature of recent shows, is not provided; the space being occupied by a deep block of machinery in motion on one side and the natural shape of the ground on the other; and the central part being occupied by two blocks or stands.

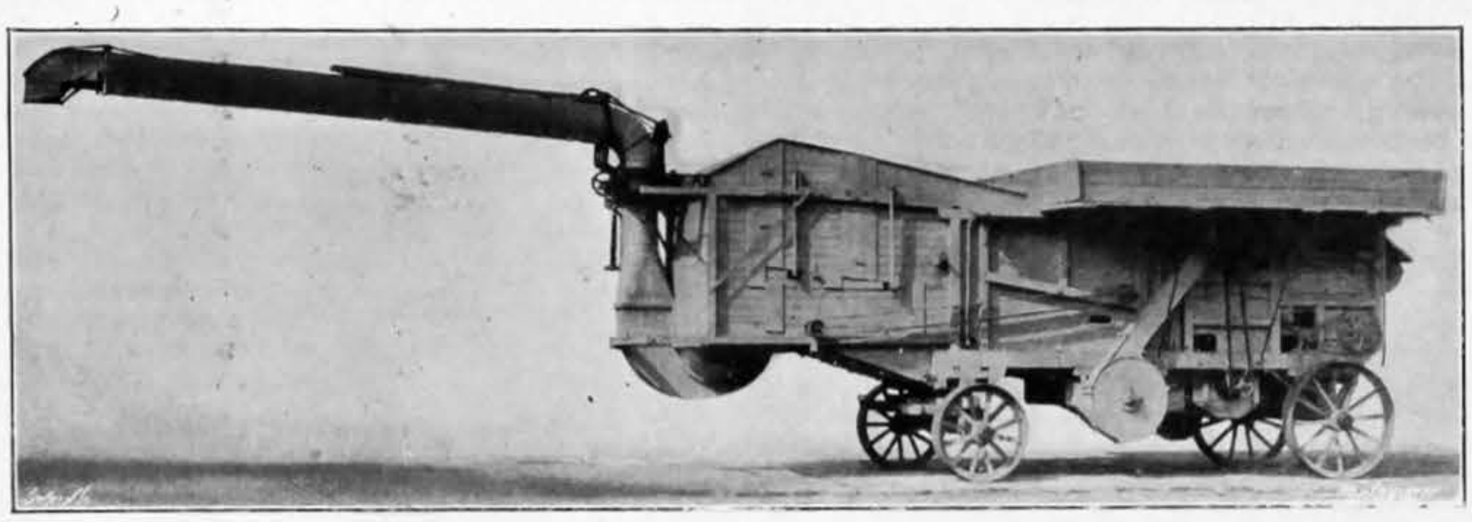


Fig. 1—FOSTER'S THRASHING MACHINE AND WIND STACKER

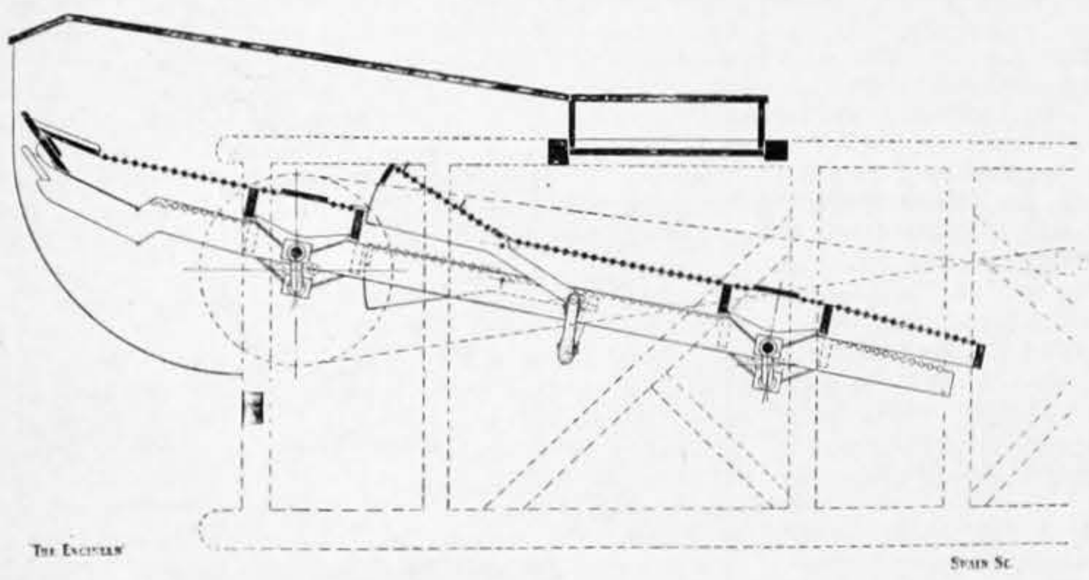


Fig. 2—CLAYTON AND SHUTTLEWORTH'S SHAKER

It was a happy idea on the part of the Council in restarting the county shows to hold a competition of gas engines and suction gas plants, as the entries have amply proved. At the present time there is probably no problem in mechanical engineering receiving more attention than this economical method of producing power. We have elsewhere dealt in detail with the twelve systems entered for the competition which has now concluded, and for description of these plants we must refer our readers to the present and last two issues of THE ENGINEER. The result of the competition was announced in the showyard on Wednesday as follows;—First prize, gold medal, the National Gas Engine Company, Limited, Ashton-under-Lyne, for a 20 brake horse-power National gas engine and suction gas plant; second prize, silver medal, Crossley Brothers, Limited, Openshaw, for a 15 brake horse-power gas engine and regenerative suction gas plant. We are authorised to state that in making the awards economy was not the only, nor, indeed, the chief point taken into consideration by the judges. The trials have been extremely close, and at the finish there was little to choose between several of the competitors, so that, although defeated on this occasion, the unsuccessful makers have nothing to be ashamed of.

Besides the suction gas plants which were entered for the trials, there were others exhibited which call for attention while on the subject. Ruston, Proctor and Co., Limited, Lincoln, have on view a 30 horse-power plant which embodies novel features. In this there is no water seal, and a three-way cock is provided for opening the generator to the atmosphere, and shutting the passage to the scrubber when closing down at night, for instance. The drain box is also closed in, so that there can be no smell on this score, and both the producer and the scrubber are arranged so that they can be disposed in different relative positions, according to circumstances. It is stated that this plant can start up on full load in twenty minutes, and the cost of the operation is equal to ·749 lb. of fuel per horse-power per hour.

As regards purely agricultural implements, the show has been the means of bringing to public attention many new or improved appliances. In this respect, attention may be called to the list of so-called "new implements" in the catalogue which are entered for the Society's silver medals. This list contains nearly sixty entries, but a microscopical investigation of some of the claims to newness would fail to show their novel features. The Council would do well to exercise more discrimination in the acceptance of entries under this heading.

One of the most prominent features of the show is the increase in the number of light steam tractors compared with previous shows. These are exhibited by Aveling and Porter, Burrell and Sons, Clayton and Shuttleworth, Foster's, Garrett's, Ruston and Proctor, and Wallis and Steevens, while the steam wagon exhibitors include Jesse Ellis and Co., Foden's, Hindley's, Mann's, the Yorkshire Steam Wagon Company, and Robey and Co., Limited. The last-named firm are newcomers in this department, and show for the first time a steam wagon with many interesting features, to which we shall refer in a later issue. Now-a-days improvements in thrashing machines partake of only a minor character, but Clayton and Shuttleworth's have introduced an improvement which needs mention. It is connected with the shaking mechanism, and it is intended practically to double the vertical movement, or shaking, of the straw in its passage from the drum, as shown in the accompanying sketch, Fig. 2, and thus make it impossible for any grain to pass over the boxes with the straw. The device is said to have been severely tested, and has been proved a success throughout lengthy experiments. The thrashing machine is also fitted with a new adjustable cavings riddle, which, by turning a thumb screw, can be varied to suit any class of grain. The loss of time and trouble involved in changing the ordinary perforated riddles is thus avoided, and the arrangement throughout is exceedingly advantageous. Another great improvement is found in the new patented rotary corn screen, the wires of which, still retaining the same special section as before, are now grooved on the inside, in order to admit of the spiral adjusting springs being more tightly and compactly bound to them. The new screen has been greatly strengthened and made still more efficient as the result of this alteration.

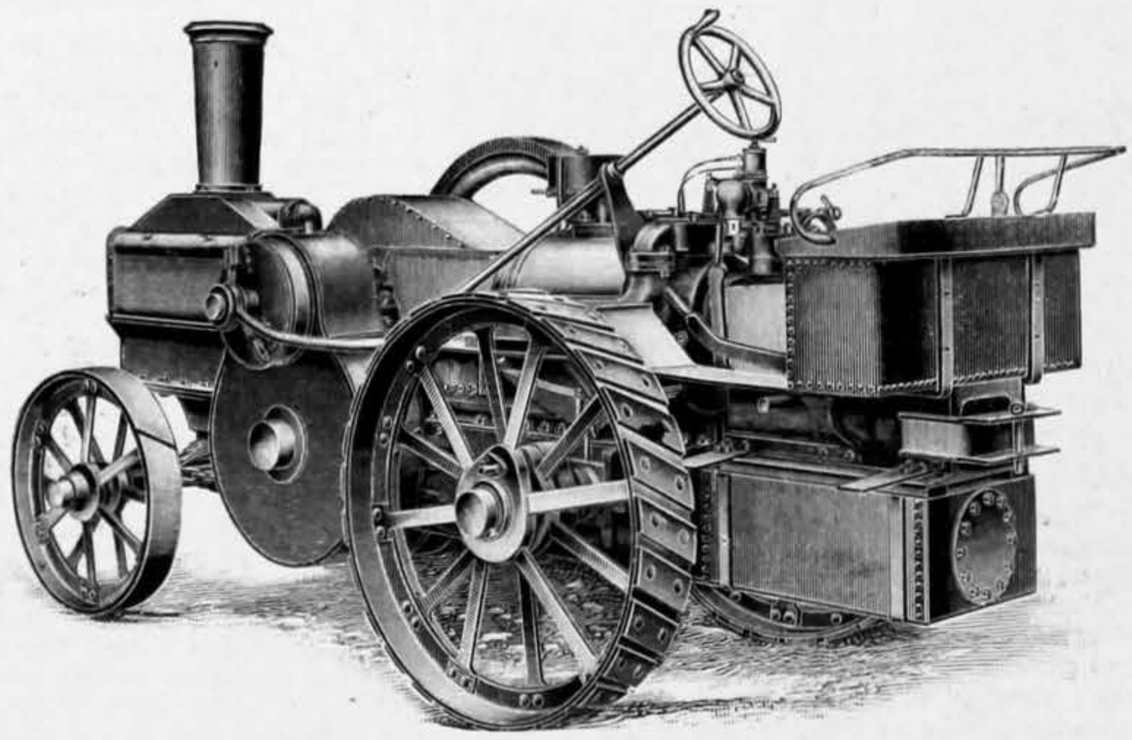


Fig. 3—PETTER'S OIL ENGINE TRACTOR

William Foster and Co., Limited, Lincoln, exhibit a 5ft. thrashing machine for the South American market, which is provided with a wind stacker, as shown in Fig. 1. The makers claim that this device will be a much-appreciated feature in countries where labour is scarce, as one man, by its aid, can build a stack without the assistance of several other labourers. The standard type of machine is used, and under the shaker end a hopper with a powerful fan is arranged. This fan delivers the straw through a long sheet iron tube. The end of the tube has a hood and deflector, by means of which the direction of the straw can be controlled. A turn-table is arranged on the top framework, on which the tube can oscillate automatically from side to side at a slow speed. In addition to this the tube can be extended or telescoped, and raised and lowered. The weight of the attachment does not make any material difference to the travelling of the machine. In this firm's steam tractor a feed-water heater has been added, and is said appreciably to reduce the fuel consumption, and as part of the exhaust steam is utilised for heating the water, ultimately exhausting into a receiver box in the ashpan, there is less exhaust steam visible from the chimney.

James B. Petter and Sons, Limited, Yeovil, amongst other machines, show a tractor in which the motive power is supplied by a horizontal single-cylinder petroleum engine capable of giving 25 brake horse-power at 300 revolutions. Paraffin is vaporised in a metal bulb which forms part of the compression space. This bulb is not water-jacketed, and the igniting lamp, which is fed by pressure from its own tank, plays against its exterior surface to provide the initial explosive charge. The crank shaft is placed transversely across the frame. A segmental expanding clutch is keyed to a projection of the shaft, and by means of intermediate gearing transmits motion to a lay shaft, from which again it is transmitted to the live back axle by means of a single roller chain. The engine has a fly-wheel 42in. diameter, weighing 6 cwt. The engine is cooled by water circulation, a belt-driven rotary pump and a special type of radiator being used. The vehicle has two speed gears, weighs 3 tons 10 cwt., and is convertible into a road roller. It is fitted with a driving pulley, and if desired may be used as a portable engine for driving thrashing machinery or other farm implements. It is shown in Fig. 3.

A new farm implement, or combination of two implements, worthy of mention is shown by J. B. Edlington and Co., Limited, Gainsborough, and is a combination of mower and swathe turner. This has been designed to meet the objection often raised that the way in which hay is now made is wasteful, because the cut end is left on the ground, and so allows most of the juices to run down the stems. It is contended that the reason why hay should be turned immediately is that the sun seals up the cut end and so prevents the juices leaving the stems, thus preserving all the feeding properties—albuminoids, amides, carbo-hydrates, &c.—which such juices contain. The combination is simple and effective.

The show opened on Wednesday last and closes to-morrow (Saturday). The attendance on the first day was greatly in excess of the attendances on the first days in recent years, notwithstanding the unpropitious state of the weather. We shall give further particulars of the more important exhibits next week.

LONDON ELECTRIC SUPPLY.

AT the moment of going to press we learn that the Hybrid Committee appointed to consider the London County Council Electric Supply Bill have come to the unanimous conclusion that they must report to the House that the preamble of the Bill has not been proved. The fact that this decision was unexpected will only add to the satisfaction of those who regard with misgiving the attempt to municipalise electric supply, and with grave disapproval the huge expenditure to which London would have been committed had the Bill been passed. An exhaustive report on the whole question of the supply of electricity in bulk in the metropolis has been drawn up by the members of the Committee, and will in due course be presented to the House of Commons. Its publication will be awaited with the liveliest interest. In the meantime we hasten to congratulate the Committee on its decision and those who resisted the Bill, promoters, counsel, and witnesses alike, on the success of their endeavours.

IT has been decided to reconstruct the Chinese Eastern Railway in Manchuria, and a wider gauge will probably supersede that favoured by Russia. During the war Japan laid a light railway on the Russian road between Sinmintun and Mukden. The railway will be sold to China, and then reconstructed with capital jointly provided by China and Japan. The traffic will be carried on in the name of the Chinese Government, but the working staff will mainly consist of Japanese. On the expiration of eighteen years, the Chinese Government is to repay the Japanese portion of the cost of reconstruction and acquire complete control of the railway. Meanwhile, Japan will hold the railway and its receipts as security.

THE INSTITUTION OF ELECTRICAL ENGINEERS.

OUR readers are already acquainted with the programme arranged by the Institution of Electrical Engineers for the entertainment of the members of kindred institutions from Canada, France, Germany, Italy, Switzerland, and the United States, who are now visiting this country. It includes visits to many of our principal cities, and to the places of most interest, either from a scientific, historical, or merely amusing point of view, in England and Scotland, and very wisely, we think, there is no formal meeting with the reading and discussing of papers.

On Monday the members assisted at the opening of the new electro-technical laboratories of the National Physical Laboratory by the Right Hon. R. B. Haldane, and were subsequently entertained by the director and his staff, and invited to inspect the other sections of the laboratory.

The new laboratory is an extension of the engineering laboratory, and is, therefore, in a building apart from Bushey House. It has just been completed by Messrs. Mowlem, who have done the work at cost price from designs by Messrs. Molt and May, who have generously given their services. The main portion of the new laboratory consists of a top lighted shed, 120ft. by 50ft., divided into two bays 25ft. wide each, one of which is again divided by a transverse partition. One of the small rooms so formed is intended for resistance experiments, and has a glass ceiling, and the lights above are glazed with a double thickness of glass; the space between the ceiling and the roof will be heated, and it is hoped thus to maintain the temperature fairly uniform. Artificial ventilation is provided. The entering air passes over steam-pipes, by which its temperature can be regulated. The other half of the same bay is designed for heavy test work. Two bed-plates are fixed in the floor, and arrangements are made for a travelling crane traversing the the length of the room. The long bay to the north of the building is for most of the ordinary test work. At the extreme west end is the main switchboard, receiving power from the dynamo room and also from the mains of the supply company, and distributing it to the machines in the building and also to the batteries. Adjacent to this will be the machines placed on a concrete platform isolated from the rest of the building. The rest of the bay is assigned to experimental work, the western portion being reserved for alternating-current experiments, and the eastern portion for direct current. The batteries are on the top floor of an annexe to the east of the main block, above the rooms reserved for photometry; thus the direct-current work requiring heavy currents will go on in the extreme eastern portion of the main bay.

The photometric department to the east of the main block occupies a space of 100ft. by 20ft., and is arranged mainly on two floors; at the south end of the block, however, there is a space extending from the ground to the roof, designed for large apparatus, or for experiments requiring a range of height. Convenient galleries enable access to be obtained to apparatus at various levels. Of the other two rooms on the ground floor one is arranged for life tests on lamps, the other for general experimental work; the photometer rooms proper are on the first floor, that to the north being for standard work, and that to the south for ordinary tests and experiments. Tracks are laid in the floor along which the photometers can be moved; one of these is the full length of the building, and gives a range of about 80ft. for work with high candle-power lamps.

The visitors, after the formal opening ceremony, visited the other rooms, where the use of the various pieces of apparatus were demonstrated by the gentlemen in charge of them. In the engineering laboratory the testing machines attracted a great deal of attention. The first was the alternating stress machine, which has now been in use for some time, and the second is, we believe, of much later date. It is a many blow impact machine of a novel kind. The specimen is a long cylinder about ½in. diameter, carried by supports some 4in. or 5in. apart. At its centre a shallow and narrow groove is turned. The diameter at the bottom of the groove is carefully gauged. Immediately above the centre of the test piece is a slide containing a metal cylinder, weighing 4½ lb., which is lifted by a cam, ½in., and dropped on the specimen. After each blow the specimen is rotated through 180 deg., and receives the next blow on the opposite side. The speed is limited by the cam, and is possibly about eighty to ninety blows per minute, so that a test which takes many thousand blows occupies a fairly long time to perform. The apparatus has not yet been in use long enough to say if it has any particular advantages or superiorities over other tests of a similar kind.

The party returned to town by a special train. In the evening a banquet, to which ladies were invited, was held in the Hotel Cecil.

The chair was taken by the President, Mr. John Gavey; and among those present were Mrs. Gavey, Lord and Lady Kelvin, Sir Alexander and Lady Binnie, Sir Charles and Lady Owen, Sir Wm. and Lady Crookes, Sir William and Lady Ramsay, Sir William and Lady White, Sir J. W. and Lady Swan, Sir A. B. and Lady Kennedy, Sir Henry and Lady Mance, Sir Charles and Lady Tupper, the Lord Mayor and Lady Mayoress of Manchester; Rear-Admiral Field, Dr. Glazebrook, Professor and Miss Pagliana, Mr. and Miss Spagnoletti, Dr. and Mrs. S. S. Wheeler, Professor J. L. Farny, Mr. P. J. B. E. Auzépy, Professor Dr. E. Budde, Dr. Emil Naglo, and Mr. Guido Semenza. The toast list was a long one, but the speeches were short. The healths of the King and Queen and of the rulers of the countries represented by the visitors at the banquet were drunk with enthusiasm.

In the absence of the Right Hon. Sydney Buxton, the toast of the visiting delegates was proposed by the President, both in French and English. He referred to the solidarity of learning, a solidarity to which engineers contributed even more than other learned societies. Wherever one engineer met another, they met not only as colleagues but as friends. The toast was responded to by Professor J. L. Farny, on behalf of the Association Suisse des Electriciens; Mr. P. J. B. E. Auzépy, the Consul General of France; Professor Dr. E. Budde, President Verband Deutscher Elektrotechniker; Dr. Emil Naglo, representing the President of the Elektrotechnischer Verein; Mr. S. S. Wheeler, President of the American Society of Electrical Engineers; and Mr. Guido Semenza, Honorary General Secretary of the Associazione Elettrotecnica Italiana. This gentleman, on behalf of the Italian electrical engineers, presented the Institution of Electrical Engineers with a bronze bust of Volta, and in a few well-chosen sentences, referred to Volta's relations with British engineering, and hoped that the gift might be a new link in the old chain of friendship between England and Italy. The President thanked the Italian engineers for their kindness in suitable terms, and at his request Professor Silvanus Thompson gave a brief description of Volta's associations with this country, and added an eloquent tribute to the great electrician's memory.

On Tuesday morning the members and their guests assembled at 9.30, and broke up into a number of groups. One of these set out to visit the London County Council Generating Station at Greenwich; another went to the Lots-road Generating Station at Chelsea; another to the Bow station of the Charing Cross Company; and others to the Post-office Telegraphs and Telephones Departments, and to the installation of the National Telephone Company. Our readers are already familiar with the general design of the various power stations visited, and there will be no need to refer to them in the present instance. A few words may, however, be usefully said regarding the gigantic undertaking of the Post-office, both in telegraphy and telephony.

In the telegraph department the visitors were shown practically everything, from the secondary batteries to the most delicate of transmitting and receiving instruments. Perhaps most interest was taken in the automatic machines, with which a speed of transmission of 400 words a minute is attained; but instruments in direct communication with far-off centres came in for a good share of attention. Naturally, from the point of view of actual study, it was a pity that only one hour could be spared for the inspection of such an amount of intricate detail.

From the Post-office the party was conveyed in its motor omnibuses to the building devoted to the Post-office telephones. Here in one building are two exchanges with connections to customers, approaching in numbers very nearly to 30,000. The visitors were shown the duct chamber through which the cables enter the building, and ascending from there they traversed one after another the various departments, and could see exactly how the whole system was worked. It happened that the time of the visit coincided with a period of great activity, and the operators were hard at work attending to the calls of the various customers. Among the points which were specially noticed were the registering meters by which the number of calls made by each customer are recorded, and the arrangements for testing faulty lines and investigating defects. The longest time out of a short hour was devoted to the trunk communication department, and the working was entered into and thoroughly understood by the visitors. For the benefit of our readers we may say that the trunk calls come to a board in charge of two attendants. These transmit the requests by telephone to a number of operators seated on each side of a long table. The details of the calls are entered on printed forms, which, when filled in, are deposited on a travelling band running in a channel down the centre of the table, and delivering on to a cross table at one end. Here they are sorted and delivered to messengers, who take them to various boards situated in different parts of the room, according to the locality with which it is desired to have trunk connection. Communication is then made between the original subscriber and the person with whom he wishes to speak. The printed slips are, after the call is over, sent to the accounts office so that records may be kept and charges made.

Leaving this place, after all too short a time, the party was conveyed to Greenwich, where it was joined by those which had visited the National Telephone Company's building and the Greenwich power station. After luncheon at the Ship Hotel, the Royal Naval College and other places were inspected, after which a return to town was made. The parties which had inspected the London stations were entertained at luncheon at the Austrian Exhibition.

In the evening was the annual conversazione, which was held, as is usual, at the Natural History Museum, where rather more of the exhibits were on view than has generally been the case – owing, no doubt, to the greater number of visitors—and an enjoyable evening was spent.

On Wednesday a most successful excursion was made to Windsor Castle, and afterwards up the river to beyond Boulter's Lock, a return to London being made at about 8.30.

Yesterday morning the visitors started very early in the morning from Euston on their long tour, which will include visits to Rugby, Birmingham, Manchester, Liverpool, Glasgow, Edinburgh, Newcastle, Leeds, &c. In our next impression we hope to give some account of this trip. To-day we only propose to discuss one of the numbers of things which the party will see. This is the applications of electricity to traction which have been made during recent years by the Lancashire and Yorkshire Railway.

In our issues of March 18th and 25th, and April 1st, 8th, and 15th, 1904, we gave a detailed description of the work which had been carried out up to that time in connection with the electrification of the Lancashire and Yorkshire Railway Company's line between Liverpool and Southport—see Fig. 1. It will be remembered that the contractors for the whole undertaking were Dick, Kerr and Co., Limited, of Abchurch-yard, Cannon-street, E.C.

Since the opening of the line in 1904 a number of developments have been carried out, and the line has been extended, and as it will be one of the features of greatest interest in the programme of the electrical engineers, we propose in the following article to bring our description fully up-to-date. In March, 1904, the electrified system embraced 47 miles of permanent way. At the present time the length is close upon 60 miles of single track, the extension being in part due to the linking up of Crossens. It will, perhaps, be of interest to refer briefly to the relative conditions obtaining under the new *régime* as compared with the time when steam locomotives were used for working the trains on this important branch of the Lancashire and Yorkshire Company's line. Then there were thirty-six trains per day in each direction between Liverpool and Southport, and a like number running in each direction between Liverpool and Crosby, a station some 6½ miles distant. The majority of these trains stopped at every station, and there were only a few expresses run in the morning and evening for the accommodation of business men. The express trains took 25 minutes to cover the distance—nearly 18 miles—between the two extreme termini. The stopping trains occupied 54 minutes. The stopping trains to Hall-road, which is just beyond Crosby, took 25 minutes, and the train mileage on the whole system was about 1900 per diem. With electric propulsion the railway authorities have been enabled to increase this to 3500 train miles per day, or very nearly double. The schedule time for the express trains between Liverpool and Southport remains the same—25 minutes—but there is one train per hour regularly instead of only a few trains in the morning and evening. The stopping time for the whole distance has, however, been reduced from 54 to 37 minutes, and that from Liverpool to Hall-road from 25 to 17 minutes. Moreover, the express trains are now run on to Crossens, beyond Southport, giving this place a service of seventeen trains each way during the day. The foregoing does not, however, represent all that will ultimately be achieved. Considerable extensions are in contemplation, and some of them are actually being proceeded with. The growth of traffic has compelled the railway company to equip for electric working all four roads between Bank Hall

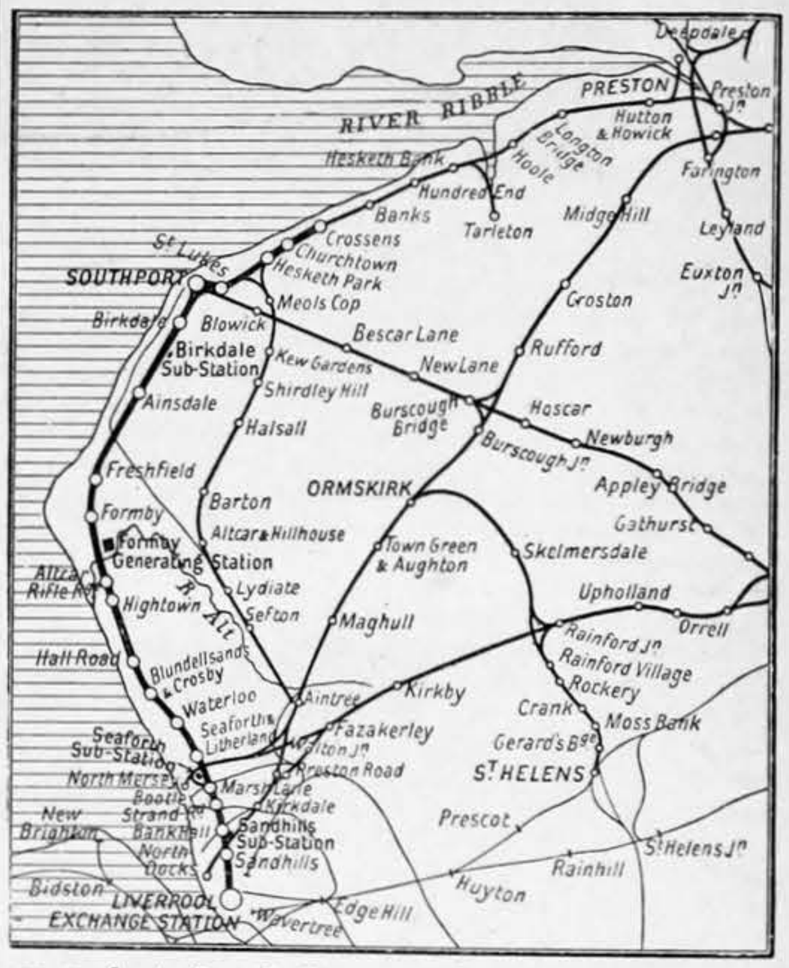


Fig. 1—RAILWAYS IN THE LIVERPOOL DISTRICT

and Seaforth Stations. Two roads are used for the fast, and two for local services. This work necessitated the equipment of eight miles of single track.

So much for the line originally electrified. The Lancashire and Yorkshire Company has by no means rested satisfied with this alone. It has launched out in other directions as well, and is electrifying other neighbouring lines of its system. We understand that matters have so far advanced that it is hoped before the end of the present year to have electric trains in operation between Liverpool and Aintree through Sandhills, Kirkdale, and Walton Junction, and that the North Mersey branch will also be completed, linking up not only to the Liverpool-Southport line at Seaforth, but also forming a through connection to the Liverpool Overhead Railway. The length of track which these extensions will add to the system amounts to some sixteen miles, which will bring up the total length of electrically operated track to about seventy-five miles. The work had progressed so far by the beginning of this month that a service of twenty-eight trains daily had been established between the Dingle station of the Liverpool Overhead Railway and a new station which has been built at Linacre-road on the North Mersey Branch. At the same time a service was also opened between the Exchange Station at Liverpool and the New Linacre-road.

The electrification of a railway renders easy the task of running trains of a capacity to suit the needs of the moment. This facility has been made the most of. The trains as run consist of two motor coaches coupled to one, two, or three trailers, according to need. The longer trains are worked during the "rush" hours in the morning and evening, and the lighter trains during the slacker hours of middle day and early afternoon. The empty weight of the motor cars is some 46 tons, and of

the trailers 26 tons, so that an empty three-car train weighs 118 tons, an empty four-car train 144 tons, and an empty five-car train 170 tons. Notwithstanding the heavy calls made on the line for the running of the increased service, opportunity is found for working a baggage car weighing 32 tons, which is kept more or less constantly in operation, and deals with baggage, goods, produce, fish, &c., which cannot conveniently be handled during the fifteen seconds station stops which is aimed at for the passenger trains.

The standard train consists of two first and of two third-class cars, the latter being at either end and equipped with two motor bogies, each carrying two 150 horse-power motors —Figs. 2 and 3. There are, therefore, eight motors, or 1200 horse-power per train. Both types of car are 60ft. long

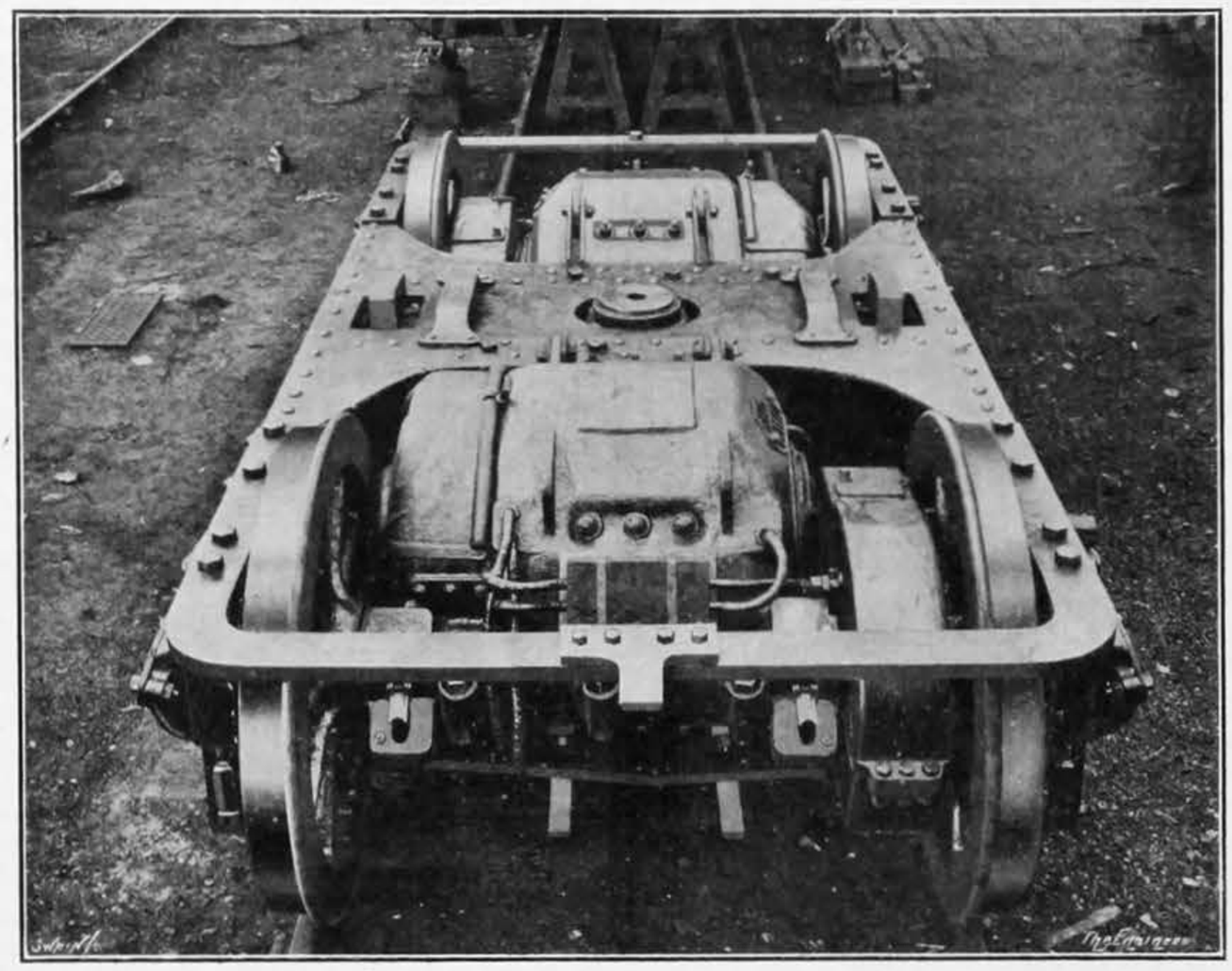


Fig. 2—VIEW OF MOTOR BOGEY

and 10ft. wide—the widest in use in this country—and they have 8ft. wheel base bogies fixed 40ft. 6in. apart from centre to centre. We described the coaches at some length in the articles already referred to, and we need only say here that those of the first class hold 66 passengers, and of the third class 69 passengers each. A normal four-coach train will therefore accommodate 270 passengers. The motors, it may be added, are designed to develop their 150 brake horse-power at a speed of 470 revolutions per minute. Their weight complete is 6050 lb. each, 1920 lb. of this being for the armature, and 500 lb. for the gearing and housing.

The average four-coach train may occasionally require as heavy a current as 2500 ampères at starting. Such a current naturally requires special handling. The controller employed is composed of two power cylinders geared together and operated by one handle. One cylinder controls the four motors of the leading coach, the other the four motors of the rear coach. Either power cylinder might be entirely disabled or disconnected without interfering with the operation of the other cylinder. In fact, the whole may be considered as two separate controllers geared together—see Fig. 4. The train is electrically connected by means of three cables which traverse its whole length. Current is collected by shoes on the front and rear coaches, four shoes being simultaneously engaged. The two sides of the controller are in parallel. The connections of each side of the controller are identical, the current in each case passing through a main switch and circuit breaker to the controller notches. The two controllers being identical and being geared together, it follows that whatever happens on the portion governing the motors on the forward coach has its counterpart on the portion dealing with the motors of the rear coach. Alongside the main controller is a small reversing cylinder, the handle of which has three positions—"ahead," "reverse," and "off." The method of driving is as follows:—The reversing handle is placed in the "ahead" position, and on operating the power cylinder the whole of the eight motors of the train come under control. The reversing cylinder at the rear of the train has been left in the "off" position, and, in consequence, the two sides of the controllers are connected together and feed the rear motors. If it is necessary at any time to reverse the train, the forward reversing handle would be placed in the "reverse" position. This would have the effect of disconnecting the rear motors, and the backing of the train would be done entirely by the four motors of the front coach. On reaching the terminus the forward reversing handle is placed in the "off" position, which leaves matters so arranged that when the driving is done from the other end of the train proper contact has been established between the two sets of motors. (For further information regarding the controller, &c., we would refer our readers to our issue of April 1st and 8th, 1904.)

Connection has now been established between the Liverpool Overhead and the Lancashire and Yorkshire Railways, but since trains of about only half the weight of the Liverpool and Southport trains can be employed on the overhead road, a system of multiple unit contact has been designed by Dick, Kerr, and Co., with a view to dividing any ordinary train, so that one of the permitted weight might be obtained. This system, which is giving very satisfactory results, the electrical engineers will have an opportunity of studying to-morrow.

The five-car trains are allowed about three minutes longer for the stopping trips between Liverpool and Southport than the four-car trains which do the journey in 37 minutes. The watt hours per ton-mile for these runs average about 80. The expresses between Liverpool and Birkdale only absorb about 53 watts per ton-mile. The current consumption per ton-mile over the whole system is 82·3 watt hours, but in considering this figure the frequency of the Hull road service and the station density between this point and Liverpool must be taken into account. It may here be mentioned that on this part of the line the stations average less than a mile apart, but that they are more widely separated on the northern portion.

Although we carefully described the method of power distribution when we described the line at the time it was opened for service, we may, perhaps, usefully recapitulate a few of the leading features. The electricity is generated at the Formby Power Station, which immediately adjoins the line at a distance of some 10¼ miles from Liverpool. The initial pressure of the current, which is three-phase, is 7500 volts, and at this it is transmitted to three sub-stations, a fourth being actually in the same building as the generating plant. The distances of the sub-stations from Liverpool are as follows:—

	Miles.
Bank Hall, distant from Liverpool	2
Seaforth, ,, ,, ,, ...	3¾
Formby, ,, ,, ,, ...	10¼
Birkdale, ,, ,, ,, ...	16⅛

In these sub-stations the 7500-volt current is first of a'l stepped down in static transformers, and is then converted in rotary converters to direct current at 650 volts pressure. Allowing for loss in transmission, &c., the maximum voltage supplied to the trains is about 600. The sub-stations are all near the line, and, except for short connecting lengths, low-tension cable is practically dispensed with.

In the first instance the scheme was designed for working twelve trains. Almost from the first, however, it was found necessary to employ fifteen trains. Then later on a ten-minute service was started between the Liverpool Overhead and the Liverpool Southport lines, and later still, a system of through trains between Southport and the Dingle additions. All of these taken together involved heavier demands for current being made on the power-house than were initially contemplated. One way of meeting the difficulty would have been to have installed further generating plant. This, however, the railway company, acting on the advice of its contractors, decided not to do, but instead to lay down a system of storage batteries connected to the line at different points. It was intended that these should be capable of dealing with the severe peak loads inseparable from the electric working of a railway requiring a fast and frequent service, short runs between many stations, and a high acceleration.

The batteries selected were of the Tudor Company's make. They have been installed in four battery sub-stations placed in positions on the line where the least influence of the rotary sub-stations was felt. The first was erected in the Great Howard-street goods yard, about a quarter of a mile distant from the Exchange Station, Liverpool. This battery has a capacity of 1300 ampères discharge for one hour, or a maximum output for short periods of 3300 ampères. Another battery sub-station was placed at Hall-road, at a point roughly midway between the Seaforth and Formby rotary sub-stations. It is at this point, it will be remembered, where the heavy local Liverpool traffic turns back. This battery has an hourly discharge capacity of 1600 ampères, and a maximum output for short periods of 4000 ampères. The third battery sub-station is at Freshfield, and the fourth at St. Luke's, which is the first stop beyond Southport on the way to Crossens. The Freshfield battery has a capacity of 1000 ampères for one hour, and a maximum discharge of 2500 ampères.

By placing the batteries in these positions relatively to the rotary sub-stations, we understand that an equilibrium in voltage and load is kept up, while steadiness of output from the power-house, reduction of peak loads, and general economy of generation is secured. Each battery is controlled by an automatic reversible booster, the plant consisting of a shunt-wound motor directly connected to a booster capable of giving the necessary rise in voltage.

The Great Howard-street sub-station is made use of for other purposes in addition to providing current for working the trains. Besides the batteries motor generators are installed, and the company now conducts all the operations of the goods yard by means of electric power derived from this sub-station, as well as carrying out all the terminus and yard lighting. In addition to this, the whole of the energy required for light and power in the company's Exchange Hotel is obtained from the same source. Hitherto this has been derived from an out-of-date engine house, which, in addition to working the heavy lifts in the hotel, drove a great number of capstans in the goods yard. A considerable economy is looked for from the change.

The equipment of the Walton Junction and North Mersey Branch necessitated the erection of another sub-station. This has been placed at Aintree, and will contain two rotary converters each of 600 kilowatts capacity, with the necessary static transformers, &c. Each unit will be a duplicate of that originally installed in the earlier sub-stations. This sub-station will, in addition, be equipped with a storage battery of Tudor cells, having a capacity for giving out 1500 ampères for one hour. This battery will be connected to the third rail through a reversible booster in a manner similar to that which has been employed at the other battery stations.

The Aintree sub-station will be connected by high-tension conductors with the Seaforth sub-station. These conductors, it may be mentioned, are run overhead in two sets of three lines, the conductors having a cross section

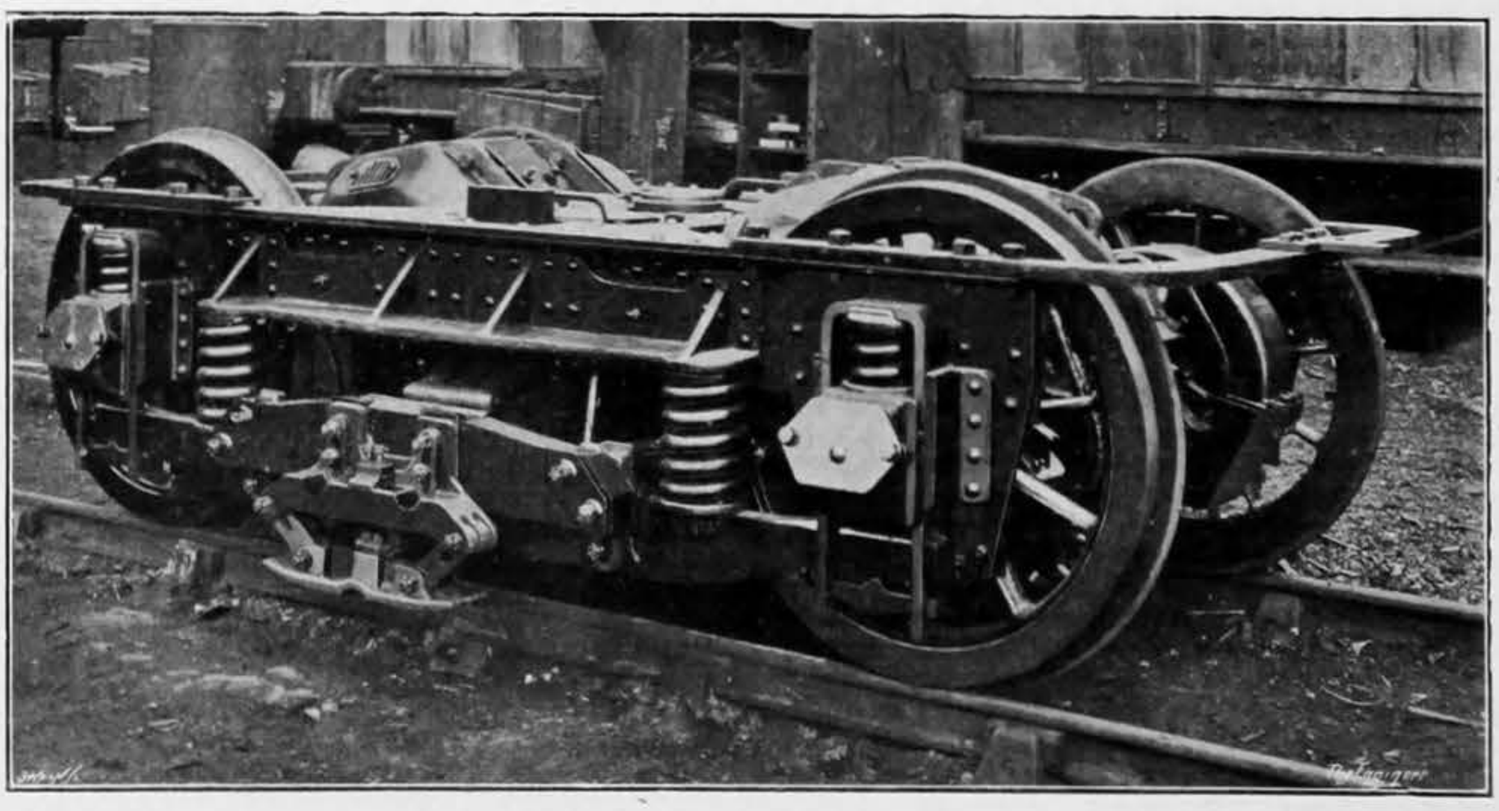


Fig. 3—EIGHT-WHEEL MOTOR BOGEY

of 0·1 square inch, and having a length of two miles. In Fig. 6 is given a diagram showing the arrangement of the high-tension conductors, with the lengths and cross sectional areas of these. The high-tension cables are in each case laid in triplicate. As a matter of fact, all three cables are used in actual running, but if one were to break down, the two remaining could do the work without the drop or the current density exceeding the permissible limit. They are of the triple triangular type, diatrine paper insulated, lead covered and armoured, and they are laid on the solid system.

A few words may, perhaps, be said regarding the fine

power station at Formby, which was not in full working order at the time our original description was published. A very fair idea of the arrangement of the engine-house may be obtained from the engraving which we give on page 654 though, perhaps, its size cannot be fully appreciated. It is, as a fact, 65ft. wide and 280ft. long, while the boiler-house which runs beside it, and is of the same length, is 56ft. wide. The four horizontal combined sets shown in the background are of 1500 kilowatts each. The engines made by Messrs. Yates and Thom as sub-contractors are cross-compound, with cylinders 32in. and 64in. by 4ft. 6in. stroke, and designed to indicate 2310 horse-power at seventy-five revolutions per minute with steam at 160 lb. pressure and superheated by about 80 deg. The engines will, however, give some 20 per cent. more power than this if called upon. Each engine has its own condensing apparatus. The vertical engine in the right foreground has cylinders 23in. and 46in., and a stroke of 3ft. 6in. It is designed to give 1180 horse-power at ninety-four revolutions per minute. It also has its own separate condenser. The alternators are of the ordinary three-phase Dick, Kerr type with which our readers are familiar. They work at a periodicity of twenty-five cycles and generate current at a pressure of 7500 volts. For the larger engines the output is 1500 kilowatts, and for the smaller 750 kilowatts. There are sixteen Lancashire boilers 32ft. by 8ft. 6in., made by Yates and Thom. For further particulars of the station we would refer our readers to the above-mentioned articles.

The various rotary sub-stations on the Liverpool and Southport line are identical in equipment, and vary only in the capacity of the latter. Three of them—those at Seaforth, Sandhills, and Birkdale—have each four rotary converters, while there are only three at Formby. In all cases, however, there is provision for extension. Each converter has its corresponding groups of static transformers and high-tension oil switches, the latter being placed underground below the floor level of the sub-station. A typical interior is shown on page 654. The rotary converters have eight poles, and are designed to develop 600 kilowatts direct current at a pressure of from 600 to 650 volts and a speed of 375 revolutions per minute. The static transformers are cooled by air blast, and each have a capacity of 200 kilowatts. They are circular, and are built up of copper strip wound on edge. The secondaries are inside next the core, and the primaries above and outside. The blowers which provide the air blast are composed of a Davidson Sirocco fan driven by a 5 horse-power Dick-Kerr motor. There are two blowers in each sub-station, and the capacity of each fan is 8000 cubic feet of air per minute at a pressure of from 2in. to 3in. of water.

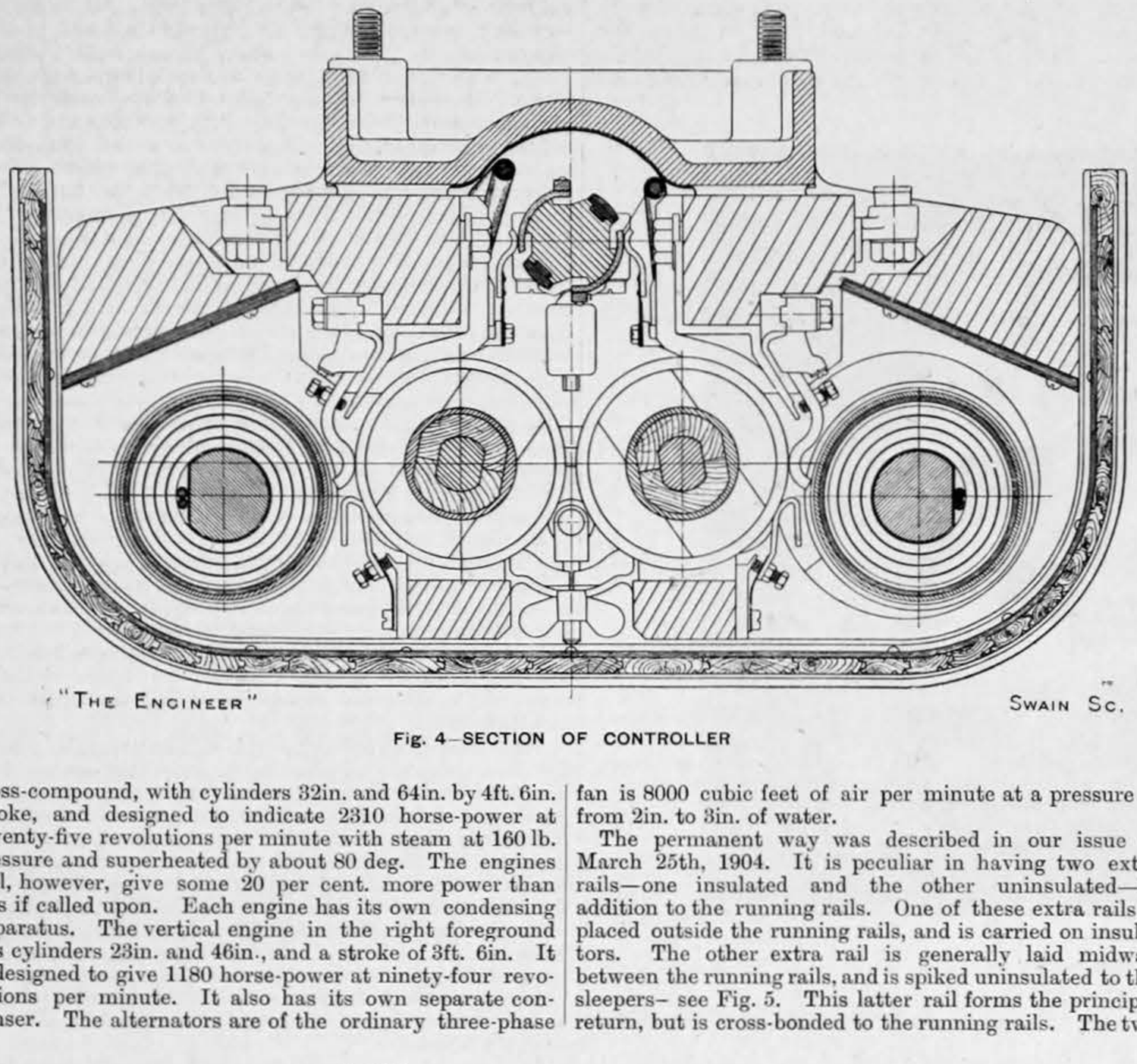


Fig. 4—SECTION OF CONTROLLER

The permanent way was described in our issue of March 25th, 1904. It is peculiar in having two extra rails—one insulated and the other uninsulated—in addition to the running rails. One of these extra rails is placed outside the running rails, and is carried on insulators. The other extra rail is generally laid midway between the running rails, and is spiked uninsulated to the sleepers– see Fig. 5. This latter rail forms the principal return, but is cross-bonded to the running rails. The two extra rails are bonded in the usual way, but the running rails are not so bonded, their ends, instead, being connected to the return rail. Slippers, of course, press on both the extra rails. We are informed that this arrangement has given great satisfaction, special advantages being reaped by the abolition of the troublesome bonding of the running rails. The two extra rails are of equal cross section, and consist of mild steel of a specially high conductivity, the electrical resistance being not greater than seven times that of an equal cross section of pure copper. One of the objections to a third rail laid near the ground level is the danger of fatal accidents from shock. In this particular instance gaps have been left at all level crossings, the ends being bonded by underground cables. Moreover, timber guarding has been provided at all busy places. At most stations the third rail is interrupted and the ends connected by cables to section switches. By means of these switches any portion of the line may be cut out at will. There have been fatalities on the line, but it is claimed that in each of the few cases which arose in the early days of the electrification causes were present which in no way reflected on the railway company or its contractors. For more than a year now close upon 50 miles of permanent way have been effectively operated by electricity and maintained without hitch or halt and without anything in the nature of a serious electrical shock or accident.

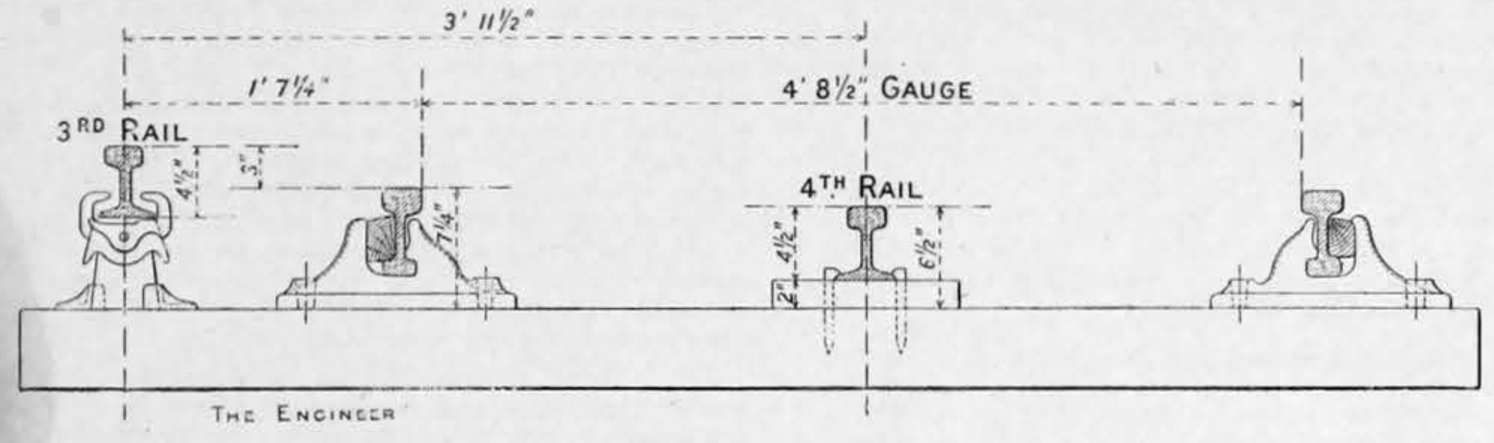


Fig. 5—CROSS SECTION OF PERMANENT WAY

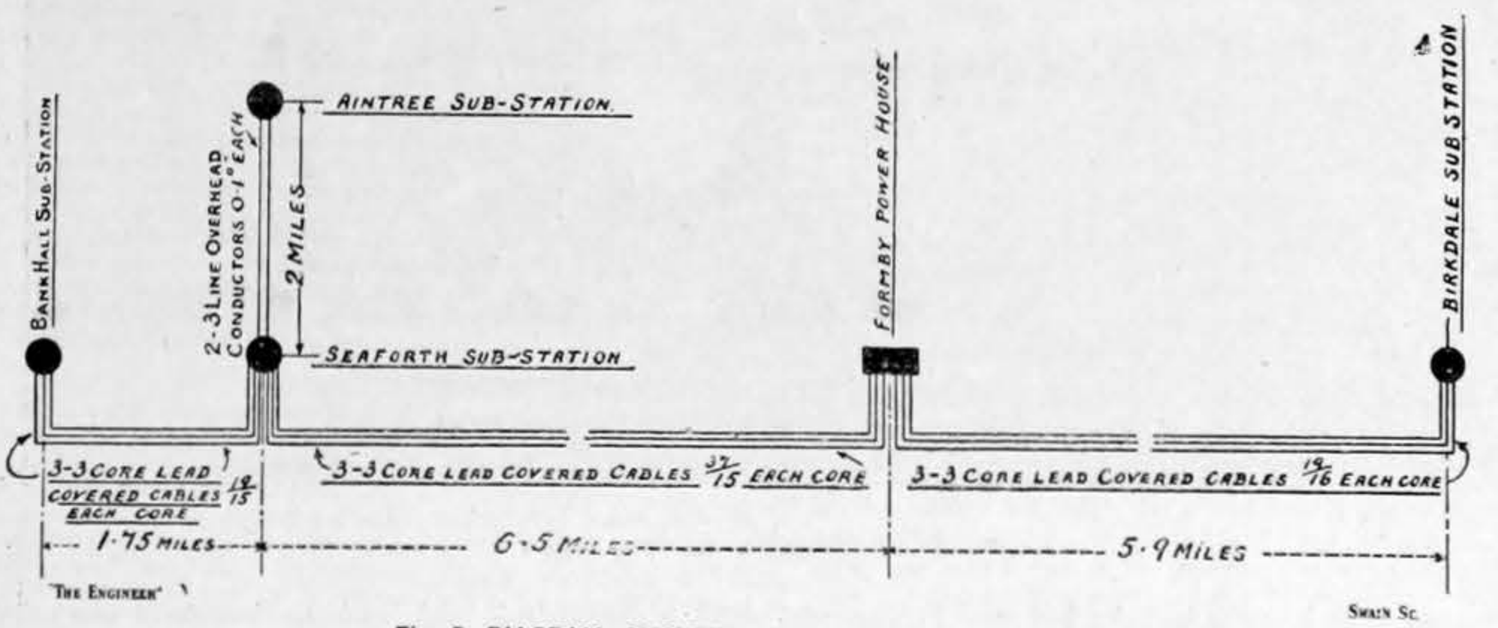


Fig. 6—DIAGRAM SHOWING HIGH TENSION CABLES

It is interesting, as far as upkeep is concerned, to find that the cost of renewals of insulators, bonds, and other details which go towards the completion of a third rail are almost negligible where the insulators have been well set and the rail itself properly anchored. Out of 30,000 insulators, the renewals, it is said, do not amount to more than 300 insulators per annum. The ordinary cost of maintenance of the permanent way is, of course, increased, but not, we understand, to any serious extent. If it be assumed that the straightforward re-laying of an ordinary road can be done at a labour cost of 7d. per yard, then the extra cost involved by the presence of a third rail will, we are informed, not exceed 1d. if bonding be eliminated, as the only complication introduced is an alteration in the lifting of the running rail next to the live rail and the attaching of an insulator to every fourth new sleeper. Generally speaking, the bonding of the live rail will not be disturbed, and the bonding of the running rail to the return rail is a matter of little cost, involving only the drilling or punching of a hole in the end of each new running rail and the pressing therein of a bond head. As regards leakage, the total loss over 50 miles has, we are informed, not at its worst exceeded an amount which is hardly measurable. On wet and slushy days, and after prolonged rain or snow, the loss is reported to be less than 2 ampères per mile.

OBITUARY.

CAPTAIN J. D. CLINK.

By the recently reported death of Captain J. D. Clink, of Greenock, at the advanced age of eighty-four, an old-time mariner and shipmaster and a noted Clyde shipowner has passed away. His death took place, after a lengthened illness, at his Greenock home on the 18th inst. A native of Greenock, he went to sea when he was only thirteen years of age, and after a service of ten or twelve years in subordinate capacities he was appointed captain of a sailing vessel in 1851. He sailed in all parts of the world, and had some interesting experienees in connection with the carrying of stores to Black Sea ports for the British troops during the Crimean War. He retired from the sea in 1861, since when he has been engaged as a shipowner, owning various sailing vessels. He took a prominent part in Greenock public affairs, and was for a number of years a member of the Corporation, acting as a magistrate for three years. He was the oldest member of Greenock Harbour Trust, and for many years sat on the Clyde Pilot Board and the Clyde Lighthouses Trust. He was also a member of the Scottish Sailing Shipowners' Association, and acted as president for some time.

J. P. LACY.

THE death is announced of Mr. J. P. Lacy, of Birmingham, who was for some years chairman of the Galvanised Sheet Makers' Association, and one of the best known men on Birmingham Exchange. Mr. Lacy's death took place on Wednesday, the cause being heart failure following an illness. He was a director of Kynochs, Limited, of Birmingham, and of the Metropolitan Amalgamated Railway Carriage and Wagon Company. Prior to the amalgamation of the Patent Shaft and Axletree Company, Wednesbury, with the Metropolitan Company, Mr. Lacy had for many years held the chairmanship of that concern.

ARTHUR COOTE.

A RAILWAY accident occurred on Friday midnight, about six miles from Glasgow, on the Caledonian Railway, resulting in the death of Mr. Arthur Coote, of Kensington Gardens, W. Mr. Coote was travelling in the express train from Aberdeen to Glasgow in order to be present at the launch of H.M.S. Agamemnon. Another train, made up of a covered truck van, three fish vans, a fish truck, and a composite passenger carriage, carrying about twenty passengers, was going in the opposite direction. Through some unexplained cause one of the fish vans became derailed, hit a bridge, rebounding against the first-class compartment in which Mr. Coote was the only passenger. Mr. Coote was a director of Hawthorn Leslie and Co., Limited, of Newcastle-on-Tyne and London, and chairman of the Anglo-Australasian Steam Navigation Company, Limited.

INSTITUTE OF SANITARY ENGINEERS.—The summer meeting of the Institute of Sanitary Engineers will be held in Manchester.

THE FOREST SERVICE of the United States Department of Agriculture has ascertained from returns representing 95 per cent. of the steam railroad mileage of the United States that 80,051,000 wood cross ties were purchased by these roads in 1905. On this basis the total number of ties used by the steam roads in 1905 was 84,400,000, representing nearly 3,000,000,000ft. of lumber, board measure. Reports came from 750 steam railroad companies, having an aggregate length of line of 278,262 miles. Oak ties were 47·5 per cent. of the total, pine 21·9 per cent., cedar 8·7 per cent., chestnut 5·8 per cent. The remaining 16 per cent. was largely fir, cypress, and tamarack. Preservative treatment was given to 7,615,000 ties, representing nearly 10 per cent. of the number reported.

ASSOCIATION OF MUNICIPAL ENGINEERS: SCOTTISH DISTRICT.—The annual meeting of this body took place at Berwick on the 15th inst. The members were formally received in the Town Hall by the Mayor, the Sheriff, and Councillors, and afterwards met in the Museum, where Mr. Holmes, burgh surveyor, Govan, presided, in the absence of Mr. Collins, Norwich, the president. Two papers were submitted for discussion, one by Mr. R. Dickinson, borough surveyor, Berwick, on the "Municipal Works of the Borough;" and another by Mr. A. H. Goudie, burgh surveyor, Stirling, on the "Plan and Register of Streets as Provided for in the Burgh Police (Scotland) Act, 1903." Thereafter the visitors were entertained to luncheon by the Mayor, after which they drove a circular tour, crossing the Whitadder and Union Bridges on the way. On the return they made an examination of Berwick waterworks. In the evening the annual dinner was held.

RAILWAY MATTERS.

ON 20th inst., Sir Hamilton Goold-Adams, Lieutenant-Governor of Orange River Colony, opened the railway line between Bethlehem and Kroonstad.

ACCORDING to the *Mexican Herald*, the contract for the construction of the first 80 kiloms. of the line between Irapuato and Paruandiro has been awarded.

AFTER a hearing extending over many weeks the London Outer Circle Railway Bill was rejected by Sir George Doughty's Committee of the House of Commons last week.

THE *Journal de St. Petersbourg* of 20th May 2nd June states that plans for the construction of a railway between Stretensk and Nicolaievsk, with branches to Blagovestchensk and Khabarovsk, are at present under the consideration of the Minister of Ways of Communication.

MANY experiments are being made with electric and gasolene motors for suburban trains, but no real step in this direction has been taken in Chicago, although it is hoped that it will be soon, in order to alleviate the present intolerable nuisance of smoke from the many locomotives.

ARRANGEMENTS have been completed by the Midland Railway Company for the sale to the Italian State Railways of fifty locomotives of a class of which they possess rather more than are required for a particular kind of traffic, but which are calculated to meet the necessities of the Italian railways.

MILWAUKEE, a distance of 100 miles north, will soon be connected with Chicago by electric railway. This road will have four lines, two for expresses and two for slow trains, and will connect towns with a combined population of over 2,500,000, as well as open up the land along the shores of the lake for suburban residences.

IN order to reduce the danger of collision on single-line railways on the Bavarian State Railways, the Bavarian Minister of Public Works has decided to employ wireless telegraphy for sending instructions and warnings from stations to approaching trains. The experiments which have been made have so far proved highly successful.

THE railway system of Bulgaria is being steadily developed, and, besides the grant made by the Sobranie for the extension of the Radomir line to the Macedonian frontier, and the connecting of the lines to the north and south of the Balkans, a further grant of £1,000,000 has been made for the construction of several small lines.

THE scheme of the Peruvian Government to construct a railway over the Andes to unite the coast provinces of the Pacific with their immensely valuable undeveloped land in the interior and extending through to the Atlantic provinces, is still in abeyance. Negotiations are in progress for raising a loan for railway construction, but so far the route of the proposed railway has not been decided upon.

THE Eastern Bengal Railway has lately completed a survey of a line on the 2ft. 6in. gauge from Krishnagar, on the Ranaghat-Moorshedabad Railway, to Jellinghee, 56 miles. The line is estimated to cost about Rs. 14,00,000, but it has not yet been decided whether the financing and construction will be undertaken by private enterprise, under a guarantee from the District Board of Nuddea, or by the District Board itself.

THE capacity of Russian goods wagons has been increased 20 per cent. without the intervention of any new construction, but simply by the order of the Ministry of Transportation that the standard freight car, heretofore limited to a load of 750 poods, hereafter may carry 900 poods. It is not many years ago that the permissible wagon load in Russia was increased from 600 to 750 poods; but then some strengthening of the springs was required.

THE new Pennsylvania Railroad Station in New York, for which the plans are now practically perfected, will be exceptional among all the railroad stations of the world in the number and convenience of its entrances and exits, says the *Railroad Gazette*. This condition is due to the fact that each of the four sides of the structure is a front, opening respectively on two wide avenues and two important streets, which latter have been widened by the company to 80ft. each.

THE Government of Guatemala has lately been interesting itself to secure a means of communication by rail along the coast of the departments of Quezaltenango and San Marcos. The idea is to extend the existing railways intersecting rich zones producing coffee, sugar cane, rubber, cocoa, and corn by a line running from Caballo Blanco to Coatepeque, and to continue from Coatepeque to Ayutla on the Mexican frontier, thus forming another link in the Pan-American Railway system.

THE London Brighton and South Coast Railway, in conjunction with the Great Western Railway, has arranged for a through train—first, second, and third-class—to run on week days on and from 2nd July next, leaving Brighton at 11.30 a.m., and reaching Paddington at 1.10 p.m., returning from Paddington at 3.40 p.m., and arriving at Brighton at 5.17 p.m. These trains give connections from the principal places on the South Coast with the principal places on the Great Western Railway.

ONE hundred and two spans, aggregating a length of about 10,800ft., or more than two miles, are required for the new railway bridge across the Hoang Ho. It will serve as a crossing for trains of the Hankau and Peking Railway, and will assist in shortening the time between those cities—754 miles apart—to thirty-six hours. The river has here a width of about two miles, but is shallow. The bridge is constructed of steel, but not of the heavy sections common in American and European practice.

ADVERTING to the notice published on page 589 of the *Board of Trade Journal* of 29th March last, and to that on page 206 of the issue for 1st February, respecting the development by the Government of the Italian railways, the report on the finances of Italy by Mr. C. des Graz, Counsellor of H.M. Embassy at Rome, states that it is the intention of the present Government to lay before Parliament a complete financial scheme providing for the large expenditure requisite on the State Railways for a period of ten years. It is estimated that £54,000,000 will be required.

THE Mexican "Diario Oficial" of 29th May contains the text of a contract entered into between the Mexican Government and Senor Lic. D. Pablo Martinez del Rio, the representative of various Mexican Railway Companies, for the construction of a railway terminus at Vera Cruz. The contract also provides for the provision of wharves, overhead cables, cranes, &c., to facilitate trade at the port. Free importation is allowed for the term of five years of all materials required for these works; during each of the ten years following, goods to the value of 20,000 dols. may be imported free of duty.

THE Southern Pacific Railway is building a line in Mexico to Guadalajara which represents a very cosmopolitan co operation in labour and materials. It is an American railway, built on Mexican territory, with rails from Spain, carried to the United States on German steamers, and unloaded by Jamaica negroes. The sleepers are from lands in the Orient acquired by the Japanese in their war with Russia. The earthwork and laying of rails and sleepers were done by Mexican Indians, Chinese, and Greeks, under the supervision of Irish gangers, American engineers, and Mexican Government inspectors.

NOTES AND MEMORANDA.

CAOUTCHOUC oil, it is said, has proved to be very efficient for preventing rust, and has been adopted by the German army. It is applied by spreading over the surface of the metal with a piece of flannel in a very thin layer, and is allowed to dry.

VALVES on iron pipes of hydraulic systems are often channelled out by iron scale carried along by the water. This scale is almost as bad and abrasive as sand. An increase of lead in the mixture will make a metal which will resist the wear better.

TESTS are being carried on at Indian Head for a new arrangement of the turrets contemplated for the new battleships to minimise the shock of the firing of the guns of the upper turret over the lower. It is planned to so arrange a steel plate between the turrets, with air space below and above so as to carry up and away the shock.

EXHAUSTIVE work upon the specific heat of superheated steam is being carried out at Sibley College, Cornell University, and at Charlottenburg, Germany. It will be interesting to see how nearly the results of these two entirely different lines of investigation conducted by the most eminent authorities in the world upon heat physics agree.

ACCORDING to the *Manufacturers' Record*, of Baltimore, there are 642 cotton mill companies and firms in the South of the United States, with 9,440,647 spindles and 216,293 looms. The actual number of mills is larger than 642, as some of the firms have more than one mill. South Carolina continues to hold the position of the foremost cotton manufacturing State of the South, having 136 mills, with 3,329,408 spindles and 84,244 looms. North Carolina is second with 243 mills, 2,463,982 spindles, and 51,265 looms. Georgia is third with 113 mills, 1,770,967 spindles, and 33,590 looms. Large additions continue to be made.

IN a paper on "The Rusting of Iron," read by Mr. J. T. Nance before the Chemical Society, it was pointed out that the interaction between metallic iron and ammonium chloride solution takes place with the evolution of hydrogen and the liberation of ammonia, the metal passing into solution in the ferrous state. The rate of rusting of iron in these solutions varies in such a manner as to suggest that the attack on the metal is due to the catalytic action of the hydrogen ions formed by the hydrolysis of the ammonium chloride. This view is supported by the fact that chlorides of weak bases accelerate rusting far more than those of stronger bases, and the effect of acids is also approximately proportional to their avidies.

COPPER may be deposited upon aluminium by the use of an anode of pure copper and an electrolyte of water, with a few drops of sulphuric acid. After the current has been in action for some time copper sulphate is formed, and from this the copper is deposited. After thirty minutes the plate was taken out in a recent experiment and well washed in water, then in a solution of hydrochloric acid, then in sodium hydroxide, and again in water. This operation was repeated several times, the final result being an even deposition of copper all over the plate. Further experiments included the deposit of antimony upon the coppered aluminum plate. On the coppered aluminium cathode the antimony adheres firmly, the current density being 0·0013 ampères per square inch, with a pressure of from 1 to 1·5 volts.

A CONSIDERABLE advance took place in the output of lignite in Germany during 1905. In 1904 the production of lignite amounted to 48,500,222 tons, whereas in 1905 it increased to 52,473,526 tons, or by nearly 4,000,000 tons; and in the first four months of the present year the lignite mines yielded 18,285,000 tons, being an augmentation of 1,356,000 tons for the term of the current year. According to the *Iron and Coal Trades Review* the impetus imparted to the lignite industry in the past eighteen months is due to two causes. In the first place, the miners' strike early in 1905 gave this particular branch an upward movement; and secondly, scientific progress has opened up new branches of application for lignite briquettes, which now offer considerable competition to pit coal or pit coal briquettes.

THE new United States battleship Georgia, on her official trial off the Maine coast on June 14th, proved herself the fastest vessel of her class in the navy, and she made a record of 19·26 knots an hour, exceeding by more than a quarter of a knot the speed required by contract. The first hour's run was the best, 19·33 knots being made. On the second hour 19·27 knots were made, 19·241 in the third, and 19·20 in the final hour. During the last hour the supply of picked coal gave out, and ordinary fuel was used. This reduced the speed for that hour and brought the average down correspondingly. On the builders' trial, held June 13th, off Rockland, the indications were that 118·9 revolutions of the propeller a minute would develop the contract speed required. The average attained June 14th was 122·28 revolutions a minute.

THE Teltow Canal system is twenty-five miles long, and is of sufficient width to allow two 600-ton vessels to pass each other. The vessels are hauled by means of electric locomotives fed from overhead wires and running on the towing path. The electric current is generated in a power station close to the canal by two 1000 h.p. Zoelly steam turbines, each working a large three-phase generator and a small continuous-current generator. The three-phase generators supply the mains along the whole length of the canal with a current of 6000 volts at 50 periods per second; the continuous-current generators supply current for working the tractors in the immediate neighbourhood of the power station. For working the further reaches of the canal a sub-station is provided, in which the high-pressure three-phase current is converted by rotary transformers into continuous current for working the tractors.

IT is said that the United States Navy Department has been unable to reach any definite conclusions from the reports which have been made on the new propellers of the cruiser Charleston, which has been sent to Rockland twice for tests. It has been found very little difference exists between the new and old screws on the Charleston, except that at high speeds the new propellers give better results, and at lower rates the old propellers do best. It is further stated that the results of the trials of the St. Louis tend to show that it makes but little difference which propellers are used on that class of vessels. The reason assigned for the vessels not making the speed which could be expected of them is that the original designs and contracts provided for a mean draught of 23ft. 6in. for vessels of this type, and a change was made to 22ft. 6in., while the other dimensions of the vessels remained the same.

IN a paper read recently before an American scientific institution by Prof. R. T. Stewart, on the collapsing pressure of steel tubes, the results of tests are said to show: first, that length was of practically no influence on the strength provided the tube is longer than about six diameters; secondly, that every known formula for the collapsing strength of tubes is radically incorrect. From the results of both series, the author deduced the following formulæ, of which the first is for values of P less than 581 lb. per square inch—or $t \div d$ less than 0·023—and the second is for values greater than these:—

$$P = 1000 \left(1 - \sqrt{1 - 1600 \frac{t^2}{d^2}}\right)$$

$$P = 86{,}670 \frac{t}{d} - 1386$$

where P = collapsing pressure, in pounds per square inch; d = outside diameter of tube in inches; t = thickness of wall of tube in inches.

MISCELLANEA.

IT is proposed to fix the minimum wage of all permanent workmen in the service of the Paddington Borough Council at 30s. per week.

ON June 2nd the U.S. Senate passed a resolution providing for the purchase of supplies for the Panama Canal in the United States, unless the President deems the prices unreasonable or extortionate.

THE foundations of the new County Buildings, Chicago, will consist of 126 cylindrical concrete piers, resting upon bed rock at an average depth of 115ft. below the street level and varying from 4ft. to 12ft. in diameter.

THE Board of Trade are in receipt, through the Foreign-office, of information to the effect that the Norwegian Customs Department have recently issued instructions to Customs officers to admit reaping machines into Norway free of duty until further notice.

THE rolling mills of Chicago are estimated to have turned out in 1905 a product valued at £17,000,000, double the amount produced in 1904, while the wholesale trade in manufactured iron increased 35 per cent. to £8,700,000, and pig iron 100 per cent. to £9,600,000.

THE increasing irrigation in the Western States of America continues, and producing farms are springing up where four years ago only cactus could grow. The United States Government has in these four years built 77 miles of main canal, 54 miles of branches, and 18 miles of ditches. A large amount is still to be spent, to be repaid in instalments by the settlers taking up the land.

A SOMEWHAT novel industry has been started at Hinckley, Minneapolis, for extracting from Norway pine stumps by a retort process which has been patented, turpentine, oil of tar, tar, acid, and charcoal, and it is said to be working satisfactorily. It is still in an experimental stage, but should it succeed it would be of much importance to this district, as the supply of pine stumps is practically unlimited.

THE Stettin municipality has sanctioned an extension of the harbour, which will comprise four docks with a width of 108 yards each, the adjacent ground being reserved for industrial undertakings. This extension has been decided upon with a view to furthering and facilitating local industries, and to encourage the establishment of new works. These docks will be built on the Parnitz, a branch of the river Oder.

THE U.S. Congress has artfully avoided the issue on the question as to whether John Paul Jones or John Barry was the real father of the American Navy, by authorising the erection of a £10,000 monument in honour of each of those sea warriors. This arrangement will probably, says the *Army and Navy Journal*, not reconcile the contentions of the partisans of the two commanders, but it will be recognised as a highly judicious compromise on an exceeding difficult question.

THE British Consul at Bordeaux reports the probability of diminished shipments of United States agricultural machinery this year to his district in view of the large stocks left on hand in 1905. He remarks that the higher price of British farming machinery is slowly but surely reducing each season the British percentage of the total of farming machinery coming to France. There are exceptions, however, in the case of certain classes of machines, particularly in that of British portable steam engines, which hold their own and are even increasing in favour.

THE British Consul at Bordeaux reports that an interesting novelty was placed upon the Bordeaux market at the beginning of 1906 in the shape of a small low-speed "essence" engine for farm purposes, such as pumping, straw-cutting, or any other farm or domestic requirements for a handy motor; these engines, running at 300 revolutions per minute instead of the 1500 to 2000 revolutions of the ordinary French engine, are particularly adapted to use by the peasantry. The two horse-power engine of this class can be sold retail in Bordeaux for £32.

A WASHINGTON telegram says that the tender of the firm of William Cramp and Co. for the construction of one of the 16,000-ton battleships Michigan and South Carolina, which are to be completed in forty-two months, is the lowest which has been received. Messrs. Cramp's tender is £708,000. As one firm will only be allowed to contract for one battleship, Messrs. Cramp's offer will be accepted, unless the Navy Department decide to accept the plans of builders including turbines, instead of adhering to the department's original plan. The lowest bid including turbines is £737,800. The next lowest tender to Messrs. Cramp's is £717,000.

THE Boston, Cape Cod, and New York Canal Company, which proposes to make the long-talked of Cape Cod Canal, has submitted plans to the Massachusetts Land and Harbour Commissioners, showing the scope of the proposed waterway, which will greatly shorten the water route between New York and Boston and points to the north, as well as eliminating perils of navigation, says the *Iron Age*. The northern approach is at Barnstaple Bay, Sandwich, and from there the route is through Sagamore, Bournedale, Bourne, and the Monument River to its mouth at Buzzards Bay. The plans are for a canal 100ft. wide at its bottom throughout, and 250ft. wide at its entrances. The minimum depth will be 25ft. below mean water level.

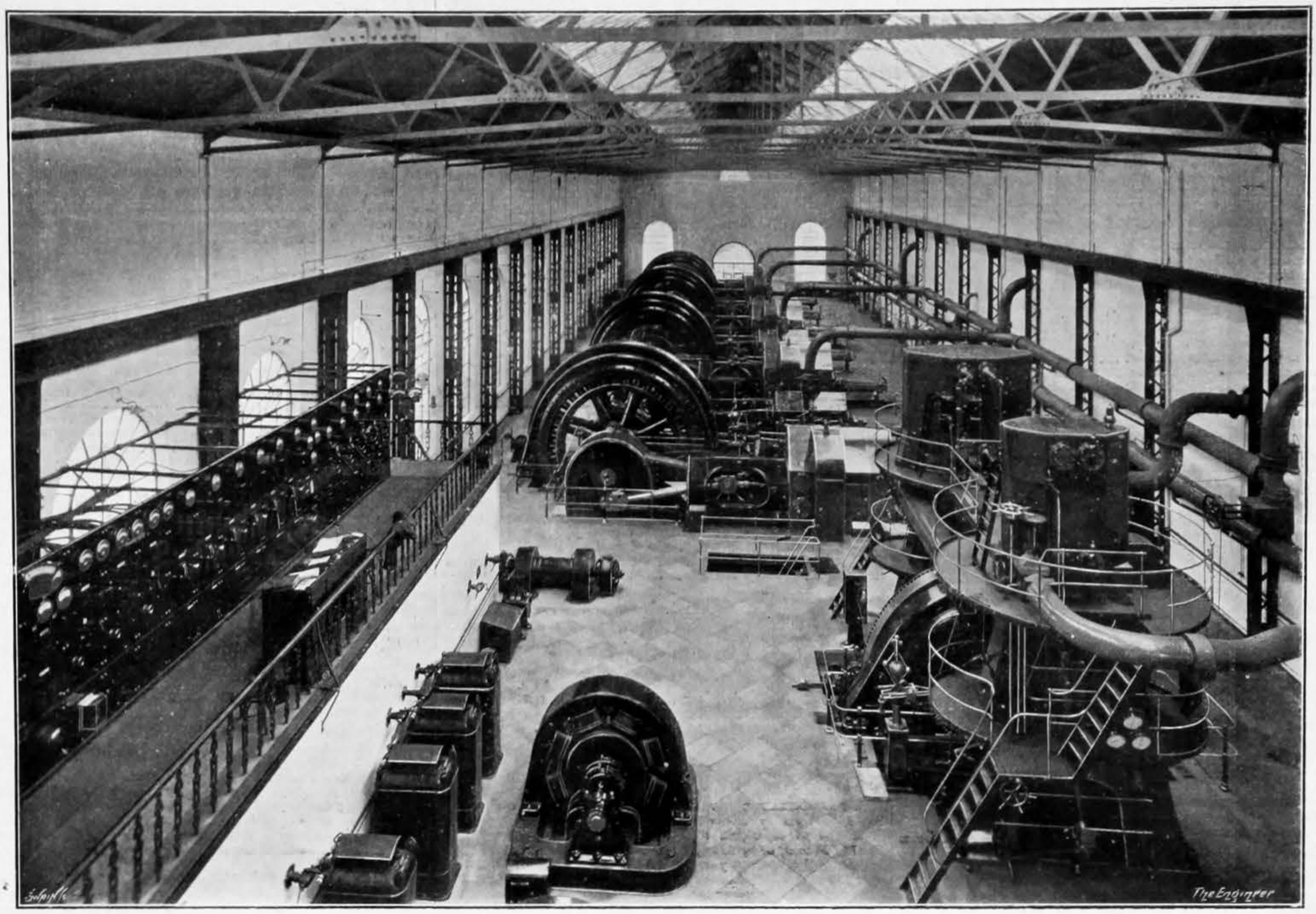
IN 1722 Reamur published the fundamental principles for the malleable cast iron process; but it is of comparatively recent years that the industrial world has utilised this knowledge. It was found that if a casting too hard to work were exposed to a continuous high heat for a number of days, imbedding in rolling mill scale—hammer slag—or iron ore, the casting would entirely change its nature, and at the time stated Reamur had collected those observations and found the principles which governed this change in the cast iron. The present generally accepted theory of the malleable cast iron process is to decarburise the metal by some oxide, which will impart a portion of its oxygen to the carbon in the metal at a red heat, forming carbonic oxide, which is given off, thus extracting the carbon. The oxidising re-agents usually employed are rolling mill scale and red hematite iron ore.

THE possible introduction of motor cars into Bulgaria has lately furnished a considerable correspondence between British motor car makers and his Majesty's Consulate-General, but up to the present there has been no real opening for British firms in this branch of trade. The total number of motor vehicles in the country does not probably exceed a dozen, of which number about half, of French make, are in use in the capital for collecting letters and parcels and conveying them to the railway station. The experiment has proved successful, and the Bulgarian Postmaster-General hopes next year to see the post-offices of all the principal towns in Bulgaria provided with a similar service. The director of the Bulgarian Railways, another enthusiastic advocate of automobiles, hopes next year to obtain a small credit from the Sobranie which will enable him to start a motor service connecting the towns in the interior of the Principality with railway stations for the conveyance not only of passengers and merchandise, but also the Government mails. There are also rumours that, thanks to private enterprise, next year will see the establishment of a service of motor omnibuses between Sofia and Banki, a village about ten miles distant from the capital, and famous for its thermal springs, and also between Sofia and Cham Koriya, a fashionable resort during the summer months.

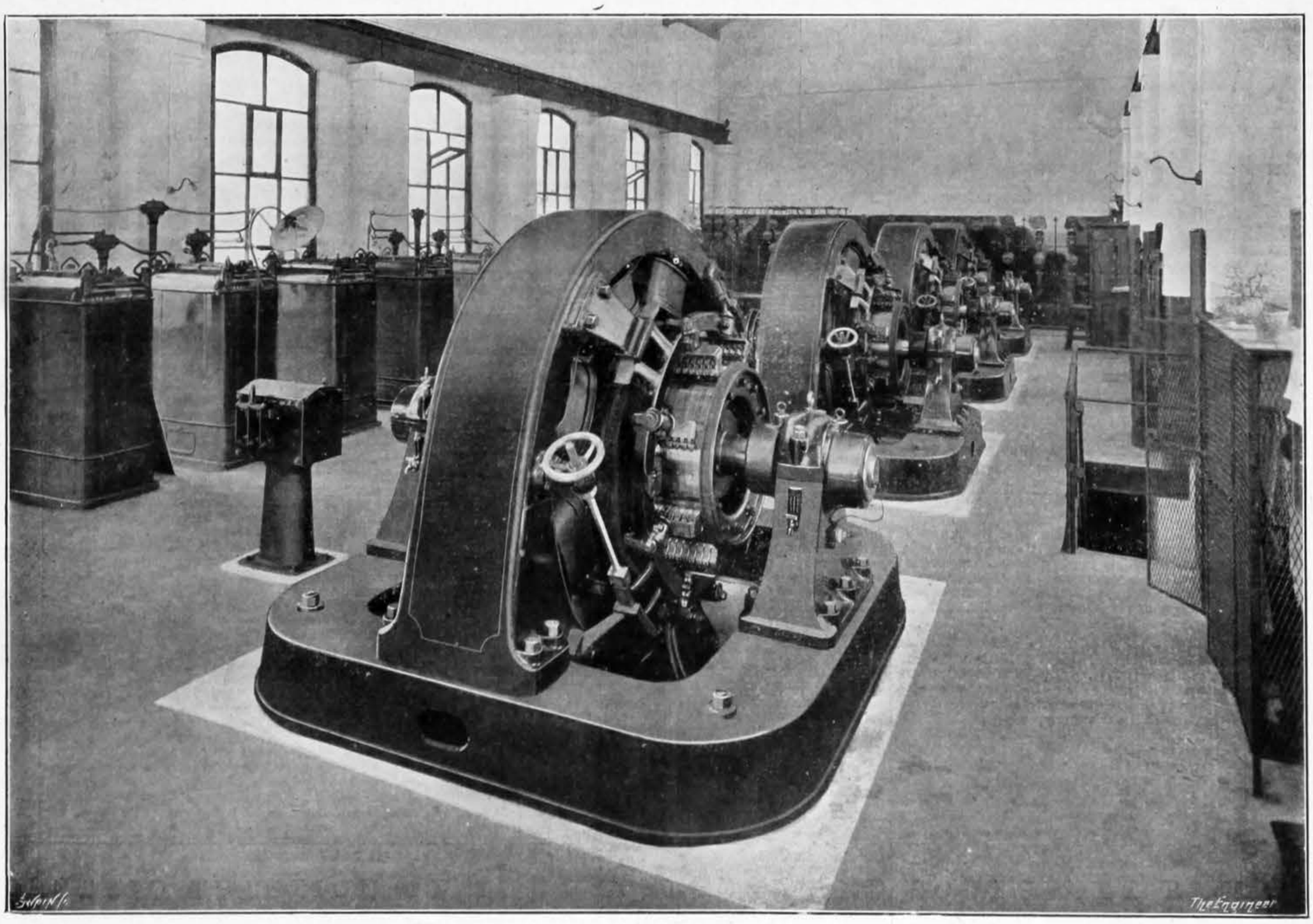
ELECTRIC TRACTION ON THE LIVERPOOL AND SOUTHPORT RAILWAY

DICK, KERR, AND CO., LIMITED, LONDON ENGINEERS

(For description see page 650)



POWER HOUSE AT FORMBY



TYPICAL ROTARY SUB-STATION

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CONTENTS.

TO CORRESPONDENTS.

☞ *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 stamped, in order that answers received by us may be forwarded to their destination. No notice can be taken of communications which do not comply with these instructions.*

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REPLIES.

A. S.—Many firms now take learners without premiums. Apply by letter to any works which you think suitable, and particularly use any personal influence you may have to get an introduction to a director or manager.

PERPLEXED.—Are you convinced the admission valve is quite tight? The defect has all the appearance of being due to a leakage of the burning gases past the valve into the admission pipe. Grind it in hot and try a stronger spring. We presume you are satisfied that the timing gear is working properly, and that there is no loose contact or any defect of that kind.

MEETINGS NEXT WEEK.

INSTITUTE OF SANITARY ENGINEERS.—Friday, July 6th, and following days, at Manchester. Summer meeting. Sir Wm. Mather, M. Inst. C.E., will preside, and a very interesting programme of discussions and visits has been arranged.

DEATH.

On the 22nd June, killed in railway accident near Glasgow, ARTHUR COOTE, director of Messrs. Hawthorn, Leslie, and Co., Newcastle-on-Tyne, and 8, Kensington Park gardens, London.

THE ENGINEER.

JUNE 29, 1906.

The Webb Compound Locomotive.

AN interesting correspondence is proceeding in our columns concerning compound engines on the London and North-Western Railway. It will be remembered that in our obituary notice of Mr. Webb we criticised the design and performance of a large number of express locomotives which he had built during the latter twenty years of his service as chief mechanical engineer of the line. To these criticisms "F.A.L." took exception. To "F.A.L." another correspondent, "Lynx," replied last week. We regret that their letters should have touched upon Mr. Webb's character and behaviour, and we ask them and any other correspondents to bear in mind that the subject for discussion is not Mr. Webb but the locomotives on which he pinned his faith.

It is a noteworthy fact that no railway authority in Great Britain and Ireland ever believed in these engines; Mr. Webb, and Mr. Webb only, had faith in them. Precisely on what evidence that faith was based we have never been able to discover. Let us consider what the Webb system was and how it worked out in practice. The theory of it was that, given two independent engines, one high pressure with two cylinders, and the other low pressure with one cylinder, they would naturally "get into step," to use an electrician's phraseology, and would consequently use steam to the best advantage, all the pressures adjusting themselves. No combination of this kind has ever been successfully attempted at sea or for stationary purposes. It might have answered with a locomotive if only the two pairs of driving wheels were really detached from each other; but they were not. A little reflection will show that they were always partially coupled by the rails. If the engines got out of step they could only get in again by the slipping of one pair of the driving wheels. It has been stated that slipping constantly went on when the rails were in the least greasy, and tires suffered accordingly. The high-pressure pistons always ran against the intermediate receiver pressure, but that receiver was very small. The distribution of work might very easily become anything but equal; but what was much worse the draw-bar pull was irregular, because the cranks did not maintain the best angular and torque relations; while the reciprocating momentum stresses, instead of compensating for each other, were free to do all the mischief they could. It is, of course, indisputable that the theory of the engine was very pretty. To get rid of side rods was no small gain. It was worth something to dispense with a separate starting valve. But the theory did not work out in practice. The idea that a heavy train could be started with certainty by a single pair of 13in. to 15in. cylinders acting on a single pair of driving wheels was a delusion. But until this pair of wheels revolved the low-pressure cylinder got no steam. Starting depended very often on the slipping of one pair of wheels; but even if the low-pressure crank was on a dead centre nothing was gained. The intermediate receiver became choked with steam, and there was simply a dead-lock. On the other hand, if the low-pressure cylinder could get steam at all, it got it with a vengeance, and the starting of a train drawn by a Webb compound was an exceedingly unpopular experience with passengers. We may add that so far as we are aware no consecutive diagrams taken over, say, a 50-mile run, from all three cylinders of one of these engines has ever been published. Such a set would tell the world at once what went on in the cylinders, and how far the engines did or did not keep step. Possibly our correspondent "F.A.L." possesses such a set, and may be disposed to send them to us for publication. That the engines were bad starters is simply notorious, yet that they could do good work on long runs may be fully and freely admitted. But, after all, this is really only one of the points at issue.

The first consideration with the locomotive superintendent is to work the traffic with certainty and punctuality. Every other consideration sinks into insignificance in the sense that nothing must be permitted to interfere with the conditions laid down by the traffic manager. But punctuality ensured, it behoves the locomotive department to seek economy. Now economy in the use of steam is tantamount to an increase in boiler power, and it may very well happen therefore that punctuality is promoted or even secured by economy. We cannot call to mind that anyone outside an exceedingly limited circle ever held that the Webb compound was much better than any other locomotive, either as a machine or a vehicle. It was not a cheap engine either to make or maintain. The only advantage that it possessed would obviously be economy of fuel. No one, it seems, has ever been able to get at any detailed trustworthy statement of the reduction in haulage expenses secured by the introduction of the Webb compound. With the assertion that the consumption of coal was reduced some 12 per cent. the world is familiar. That, indeed, appears to be the normal saving effected by all compound locomotives. On the other hand it is well known that Mr. Webb was not able to reduce his grate surface; and the "Dreadnoughts" had the largest fire-boxes ever used on the London and North-Western. If any of our correspondents can supply trustworthy information on this point, they will do very good service. It would then become possible to establish a comparison between the Webb engine and a three-cylinder compound with the driving wheels coupled. The only important element of difference would be the coupling rods. If it can be shown that there is much loss due to the coupling rods, then it must be worth while to try a four-cylinder compound, each pair of cylinders, high and low, working one pair of driving wheels, no coupling rods being employed.

We cannot quite agree with the opinion sometimes expressed, that because a particular type of machine has gone out of date it is no longer worth while to write or speak about it. The Webb engine was in all respects original. Its use constituted a very great experiment. Nothing that its inventor could do to make it a success was wanting. The performance of the engines was carefully watched. One was tried by Mr. Stirling on the Great Northern. We have always heard that it failed to keep time. The first failures were said to be due to the grate bars being unsuitable to the Great Northern coal. So Great Northern bars were fitted, but the result was the same. One was sent to the United States, but it did not find favour. That the engines could do fine work was proved by the splendid performance of the "Jenny Deans." Nothing, we believe, militated more against the whole design than the impossibility of finding out whether the compound system did, or did not, effect a reduction in the cost of haulage. "F.A.L." was apparently behind the scenes. We look to him for some authoritative information on this question.

Steel in Theory and Practice.

STEEL in theory, regarded from one point of view, is a material so untrustworthy that its use cannot fail to involve many risks. In practice these risks are incurred, and nothing very dreadful happens. The theory is based on the results obtained in the testing machine, backed up and enforced by rare breakages more or less inexplicable. Practice is based on the fact that, in spite of the teaching of the laboratory, and a few unpleasant episodes, steel has proved itself an excellent constructive material, cheap and trustworthy. Opinions as to the merits and demerits of steel have fluctuated for many years. No sooner was a question about it answered than another cropped up. But it is well to remember that enormous weights of steel are in use, and that its failures have been, on the whole, in practice very few and far between. Furthermore,

in almost all cases they have been sensational; and for that reason have attracted a great deal of attention. If a wrought iron piston-rod broke, and two or three lives were lost, the catastrophe would be accepted without much remark as a thing to be expected; but if a steel rod breaks, the matter is talked about from one end of the country to the other. The mental attitude of a considerable section of the engineering world with regard to steel is peculiar, and not very easy to explain. There is a fluctuation of opinion continuously going on, and our purpose at present is to draw attention to a change in the way in which some steels are regarded which is full of interest.

Hitherto ductility has been regarded as an essential quality in all steels, and particularly in those submitted to dynamic stresses. It is clear that in a railway bridge, or floor or roof girder, the stress being invariably inside amounts far within the elastic limit, ductility can only have an indirect value. But for machinery subject to rapidly alternating stresses the conditions and environment are so different that ductility ought to be of immense value. If we come to examine the idea at the root of this hypothesis, we can express it in very few words—it is better that a part of a machine should bend than break. There is no answer in the negative to this proposition. It is manifestly and axiomatically true. The natural deduction is that the steel should be ductile and not "brittle"; and to secure this quality most engineers specify the chemical constitution of the metal, as well as the tests which specimens shall withstand. Roughly speaking, sulphur, phosphorus, and silicon are kept down to very small percentages. Carbon is strictly conditioned in quantity by the purpose to which the steel is to be put; and the breaking strength varies between 28 and 35 tons on the square inch, with extension percentages of 23 to 30, and bending tests of considerable severity.

Such tests as these pay no attention to the purpose for which the steel is to be used. Whether it is a boiler plate, or a piston-rod, or a girder plate, the test is the same in character. Recently we have had the impact test introduced, which it is well known has condemned many steels as bad, which, nevertheless, have been in practical use for long periods without accident. The result of much that has been written and said within the last few years is a revulsion of feeling among many mechanical engineers; and doubt is now being cast on the necessity for extreme ductility. It is argued that when fractures take place, in engine work let us say, the broken parts have not stretched at all. In other words, ductility is a factor which may be disregarded. It never appears to have any chance of manifesting itself usefully. When a boiler bursts the plates break up like glass. If a furnace crown comes down the ductility which permits its descent is due to the red heat of the plate. Whatever may be the cause of fracture, so far as can be known the quality of ductility is no safeguard, the most ductile metal in the laboratory or the testing-house breaking just as readily and just in the same way as that which is brittle. Be the explanation what it may, it is clear that "test-house stretch" is not indefeasible evidence one way or the other as to the fitness or not of a given steel for use, say, in a connecting-rod; yet it would be difficult to induce any ordinary engineer to give it up. It possesses the great value that, let what will happen in the way of destruction of life or property, the designer can say that he had taken every possible precaution to avoid an accident.

There is, however, another way of looking at the whole question. There is no certainty that the tensile test secures safety, while it involves the use of a material comparatively weak. Why should not a high steel be used instead of a low steel, a much higher factor of safety being adopted, even though the weight used is much reduced? It must be carefully borne in mind that we are not now speaking of vanadium steel, or any other exceptional alloy. The makers of motor cars, at all events, see no reason. They are using 60-ton steel for crank shafts, connecting-rods, and, in fact, in every part of the engine submitted to exceptional stresses. Why should engineers cling to a 30-ton steel that cannot bear shocks any better than a 60-ton steel, particularly when the results obtained in practice more than justify the employment of high steel for crank shafts and such like? Of course, it may be argued that what will do on a small scale will not do on a large scale, and to this argument we have no direct answer to suggest. The indirect reply is that, so far as can be seen, the soft ductile steel is not more trustworthy, but less trustworthy, under the conditions than the hard steel, while the use of the latter permits of achievements in the combination of lightness and power which with weaker metal would be impossible. If we push this inquiry into the region of alloys, we shall find further evidence of a new departure. There is now in the market a vanadium steel with an ultimate strength of 100 to 110 tons, an elastic limit of 93 tons, and a stretch of 13 per cent. in 2in. Another crank-shaft steel, probably chrome, is 71 to 77 tons, elastic limit 60 tons, elongation 13 per cent. These are, of course, crucible steels. But it must be remembered that very large masses of crucible steel can be had for the asking—at a price.

Regard the matter as we may, we cannot shut our eyes to the fact that men making most beautiful machinery, exposed to most violent stresses—machinery whose failure may cause disastrous breakdowns—are deliberately using a metal which large numbers of engineers still pronounce quite unsuitable for the intended purpose. No one seems to know why a steel is or is not brittle, and on the whole it seems to be better policy to use a very strong rather than a tolerably weak metal. Perhaps, after all, the favour which low steel enjoys may be more a matter of prejudice than common sense. If it could only be proved that this was the case, and that a 60-ton steel was as safe as a 30-ton steel, the construction of machinery, particularly for marine work, would be revolutionised in some respects. That those having authority do not stand in the way is a reassuring fact. Lloyd's draw no hard and fast line, and will accept any steel for crank shafts if good reason is shown. The Marine Department of the Board of Trade has gradually raised the limit for crank shaft steel from 30 tons to 40 tons, with 20 per cent. elongation in 10in. The facts as they stand add another complication to the steel question, and the result of what is in effect, a policy certainly novel in the extent of the practice which is its embodiment, will be regarded with interest, as it may have very far-reaching results. That high steels have been used sporadically in the construction of machinery is nothing new; the fact of their extended use on a large scale is quite a different matter.

Inasmuch as the policy of motor car builders is, we have reason to think, very far from being generally known, we may say that particular qualities of steel are used for every particular part of a car. What answers for gearing will not do for crank shafts. But one strictly original departure deserves special mention. As a rule, when a shaft breaks, engineers will replace it with one of larger dimensions; but certainly one Coventry firm has found that the way to prevent fractures is to use smaller, not larger, shafts, and a better steel. Steel can be had now with a breaking strength of 110 tons, and considerable ductility. Crank shaft steel is regularly made with a breaking strength of 90 tons, an elastic limit of 70 tons, and an elongation of 18 per cent. in 2in. With such facts before us, is it not absurd to continue the use of a material not one half as strong? Is not the mechanical engineering world shutting its eyes to the enormous developments that have taken place in steel manufacture. Is it not evident that the advantages possessed by 30-ton steel over 60-ton steel are theoretical? The whole problem of the use of steel in the construction of machinery demands careful revision in the light cast upon it by recent practice. Of course increased strength means less weight, so that first cost need not be augmented, although a better quality of steel was used. We are, moreover, very far from advocating a sudden jump in marine work—for instance, to a 90-ton steel. But we think that Lloyds and the Board of Trade would do well to reconsider some of their rules and regulations.

The Efficiency of Steam Plant.

Two papers, discussing the efficiency of steam engines and boilers, were read in London upon Friday, the 22nd inst., at the eleventh annual meeting of the Incorporated Municipal Electrical Association. The first of these papers dealt with the use of live steam for heating the feed-water of boilers, and was contributed by Mr. George Wilkinson, chief electrical engineer, of Harrogate. The live steam feed heating apparatus used in these experimental trials was constructed by Messrs. Dales and Braithwaite, of London, and is based upon the principle of spraying the feed water into a chamber which is connected with the steam portion of the boiler. This system of pre-heating differs from the much-discussed thermal storage system of Mr. Druitt Halpin, in that all the feed-water used in the boiler is passed first through the economiser and then through the live steam feed heater, and is thus raised nearly to the steam temperature before it enters the boiler. The experiments made at Harrogate by Mr. Wilkinson were carried out with an ordinary type Lancashire boiler, provided with a Green type of economiser of 288 pipes. The economiser alone raised the feed to a temperature ranging from 213 deg. Fah. to 265 deg. Fah. The Dales and Braithwaite apparatus added from 83 deg. Fah. to 120 deg. Fah. to this temperature, and the feed-water in these experiments could thus be raised to a temperature ranging from 333 deg. Fah. to 348 deg. Fah. The temperature of the steam during these tests of the live steam feed heater was between 353 deg. Fah. and 360 deg. Fah. Six steam-raising tests were made during the trials of this system at Harrogate—one with cold water feed, two with economiser feed, and three with both the economiser and the live steam heater in operation. The results showed a gain of 12·7 per cent. in the combined efficiency of the plant, when the live steam heater was in operation, and the consumption of coal was at the rate of 27·31 lb. and 29·53 lb. per square foot of grate area per hour, while at a lower rate of fuel consumption the gain by the use of the live steam feed heater was 7·0 per cent. If the tests carried out by Mr. Wilkinson are correct—and we see no reasons to doubt their accuracy—the gain in the thermal efficiency of a boiler by use of a live steam feed water heater, has been clearly proved under working conditions.

The claims made by Mr. Druitt Halpin, by Mr. Hamilton, by Messrs. Booth and Kershaw, by Colonel Crompton, and by ourselves, for the advantage and economy of hot feed-water are therefore at last likely to receive recognition and application, from the branch of the engineering profession engaged in the generation of electricity. Perhaps the most suggestive portion of Mr. Wilkinson's paper, however, is that in which he asserts that a much higher evaporative duty than at present is usual, may be obtained from steam boilers by the use of hot feed-water and rapid combustion. He considers that a coal consumption treble or quadruple that at present considered good work is possible with a boiler plant properly designed and equipped for the new system of working. A method of trebling or quadrupling the steaming power of their present boiler plant by comparatively simple means, would thus seem to be within reach of all steam users. We hope Mr. Wilkinson will follow up this suggestion by carrying out at Harrogate some tests of the live steam feed heater, with still higher rates of fuel consumption than the 29·5 lb. per square foot of grate area given in No. 4 of his boiler tests. A boiler with a specially large fire grate and combustion chamber would be required to give this method a fair trial, but the cost of providing this would be saved, we believe, in the reduced consumption of fuel, one of the most interesting of Mr. Wilkinson's observations being that at these high rates of combustion the whole flue space of the boiler becomes filled with incandescent gas. A considerable portion of Mr. Wilkinson's paper is devoted to the theoretical side of the subject, and an attempt is made to answer the question, "Why should a boiler show a higher thermal efficiency when fed with water at or near the temperature of ebullition?" The experiments of Sir William Anderson, Sir Frederic Bramwell, Miss Bryant, Mr. Dales and Mr. A. W. Hamilton, are referred to in this connection. These all prove that the higher the temperature of the water on the one side of the boiler plate, the greater is the rate of heat transmission from the source of heat on the other side of the plate, and that the maximum of heat transmission occurs during ebullition. Many theories have been advanced by boiler engineers and others to account for this fact. The theory which finds most favour with the author of the paper we are discussing is that, at the moment of its conversion into steam, the water takes up from the plate with great rapidity the whole of the thermal energy represented by the latent heat of steam—or about four times that required to raise the temperature of the same volume of water from 0 deg. Fah. to 212 deg. Fah. Therefore, at those portions of the boiler where ebullition is occurring, the rate of heat transmission must necessarily be much higher than at those portions where water is being raised to the ebullition point. The objection usually advanced to meet this theory is that the production of steam from water at the temperature of ebullition, does not occur instantaneously at the surface of the plate. A small bubble of steam forms here, it is true, but this detaches itself from the plate almost as soon as it is formed, and as it rises up through the heated water it gains enormously in size. The formation of steam is occurring, in fact, at all stages of its upward journey, and not only at the surface of the boiler plate—and this formation of steam and absorption of heat only ceases when the bubble arrives at the surface of the water and escapes as wet steam. Another objection to the theory advanced by Mr. Wilkinson is that, if true, boilers would produce steam with almost explosive violence, for all the water in contact with the boiler plates would be converted into steam instantaneously. A theory which is proof

against all hostile criticism has, in fact, yet to be formulated, and it would be of much assistance in this matter if one could construct a high-pressure boiler of glass or of some other transparent material, which would allow one to see what was occurring during ebullition. Until this is done, we fear the exact cause of the gain in thermal efficiency of boilers fed with water at the temperature of the steam will remain unexplained. However, while we thus dismiss the theoretical side of Mr. Wilkinson's paper as of little value, its practical importance is great.

Mr. Walter A. Vignoles, the author of the second paper, is Chief Electrical Engineer of Grimsby, and his paper, entitled "The Efficiency of Steam Plant," is an attempt to explain why the coal consumption is much higher in central generating stations than in marine work. Upon the subject of boiler house economy Mr. Vignoles has nothing novel to say, and as he evidently never makes any tests either of his fuel or of his waste gases, we cannot regard the plant under his charge as one which is being worked to the fullest advantage. The figures given in Table IV. of Mr. Vignoles' paper confirm this opinion. Under "Plant Economy," Mr. Vignoles tabulates the results of tests made at the Grimsby Works, showing the extra steam consumption due to the stand-by and other losses. These losses, and the diagrams given in Mr. Vignoles' paper, are chiefly interesting to electrical engineers, but his remarks concerning the wasteful steam consumption of the auxiliary engine plant have a more general application. In the tests made at Grimsby Mr. Vignoles found that the auxiliaries consumed 5·1 lb. of steam per kilowatt-hour, as compared with 31·6 lb. for the main engines. Thus, nearly one-seventh of the steam generated was used for the auxiliary engine plant. Mr. Vignoles recommends the use of electrically-driven pumps in order to reduce these losses.

The two papers which have been discussed above show that electrical engineers are taking an intelligent interest in their steam-raising plant, and are beginning to understand more fully than before that it is in the boiler-house, rather than in the dynamo room, that the greatest scope for improvement and economy lies. Messrs. Booth and Kershaw, in their paper entitled "Fuel Economy in Steam Power Plants," read before the Institution of Electrical Engineers in January, 1905, emphasised the importance of the boiler in the economical generation of electricity, and suggested experiments upon the lines of those carried out by Mr. Wilkinson at Harrogate. It is obvious that both Messrs. Wilkinson and Vignoles have been close students of that paper.

Greenwich Observatory and the County Council.

"A GIGANTIC mistake has been made—a mistake by the Admiralty, by the Astronomer Royal, by the County Council, and by Parliament." In was with these words that Lord Goschen concluded his speech on June 20th, when the questions at issue between the Astronomer Royal and the London County Council were under discussion. There can be no doubt that the prospect of the scientific investigations at Greenwich being impaired, if not altogether paralysed, is a matter of national, if not world-wide importance. It is no mere æsthetic objection that is being taken by those who are interested in the Observatory to the proximity of a large generating station, but a very real one, it appears not improbable that serious interference must result if the generating station is used.

Two or three facts may serve to show how delicate are the instruments and apparatus which are used at an Observatory, and how easily they may be upset by outside influence. Take, for instance, the artificial horizon which is placed under a meridian circle, and is used for the purpose of ascertaining whether the axis of the instrument is exactly horizontal, or, rather, for correcting any error to which the instrument may have become subject. This artificial horizon is nothing more elaborate than a bath of the purest mercury, but the smallest degree of vibration is sufficient to set up tiny waves on its surface and render it useless. At the Dunsink Observatory, near Dublin, the observers often found that they were unable to use the horizon with any degree of accuracy. The reason was far to seek. About three miles away from the Observatory—which is built on limestone—runs the Irish Great Western Railway, and it was discovered that the vibration caused by the passing trains was sufficient to account for the disturbance. If a railway train passing at so great a distance is a source of trouble, what shall be said of a generating station which, when complete, is to produce 52,000 horse-power, and is only removed from the Royal Observatory by a distance of a quarter of a mile? Vibration, however, is not the only mischief to be feared. The generating station is bound to produce large quantities of smoke and vapour. It is plain to the meanest intelligence that volumes of black smoke in the neighbourhood of an Observatory are likely to cause interference with observations, especially at Greenwich, where the the atmosphere is none too translucent at the best of times. But the astronomer is worried almost as much by invisible vapours. A column of hot air ascending in the front of the object glass of a telescope is fatal to the view. Visitors to an Observatory are often surprised that the "dome" is never heated by artificial means, and that the astronomer who must keep a vigil on a winter's night must do so all wrapt in furs. The reason why no stove can be placed in the "dome" is that it might cause a current of slightly heated air to ascend and pass out through the open shutter and in front of the objective. But there are other hot air currents which are also productive of damage, and are not under the control of the astronomer. There are other movements in the higher regions of the atmosphere which render it impossible for the astronomer to use his full power. To all appearances the night may seem to be an ideal one from the astronomical point of view; yet the influences above mentioned may be at work to distort the field of vision. It follows that although the chimney stack of the new generating station may emit no visible smoke, the fumes of a clear furnace at the County Council station may be disastrous to the neighbouring Observatory.

The fact of the interference of the generating station with the work of the Observatory being granted, the question arises as to the best method of correcting the mistake. Let us first consider the rights of the Astronomer Royal and the possible liabilities of the County Council in this matter. It is provided by every tramway order that "nothing in this order shall exonerate the promoters from any indictment, action, or other proceeding for nuisance, in the event of any nuisance being caused or permitted by them upon any land acquired by them." It is even within the bounds of possibility that the Court would grant an injunction. It may not be a question of damages. Thus it was laid down by the late Lord Justice A. L. Smith that: "Damages in substitution for an injunction may be given (1) if the injury to the plaintiff's legal rights, is small; (2) is one which is capable of being estimated in money; (3) is one which can be adequately compensated by a small money payment; and (4) the case is one in which it would be oppressive to the deputant to grant an injunction. There may also be cases in which, though the four above-mentioned requirements exist, the defendant by his conduct—as, for instance, hurrying up his buildings so as if possible to avoid an injunction, or otherwise acting with a reckless disregard to the plaintiffs' rights—has disentitled himself from asking that damages may be assessed in substitution for an injunction." On the other hand, there may possibly be some question as to whether the Astronomer-Royal would be entitled to a special meed of protection under the ordinary law, inasmuch as the damages which he fears he may sustain are due to the particular and somewhat extraordinary use which he is making of his own land. Apparently, however, this defence cannot avail the County Council, for the Observatory has been given special protection by the Act passed in 1902, which provides that where the use of electric power acts, or was likely to act, injuriously on any instrument or apparatus used in any Observatory or Laboratory under the control of the Board of Trade, the department should have power to require reasonable and proper precautions to be taken. Apparently the choice of a site lay to some extent with the County Council, and without reckoning how serious a step they were taking, they deliberately chose the position now occupied by their generating station. But how they were allowed to carry the work to the position it has now reached, is a question which both they and the directors of the Observatory will have to answer.

However, since the destruction of the work of the Observatory cannot be measured in money, any question of compensation for harm done is almost beside the point, unless, indeed, the removal of one or other of the establishments should be found unavoidable, and we trust, however, that the resources of science and engineering may be potent enough to find some less extravagant path out of the difficulty. The chimneys could certainly be done away with or removed to such a distance that they would rarely or ever interfere with the invaluable work of the Observatory. Means too may be found of arresting vibration before it has reached the artificial horizon. But if all such steps should fail, and the station should interfere with the work that the Observatory has carried on for so long, the sympathies, not only of all England, but of the whole world, will be on the side of the Observatory.

Highgate Tramcar Accident.

ON Saturday afternoon last a serious accident occurred at Highgate owing to the driver of an electric tramcar losing control of the vehicle. The runaway car belonged to the Metropolitan Electric Tramways Company, Limited, whose system extends from Whetstone to Holloway. Considering the nature of the accident, the time, and the locality in which it took place, there was, happily, a very small death roll. All the passengers escaped death, but, unfortunately, owing to a Vanguard motor omnibus being forced on to the pavement by the impact of the errant car, three persons lost their lives, and about twenty-seven people were more or less seriously injured. The scene of the disaster was on the steep gradient connecting Holloway and Junction-roads with that portion of the Great North road known as Archway-road, Highgate. The exact cause of the accident is not known, and, indeed, is not likely to be officially stated until after the Board of Trade inspection of the damaged car. Sufficient evidence was, however, given at the inquest on the unfortunate victims by the driver, Ernest Henry Cone, to leave little doubt as to the real cause. It appears from his evidence that before he reached the hill on which the mishap took place he had already had trouble with the braking of the car. At the Highgate Police-station he had been unable to stop owing to the wheels skidding on a slippery road, and although he took off the hand-brake the wheels failed to revolve. This statement is probably the most important in the evidence. If it be true—and we have no reason at all to doubt the veracity of the driver's statement—it shows that there must have been some defect in the running gear of the car, or that the brakes remained on, although apparently released. Of these two alternatives the first can probably be dismissed at once, owing to the subsequent behaviour of the car. The second is the more likely cause of the disaster, although it is difficult to understand how such a condition could arise. One thing, at least, is certain, the wheels were locked, and the driver was unable to release them. Unfortunately, unless the wheels revolve the magnetic brake is useless. There appear to have been only two brakes on this car. These presumably were considered sufficient, or the Board of Trade would not have passed them. This plan works well, as long as the drivers are careful, to check the speed of the car by the magnetic before applying the hand brakes. This, however, it is difficult to teach them to do, and in spite of instructions they frequently use the hand brakes when descending hills. It does, moreover, seem rather inconsistent to have two brakes so placed that if one fails through the most likely channel—the locking of the wheels—then the other is inoperative. This system is admittedly adopted by nearly all tramways, but in hilly districts an emergency slipper brake which acts on the rail is also used. For the obvious reason that the trolley may leave the wire and so cut off the current, it is desirable that such brakes should be applied mechanically, as in the case of Halifax, where very steep hills have to be descended. With the combination of these three brakes tramcars have been running for years, without having any accident, in districts which have hills and other conditions far worse than any to be found in the metropolitan area.

Conference in the Engineering Trade.

THE Engineering Employers' Federation has, we are informed, agreed to the request of the Amalgamated Society of Engineers, the Steam Engine Makers' Society, and the United Machine Workers' Association to hold at an early date a conference to reconsider the terms of settlement which were jointly adopted after the great strike, and which have been in force since January, 1898. We are not in the position at the present time to give in any detail the proposals which the unions intend to lay before the employers, but they refer to the limitation of the total number of hours of overtime worked per month; to the limitation of apprentices; and, finally, to the position of unionist workmen. These are all old causes with which numerous struggles have made us familiar. Of the three, the last is the most serious. We cannot give the precise terms of the demand, but, broadly speaking, it is that unionist workmen are to be given the preference of employment over non-union men. Whether the conditions which accompany this request so modify it that the employers can agree to it without hampering their interest or sacrificing their freedom remains, of course, to be seen. But that the unions are determined to press the demand to the utmost

is unfortunately a fact, and there is, therefore, some danger of disturbance in the trade. We trust, however, that before the conference nothing will be said or done to inflame the feeling on either side, so that the meeting may be as friendly and conciliatory as many that have been held between capital and labour in the engineering trade during the last few years. Labour has now its representatives, who take some share in the management of the country and the Empire, and the sense of responsibility which attaches to that high duty will, we earnestly trust, direct them to do nothing which may seriously hamper one of our most important industries. That they have any real grievance it is difficult to believe in the face of the fact that, on the whole, harmony has prevailed since the signing of the 1897 agreement.

RAILWAY ACCOUNTS.

As briefly stated in our issue of the 23rd inst., a Departmental Committee has been appointed by the Board of Trade "to consider and report what changes, if any, are desirable in the form and scope of the accounts and statistical returns—capital, traffic receipts, and expenditure—rendered by railway companies under the Railway Regulations Acts."

The Committee consists of Mr. A. Clayton Cole, chairman; Mr. W. M. Acworth; Mr. W. Bailey, chief accountant of the Midland Railway Company; Mr. G. Stapylton Barnes, comptroller of the companies' winding-up department of the Board of Trade; Mr. A. Wilson Fox, C.B., Board of Trade; Sir Chas. J. Owens, general manager, London and South-Western Railway; Mr. G. Paish, the Hon. George Peel, Mr. G. J. Whitelaw, chief accountant of the Great Western Railway; with Mr. H. Fountain, Board of Trade, as their secretary. Mr. Clayton Cole is a director of the Bank of England, and an authority on economic questions. He may, therefore, be regarded as an independent chairman. The representatives of the railways will commend themselves to the public as well as to the railway interest. Mr. Bailey, in particular, is an ideal member, as was proved by the excellent work he did for the railways and for the public when in Belfast as accountant to the (then) Belfast and Northern Counties Railway, and prior to his present appointment at Derby. Mr. Acworth is well known to our readers as an authority on the subject, and was one of the leading champions for reform in railway statistics. Mr. Paish, too, is known as an ardent reformer. He is one of the editors of the *Statist*, the author of "The British Railway Position," and one who has been for many years intimately associated with the financial aspects of American railways. The Hon. George Peel is the chairman of the Railway Investment Company, and a member of the Shareholders' Committee which have urged on the London and North-Western Company the need for more information as to details of expenditure and receipts.

The Committee had an informal meeting last week, when it was decided that they would commence taking evidence on Tuesday last, the 26th. They further decided that the proceedings would not be open to the public, and that a summary of the evidence would be published in their report.

The much debated subject of ten-mile statistics naturally arises in one's mind on hearing of the appointment of this Committee, but there are other points that will come under their review. It must be borne in mind that the companies are legally bound to furnish two returns as to their financial condition and business done. The first of these is for the information of the shareholders and the second is for the Board of Trade. The form and scope of the return supplied to the shareholders was laid down in the Railway Regulation Act of 1868. The return for the Board of Trade was fixed by the Railway Regulation Act of 1871. Their form was therefore adopted thirty-five to thirty-eight years ago, in the earliest days of railways, and they practically remain the same to-day as then. The Board of Trade possess powers to call for more information, as in the Railway and Canal Traffic Act, 1888, it was provided that "the returns required of a railway company under Section 9 of the Railway Regulation Act, 1871, shall include such statements as the Board of Trade may from time to time prescribe, and the forms referred to in that section may from time to time be altered by the Board of Trade in such manner as they may think expedient for giving effect to this section." The powers conferred on the Board by this clause have practically lain dormant, due, possibly, more to the want of pressure of public opinion than to the unwillingness of the Board of Trade to ask for it and of the railway companies to furnish it. Some very slight modifications have, however, been made, as, for instance, the mileage of track—single line of rails, double line, three lines, &c.—has been given for the last two or three years.

The half-yearly reports issued by the companies to their shareholders require considerable amendment and amplification. There is also no more need for the figures to be issued half-yearly than with other corporate concerns. A yearly report with an interim dividend should suffice. The complete figures for the year would then be available, and these would be easier of comparison. Without going through each table of a report seriatim, it may be remarked that more detail is required as to the capital authorised and created, the capital raised by loan and debentures, and the receipts and expenditure on capital accounts. More information should certainly be afforded as to rolling stock. Instead of only the number of tender and tank engines being given, the proprietors should have an idea as to the tractive power capacity of the locomotives, and in addition to being told how many of each pattern passenger vehicles the company possesses they should be informed of the seating capacity of same, and, similarly, the tonnage capacity of the wagons. Mr. Acworth, in a paper he read before the Royal Statistical Society on this subject in December, 1902, compared the methods adopted by the Pennsylvania Railroad with the British plan of supplying the figures for traffic expenses and general charges. The former on our railways consists of eight items:—Salaries and wages; fuel, lighting, water, and general stores; clothing; printing, stationery, and tickets; horses, harness, vans, provender, &c.; wagon covers, ropes, &c.; joint station expenses and miscellaneous expenses. General charges are comprised of:—Directors; auditors; salaries: secretary, general manager, accountant, and clerks; office, travelling and incidental expenses; advertising; fire insurance; electric telegraph expenses; Railway Clearing House expenses; and contributions to superannuation funds. On the Pennsylvania Railroad the traffic charges are divided into the following heads, each division—there are four divisions—having a separate table; the cost per year, and increase or decrease over the previous year following each item:—

Conducting transportation.—Superintendence; clerks, attendants, and office expenses; enginemen and firemen; roundhousemen; fuel for locomotives; expenses of fuel stations; water supply for locomotives; stores for locomotives; other supplies for locomotives; conductors, baggagemen, and brakemen; heating and lighting cars; cleaning cars; lubricating cars; other train supplies and expenses; yardmen; switch tenders and signalmen; watchmen; telegraph expenses; station agents and clerks; station labour; heating and lighting stations; signals and interlocking plants; expenses of operation and supplies; other supplies and expenses of stations; switching charges, balance; car mileage, balance; loss and damage; injuries to persons; clearing wrecks; barges, car floats, and canal boats, charters, incidentals, superintendence, and manning; elevation and longshore labour; steamboats and tugboats, charters, fuel for, incidentals, superintendence and manning; advertising; foreign agencies; stock yards and elevators; rents for tracks, yards, and terminals; rents of buildings and other property; stationery and printing; motormen and conductors; power houses, expenses of operation; yard and street lighting; insurance; incidentals.

General expenses.—Clerks; heat and light; office expenses and supplies; expenses of relief department; law expenses; stationery and printing, general office; advertising; incidentals.

It will thus be seen that what is generally the heaviest item in expenditure out of revenue, viz., the traffic charges, is very fully amplified. In our returns most of the items under the head "General Charges" should be divided amongst the expenses of the departments.

The annual returns sent to the Board of Trade under the Act of 1871 are built up in the same meagre way. That they can be supplied in greater detail we are satisfied. It is not a question of mere book-keeping, because the companies already possess the information. The proprietors certainly are entitled to the knowledge as to how the money they have invested has been cared for. It is true that in giving them this information it becomes public property. Some railway officers may object to giving their neighbours such information, but if legislation compels universal action, then what one officer considers he gives away is compensated for by the information he gains about his neighbours.

In this part of their labours the Committee will not have much difficulty in arriving at a decision as to what shall be recommended, but the heaviest task and possibly the real work of the Committee will come when they have to deal with the wisdom or fallacy of ton-mile statistics.

PISTON RINGS.

A NEW form of piston ring has been placed on the market by Messrs. P. A. Mudd and Co., of Church-street, West Hartlepool. Rings of this make have been applied to cylinders with diameters varying from 10in. to 100in., and with pressures varying from something quite low to high pressures with superheated steam, the highest pressures yet dealt with being in the high-pressure cylinders of five sets of quadruple-expansion engines with a boiler pressure of 267 lb. per square inch. The

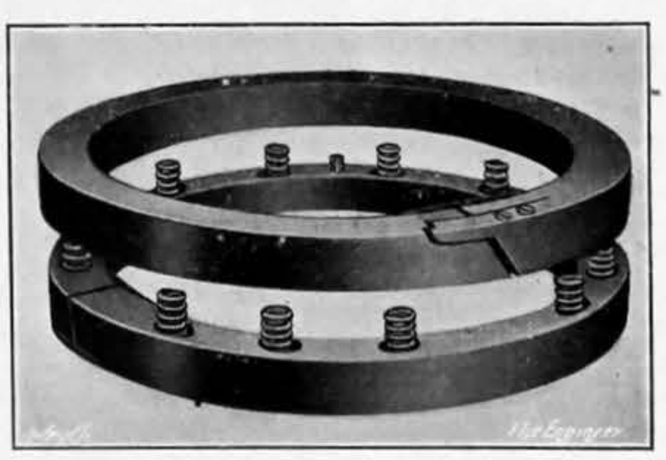


Fig. 1. MUDD PISTON RING

makers claim that a considerable experience with them has shown that these rings are perfectly steam-tight; that there is a remarkable absence of wear, showing that the friction is low; that there is no barrelling of the cylinders, and that the rings are easily examined and adjusted.

The rings are of cast iron and of rectangular section, and they bear upon a wide surface on the junk ring and piston flange. They have between them strong helical springs always tending to exert a pressure on the surfaces of the junk ring and flange. This pressure is made proportional to, and is designed to exclude, the steam pressure behind the rings, and tending to force them against the cylinder walls. This pressure being counteracted, it is only necessary in order to ensure steam-tightness to exert a small pressure against the cylinder walls. To obtain this pressure the rings are split, a small piece being cut out of each. They are then compressed, and in this condition they are turned to gauge. The pressure exerted by the rings against the cylinder walls is then adjusted

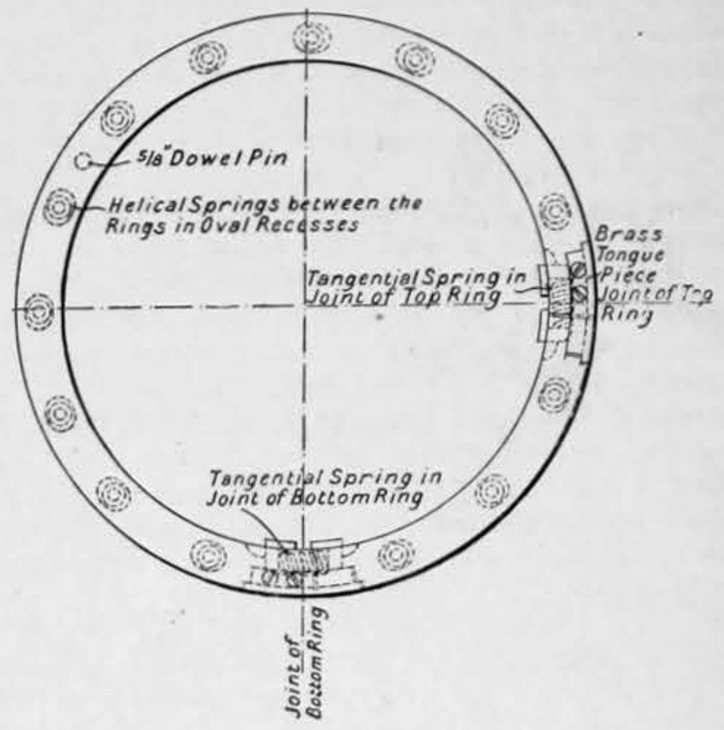


Fig. 2

by means of a tangential helical spring fitted in the joint so that one man can move the rings in the cylinder, so slight is the pressure. Indeed, we are informed that when the rings are new the spring is only very slightly compressed. Then when wear has taken place washers are used to compress it just sufficiently to keep the rings steam-tight. The adjustment is said to be quite easy, and the rings to have a long life.

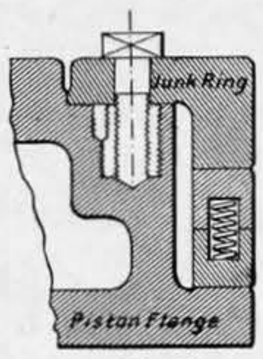


Fig. 3

A further feature claimed for the rings is that they are "floating," that is to say, that they are tolerably independent of the piston and follow the line of the cylinder walls, while the piston is free to follow the line of the guides. This quality, it is pointed out, is of high importance in connection with the preservation of the circular form of the cylinder.

The general construction of these rings is well shown in Figs. 1, 2, and 3, of which Fig. 1 is a perspective view, Fig. 2 a drawing showing the positions of the joints and the two kinds of springs, and Fig. 3 a sectional drawing showing how the rings are arranged with regard to the piston.

TEST OF A PUMPING ENGINE.

THE new pumping engine for the water supply of St. Louis has developed in the official test a duty of 158,851,000 foot-pounds per million British thermal units, or 181,068,605 foot-pounds per 1000 lb. of steam. This, it is claimed, is the highest duty record ever made by pumping engines, and earned for the builders the bonus of £9214, at the rate of £200 per million foot-pounds above the contract requirement of 135,000,000 foot-pounds. The engine was built by the Allis-Chalmers Company, who send us the following details:—

The engine is rated as of 20 million gallons daily capacity, and is of the vertical triple-expansion type, with single-acting outside-packed plungers directly under the cylinders. The engine is one of a set of three at the Bissell's Point high-service pumping station, and has steam cylinders 34in., 62in., and 94in. diameter, with 33¾in. water plungers. The stroke is 72in.

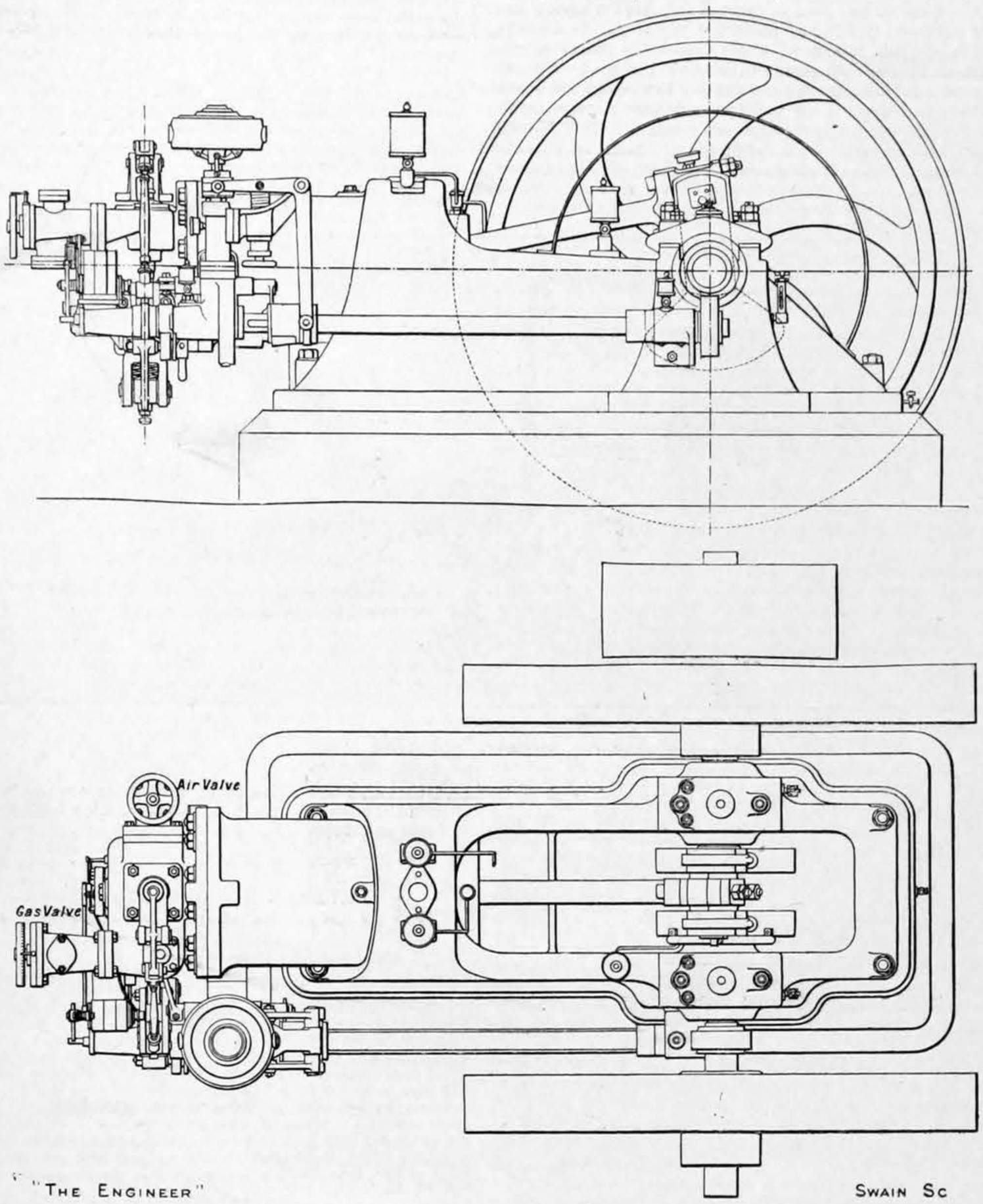
The official test was of twenty-four hours' duration, and before the start the water plungers were carefully calibrated by micrometer calipers and steel tape measurements of their circumferences. The stroke of each plunger was also measured, and all the pump valves were inspected and found tight under pressure. The head on the discharge main was read by a mercury column with scale graduated in feet, and the suction head was indicated by a float gauge. The contract required that, in order to determine the amount of steam used by the engine, the water must be weighed twice—that is, both the feed-water going in and the condensed steam coming out to be measured. The condensation from the condenser, cylinder jackets, receivers, and drips from stuffing-boxes was weighed as received from the engine and delivered at the boiler-room, and was found to check by 0·12 of 1 per cent. The general results of the test were as follows:—

Duration of test	24 hours
Diameter of steam cylinders	34in., 62in., and 94in.
Diameter of water plungers	33¾in.
Stroke	72in.
Moisture in steam	0·13 per cent.
Average pressure at engine	140·24 lb.
" " at first receiver	26·36 lb.
" " at second receiver	2·77 lb.
Average vacuum pressure	13·21 lb.
Average barometer pressure	14·46 lb.
Average net head pumped against	238·2323ft.
Average head at discharge pipe	100·021 lb.
Revolutions per minute	16·539 revolutions
Piston speed per minute	198·440ft.
Total water pumped	20,070,690 gallons
Total water received from engine	220·129 lb.
Plunger leakage, per hour	16·77 gallons
Indicated horse-power	865·23 horse-power
Delivered horse-power	842·69 horse-power
Percentage of friction	2·60 per cent.
Average moist steam per indicated horse-power per hour	10·60 lb.
Average dry steam per indicated horse-power per hour	10·59 lb.
Average B.T.U. per indicated horse-power per minute	261·39 B.T.U.
Mechanical efficiency	97·4 per cent
Thermal efficiency	21·06 per cent.
Duty per 1000 lb. of steam	181,068,605 foot-pounds
Duty per 1,000,000 B.T.U.	158,851,000 foot-pounds

MOST of the sugar machinery in use in Peru is obsolete, and, according to the British Consul, requires to be renewed.

ENGINE FOR SUCTION PRODUCER GAS

THE RAILWAY AND GENERAL ENGINEERING CO., LIMITED, NOTTINGHAM, ENGINEERS



SUCTION GAS PRODUCER TRIALS.

No. III.*

THE general arrangement of the plant submitted by the Railway and General Engineering Company, Limited, of Nottingham, is shown in the illustrations, Figs. 15 and 17. This firm is using a Dowson gas generator in conjunction with its "Midland" gas engine. The latter is illustrated above. It is designed to develop 20 effective horse-power at 170 revolutions per minute, when working on suction gas. The ordinary "Otto" cycle system has been adopted, and the speed is governed by a reducing gas cam which reduces the amount of lift of the inlet valve. The speed of the engine can be adjusted to suit requirements by means of a spring resistance. The cylinder is water-cooled, and is fitted with a separate removable liner made of specially hard metal. The arrangement of the inlet and exhaust valves is shown in Fig. 16. They are placed one above the other, and both open direct into the combustion chamber. The inlet valve is carried in a separate removable valve plug, thus allowing easy access to exhaust valve for examination and grinding purposes. A supplementary cam has been provided for opening the exhaust valve and easing the compression for starting the engine. The gas valve chamber is cast with a breech end. The gases pass through a port in the air valve chamber, and are thoroughly mixed with the air on each suction stroke of the engine. Gas and air cocks are provided for adjusting the mixture. Ignition is effected by means of a low-tension Fischer magneto machine. Considerable care has been bestowed upon the method of lubricating the various parts. The piston and piston pin are lubricated by means of sight-feed lubricators. The crank pin is oiled by a centrifugal oiling ring. The main bearings are ring lubricated, which keeps them always covered with a film of oil. Attention has also been paid to balancing the engine. Counterweights are bolted to the crank webs in order to counterbalance the revolving parts. Both ends of the connecting-rods have marine type brasses, which can be easily adjusted when wear takes place. The cylinder jacket is cast with the bed-plate. The breech end is bolted on to the cylinder, and is designed to reduce strains due to expansion. The bed-plate extends well under the cylinder, and provides an evenly distributed load on the foundation. The engine is provided with a self-starter.

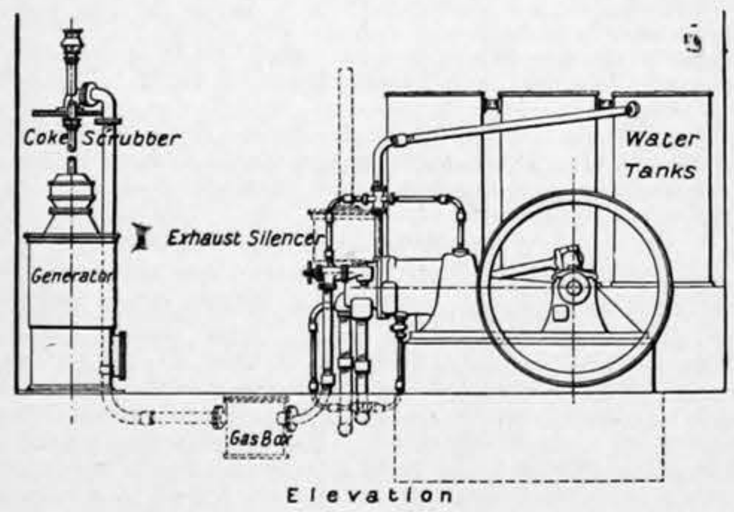


Fig. 15—RAILWAY & GENERAL ENGINEERING CO.'S PLANT

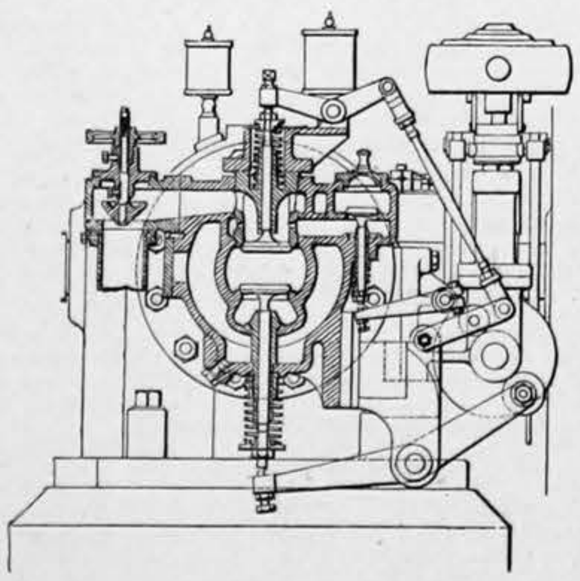


Fig. 16—INLET AND EXHAUST VALVES

The next engraving—Fig. 18—illustrates a section of the National suction gas producer made by the National Gas Company, Limited, of Ashton-under-Lyne. It is an interesting plant, possessing as it does some features which are not embodied in the other plants. The vaporiser consists of an internal cylinder A with an external cylinder B. The latter can be readily removed, when the whole of the inside of the vaporiser is exposed to view for examination. This arrangement will be fully appreciated by those who use suction gas plants in places where hard water only is obtainable, in which case the effective cleaning of the vaporiser is of the utmost importance to the effective working of this type of power plant. Attention should also be directed to the method of distributing the water over the available heating surface of the vaporiser. An open cup C is formed at the top of the vaporiser, and V-shaped notches are cut in this cup at intervals. It is said that it requires practically all the notches to be put in operation to convey away the requisite water for vaporisation, with the result that when the water is poured into the cup-shaped trough at the top a portion overflows through each notch, and then falls down on to the ribs immediately below. The water spreads horizontally along the ribs, and as these are arranged with different widths, the widest being at the bottom, it is impossible for the water to drop from the top to the bottom of the vaporiser. It must either trickle down the sides or else drop from rib to rib. This arrangement is said to have proved to be most effective in practice, and to add greatly to the efficiency of the vaporising part of the plant. The generator works on the regenerative principle as far as possible. In order that the air which passes into the generator may always carry with it the requisite quantity of steam in suspension, it is desirable to pre-heat the air. This is done here by utilising the waste

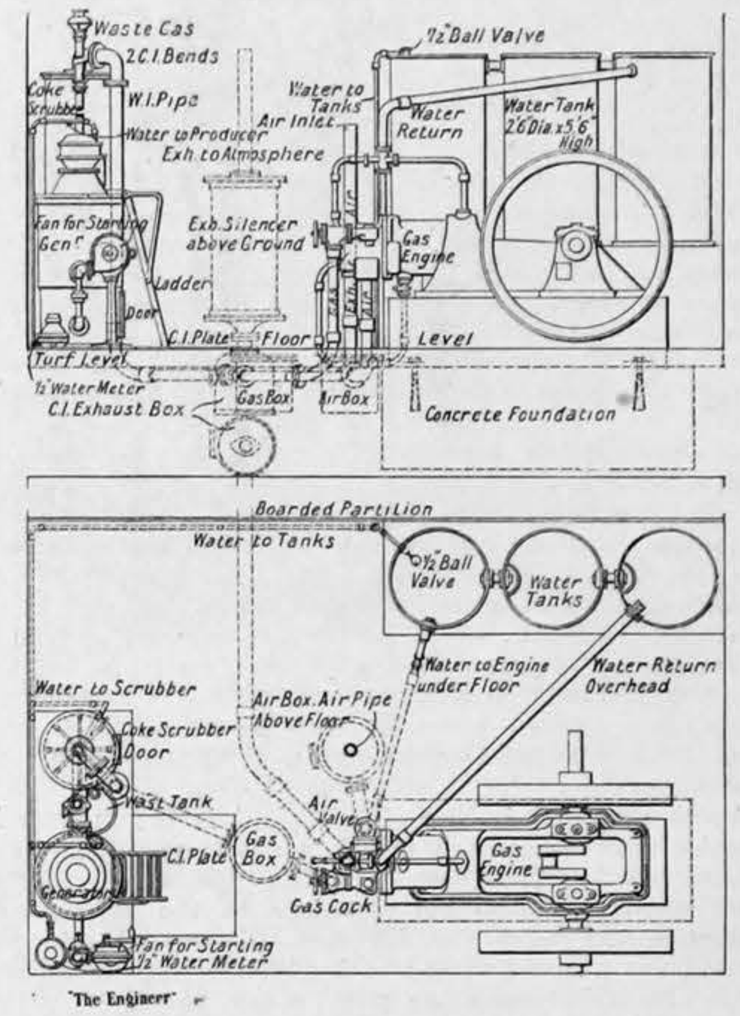


Fig. 17—RAILWAY & GENERAL ENGINEERING CO.'S PLANT

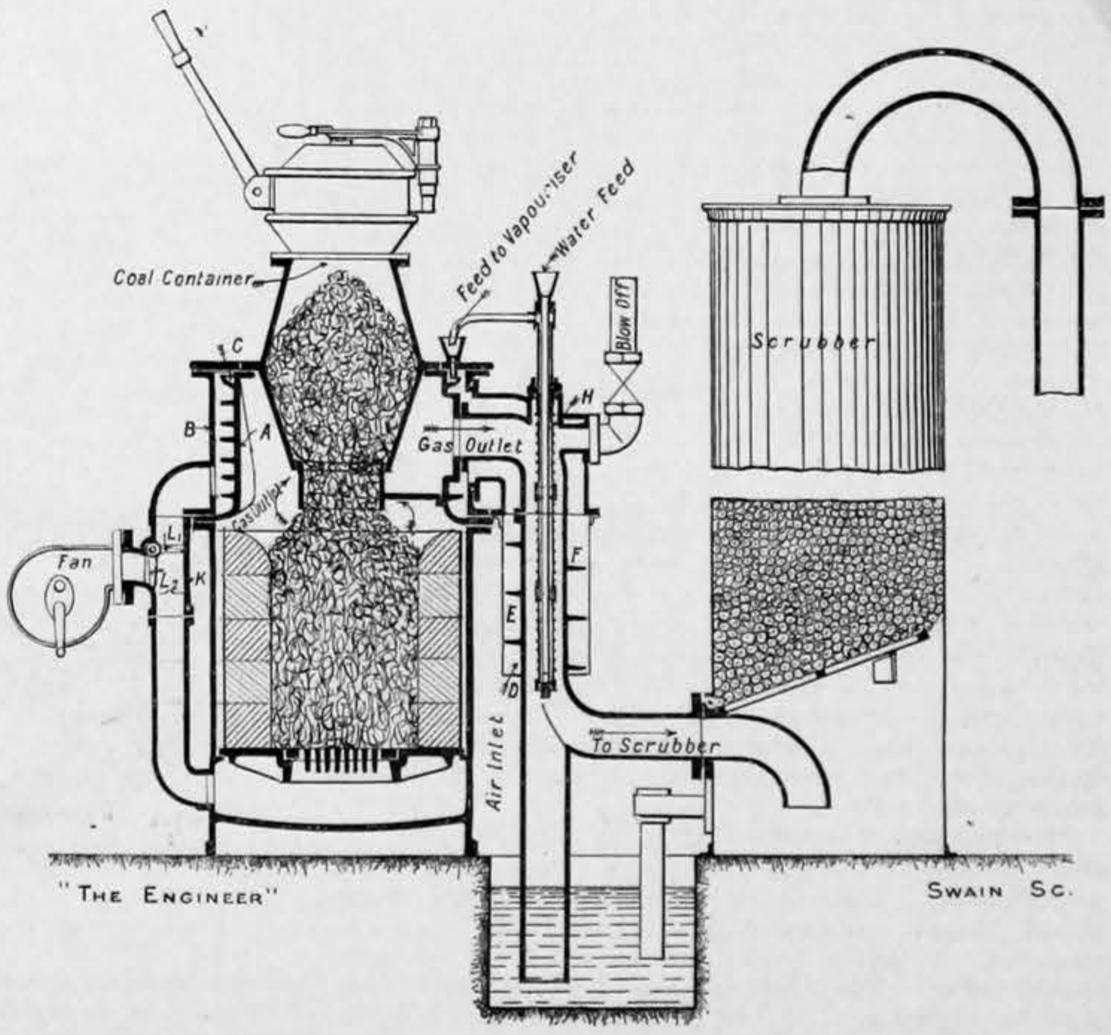


Fig. 18—NATIONAL GAS CO.'S SUCTION PLANT

* No. II. appeared June 22nd.

heat of the outlet pipe from the generator to the scrubber. This arrangement will be best understood by reference to the illustration. The pipe D has a number of vanes cast on it, and this portion of the pipe is encased. The vanes are so shaped that the air, which enters at the bottom, has to pass round and round the passages E and F, so that when it reaches the vaporiser its temperature has been raised considerably. In order to facilitate steam raising, the feed water enters at the top of a ribbed pipe H, which passes down the centre of gas outlet pipe from the generator, and so thereby heated to a high temperature before it passes into the vaporiser.

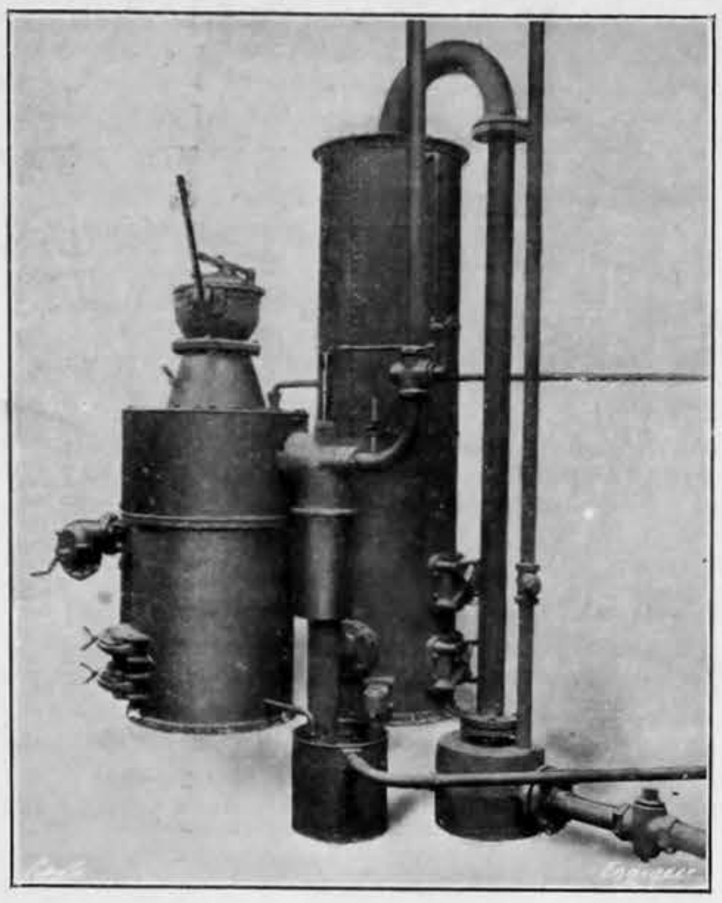


Fig. 19—THE NATIONAL PRODUCER

Another special feature of this plant is the manner in which the fan has been attached and is operated. It is fixed to a junction piece K on the pipe, which conveys air and steam from the vaporiser to the ashpit. In starting the plant the deflector L is moved into the position L^1, whilst when working it occupies the position L^2. By this means the usual cocks and blank plates have been dispensed with. The gases are cleaned and cooled by being passed through an ordinary coke scrubber, and are taken direct from the top of the scrubber to the engine. An illustration of the complete plant is given in Fig. 19.

Kynoch's Limited, of Lion Works, Witton, near Birmingham, are competing with the plant shown in Figs. 20 and 21. The makers appear to have paid particular attention to making all the parts easily accessible for cleaning. It does not work on the internal vaporiser principle, but has a separate boiler between the generator and the scrubber. The generator is of the usual construction, consisting of a metal casing lined with fire-brick. The hopper is fitted with a valve, which is operated from outside. Fuel is placed in the hopper and the cover replaced, then by lowering the lever *i* the coal drops into the fuel container. The vaporiser consists of a hollow pipe, on the outside of which is cast a spiral groove. The gases pass from the furnace through this pipe, imparting the heat to the sides. Water is allowed to trickle on to the groove at the top, and before reaching the bottom it has been converted into steam by the heat of the gases passing through the pipe. Air is admitted at *x*, and this mixes with the steam, the mixture being drawn through K, and up through the grate into the furnace *a*. The scrubber is similar to most of the others. The gas leaves it at the top and before entering the engine it passes into an expansion box 19. The plant is arranged to work on anthracite, gas, coke, or charcoal. It is of simple construction, and there are no internal pipes or vaporiser. Everything is external, and easily accessible.

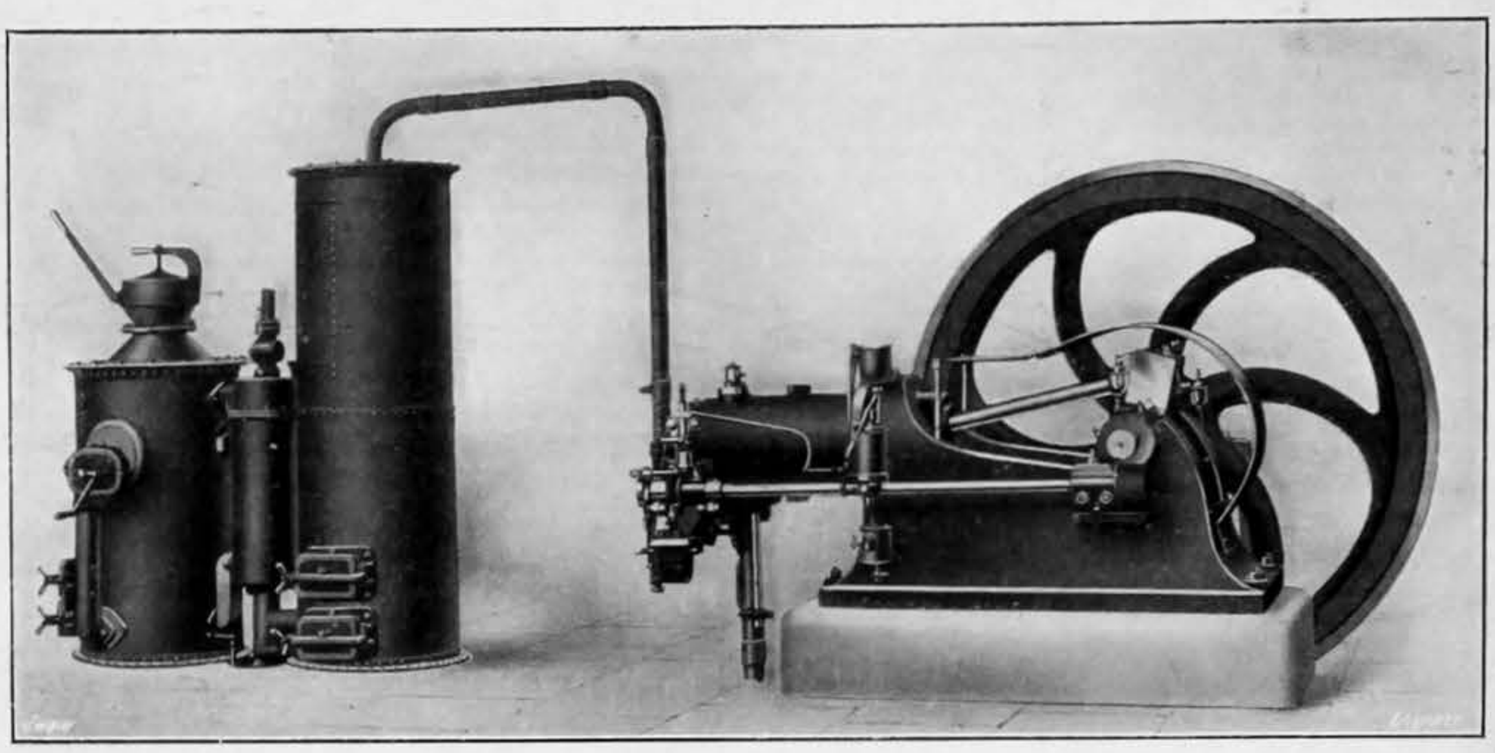


Fig. 21—VIEW OF KYNOCH'S COMPLETE INSTALLATION

The awards were published on Wednesday at the show-yard, but the judges' report will not appear for some time. The gold medal was gained by the National Gas Engine Company's 20 horse-power plant, and the silver medal by Crossley Brothers' 15 horse-power plant.

THE COMPLETION OF A CONTRACT.

THE question as to when a man who undertakes a contract for work and labour is entitled to sue for the contract price not infrequently arises in relation to engineering contracts. Suppose the contract provides that certain machines shall be supplied, erected, and put into good working order for a specified sum of money. The contractor supplies the machines and does the greater part of the work. Owing to lack of funds, or for some other reason, he does not fulfil his entire obligation. Can he recover payment for the work done? The law says "No. If the contract is entire the work must be fully performed. Otherwise he cannot recover anything." Cases may arise, however, in which the employer may be taken to have accepted that part of the work which has been performed, and he will then have to pay for it according to measure and value. In other words, to use a legal phrase, the contractor will be entitled to sue on a *quantum meruit*. But what constitutes "acceptance" of work for this purpose? If A. erects a machine on B.'s land, B. is bound to accept the result of A.'s labour; he cannot help himself. Hence the fact that an employer does not remove the work from his premises, or that he makes use of it, is not evidence of acceptance. But if he puts it out of the power of the plaintiff to complete the work, as by completing it himself or employing another contractor, then must he pay for what has been done? In a case which was recently heard in the Divisional Court, an engineering firm had contracted to move certain machinery into a laundry and to put it into "good working order." Having completed the job—as they contended—they sued for the price. The employer resisted on the ground that the work was badly done, but in one letter they wrote "we have had to call in another engineer to complete." The Court held that this was evidence of acceptance *pro tanto*, and allowed the plaintiffs to sue for the work done according to measure and value.

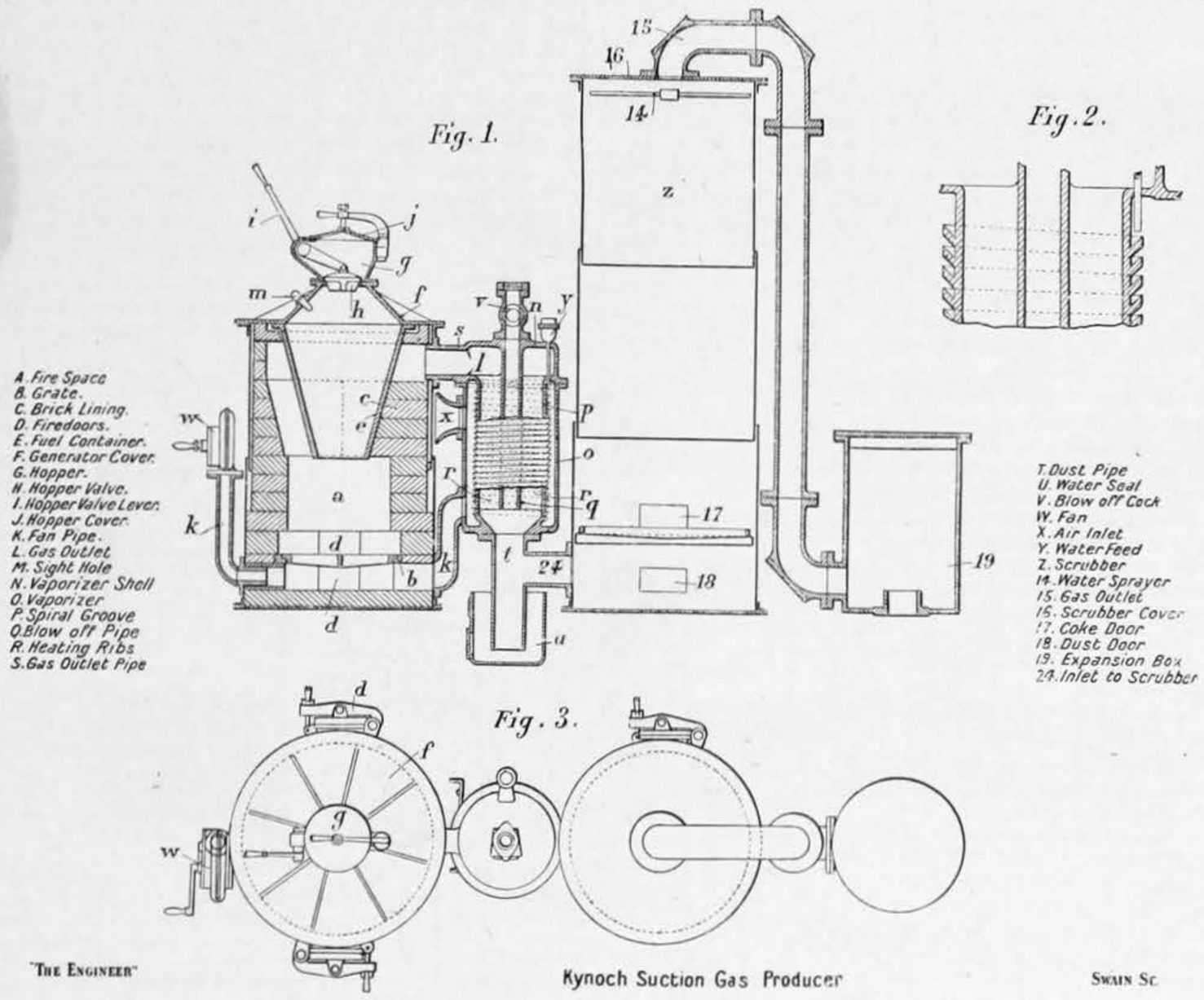


Fig. 20—SECTION OF KYNOCH'S SUCTION GAS PRODUCER

LETTERS TO THE EDITOR.

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

THE LATE MR. F. W. WEBB AND COMPOUND LOCOMOTIVES.

SIR,—In the current issue of THE ENGINEER I note a letter from a correspondent signing himself "Lynx," *à propos* of my letter of June 8th, which you were good enough to publish, in which I endeavoured to do justice to the late Mr. F. W. Webb's professional career and his services to the London and North-Western Railway. I do not think your correspondent's letter is at all likely to affect the favourable judgment regarding these points which so many members of the engineering profession and of the public who are interested in railway matters hold in common with myself, and which my letter intended and ventured to express. But there are some rather remarkable misstatements in your correspondent's letter I should like, with your permission, to correct. Personally I have the greatest possible admiration for the London and North-Western Railway generally, and, as I have already sufficiently indicated, for its locomotive department particularly; and in appreciating the latter and its late chief, I must be understood to do so defensively, and not offensively, and only because I do not think sufficient justice has been done to either.

Your correspondent's statement as to the Webb compounds having to be "assisted to start their trains out of stations for a given distance" by an engine in the rear "as a regular practice," so far from being an indubitable fact, is an indubitable error. I have certainly known trains assisted out of a station by a light engine in the rear on occasions, but not as a regular practice or when the Webb compounds specially were on the trains, but only when the excessive weight of the train, the state of the weather, and perhaps the condition of the rails, or the fact of there being a heavy adverse gradient to face at the outset may have required it; and this asistance was rendered totally irrespective of the type or duplication of the engine drawing the train. The only places on the London and North-Western Railway where I have known such starting assistance given are Euston, Carlisle, and Shrewsbury, each of which stations lies at the foot of a very heavy gradient, aggravated in the latter case by a sharp curve out of the platform. The sharp rise out of Euston to Camden-road is well-known; and at the south end of Carlisle Station begins the heavy and continuous rise to Plumpton, near Penrith. For trains stopping at Penrith as a regular thing, and for non-stopping trains in adverse weather such as one so frequently meets with on the Preston-Carlisle road, a bank engine from Tebay to Shap Summit has been a recognised thing always, and simply a means of saving time—not a reflection on the train engine's capability of getting up. And there again one has a continuous climb of over seven miles, starting on a gradient of something like 1 in 150, and consisting chiefly of 1 in 70, and the down Shap climb actually commences 1½ miles south of Tebay Station at the water troughs.

As regards the Euston incline, also 1 in 70 and a mile long, I can very well remember when all the principal trains going out of Euston were given an energetic shove up to the canal bridge and engine sheds at Camden by a small light engine, which used to lie in wait at the north end of the down platform and rush after the train and butt up against the tail of it in a fussy and amusing fashion; and this was done as a regular practice, quite regardless of the class of engine or engines pulling the train. But one day the "banker" overdid things, and owing to the clouds of steam from its own cylinder cocks or a fog, concealing the train it was to assist, it ran violently into the rear coach and butted it off the rails. After this, which was, I think, in 1889, the Board of Trade stopped the performance. Your correspondent states that the Webb compounds were bad at getting away with a train and bad timekeepers. They were nothing of the sort. As a matter of fact, the compounds worked best when working their hardest, as all compounds do, and they were first-rate hill-climbers. Their working with heavy trains up the steep hills on the Preston-Carlisle road was entirely satisfactorily, and a revelation of locomotive power and efficiency; and they could be run down hill and generally pushed without any difficulty whatever.

Your correspondent further states that they were expensive failures. I say they were economical and efficient successes, though not equally so in all classes; and I say, further, that, granted the inevitable but not very much higher first cost and repair and maintenance costs, the actual mileage costs of all the Webb compounds were no higher than for the ordinary type of locomotives. It must be remembered that the compounds, both goods and passengers, were given the heaviest traffic of the line

to deal with—that is indisputable; and the compound mileage was, per engine, very considerably higher between repairs and per annum than that of any other class of engine on the line. Your correspondent states that "the small saving in fuel consumption of the Webb compounds was a negligible quantity." That, again, is entirely wrong; but it is something for him to admit that these engines did effect any saving.

And here also I am speaking from intimate, personal, and practical knowledge, and have before me the figures for twelve consecutive months' passenger and goods locomotive working of the entire London and North-Western Railway, taken by myself from the monthly official sheets as posted up in the engine sheds, *i.e.*, total engine and train mileage, total coal, oil, and tallow consumed, and total of each per engine and train mile, wages of drivers, firemen and cleaners, and total inclusive costs per engine and train mile. Also I have similar figures for coal consumption, cost per mile, total mileage, &c., for the other twenty-four principal railways of the United Kingdom, for twelve consecutive months, and it happens that the London and North-Western Railway coal consumption per engine and train mile is ·2lb. above the average, and a long way below the maximum, while the cost per mile is appreciably below the average, and well below the maximum. And of the London and North-Western Railway engine and train mileage, that run by the Webb compounds represents a very considerable percentage. The most successful class of passenger compounds was the 7ft. or "Teutonic" class—the third in order of creation—and one of these engines did over 200,000 consecutive miles on a checked coal consumption of 32lb. per mile, working the heaviest Scotch express traffic from Euston to Carlisle and back, *i.e.*, 600 miles, each day, for six days a week. This was, of course, an exceptional duty, and a special test, repairs and special cleaning being attended to every Sunday at Crewe. But it shows what these engines were capable of doing. In fact, the general indictment, which your correspondent brings against the Webb compounds cannot possibly be sustained, either by his bare assertion, or by the actual facts of experience, which are emphatically against him.

I do not say that they were faultless or incapable of improvement; I do claim that Mr. Webb was fully justified, both by preliminary experiment and by practical results, in developing the application of the principle and his system of compound locomotives on the London and North-Western Railway as extensively as he did, and that in doing so he effected a distinct economy in his department, and neither caused the London and North-Western Railway any loss nor did the shareholders any injustice.

As to his successors' locomotives, the new powerful four wheels coupled bogie engines, I have nothing to say against them. I have had no practical experience of them other than travelling behind them and watching them at their work, but I should say they were thoroughly good engines, of satisfactorily simple design, and quite as heavy and powerful as any locomotive in this country needs to be. The six wheels coupled bogie passenger engines, of the MacIntosh type, I consider a mistake, like the rest of their kind, as the multiplication of large coupled wheels in a fast-running and heavy-working engine is not conducive to efficiency or any sort of economy, and does not leave sufficient margin of brake horse-power for the work required to be done. Too much power is absorbed in the working of the engine itself.

I must apologise for the length of this letter, Sir, and hope I may be excused for trespassing so much on your courtesy. F. A. L.

SIR,—I must say I agree with your correspondent "Lynx" that it is a great pity any attempt should be made to justify the introduction of the three-cylinder compound engines on our premier railway.

Speaking as a frequent passenger on the line, it was a marvel to me how the traffic department got through the "compound era" without serious loss of prestige.

A very consistent policy of "double-heading" on all the principal expresses was rightly adopted, as I can vouch for the fact, by repeated and exasperating experiences, that even with moderately weighted and timed trains the compounds often lost time badly. And I well remember one most aggravating delay on the curve outside Wolverhampton, when a "Dreadnought," that had lost time steadily from Crewe and was stopped by signal, was quite unable to move until a tank engine could be procured to assist her in.

Very few, I think, will deny that Mr. Whale has done the right thing in relegating the whole of these most unsatisfactory machines to their proper place—the scrap-heap; and though certain critics sneer at his new engines, and call them "glorified steam winches," my very satisfactory experiences behind them on the heaviest and fastest London-Manchester work leads me to think that they might very properly be called "glorified Dunalastairs," and I don't think higher praise could be accorded to them. They are the best timekeepers in England. G. D. S.

Manchester, June 25th.

PATENT LAW.

SIR,—It must indeed be some consolation to find that Mr. Carpmael and I are agreed upon one point, namely, that our correspondence has lasted long enough, but I cannot permit his misleading statements to close with an equally misleading summary.

The three most essential points at issue are:—

(1) Is our law for compulsory licences adequate and satisfactory?

(2) Is the grant of compulsory licences preferable to compulsory working?

(3) Is it true that if this country introduces compulsory working it would be compelled to withdraw from the international union?

I have fully dealt in a separate letter, published in your issue of June 1st, with points one and two; permit me to add only a few words to point three.

It is quite true that the Chambers' resolution proposes that patents for inventions which are worked without, but not within, the United Kingdom should be revoked, subject to certain safeguards for the protection of the owner of the patent, whether British or foreign. It is also true that, in effect, this resolution, if adopted, would chiefly concern foreign holders of British patents, but it is not in any way invidiously directed against foreigners. It would in like way compel any holder of a British patent, whatever his nationality, to work it here if he worked it abroad. I need not reiterate the arguments; the justice of the Chambers' resolution is self-evident. So far from its being true that the Chambers' proposal would necessitate the withdrawal from the Union, I have shown in my letter published in THE ENGINEER of May 18th that the International Union has actually provided for the forfeiture of patents not worked within a certain time.

The resolution unanimously passed by the United Chambers of Commerce is much more lenient to the foreign or British owner of a patent than the provision of the International Union. By the Chambers' proposal a British patent cannot be forfeited within the whole legal term of a patent so long as it is not worked abroad. The working abroad is the test whether or not the owner of the patent has got over the initial difficulties of carrying out the invention. One effect of this correspondence, in which you have been good enough to allow the controversialists full scope, is that the whole ground has been thoroughly gone over. There is, however, one disadvantage to a weekly reader—an able dialectician, such as Mr. Carpmael, if left uncorrected, is capable of making "the worse appear the better reason." Necessary correction cannot appear until the next issue, whereas the bane and its antidote ought to be taken at the same time.

The Manchester Chamber of Commerce is therefore taking steps to publish *verbatim* proceedings before Mr. Lloyd-George—and will include, Sir, with your permission, this correspondence—in pamphlet form, and its secretary will be glad to send a copy to any person who has been sufficiently interested to follow the controversy. IVAN LEVINSTEIN.

Manchester, June 20th.

BOILER EXPLOSIONS IN SINKING SHIPS.

SIR,—In your issue of May 11th I noticed a letter on the prevailing fallacy that boilers under full head of steam explode when suddenly submerged in water, and the following may be of interest in support of your correspondent's contention. In 1883 an old paddle steamer called the Yat-sai was generally overhauled and renovated, and was fitted with two new cylindrical boilers to carry 40lb. working pressure. I was invited as a guest for the trial trip of 39 miles out and back, but being very busy at the time preparing for a trial trip of my own, I did not form one of the party. About half way on the outward run one of the boilers burst, blowing away the whole side of the vessel and the superstructure, together with all the guests and officers who were at lunch.

As they sat at table each alternate one was killed. The survivors, who were said to have been thrown 100 yards, except for shock were uninjured, and heard no sound of the explosion.

It was abundantly proved that the explosion was in no way due to defects in the boiler, which had a high factor of safety in all parts, and it was understood at the time that the bursting pressure was fully 240lb.

The boilers were set very close together, and the neighbouring boiler was absolutely uninjured, although it must have been immersed in a few seconds.

When H.M.S. Victoria went down in the Levant, the survivors reported that they heard the boilers explode. But she was under full speed at the time, and she turned turtle, so that when the water reached the fires the steam generated had no free exit, and would, therefore, but on a much larger scale, make much the same noises as are made by a boiler blowing off under water. I am sure no boiler explosion took place.

I was once in the engine-room of a steamer that was very rapidly sinking and while the stokeholds were flooding. She had passed over a rock at full speed, cutting great holes in her bottom, and the sixteen fires had been pushed to the utmost. There was no explosion, but the fuss made by the water coming in sudden contact with 280 square feet of incandescent fuel might have led an outsider to describe it erroneously as such.

Victoria, B.C., Canada, May 31st. JAMES K. REBBECK, Consulting Engineer.

THE COMMERCIAL ORGANISATION OF ENGINEERING FACTORIES.

SIR,—In Mr. Henry Spencer's interesting article on the above in your issue of June 22nd, the method of drawing material from the stores by foremen's requisition notes is not altogether satisfactory. The foreman in charge of a considerable number of men should spend his whole time in supervising their work, and in performing other duties which cannot be relegated to a subordinate. A much better plan of obtaining the necessary material is to issue the requisitions and job cards for both material and labour from the shop manager's office to the foreman showing the exact quantities required, the latter being obtained from the lists of parts; this method relieves the foreman of all clerical work, excepting in cases of spoiled material, which must obviously be replaced by a special note. In this connection the system in vogue in several works for dealing with wasters consists of charging them to one of three accounts, entitled "faulty design," "faulty material," and "bad workmanship," which are placed before the works manager at stated intervals. This plan has much to recommend it, as an excellent check is thereby had on the foremen, who are thus entirely debarred from drawing stores for works order numbers.

Another point in Mr. Spencer's paper is the method of manufacturing finished parts in batches without due regard to the number of cars on order. If the latter are only being made for customers in a small way this plan is unavoidable; but in large works, where all orders are or should be for stock, batches of finished parts should exactly suit the requirements of the shops for stock car orders, with slight additions to cover breakages in some cases.

If this rule be departed from in manufacturing motor cars, which are continually being improved in design, the undertaking will be saddled sooner or later with numbers of obsolete parts which must either be scrapped or worked into cars specially designed to use them in.

Ipswich, June 26th. W. O. HORSNAILL, A.M.I. Mech. E.

IRISH LIGHT RAILWAYS.

SIR,—I think the writer of the paragraph on Donegal 3ft. gauge railways in your last issue was not sufficiently acquainted with his subject. To deal first with insufficient maintenance, I am not concerned to defend the northern line farther than to say that what one man calls penuriousness another man calls wise economy, and it is often an open question which is which.

With regard, however, to the southern line, I really must point blank deny that there are dirty engines with leaky joints to be seen on it.

Moreover, there is really no excuse for and no existence of insufficient maintenance of the State lines even if the Board of Works would permit it, because the company did not expend the capital, and cannot, therefore, expect a return on it; and as far as the southern company is concerned, on the Donegal to Killybegs portion they are indemnified against loss by portions of the county, and on the Stranorlar to Glenties there has usually been a small profit on the working. Further, both the northern and the southern companies are dividend paying lines.

With a good deal of the latter part of your article I am in agreement, especially as to the cost of complying with the requirements of the Board of Trade. On the other hand, the idea of making a road, even through the mountain districts, without fences would be quite impracticable, and any attempt to make an unfenced line through the populous parts would have had to be carried out under police protection.

With regard to train mileage, it is much more difficult to reduce with profit than a stranger passing through the country would think; and though one goods train a day each way would do all the work, you would lose all your passenger traffic except long-distance fares, for people in this country will walk long distances to save two or three pence.

Probably one goods train a day and more frequent steam motor service for passenger, parcel, and mail traffic would be more to the point. THE CHAIRMAN OF THE DONEGAL RY. CO.

June 28th.

RAIL MOTOR SERVICES.

SIR,—I note with satisfaction, which not a few of your readers will share with me, that a rail motor service connects Belmont with West Croydon. Would it be asking too much of the London, Brighton, and South Coast Railway to inaugurate a like benefit to the public between Seaford and Lewes, with halts at Iford and Piddinghoe? These halts might be connected to the towns named after them by ferries, and these ferries ought to find employment for superannuated London, Brighton, and South Coast Railway Company's servants. A half-hourly service betwixt Seaford and Lewes would be as greatly appreciated as an hourly one between Hastings and Ashford would be if the South-Eastern Railway Company thought fit to benefit the public in that locality, where a rail motor service would be an unspeakable boon.

Folkestone, June 16th. HENRY JAMES.

P.S.—How much longer will it be before the *entente cordiale* is realised sufficiently to allow of the Franco-English submarine tunnel being made?

AMERICAN NOTES.

(*From our own Correspondent.*)

NEW YORK, June 13th, 1906.

CROP reports just published to-day by the Government show the prospective wheat supply at 713,399,000 bushels. These figures have been exceeded only once, namely, in 1901, when the production was 748,460,000 bushels. Other cereal crops are similarly abundant. Advices from the south are also quite favourable as to cotton. Such conditions as these are naturally having a favourable influence upon general trade conditions.

The steel industry is still feeling the influence of a heavy demand all along the line. Announcement has been very recently made through the United States Steel Corporation of this city of the purchase by various interests of some 250,000 tons of Bessemer pig for use during the latter part of the year. Quite a number of rail contracts have also been reported from the same source, some of these contracts running into very large figures, and nearly all for next year's delivery. The reason for this activity and the accompanying demand for basic and Bessemer pig is due in large measure to a feeling of alarm among the larger producers of rails and shapes that the supply of raw material is likely to run short during the next six or eight months. In addition to this, there has been some difficulty in Bessemer furnaces obtaining a prompt supply of ore. A good many of the furnaces have been running so long without stoppage for repairs that they will soon be obliged to blow out, and this means a material decrease in the supply, and just at a time when the trade can ill afford to encounter a deficiency. The situation is critical in a measure on account of the almost unexpected presentation of extensive requirements for crude and finished material from sources of demand that were not anticipated. A great many enterprises are springing up, and the first intimation of the situation is inquiry from those promoters who desire material of various kinds furnished at dates between September and the following six or nine months. In this way the market is kept in an agitated condition, and prices, instead of showing any tendency downward, are destined to remain about where they are. There is an excellent demand for foundry irons for special purposes by hardware founders, agricultural and implement manufacturers, makers of special machinery and general jobbing houses.

The recent advices concerning copper from Montana are that the increase in production this year over last is about 20 per cent., and that the production of copper in all sections is at the rate of 90,000,000 lb. per month. Adding to this the imports, it brings the total available supply proper to about 108,000,000 lb. per month. The average export of copper, so far this year, has been 16,500,000 tons monthly, and the domestic consumption has been at the rate of 30,000 tons monthly. The total supply has exceeded the coal consumption since the first of the year by upwards of 25,000 tons. It is a question how long the accumulation of copper will continue in the face of such circumstances. Copper consumers have been looking for a decline for the reasons mentioned; but the buying up and holding of copper has thus far served to maintain prices, which at present are for August and September delivery 18½ cents for electrolitic.

NEW YORK, June 20th.

The entire steel market is in a very satisfactory condition, and a heavy demand is being developed day by day from all parts of the country. A great many new enterprises are coming to the surface, and the promoters of these enterprises are anxious to obtain material as rapidly as possible in order to prosecute work during the last half of the year. The pig iron output for the current year, it is now estimated, will reach close to 25,000,000 tons. The demand for May was unprecedented, and it is believed that this demand is partly due to the knowledge that quite a number of blast furnaces would blow out and remain out for several weeks. Quite a number have blown out within the past week, and a number will blow out within the next few days. During the past week the highest price for the year in pig iron was reached, and to-day's indications are that basic and Bessemer will go a little higher. The Cambrian Steel Company has contracted for 90,000 tons; the Republic Iron and Steel Company for 60,000 tons. The belief is that the larger concerns are stocking up for future emergencies. The steel billet market is very strong, and sales have been made for large lots at 27 dols. at Pittsburg and 28 dols. for open hearth. Large orders for corrugated iron roofing are coming from San Francisco. Plate iron has received a stimulus from the announcement that the American Shipbuilding Company has undertaken to construct ten large Lake vessels. Contracts have already been placed for two of them. The bar iron market is also active as well as the sheet iron department, and the mills are running full time and are unable to accumulate any material.

The Western implement interests are still buying freely of various kinds of steel, and the large engineering plants are also extending their engagements, and are purchasing special brands of iron for which they are glad to pay full prices. The fuel market is active, and the entire coke production is moving into consumptive channels as rapidly as cars can be loaded. The copper market is without special interest, excepting that there was a break in prices due to London advices. The total exports for the first seventeen days of June are 10,865 tons. A good deal of copper development is in progress throughout the Western mining section. It is certain that the domestic copper supply will be materially increased within the next few months. These sources of supply are under independent control. The lead market is quiet at 5·90, and spelter is selling at 6·15. The rumours are again renewed that certain large consumers of steel will place orders for supplies during the month of July, and there are some reasons for attaching importance to them. The producing interests are content with the situation as it is, as the mills are overloaded with orders, and the current requirements from small buyers will be sufficient to absorb their entire spare capacity.

THE work of extending the Freycinet Docks at Dunkirk, authorised by the law of December 24th, 1903, has been commenced. The work comprises the lengthening of the existing dock accommodation by about a mile of quays. This has necessitated the cutting of the fortifications on the western side of the town, which has been begun, and as the docks will occupy the site of maritime goods sidings of the Northern Railway it is intended to remove the fortifications to about 1½ miles distance, which will then leave space for further docks.

CONTRACTS.—We are informed that the North-Eastern Railway Company has placed an order for two 30-ton chain-testing machines with Messrs. W. and T. Avery, Limited, of the Soho Foundry, Birmingham. This firm has also secured an order from the Mersey Dock and Harbour Board for two 30-ton improved railway weighbridges, sufficiently strong to allow of a 60-ton locomotive passing over.—The Mirrlees Watson Company has recently secured a number of important contracts for independent condensing plant, including the following:—A surface condensing plant to work in connection with a 3000-kilowatt Willans turbine for City of Leeds electric lighting station; an elevated self-draining counter-current jet condensing plant, dealing with 80,000 lb. of steam per hour, for the Dalzell Steel Works, Motherwell—Messrs. David Colville and Sons, Limited.—The Leyton Council have accepted the tender of Messrs. Helliwell and Co., Limited, of Brighouse, Yorkshire, for the glazing required to their new car sheds, the glazing to be on their "Perfection" system. The same company has also in hand the glazing for the extensions to the power station. Messrs. William Simons and Co., of Renfrew, have received an order from the Crown Agents to construct a 1200-ton twin-screw sand pump hopper dredger, fitted with special appliances for dredging the bar at Lagos, West Coast of Africa.

PORT IMPROVEMENTS AT HARTLEPOOL.

FOR many years the port of Hartlepool, well known for its imports of timber and iron ore, exports of coal, and the product of its shipbuilding yards, has held a high place among British seaports. The ever-increasing tonnage of modern ships, however, and the demand of traders and shipbuilders for greater facilities and accommodation, have caused the North-Eastern Railway Company and the Port and Harbour Commission—the two bodies which jointly control the port—to embark on an extensive policy of harbour improvement. The preliminaries for this work have already commenced.

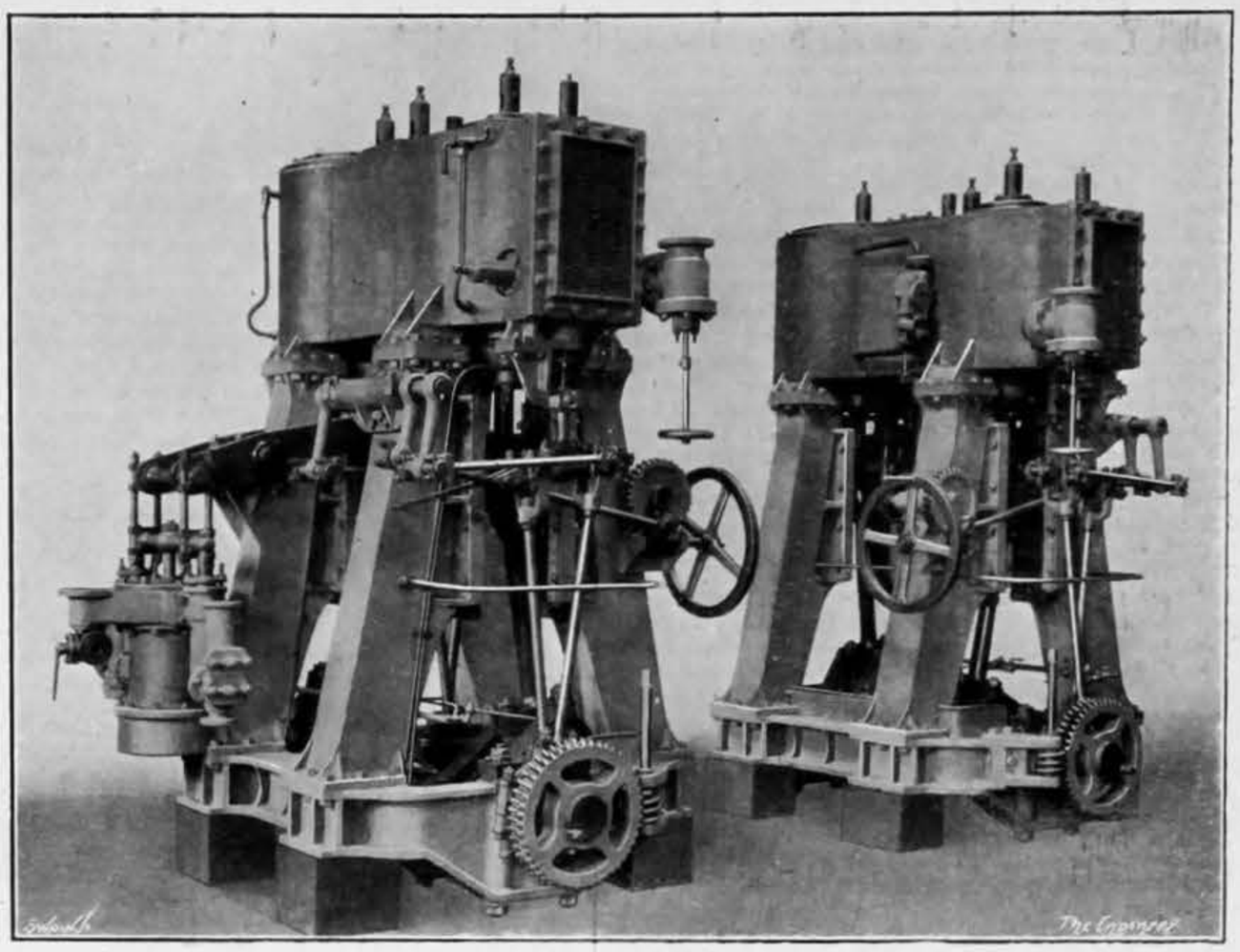
The railway company is now engaged in dredging the old harbour, which will eventually be deepened to 24ft. at low water of spring tides. The old-fashioned coal spouts between the old harbour and the Victoria Dock have been removed, and the quay is being set back and reconstructed so that the largest vessels can lie alongside at all states of the tide, and can be quickly coaled by hydraulic coal hoists of the most modern description. An entrance, 80ft. wide, spanned by a swing bridge, is to be cut through the existing fish quay into the mud flat known as the Slake, which will be converted into a tidal basin of some 12¾ acres in extent, having a depth at low water of spring tides of 24ft. Accommodation will be found for fishing craft at a new fish quay of over 600ft. in length at the north-east corner of this basin, adjoining the main road and the railway. On the south side of the basin will be a quay of over 800ft. in length, where new ships of the largest dimensions can be fitted with engines, boilers, and machinery. A new entrance, 70ft. wide, with hydraulically operated gates and a depth of 30ft. on the sill, will be made into the North Basin, in order that the largest class of cargo vessels may be admitted to the docks. The company's existing graving dock of 570ft. in length will also be widened and generally improved.

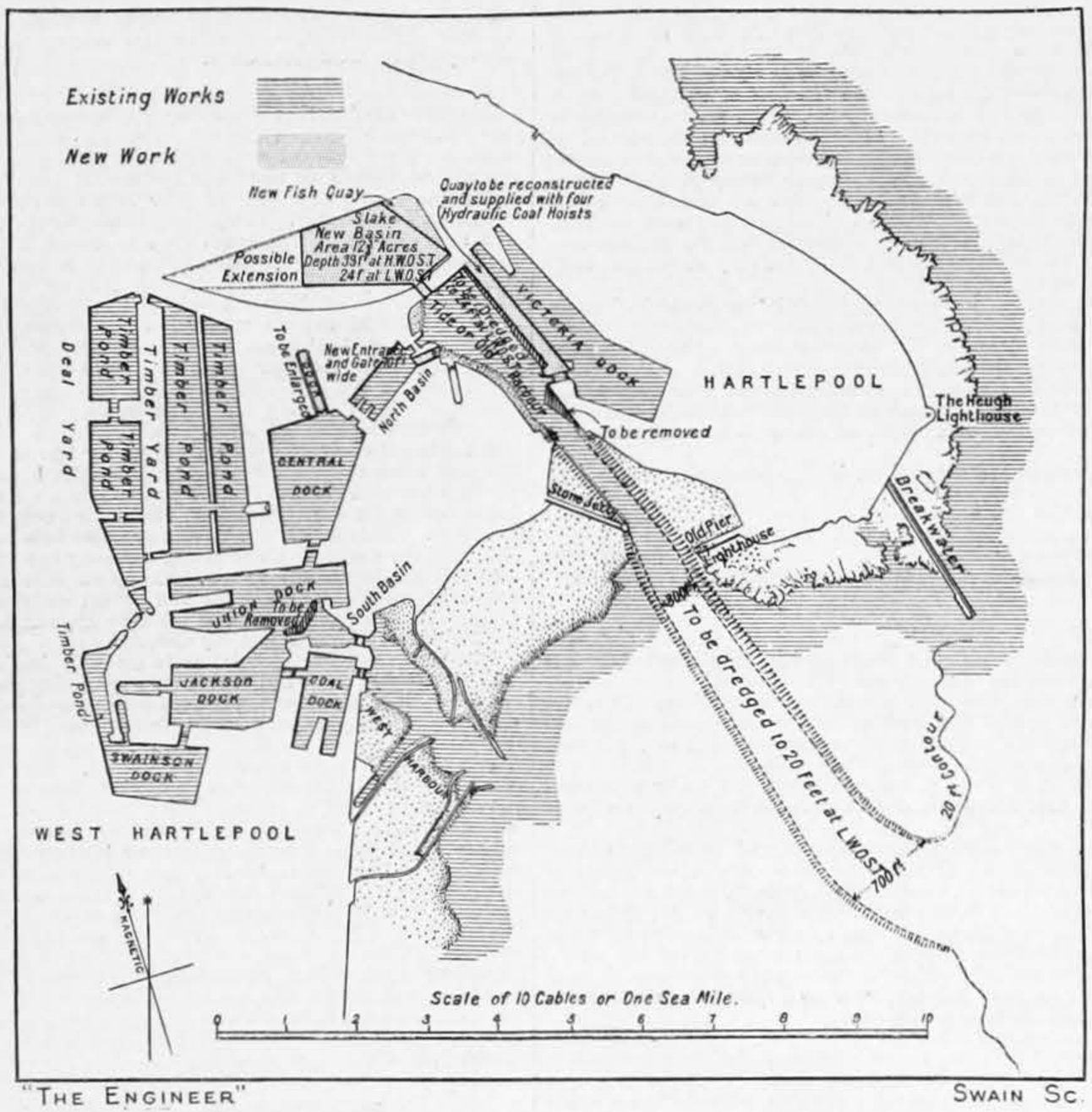
The Port and Harbour Commissioners on their part, acting on the advice of their engineer, Mr. J. D. Howkins, have decided to deepen the entrance channel to the port from its present depth of about 13ft. at low water of spring tides to a minimum of 18ft. at the inner end and 20ft. at the outer. As the rise of spring tides is 15ft., the depth at high-water will thus be from 33ft. to 35ft. For this purpose they have added to their existing dredging plant by the purchase of a new dredger and steam hopper barge. The dredger named "Hartness," an illustration of which is given below, has just been completed at the yard of Messrs. Fleming and Ferguson, Limited, of Paisley, to the requirements of the Commissioners' engineer. She is of the barge-loading, self-propelling type, and is capable of a minimum output of 600 tons per hour at a depth of 40ft. Her dimensions are—length, 160ft. overall; beam, 30ft.; and moulded depth, 12ft. Steam at 120 lb. pressure is supplied by two single-ended marine boilers of 9ft. 6in. diameter by 8ft. 6in. long to a compound inverted surface-condensing engine, having cylinders of 20in. and 40in. diameter by 24in. stroke. The buckets are of 16 cubic feet capacity, are specially designed to cut and deliver clay, and can be run at a speed of either 18 or 14 per minute. Two powerful steam winches are fitted at bow and stern for operating the mooring chains. The shoots are also worked by steam power, and the ladder is served by a powerful two-cylinder hoisting engine.

The steam hopper barge, built by Messrs. J. T. Eltringham and Co., and engined by Messrs. Hepple and Co., both of South Shields, is a twin-screw vessel of 127ft. by 29ft. by 12ft. Her hopper capacity, exclusive of coamings, is 500 tons, and her speed 9 knots. The hopper doors are lowered and raised by powerful steam winches, and a winch is also fitted forward for lifting chains and anchors and laying moorings. A view of this vessel is also given below, and an engraving of her engines above.

It is anticipated that with the dredging plant now available the required depth in the Commissioners' channel will be obtained in a couple of years. Dredging operations will then be directed to still further widening and improving the channel. A drawing of the port showing the old and new works is given herewith.

ENGINES OF HOPPER BARGE FOR HARTLEPOOL



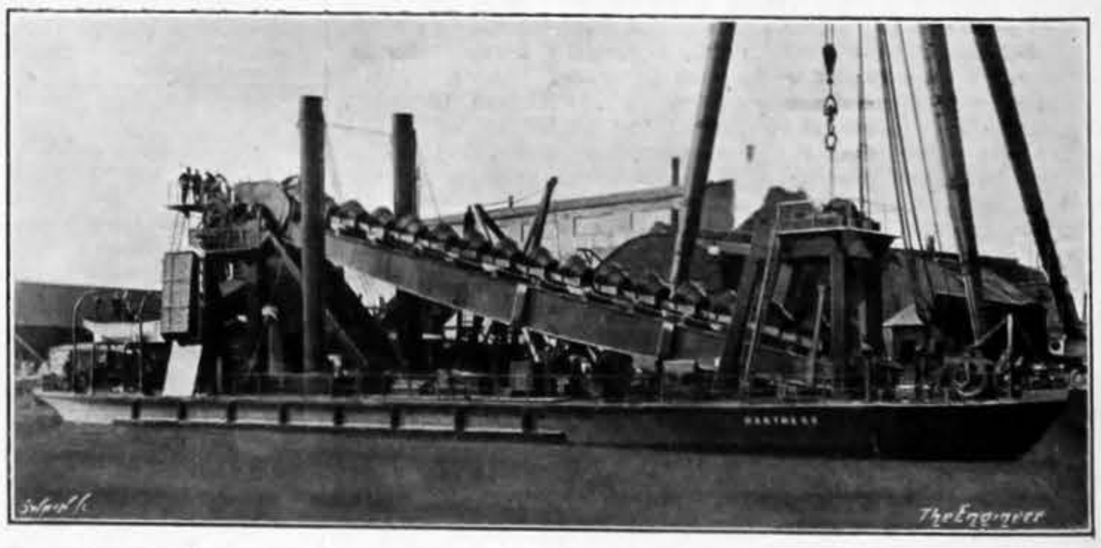


HARTLEPOOL DOCKS

NEW FIFESHIRE RAILWAY.

A BILL for the construction of what is named the Newburgh and North of Fife Railway was obtained as long ago as 1897, but owing largely to the position of railways generally during the succeeding years, nothing was done till recently towards raising the money necessary for making the line. Now, however, contracts for the construction of the railway have been let, and the work will be proceeded with at once. The new railway will open up one of the most attractive parts of Fife to the public of Dundee, Perth, and intervening places on the south side of the river Tay. It commences by the junction with the North British main line at Glenburnie, and passes through the villages of Lindores and Kilmany. It then follows the line of the Motray Water and joins the North British main line to Aberdeen at St. Fort Station. At this end there is a loop line turning south towards Leuchars and St. Andrews. This loop is made so as to afford through communication from the West and North of Scotland to St. Andrews and the east of Fife district. In addition to the advantages which will be derived from the line by those resident in the district, its construction will provide a direct through route from Perth and places north and west of it with Dundee, Broughty Ferry, Monifieth, Carnoustie, Arbroath, and Montrose on the East Coast, as well as St. Andrews and the East Fife Coast, without the drawback which at present exists at Dundee through passengers having to go from the west to the east station. By its construction the last link in a continuous line of railway from the north of Aberdeenshire to Berwick along the East Coast will be supplied. This line, which is twelve miles long, is being constructed by a separate company, and is to be worked by the North British Railway Company under agreement.

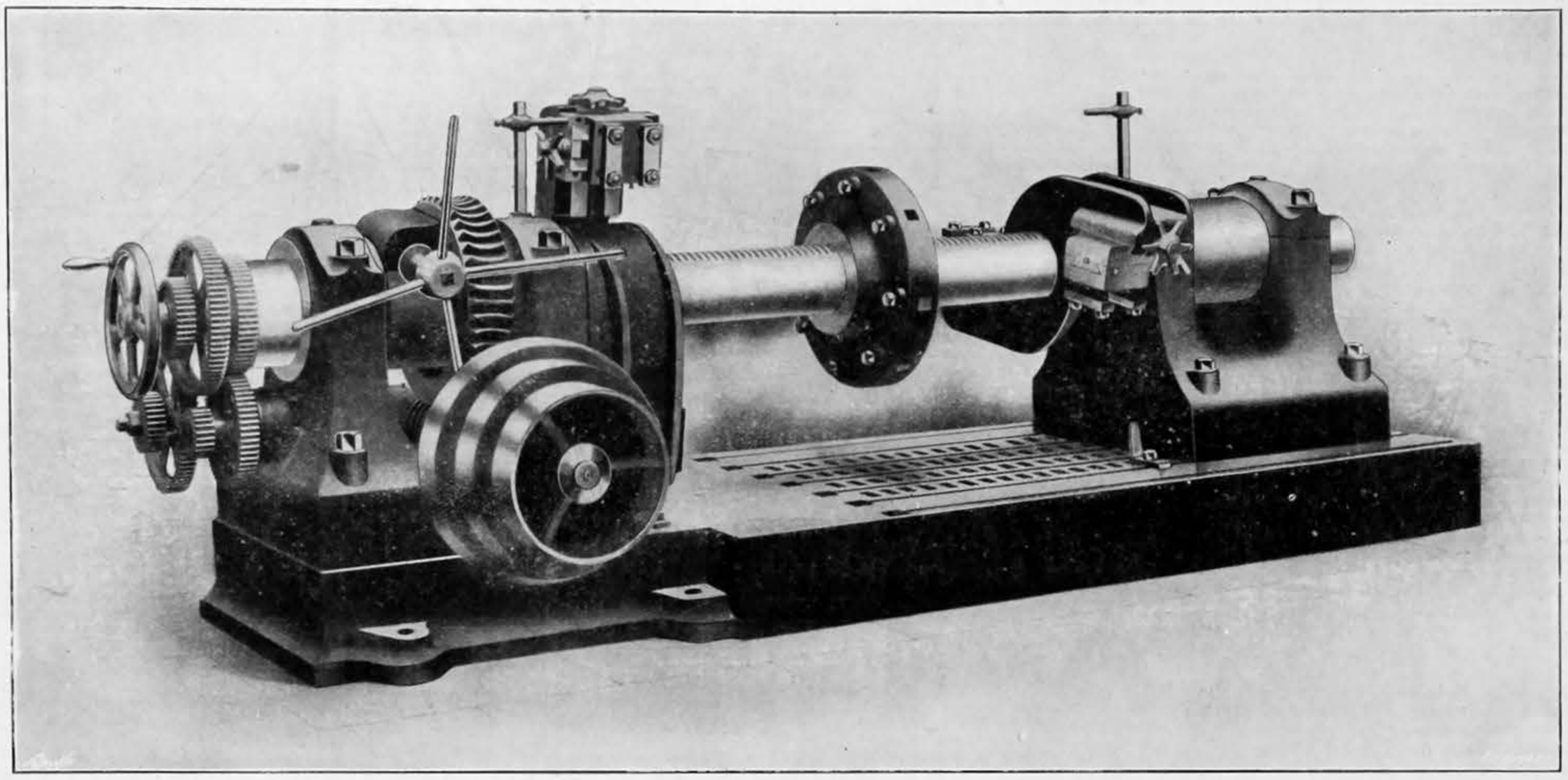
STEAM HOPPER BARGE



HARTLEPOOL DREDGER HARTNESS

BORING MACHINE

POLLOCK AND MACNAB, LIMITED, BREDBURY, ENGINEERS



HORIZONTAL BORING MACHINE.

A BORING machine designed and made by Pollock and Macnab, Limited, Bredbury, near Manchester, for machining cylinders, stern frames, &c., forms the subject of the illustration above. The driving head is actuated by a three-speed cone through worm gear on a sleeve, through which the boring bar travels, the sleeve being carried in two journals, with loose caps. The travelling head is mounted on the bar, and is moved along by a screw and nut, the screw extending the whole length of the bar. The head can be moved along by a hand wheel, or by power through feed wheels. Two facing heads, each having two tool-boxes, are provided. The facing tools are fed to and from the centre of the spindle by star wheels or by hand for setting in the usual way, and a hand setting up motion for adjusting the depth of cut without having to move the tools in the tool-boxes is provided. The boring head has square holes, in which cutting tools are held by set screws. The bar is of mild steel; the feed screw lies in a slot, which serves also to drive the boring head and the two facing heads. A rack is cut on the circumference of the boring bar for adjusting by hand by means of the pinion fixed to the main worm driving wheel. The bar is carried in a sleeve in the loose headstock. The base-plate is 10ft. long over all by 3ft. 6in. wide by 9in. deep, with T-slots and barring holes—the slots being planed out and under-cut for easy adjustment of the holding-down bolts. The maximum distance between the two facing heads is 3ft. 6in.; the diameter of boring bar, 7in.; its length over all, 10ft.; the largest cone is 20in. diameter by 4in. broad. This machine, which is one of several sizes, will bore 3ft. 6in. long; the feeds vary between 4 and 35 per inch, and the maximum gear ratio is 45 to 1.

AMERICAN ENGINEERING NEWS.

Bascule bridges.—In bascule bridges of the trunnion type, revolving on fixed bearings, a deep tail pit extending below the water line is almost invariably required to receive the counterweight arm, and this not only adds considerably to the cost of foundation and masonry work, but is difficult to make water-tight, and is more or less of a nuisance. In the Strauss design of bascule bridge, which has been adopted in several cases in the United States, the tail pit does not extend to the water line. This is effected by making the counterweight separate from the tail ends of the trusses, and supporting it from the trusses by a system of hinged links, so that the movement is in practically a parabolic curve, and the counterweight box remains all the time in a horizontal position. It may be built with the counterweight beneath or above the bridge. In the former case the tail ends of the trusses are carried under the floor of the fixed approach, and between them is hung the rectangular counterweight box, which is usually shallow, but wide and long. In the latter case the box is deep and narrow, and often placed excentrically in relation to the supporting tail pins. When the bridge is lowered the counterweight is above the headway clearance line; when the bridge is open the counterweight is within a short distance of the pavement of the approach. This latter arrangement has been adopted in the new Knippel bridge at Copenhagen, Denmark, where the counterweight will move between the towers of ornamental entrance gateways or portals.

A large rock-crushing plant.—A large stone-crushing plant, with a capacity of 7000 tons of product per day of ten hours, and operated entirely by electricity, has recently been built at Little Falls. The larger stone will be used for roads, railway ballast, concrete, &c., and the dust and fine screenings will be used in making cement bricks and concrete blocks at a plant operated by the stone company. The crusher is of the McCully vertical gyratory type, the gyrating shaft weighing about 9 tons, and the weight of the entire machine being about 110 tons; its height is 25ft. It has three feed openings 2ft. wide and 5½ft. long, so that it will take in stones of practically any size that may be fed to it, and it will be fed direct by small trucks from the quarry. The stone is delivered from the main crusher mainly as 5in. cubes, and falls upon a belt conveyor 32in. wide and 25ft. long, which delivers it to an inclined bucket conveyor or lift 60ft. long, from which it is discharged into two revolving perforated screens. These screens are 5ft. diameter and 15ft. long, supported by bearing rollers at the receiving end and at the middle. The discharge end is free. The rejections from these screens pass to four smaller crushers, the product from which is delivered into the conveyor, which again discharges it into the screens. The stone passing through the perforations of these screens falls upon a belt conveyor, and is delivered to two 35ft. sizing screens, from which it is delivered to the storage bins, which are 117ft. by 34ft. and 30ft. deep, with a capacity for 4500 cubic yards. These bins are built of reinforced concrete. The crusher is driven at a speed of 350 revolutions at the main shaft, giving 135 revolutions of the gyrating shaft; for the full capacity of 700 tons per hour it requires about 175 horse-power.

Geared locomotives.—The Chesapeake and Ohio Railway, is using six geared locomotives of the Shay type for steep-grade branches to mines. A three-cylinder vertical engine at one side of the fire-box drives a crank shaft connected by flexible sleeve couplings with shafts or bogies under the boiler and coal bunker, and on two bogies under the tender. These shafts have bevel pinions gearing with bevel wheels bolted to the faces of the bogie wheels. The total tractive effort is 53,000 lb., and the principal dimensions are as follows:—

Cylinders, three	17in. by 18in.
Cylinder volume	7·09 cu. ft.
Wheels, engine and tender	3ft. 10in.
Wheel base of each bogie	5ft. 4in.
Wheel base of engine	34ft. 4in.
Wheel base of engine and tender	58ft. 4in.
Length over all	70ft. 6in.
Boiler diameter	5ft. 2in.
Steam pressure	200 lb.
Fire-box	9ft. 6in. by 5ft. 1¼in.
Fire-box, depth at front	6ft. 10½in.
Fire-box, depth at back	6ft. 6¾in.
Tubes: number, 316; length	13ft. 6in.
Heating surface, fire-box	180 sq. ft.
Heating surface, tubes	2220 sq. ft.
Heating surface, total	2400 sq. ft.
Grate surface	48½ sq. ft.
Coal in engine bunker	9 tons
Water in tender tank	8000 gallons
Weight on front bogie of engine	47½ tons
Weight on rear bogie of engine	46 tons
Weight on front bogie of tender	36 tons
Weight on rear bogie of tender	35 tons
Weight of engine	93½ tons
Weight of tender	71 tons
Weight of engine and tender	164½ tons

Electric rack-rail haulage in mines.—The Donohoe coal mines have a rack-rail and cog-wheel system of underground haulage, operated by electric locomotives. The haulage ways are lighted by electricity, and the pumping is done by electrically-driven triplex and centrifugal pumps. There are five main entries, the middle entry being the main air course, with haulage-way and air-way on each side. The entries follow the line of dip, and from them on each side at 500ft. intervals are face entries driven on the level. This arrangement gives a large tonnage of output per horse used in gathering, while all uphill hauling is done by the electric locomotives. The main haulage-way is 3000ft. long, with gradients of 1 in 42 to 1 in 25, although originally there were gradients as steep as 1 in 13. The five entries have a total length of about 10,000ft. The locomotives run into side entries to partings at which loaded trips are gathered by horses. As these increase and cause inconveniently large hauls for the horses the rack-rail permanent way is extended, using worn out material from the main haulage lines, these side entries being level. At each entry is a coloured electric lamp, which is lighted by a switch when a trip in the entry is ready for the locomotive. The voltage used is 250, and there are two four-axle locomotives of 160 horse-power. The rack is between the rails, and is a slotted plate with its sides sandwiched between two timbers, leaving only an opening wide enough for the collecting cog-wheel on the locomotive, the rack-rail being the conductor. In one test thirty-five trips were hauled from seven entries, with a total of 828 wagons or 93 tons per trip. The total distance travelled by the engine was 40 miles, and the total load was about 3100 tons, of which the coal itself represented about 1900 tons.

STEAMER FOR LAKE VICTORIA NYANZA.

THERE has recently been shipped to Mombassa from the yard of Bow, McLachlan and Co., Limited, Paisley, a new steel twin-screw steamer named the Clement Hill, which is

BOW OF THE CLEMENT HILL

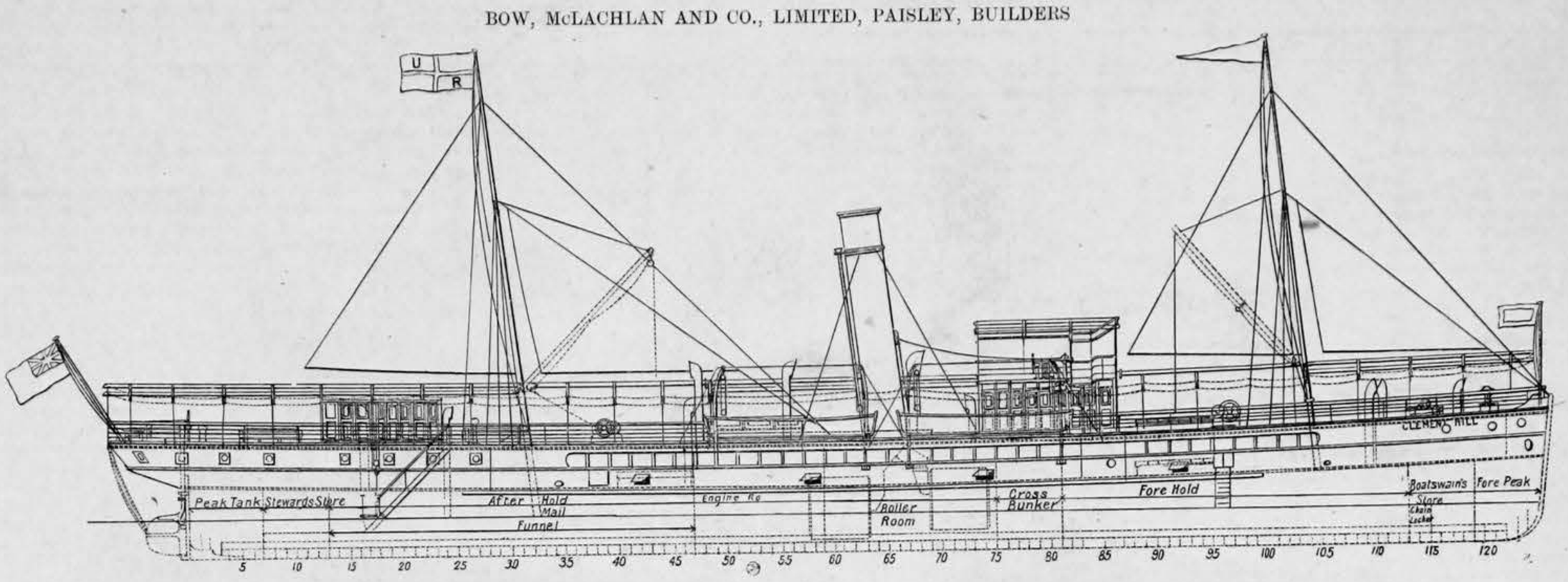
intended for service on Lake Victoria Nyanza. This vessel, drawings of which are given on the next page, has been constructed to the order of the Crown Agents for the Colonies from designs by Messrs. Rendel and Robertson. Her principal dimensions are—length over all, 232ft.; length between perpendiculars, 220ft.; breadth moulded, 32ft. 3in.; depth moulded, 10ft. The propelling machinery fitted is of the

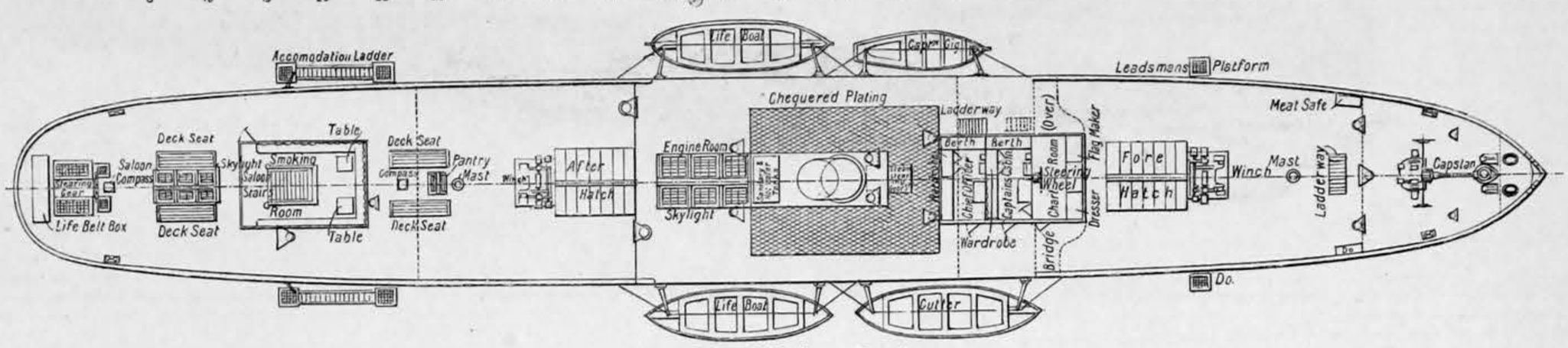
STERN OF THE CLEMENT HILL

twin-screw triple-expansion surface-condensing type, which is supplied with steam by three horizontal return-tube boilers. The vessel is fully equipped with up-to-date appliances for the expeditious handling of cargo, and is also provided with

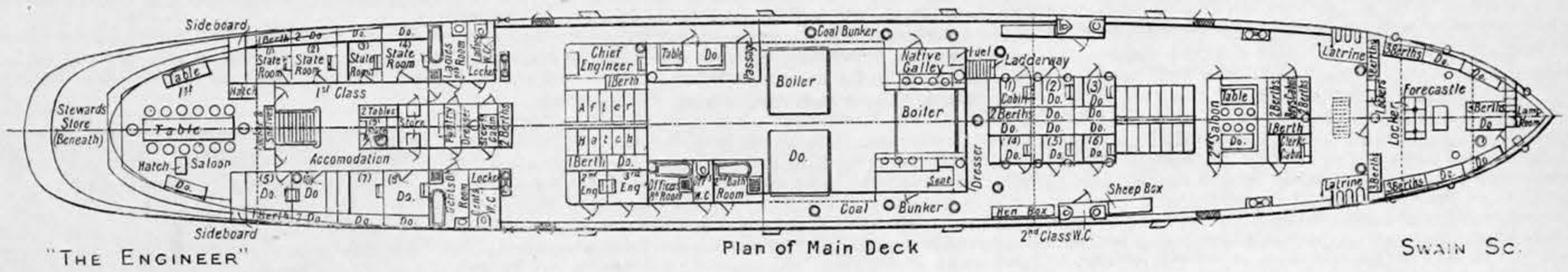
TWIN-SCREW STEAMER FOR LAKE VICTORIA NYANZA

BOW, McLACHLAN AND CO., LIMITED, PAISLEY, BUILDERS





Plan of Shelter Deck.



Plan of Main Deck

"THE ENGINEER" SWAIN Sc.

accommodation for first and second-class passengers, and for natives. The first-class accommodation is of a complete nature in anticipation of increased passenger traffic on the lake when the new Cape to Cairo Railway is completed.

Electric light is fitted throughout the steamer, the engines and dynamo, &c., being of the builders' own make, and the saloons and cabins are equipped with an installation of electrically-driven fans for ventilating purposes. The engravings on the previous page show the vessel erected complete in the yard of the builders, where she was put through a successful steam trial. After being suitably marked for re-erection at the lake side the vessel was taken to pieces, packed and shipped on board an export steamer to Port Kilindini, and from there she will be conveyed to the lake side over the Uganda Railway. This is the third steamer by the same builders for service on the lake, the two former being named the Winifred and the Sybil.

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

(From our own Correspondent.)

Raw Iron Trade.

IN pig iron the only relief to the surrounding weakness is seen in respect of Lincolnshire qualities. Foundry and forge sorts of this material have been this week officially advanced 1s. 6d. per ton, and basic iron 2s. per ton. The minimum official price, free on rail, is now as follows:—Foundry iron, 62s. 6d.; forge iron, 50s.; and basic iron, 53s. per ton.

Black and Galvanised Sheets.

The galvanisers are decidedly busier than a while ago, and the effect is witnessed in activity at the black sheet iron mills. Ironmasters in this branch are much better occupied, and a hopeful view is taken of the future. Quotations are firmer, and £7 17s. 6d. to £8 is now obtainable for sheets of 24 w.g., while material of 20 w.g. is £7 15s. to £7 17s. 6d., and of 27 and 28 w.g. £8 10s. to £8 12s. 6d. The Galvanised Iron Association report that there are plenty of orders, and prices are strong; £12 10s. to £12 12s. 6d. is being got for galvanised corrugated "doubles."

Revival Needed in Bar Iron.

Revival is greatly needed in the unmarked bar trade. Demand from various causes has dropped off very much in this branch, and the competition for orders has brought prices down to a very low level. Improvement is promised after the quarterly meeting, which is fixed for July 12th, but it is at present difficult to see where it is to come from. Quotations are £6 5s. to £6 10s. per ton. There is a steady trade in marked Staffordshire bars, on the £9 basis for chain and anchor making, Admiralty work, and other purposes. Second grade best bars are £8. North Staffordshire bars keep at £7 5s., with a steady trade. Hoop iron of South Staffordshire make is £7 15s., and gas tube strip £6 12s. 6d. to £6 15s. per ton.

Steel Trade Good.

Steel occupies a sound position, and buyers have to be very pressing to obtain supplies, so busy are producers. The buyers have little to complain about, however, on the score of price. Steel makers, probably warned by previous experience anent foreign competition, are not taking undue advantage of the present buoyancy of demand to advance prices of rolled material. In this they are wise. The rise in finished steel has been very small. Mild steel bars are quoted £7 10s. to £7 15s.; engineering angles, £6 15s. to £7; and girder plates, £7 10s. to £7 15s.

Steel Rails.

Steel masters are watching with mixed feelings the information concerning the continued development of Canada's steel rail works for the supply of her own needs. Cable advices this week from America state that, owing to the pressure at American rail mills, heavy contracts for rails have just gone to Canada, where the works in Nova Scotia and Ontario are developing into big producers. The important contracts for steel rails required in the construction of the Grand Trunk Pacific Railway, which have just been divided by the Canadian Government between the Dominion Iron and Steel Company, Sidney, Cape Breton, and the Iron Company at Sault St. Marie, mark the transition in Canada from dependence upon British, American, or Continental manufactures to complete native producing. Already Canada is manufacturing rails at the rate of 350,000 tons per annum. This large quantity for so young a country may be increased indefinately, it is stated. An engineering expert, who has just returned from travelling in the Dominion states this week, locally, that British railmakers need not much longer anticipate any considerable market in Canada. If English makers desire to participate in the passing "boom," this authority pronounces that their only course is to imitate American enterprise, and establish branch steel works in Canada itself.

Engineering.

The engineering trades in Birmingham and district continue under considerable pressure for the execution of orders, as they have been since the year commenced. The railway wagon-building shops are being worked to their fullest capacity, night shifts having been requisitioned at some concerns. Good orders for wagons are forthcoming both from this country and abroad. The bridge-building yards are in regular employment. It has to be remembered in this connection, too, that improvements in their equipment and economy have materially enlarged their output during recent years. The different departments of the machinery trades are mostly busy. Many of the leading machinists are running plant overtime to keep pace with the demand. Makers of suction gas plants are in steady occupation.

Tin.

Birmingham manufacturers who have been inconvenienced by the advances in the metal market are very curious concerning a question which is to be asked of the President of the Board of Trade in Parliament next week by Mr. William Field. The President is to be asked "if he is aware that owing to American gambling in warrants in tin in London a corner was lately formed, and the price artificially raised to £203 per ton." Loss to British manufacturers in Birmingham, the Midlands, and South Wales is alleged. Further, the President is to be asked "whether he is aware that owing to the action of a bear clique in London, the corner has now collapsed, and that the price has already declined in a state of panic some £30 per ton, or to £174, thereby again jeopardising the whole trade?" The reply of Mr. Lloyd-George will be awaited with interest. Mr. Field wants the Government to prevent a recurrence of the gambling, but it is a foregone conclusion that they can do nothing.

Profit Sharing.

A profit-sharing scheme is in operation at Stafford in the gas and electric lighting departments of the Corporation, and the clerks and workmen of the gas department have just received a bonus for the past year representing 7½ per cent. on their wages, and the same classes of labour in the electric lighting department have received a 6½ per cent. bonus.

NOTES FROM LANCASHIRE.

(From our own Correspondents.)

MANCHESTER, June 28th.

The Engineering Outlook.

FROM a conversation with the leading member of a large engineering firm in the Manchester district, we gathered that there is great briskness in most departments of this important industry. There is, however, an undercurrent of discontent amongst the men with the present conditions of labour, and in common with artisans in other trades, they are agitating for an advance of wages, and even a rescission of former agreements for the regulation of disputes and other points at present dealt with by arbitration. No doubt there is much to be said on both sides—by the men, that the present busy state of trade warrants a substantial advance in wages; on the part of the employers, that competition is exceedingly keen, and that orders are obtainable only by exercise of the utmost economy in production, &c. A conference will be held, when the points involved will be fully discussed, and it is to be hoped, in the interests of all concerned, that an amicable and mutually advantageous understanding may be arrived at.

The Pig Iron Position.

While there has been little or no change to record on the week, the position of pig iron remains very uncertain. There are many who think that the present lull is only of a temporary character, while others of the "bear" order are very pessimistic. Having made searching inquiries, we should be inclined to say that, having in view the continuance of heavy shipments and the small quantity going into stock, matters should improve rather than otherwise. Amongst consumers here there is no disposition to speculate, and practically they only cover immediate wants. The fact of the premium which has been asked for Lincolnshire foundry and forge iron was confirmed at the Saturday's meeting, coupled with a certain stiffness amongst English makers, points to a better state of things. On the other hand, Scotch pig, as also hematite, has given way by about 6d. per ton, and in second hands iron is being offered at under makers' rates. June, of course, is always a bad month, and this should be taken into consideration in estimating the various factors which go to make up the position.

Finished Iron.

Merchants report a very level trade passing. Bar makers in the district adhere to their quotations, and are well booked forward.

Steel and Semi Products.

Billets remain very steady, and there is a fair demand for plates.

Manufactured Copper.

Last week's reduction in sheets does not seem to have given any stimulus to the demand, and there is also very limited inquiry for both copper and brass tubes. The way in which raw copper was rushed up has been followed by a reaction, and buyers are holding off in anticipation of lower prices.

Sheet Lead.

Steady and unchanged.

Quotations.

Pig iron: Lancashire No. 3 foundry, 61s.; Lincolnshire, 56s. to 56s. 6d.; Derbyshire, 57s. 6d.; Staffordshire, 55s.; Middlesbrough, open brands, 59s. 4d. to 59s. 8d. Scotch: Gartsherrie, 63s. 6d. to 63s. 9d.; Glengarnock, 61s. 6d. to 61s. 9d.; Eglinton, 61s.; Dalmellington, 60s. 6d., delivered Manchester. West Coast hematite, 65s. 3d., f.o.t.; East Coast ditto, 66s. 6d. f.o.t. Scotch, delivered Heysham: Gartsherrie,

62s. 6d. to 62s. 9d.; Glengarnock, 59s. 6d. to 59s. 9d.; Eglinton, 59s.; Dalmellington, 58s. 6d. Delivered Preston: Gartsherrie, 62s. 6d. to 62s. 9d.; Glengarnock, 60s. 6d. to 60s. 9d.; Eglinton, 60s.; Dalmellington, 59s. 6d. Finished iron: Bars, £7 5s.; hoops, £7 17s. 6d.; sheets, £8 7s. 6d. to £8 12s. 6d. Steel: Bars, £7 5s.; hoops, £7 15s.; boiler plates (official), £8 12s. 6d.; plates for tank, girder, and bridge work, £7 7s. 6d. to £7 12s. 6d.; English billets, £5 7s. 6d. to £5 15s.; sheets, £8 17s. 6d. Copper: Sheets, £96 per ton; seamless copper tubes, 11¾d.; brazed ditto, 11½d.; seamless brass tubes, 9½d.; condenser, 10½d.; brazed brass tubes, 10½d. to 10¾d.; rolled brass, 8¾d. to 9d.; brass wire, 8¾d. to 9d. per lb. Sheet lead, £19 15s. per ton.

Lancashire Coal Trade.

Short time is becoming general owing to the limited demand for house and shipping coal, and this causes a scarcity of slack and engine fuel generally. Meantime, prices tend in buyers' favour, although colliery owners, in most cases, adhere to official rates. Ordinary quotations are: Best coal, for domestic purposes, 13s. to 14s.; seconds, 12s. to 12s. 6d.; common, 9s. to 10s.; best engine fuel, 8s. 2d. to 8s. 11d.; steam and forge coal, best, 8s. 8d. to 9s. 3d.; best slack, 7s. to 7s. 6d.; medium, 6s. 5d. to 7s. 2d.; common, 5s. 5d. to 6s. 2d., at the pit; screened coal, 10s. to 10s. 3d.; unscreened, 9s. 6d. to 9s. 9d., delivered Manchester Ship Canal.

BARROW-IN-FURNESS, June 28th.

Hematites.

The hematite market remains remarkably active, seeing that general indications foreshadow a reduction of business, by the falling off in the demand from the chief sources of consumption—steel rails and steel plates. Makers are, however, very busy, and are well sold forward. They are producing as much iron as is possible with the plant they have available, and it is all going into consumption. Further than this, 1126 tons have been cleared out of warrant stock this week, and there is now on hand 74,145 tons. Makers hold comparatively small stocks. There are 38 furnaces in blast, and it is intended to put one or two charcoal furnaces in blast at an early date, but it is thought probable first of all that one or two of the furnaces now producing hematite iron will either be blown out or damped down at an early date, and, secondly, that prices will be easier before long. This prospect is doubtless keeping back some prospective business, and it is quite probable when lower values are reached a better demand will spring up from the users of iron in the steel trade who stand the chance of getting new orders if they can submit lower prices for rails and plates. Some good sales of ferro-manganese and spiegeleisen are reported, and in a short time the Workington Iron Company will enter the market with spelter produced from the dust which accumulates in the flues connected with furnaces engaged in the production of spiegeleisen. The demand for forge and foundry iron is quiet, but there are still large sales of scrap iron and other metals, some of which are produced from the breaking up of old warships at Morecambe and elsewhere. Iron ore is in good demand, and business is being done on a comparatively large scale forward, as the native supply is inadequate for the furnaces in the district, and large supplementary supplies are therefore obtained from foreign sources. Prices are steady at late rates.

Steel.

The outlook in the steel trade is not satisfactory. Although full time is being worked at the rail mills, the orders in the market are not numerous, and probably it will soon be necessary to curtail the output. Prices are steady at £6 7s. 6d. per ton for heavy sections net f.o.b. Shipbuilding material is in quiet demand. Plates are quoted at £7 7s. 6d. net cash. There are still some prospects of local orders for shipbuilding material. Merchant steel is very quiet. Steel foundries are only about half employed. The British Griffin Chilled Iron Casting Company is busy on wheels and other classes of castings.

Shipbuilding and Engineering.

Owing to the scarcity of orders in shipbuilding there is some talk of putting down two large cargo steamers for a possible purchaser. The Chilian Government are wanting two new battleships, and builders have sent in designs and tenders. Very little is being done in marine engineering, but orders for gun mountings, gun-carriages, and projectiles are plentiful.

Shipping and Coal.

Shipping is more briskly employed on iron and steel exports, which last week amounted to 24,137 tons from West Coast ports, an increase of 9663 tons on the corresponding week of last year. The aggregate shipments this year have reached 377,038 tons, being a decrease of 31,791 tons on the corresponding period of last year. Coal and coke are brisk, and prices are well maintained.

THE SHEFFIELD DISTRICT.

(From our own Correspondent.)

The Trade Outlook.

IN the matter of business transactions the present week is regarded locally as one of the quietest of the year. Manufacturers are thinking of their half-yearly stocktaking, and are not desirous of entering into fresh commitments for raw material; while trade customers prefer to wait for the turn of the month before placing orders, however small. It says much for the soundness of the iron and steel trades in Sheffield when manufacturers are willing to accept deliveries of pig iron on current account, and this is reported to have been done in two or three cases, though, of course, most firms, if they can manage at all, are waiting for next week. The most satisfactory feature is the entire absence of grumbling, for usually when responsible officials of the large firms are asked as to the position of affairs, they have been inclined to adopt a very pessimistic attitude, and admit that while things might be worse, further depression was hardly possible. We hear none of that now. "We haven't any large new orders worth talking about," said a director of a world-famed concern, "but we have no cause for complaint. We have plenty of orders booked, and new ones, though small, are of sufficient volume to keep us well employed." This is the general experience, and there is no reason to doubt its continuance.

The Demand for Steam Coal.

The pressing demand for steam coal for shipment remains one of the chief features of the trade in the Yorkshire coalfield. All the hard coal pits are working full time, and a remarkably heavy tonnage is going by both rail and water to the shipping ports. The exports from the Humber last week were roughly 12,000 in excess of the corresponding week in the previous year, but single weeks are by no means a guide, and this figure is certainly much below the average. A good indication of the prosperity of the South Yorkshire coal trade is furnished by the traffic returns of the Hull and Barnsley Railway, and those for the twenty-five weeks of this half-year to date show the substantial improvement of £32,203, an appreciation of about 15 per cent. There seems at the present moment no likelihood of any break in this activity. Though the collieries are going, for the most part, the full six days a week, there are no signs of increasing stocks, notwithstanding that production now-a-days has enormously increased. The output of coal throughout South Yorkshire is heavier every year, and rapid progress is now being made with several new pits, so that trade activity is an absolute essential.

The Repeal of the Coal Tax.

A stimulating effect to business here, as well as in other colliery districts, has certainly been given by the repeal of the coal tax and inquiries from quarters which have for long neglected Yorkshire are coming in quite briskly. The stipulation, of course, is for shipment after November 1st, and we understand that the Mediterranean ports are likely to be large buyers.

House Coal Prices.

It is stated that the colliery owners in the immediate neighbourhood of Sheffield have decided not to follow the lead of their competitors in West Yorkshire and in Derbyshire in the matter of house coal prices for the summer months. In the Wakefield, Normanton and Barnsley districts, as well as round about Chesterfield, owners have all agreed to the usual 1s. per ton summer reduction, the lower figure applying until the 1st of September. In the Sheffield district this is not to be done, not because there is any particular briskness in the house coal trade, but presumably because an effort is to be made at the beginning of September to hoist quotations above the level of those of last year. In the meantime no doubt the various collieries will make bargains where they can, perhaps with ruinous underselling, but giving the buyers to understand that the concession is—a concession and nothing more.

Coke and Nuts.

Prices for coke show a rather firmer tendency, and the outlook in this department is particularly gratifying. Best washed foundry samples have no difficulty in bringing 12s. 3d. to 12s. 6d. per ton at the ovens, while there is a strong inquiry for gas coal at firm rates. Nuts and small manufacturing fuel continues in strong request, with no falling away in quotations.

An Advance in Pig Iron.

The firms comprising the Lincolnshire Ironmasters' Association have at last made the expected move in an upward direction, for at their meeting last week-end they decided to advance the minimum quotations of forge and foundry iron 1s. 6d. per ton, and of basic iron 2s. per ton. This movement only brings the official quotation into line with the basis of recent transactions, for business for the last month has only been possible at rates averaging 2s. per ton over the minimum figures, but it is important as indicating renewed confidence in the future. There are many who regard this step as but the first towards a general revival similar to that which put the trade on its feet a year ago, and certainly the general position of trade warrants this optimism. Quotations for raw material delivered in Sheffield are now as follows:—Lincolnshire forge, 53s. 6d.; ditto foundry, 56s.; ditto basic, 54s. 6d.; Derbyshire forge, 52s. 6d.; foundry, 56s.; East Coast hematites, 72s. to 72s. 6d.; West Coast ditto, 73s.

Railway Material.

The manufacture of railway rolling stock material continues to be one of the staples of the large firms, and it is gratifying to hear that not only are they fully employed now and with work booked to cover them for the next few months, but that substantial inquiries for new contracts are being constantly made. One of the Argentine railway companies has sent out invitations for tenders for a heavy quantity of carriage and wagon axles, and the Bombay and Baroda Company is in the market for a large supply of general railway material.

Staveley Coal and Iron Company.

There is much speculation just now as to the proposals of the directors of the Staveley Coal and Iron Company. In February last the shareholders received a circular stating that it was proposed largely to extend the business by the construction of new blast furnaces and new coke ovens, while the company was joining with the Hickleton Main Company in the sinking of new pits at Brodsworth, near Doncaster. It was intimated then that new capital would be required, and that advantage would be taken of the opportunity so to deal with the present shares as to make them less unwieldy. We now understand that it is proposed to give £1 shares to the full value in exchange for the present £60 paid shares, while the new capital will not be raised by any call on the liability of the present shares—the "A" shares, for instance, though £60 paid, are of the nominal value of £100—but new £1 shares will be issued, and they will be offered to present shareholders on terms which will represent a very considerable bonus.

Large Order for Projectiles.

Advices have been received from Rome that Messrs. Thomas Firth and Sons, Limited, of Norfolk Works, Sheffield, have been awarded the contract for the supply of heavy projectiles to the Italian navy, the value of the order being said to approach £200.000. Up to the time of writing, the firm is without further details, but does not doubt the correctness of the report.

NORTH OF ENGLAND.

(From our own Correspondent.)

The Situation in Warrants.

VERY little business has been done of late in Cleveland pig iron warrants, and the fluctuations in them have been within rather narrow limits, the highest price this month being 51s. 0½d. cash buyers on 11th, and the lowest 49s. 9d. on Tuesday of this week, but mostly the quotation has been about 50s. It is a long time since holders of warrants have shown such an disinclination to operate, and the lack of transactions is due more to that than to the backwardness of buyers. It may be inferred from this that the holders do not think that this is the most favourable time to sell, and that if they continue to keep the iron for some time longer they will be able to realise better prices. This is not likely next month, but almost invariably in the latter half of August and in September prices improve with the brisker autumn trade. It is pretty clear also that though there is a stock of over 640,000 tons of Cleveland pig iron in Connal's public stores, it is held in comparatively few hands, otherwise there would be a good deal more selling. It is believed that if a price close to 50s. can be got for Cleveland warrants in what is usually such a quiet month as June, August will bring a still better figure. Cleveland warrants are evidently in strong hands, and with cheap money the cost of carrying will not be heavy. The outlook for the autumn is good.

Cleveland Pig Iron.

Makers' iron continues dearer than Cleveland warrants, and, moreover, is not so readily obtainable for early delivery, as few of the makers have any in stock, and what they will produce for some weeks to come is in most cases already sold. No. 3 Cleveland G.M.B. pig iron has been sold this week as low as 50s. 3d. per ton for early f.o.b. delivery, but 50s. 6d. has been the regular figure at which business has been done. Germany during the past half-year has taken a large quantity of Cleveland foundry iron, but it is to be doubted whether anything like the same quantity will be wanted in the second half, as the German ironmasters are doing their best to increase the production and do away with the shortage in the output there. The price of No. 1 Cleveland pig iron is 52s.; No. 4 foundry, 49s. 9d.; No. 4 forge, 49s.; mottled, 48s. 6d.; and white 48s. per ton, all for early delivery. The lower qualities of Cleveland pig iron have of late been more largely produced, and the prices are, therefore, relatively cheaper than that of No. 3.

Hematite Iron and Ore.

Buying continues slow, as far as regards East Coast hematite pig iron, but all that is being produced is going direct into consumption, and makers have practically no stock, neither is there any in the public warrant stores. Still the prospects of the shipbuilding industry, and through that of the plate and angle trades, are not favourable to any increase in the demand for hematite pig iron, and people are not much disposed to buy for delivery ahead. Makers, however, will not further reduce their quotations, and this week the regular figure for mixed numbers has been 65s. 9d. per ton for early delivery, with 63s. 6d. for No. 4. Merchants likewise adhere to that rate, but there is not much in second hands. The price of Rubio ore has been reduced to 19s. 6d. per ton, c.i.f. Tees, but it is still too high.

Pig Iron Stocks.

Makers have very little in their yards, and the stock in the public stores is quickly declining. An increase was reported one day since last report of 2343 tons, but that was due to the fact that the shipping facilities were not adequate, and the vessel chartered had to get her cargo at some of the makers' wharves. Up to 27th Connal's stock of Cleveland iron in June had decreased 27,850 tons, making 108,048 tons since the stock began to decline in March, the quantity having dropped to 642,047 tons.

Shipments of Pig Iron.

These bear testimony to the great activity of the pig iron trade; and deliveries on export account have never been so large in any month in the history of the trade, and traders are agreeably surprised to see the shipments so well kept up in June, which is usually a quiet shipping period. It was hardly expected that the figures for May would have been exceeded. Germany has taken 10 per cent. more than last month, but Scotland has received less Cleveland iron, the prices being higher than consumers there are prepared to give, especially as cheaper iron is forthcoming from other quarters. The shipments of the first half of this year exceed those of any half year on record, but it is doubtful whether they will be kept up at such a rate during the second half of the year. The quantity shipped in June up to 27th was 120,902 tons, as compared with 119,002 tons last month; 82,078 tons in June, 1905; and 65,055 tons in June, 1904, all to 27th. Italy is receiving considerable quantities of hematite iron from the Tees, and there is fair shipments of this quality to the United States and Canada.

Manufactured Iron and Steel.

While works are kept well occupied on old contracts, there is very little disposition to give out any more at present, and inquiries are very few. That producers are not badly situated for work, and that there is as yet no necessity for them to seek for orders, can fairly be inferred from the fact that they are not reducing their quotations, even the prices of plates and angles being kept up, though some of the makers complain that the shipbuilders are backward about furnishing the specifications for the steel which they have bought. Not less than £7 will be taken for steel ship-plates; £8 for steel boiler-plates; £7 5s. for iron ship-plates; £6 12s. 6d. for steel ship angles; £6 for packing iron; £7 17s. 6d. for iron ship rivets, all less 2½ per cent. f.o.t. A good tonnage of shipbuilding material is being sent from this district to Germany and Denmark. Bar manufacturers are fairly well off for orders and keep the price of iron bars at £7 5s., and steel bars at £7, both less 2½ per cent. f.o.t. Steel rails are in better request, and at least £6 7s. 6d. net f.o.t. must be paid for them. For chairs and sleepers the orders are few, and the prices are hardly so firm as they are for rails. The bulk of the steel sleepers now wanted are for India, to which the deliveries of all kinds of manufactured iron and steel from the Tees this month are very large, as they are also to Japan.

Shipbuilding and Engineering.

Shipbuilders are clearing off their orders much more rapidly than they are booking others to replace them. For some time there has been an almost complete absence of fresh contracts for new steamers, and that cannot be surprising when the state of the freight market is taken into account. The outlook is far from encouraging for the owners of tramp steamers, and a good many of these even now are not earning enough to cover cost of running. The promises of better times for shipowners so generally reported in the early part of the year are not being fulfilled. There is an order on the market for twenty steamers for the Brazilian Lloyd's Company, which is renewing its fleet. The order includes ocean, passenger, and cargo steamers, as well as river and coasting boats. Marine engineers have plenty of contracts on hand, but fresh orders are few.

Railway Bridge over the Tees.

The North-Eastern Railway Company has decided to renew the superstructure of the bridge carrying the passenger lines over the river Tees at Thornaby, and they will also erect a new steel bridge of five spans of a total length of 340ft.

A Zinc Works on Teesside.

A London firm of zinc manufacturers has purchased a large tract of reclaimed land from the Tees Conservancy Commissioners, on the north bank of the Tees, opposite Middlesbrough, for the purpose of building a zinc manufactory.

Cleveland Miners' Wages.

The Executive Council of the Cleveland Ironstone Miners' Association have decided to ask the employers for a substantial advance in wages, but will not press the question of a twelve o'clock Saturday for mechanics at the mines.

North-Eastern Railway Wages.

Though a good deal of dissatisfaction has been expressed by various sections of the men, it is expected that the concessions offered by the company will be accepted, and the proposal to form a permanent Conciliation Board, to deal with grievances as they arise, is generally favoured; in fact, the Executive Council are urged to approach the company on this matter.

Coal and Coke.

The coal trade shows considerable improvement, and branches which are usually at their slackest at this period of the year are doing well. The Durham gas coal business is very active, and satisfactory orders are coming forward from the Continent. Thus there is not in this branch the customary slackness noticeable about midsummer. For next year's delivery, 10s. 3d. to 10s. 6d. f.o.b. is quoted for best gas coals, and for seconds 9s. 6d. Steam coal is in good request, but this week, in the Newcastle district, the race holidays have lessened the production, and supplies are scarce. For best steam 10s. 6d. f.o.b. has to be paid, and seconds are 9s. 9d. to 10s. Bunker coals are in brisk demand, and owners of steamers are paying 9s. to 9s. 3d. f.o.b. for unscreened. Coke also is dearer, the over-production having been corrected by a reduction in the output, and 17s. per ton is now obtained for medium coke, delivered at the Middlesbrough furnaces, while 18s. 6d. f.o.b. is the price of best foundry coke.

NOTES FROM SCOTLAND.

(From our own Correspondent.)

General State of Trade.

THE general condition of trade does not appear to have undergone any material change since last report. In the leading branches of manufacture there is steady employment, with contracts existing that will keep the works going for a considerable time to come. As regards the great shipbuilding industry, it is noticeable that the fresh work coming to hand at the moment is inadequate to take the place of that being completed, but it has to be remembered that we are on the eve of the trade holiday season,

when new orders are only placed in exceptional circumstances. On the whole, therefore, the trade position may be regarded as fairly satisfactory.

The Warrant Market.

There has been a steady feeling in the Glasgow pig iron market, with a moderate business. Reports are current as to further very considerable purchases of Cleveland iron for shipment abroad, and these have not been without their influence on the market. Business has been done in Cleveland warrants at 49s. 9d. to 50s. cash, and 50s. 2d. for delivery in one month. Scotch warrants have been at 56s. 6d. to 56s. 3d. cash; Cumberland hematite, 64s. 7½d.; and standard foundry pig iron, 49s. 10½d. per ton.

Scotch Hematite Iron.

There is a large current production of this class of iron, the makers evidently having every confidence that it will all be required in due time, although a somewhat easier feeling has been reported in the market within the last few days. Prices are practically unaltered, merchants quoting 69s. 6d. per ton for delivery at the West of Scotland steel works.

Output and Stocks of Pig Iron.

There are 88 furnaces in blast in Scotland, compared with 85 at this time last year, and of the total 45 are making hematite, 37 ordinary, and six basic iron. While the current business in pig iron is moderate, makers have every prospect of disposing of their output on satisfactory terms. The stock of pig iron in Glasgow warrant stores shows a decrease for the past week of 143 tons. The stores now contain 12,086 tons ordinary and 6650 tons standard foundry pig iron.

Scotch Makers' Pig Iron Prices.

In one or two cases the prices of the special brands of Scotch pig iron show a reduction since last week of 6d. per ton. G.M.B., No. 1, is quoted at Glasgow 57s. 6d.; No. 3, 55s. 6d.; Monkland, No. 1, 58s.; No. 3, 56s.; Carnbroe, No. 1, 61s.; No. 3, 58s.; Clyde, No. 1, 65s.; No. 3, 60s.; Gartsherrie, No. 1, 65s.; No. 3, 60s.; Calder, No. 1, 66s.; No. 3, 61s.; Summerlee, No. 1, 68s.; No. 3, 63s.; Langloan, No. 1, 69s.; No. 3, 63s.; Coltness, No. 1, 73s.; No. 3, 62s.; Glengarnock at Ardrossan, No. 1, 66s.; No. 3, 60s.; Eglinton at Ardrossan or Troon, No. 1, 60s.; No. 3, 57s. 6d.; Dalmellington at Ayr, No. 1, 62s. 6d.; No. 3, 57s. 6d.; Shotts at Leith, No. 1, 66s.; No. 3, 61s.; Carron at Grangemouth, No. 1, 67s.; No. 3, 62s. per ton.

Pig Iron Shipments.

The shipments of pig iron from Scottish ports in the past week amounted to 5589 tons, compared with 5068 in the corresponding week of last year. There was shipped to the United States 25 tons, Canada 80, South America 135, India 50, Australia 655, Italy 360, Germany 165, Russia 25, Holland 120, Belgium 30, China and Japan 283, other countries 300, the coastwise shipments being 3369 tons, against 2524 in the same week of 1905. The total shipments for the year to date amount to 141,948 tons, being 2442 tons more than in the corresponding period of last year.

Arrivals of English Iron.

The arrivals of pig iron at Grangemouth from the Cleveland district in the past week were 10,485 tons, being 4222 tons less than in the same week of last year. There is, however, a total increase in these imports for the year to date amounting to 16,250 tons.

The Steel Trade.

The chief matter of interest at the moment in the steel trade is that of competition between English and Scottish makers, which has recently been the means of a great deal of discussion and negotiation. Representatives of the English and Scotch makers meet at Carlisle on Friday, when it is hoped some satisfactory arrangement may be reached. It is said that there is substantial agreement that the districts hitherto competing so keenly to the detriment of both, in the matter chiefly of prices of angle steel, should be reserved, Scotland to the Scotch and England to the English makers; but the report goes that as regards Belfast, where an important trade is done with the shipbuilders, there has been some difficulty in coming to an arrangement. Business has been done, it appears, at low rates to such an extent that makers, north and south, are represented as anxious to reach a settlement that would prevent unprofitable cutting of prices in future.

The Finished Iron Trade.

The makers of malleable iron in this district have had the state of the market and prices under review. A considerable business has been offering for shipment to the East, but the makers have not been inclined to accept the rates offered, although there appears to be an expectation that parties may eventually come to terms. Prices of malleable iron generally are unchanged, but offers were made to tube-makers to make a reduction in both iron and steel strips and hoops, provided orders were placed within a few days, after which the former rates were to prevail. It is stated that with the exception of only one firm, consumers were prepared to take advantage of this offer and book their orders.

The Shipbuilding Trade.

The new work at present coming forward is not very large; but several good orders for abroad are expected to be placed soon on the Clyde.

The Coal Trade.

Business is fairly active in the different branches of the coal trade. While shipments are not quite so large as in the preceding week, they compare favourably with those of this time last year. The inland demand for home use and industrial purposes is well maintained, and prices are quoted without material change.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

The State of the Coal Trade.

STEAM coal continues the chief quality in demand. One can see in most districts, at collieries and railway sidings, a few trucks of house coal, Monmouthshire predominating, but the chief coals are steam, and for these there has been no slackening in demand. Last week the principal ports were busy. Several days Cardiff, Penarth, and Barry had a long list of clearances; Newport continues its high averages by despatching over 90,000 tons, and Swansea nearly totalled 60,000 tons. Mid-week the report on 'Change, Cardiff, was that new business was restricted, owing to the heavy engagements entered into for delivery up to the middle of July. Very best Admiralty qualities are very firm, and owners quote 16s. 3d. freely. Ruling quotations are:—15s. 9d. to 16s 3d. for best; and best seconds are very firm at 15s. to 15s. 6d.; seconds, 14s. 6d. to 14s. 9d.; drys, 13s. to 13s. 3d.; best washed nuts, 12s. to 12s. 6d.; seconds, 11s. 6d. to 11s. 9d.; best washed peas, 11s. to 11s. 3d.; seconds, 10s. 3d. to 10s. 6d.; very best smalls, 9s. 9d. to 10s.; best ordinaries, 9s. 3d. to 9s. 6d.; seconds, 8s. 6d. to 9s.; inferiors, 8s. to 8s. 3d. Monmouthshire semi-bituminous:—Very best large, 15s. to 15s. 3d.; best ordinaries, 14s. to 14s. 3d.; seconds, 12s. 6d. to 13s. 3d. House coals:—Best, 15s. 3d. to 15s. 6d.; best ordinaries, 14s. to 14s. 6d.; seconds and other kinds, 11s. to 13s.; No. 3 Rhondda, 15s.; brush, 13s.; smalls, 11s. to 11s. 3d.; No. 2 Rhondda, 10s. 9d. to 11s. Patent fuel, 16s. to 16s. 6d. Coke, 17s. to 25s. Pitwood firm at 21s. 9d. to 22s.

Anthracite Coal.

In the Swansea district an improvement is recorded:—Best malting is quoted at 17s. 6d. to 18s.; seconds, 16s. to 17s.; big vein, 12s. to 12s. 6d.; red vein, 9s. to 9s. 6d.; cobbles, 17s. 6d. to 18s.; nuts, 17s. 9d. to 18s. 6d.; peas, 11s.; culm, 6s.; duff, 4s. 6d. Steam coal is quoted at 15s. to 16s.; No. 3 Rhondda at 14s. 6d. to 14s. 9d.

The Non-Unionist Difficulty.

As I had anticipated, there has been a considerable number of outstanding arrears paid up by the colliers, who objected, in the Cyfarthfa and Plymouth districts, to pay to the federation. Some still remain out, and though it is stated that contracts will be regarded as terminated on Saturday next, unless all join, there is every likelihood of a peaceful settlement.

Tynewydd Repeated.

There was an inrush of water this week in a colliery "stant" known as Caradox Vale, near Hendre Fagan Railway Station. The colliery is worked by a French company. On Tuesday the inrush took place in the drift, and after the outward rush of the men had ceased it was found that six men were entombed, and the prospect, as I write, is regarded as very serious, if not hopeless.

Irregular Practices in Welsh Mines.

Mr. J. E. Martin, Inspector of Mines, calls attention in his annual report to irregularities in Welsh mines. In some he has found the practice of using naked lights continued, and he comments upon the gravity of a course of things likely to be attended with serious results. The special rules in force respecting "falls" in collieries had now had twelve months' trial, and he commended highly managers and coalowners for the attention given. In respect of haulage, he regrets that South Wales and Monmouthshire had a bad record, and the description given by him of the large and heavy trams, the broken roads, and their deep muddy character, is one certain, one will expect, to be noted and corrected. One of his most important comments refers to repairers, and the folly of stopping them shown by men on strike.

Iron and Steel Trades.

A leading incident of the week has been the receipt in Newport of about 4000 tons of steel billets from New York and of several cargoes of German billets from Antwerp. There is, fortunately, no falling away in local enterprise, depressing as the competition of America and Germany is. The Welsh ironmasters are not abating in vigour, the influx of ore from Spain is continuous, and the developments at Dowlais and Ebbw Vale in particular are of the highest order. One "parcel" of steel rails and fish-plates came to Cardiff from Harrington, and, on the other side, a large cargo of rails left Newport for Bahia. Mills have been tolerably busy with home and colonial rails, both light and heavy figuring; "finished" goods bulked largely last week; fish-plates and angles were turned out freely, and billets in moderate quantities. Mid-week over 5 00 tons iron ore came to Ebbw Vale from Agua Amarga and Castro Urdiales. Blaenavon and Cyfarthfa are also busy importing ore. In the Swansea district the steel trade is in a healthy condition, and the principal works have bar orders in hand that will take some time to complete. On 'Change, quotations for Bessemer pig iron, mixed numbers, are 64s. 7½d.; Middlesbrough, 49s. 8½d.; Scotch, 56s. 3d.; and Welsh hematite, 70s. to 71s. Steel bars remain at £5, both Siemens and Bessemer. Iron ore, Cardiff and Newport, 18s. 9d. to 19s. for Rubio, 18s. 9d. for Almeria.

Unusual Incident in Tin-plate.

A suggestive incident has occurred in the tin-plate districts—the receipt of a large quantity of returned tin-plates from Russia. This shows an almost hopeless condition of things, and indicates, at least, that a recovery of trade is yet some way off.

The Far East Tin-plate Trade.

I am glad to note that, as a contrast to the slackness in Russian trade, prospects in the Far East are improving. A few days ago, at Swansea, the Ching Wo, for China and Japan, loaded 2600 tons of tin-plates, galvanised sheets, &c. A tolerable quantity of tin-plates is also loading for South America, Italy, Holland, France, and Rio. Spain and Denmark are also buyers. Last week the total shipments were still below the averages that were recorded before the holidays, only 44,986 boxes being despatched. Per contra, the quantity received from the works was large, amounting to 70,000 boxes; no stocks now show great accumulation, and are at present over 207,000 boxes. As remarked on 'Change this week, the outlook is gloomy, but with tranquil labour prospects a turn in the tide is possible.

Tin-plate Prices.

Mid-week on 'Change, Swansea, tin-plate prices were stated to be nominal; ordinary plates, I.C., 20 by 14, 112 sheets, are quoted at 13s. 1½d. to 13s. 3d., Bessemer; while Siemens are given at 13s. 4½d. C.A. roofing sheets are at £9 per ton. Big sheets for galvanising, 6ft. by 3ft. by 30 gauge, £9 7s. 6d. Finished black plates, £9 10s. Block tin is at £176 15s. Lead, £16 17s. 6d. Copper, £81 5s. Silver, 30d. per oz. Spelter, £27 2s. 6d.

Associated Industries.

Copper trade is reported as holding its own, and regular employment is prevailing at Morfa, Middle Bank, and Hafod. Spelter works are busy; Mannesmann Tube Works actively employed principally on 8in. to 12in. tubes. Foundries and engineering works brisk.

Tin-plate Settlement.

A satisfactory arrangement has been brought about between employers and men, and the "list" is to be maintained for another year. At a meeting in Swansea on Saturday Mr. John Hodges paid a warm tribute to the chairman, Mr. Trubshaw, for his bringing about the arrangement and for his statesmanlike administration.

Llanelly Trade.

There is still scope for improvement in the tin-plate trade of this district. As stated in connection with the trade of Swansea last week, the holiday has not been followed by the much needed briskness of demand, and this week it was stated that several works are going on altogether on black-plate. The steel trade is better, and demand from the Midlands is continued. In the matter of anthracite, a steady improvement is shown, and the demands from France and Germany are well maintained.

The Rhymney Iron Company.

The annual report of the directors shows a profit for the year ended March of £41,495 15s. 9d. A dividend of 2 per cent. free from income tax was recommended. The quantity of coal raised during the year was 798,230 tons, against 783,531 tons for 1905. The market for steam coal was reported as satisfactory. The make of coke was 41,380 tons against 40,307 tons, all of which was sold at satisfactory prices. With regard to future business it was reported that the sinking of the Groesfaen pit had been completed, and the steam measures reached at 698 yards. A connection with the Penycarrey pit has been completed, coal reached at Pengarn at a depth of 315 yards; a junction connecting the new sidings with the Brecon and Merthyr Railway Company's main line put in; and at the new Duffryn pit the work of proving the lower four feet continued. Under the able management of Mr. Smith prospects continue very favourable.

The Barry Railway Bill.

In the House of Commons Committee this week the Barry Railway Bill was ordered for third reading.

Great Western Railway Movement in Pembrokeshire.

In Swansea this week 200 navvies were engaged, as the result of advertisements for hands, and sent by free pass into Pembrokeshire. As showing the abundance of spare labour amongst this class, fully 500 men presented themselves.

Milford and Manchester Railway.

The leasing of this line by the Great Western is now stated to be completed. In the district the undertaking is regarded with favour, and a vigorous policy is expected, with increased facilities and other public benefits.

NOTES FROM GERMANY.

(From our own Correspondent.)

From Rheinland-Westphalia.

SINCE last week's report no change that would be worth mentioning has taken place on the Rhenish-Westphalian iron and steel market, business transactions remaining satisfactory as before. Plenty of fresh work has been coming in, and the iron and steel-producing establishments are all engaged to their fullest capacity. Though the output in pig iron is larger than ever, it is hardly sufficient to cover the steadily increasing demand, and the number of blast furnaces, therefore, is going to be raised; about twelve blast furnaces are reported to be in course of construction, and the increase in output is estimated to amount to about 1,000,000 t. The Pig Iron Convention, at a recent meeting, has withdrawn the decision regarding the abolition of the export bounty, and is going to grant the bounty, as formerly, during the third quarter of present year, under condition, however, that the Coal Convention likewise continues to grant the above-mentioned bounty. Also in semi-finished steel consumption is heavier than output, and here, too, extensions of existing establishments, as well as the building of new steel works, has been taken into consideration. A further improvement can be reported from the scrap iron market, both as regards demand and prices. The question of prolonging the Steel Convention has been to the fore lately; at a meeting that took place on the 31st of last month it was proposed to prolong the Convention, which ends on June 30th, 1907, for another year, but the more far-seeing members of the Union request a prolongation for at least several years. In the girder and sectional iron department production is readily consumed, and the bar trade shows quite an exceptional briskness for this time of the year. The condition generally on the plate market may be regarded as satisfactory, even though the costs of production have increased for the "pure" rolling mills; they are still working with a fair profit, and the outlook is pretty favourable, too, activity in the shipbuilding and boilermaking departments increasing steadily. Many mills have secured work till autumn, and some can boast of having orders on their books till far into the last quarter of the present year. Wire and wire nails sell freely, and at paying prices.

Upward Tendency in the Siegerland.

Though prices have met with considerable advances since early spring, the number of orders coming in at the iron and steel works increases from week to week: the tone, therefore, is exceedingly firm, and an upward movement is generally perceptible. The works, in a number of cases, have booked orders till far into the fourth quarter. A very large demand is experienced in the semi-finished steel trade, where consumption is, on the whole, higher than output. For bars, M. 130 p.t. has been asked; sheets stand on M. 145 p.t., and for large orders only slight concessions are agreed to. Heavy plates have realised M. 135 p.t. at recent sales, and for galvanised articles, too, higher prices are quoted.

Iron and Steel in Silesia.

Very good accounts can be given of the business done in the various branches of the Silesian iron industry. More orders have been coming in lately than at any other time of the year, and the shops and factories are all very actively engaged, the structural iron and engineering departments being particularly well occupied. Quotations, though exceedingly firm, have not moved in an upward direction, but there may be a rise, here and there, for articles specially well inquired for, in autumn.

The German Coal Trade.

The aspect, generally, of the coal and coke trade over here has not altered since previous letters, showing strength and briskness in all districts. Coal for coke making is rather scarce, and will most likely meet with an advance in price. The number of men in the Rhenish-Westphalian district is still insufficient, and there is but little chance of securing more hands at the pits when all the iron and allied industries are so vigorously engaged. From the Government collieries on the Saar a number of men are reported to have gone to the Ruhr coal district, but the managers of the Saar pits have officially announced that these colliers are not likely to find employment again at the Government pits, should they return.

Austro-Hungarian Iron Industry.

The business in pig iron continues very firm, and for heavy plates and sheets a good demand has likewise been coming in, but girders, as well as bars, have been showing some weakness lately. Satisfactory employment is reported to continue at the foundries and machine factories. Engine fuel sells freely in Austria-Hungary; house coal has been fairly quiet, but prospects all round are improving. The sugar mills are expected to purchase largely later on.

Condition of the French Iron Trade.

Plenty of fresh work is stated to have come in on the French iron market in the course of the past week, but the strike in Paris has, of course, checked transactions considerably in many cases, and a number of orders have been going to foreign firms which would have helped to keep the inland works in brisk employment. The general tendency, however, is firm. Stiffness in price and an active demand are the characteristic features of the French coal market. During the last week an upward tendency in quotations could even be perceived.

From the Belgian Iron Market.

All the principal trades are reported in excellent employment, and fresh orders come to hand freely. An increasing firmness as regards quotations is perceptible also for those articles that had been somewhat neglected until now. The following prices have been fixed for bars in iron:—No. 2, 142·50f. p.t. for export, and 155f. p.t. for inland consumption; No. 3, 145f. p.t. for export, and 157f. p.t. for inland consumption. Steel bars are quoted 147·50f. p.t. for export, while inland quotation is 160f. p.t. Higher prices than those above quoted are hardly obtainable. In plates a good business is done at the following prices:—

	Export. Francs.	Inland. Francs.
Iron plates, No. 2, and steel plates	160	170
Iron plates, No 3	165	175
Siemens-Martin plates	170	180

Increasing Activity on the Belgian Coal Market.

A most lively business has been transacted in the coa districts of Belgium during this week and the last, and the tendency of prices is decidedly upwards. Dry sorts of coal meet with exceptionally good request, so do briquettes; and coke, which sells very freely, is firm at 23f. to 26f. p.t., consumption being rather heavier than output.

BRITISH PATENT SPECIFICATIONS.

Selected and Abridged by **JAMES D. ROOTS,** *M.I. Mech. E.*

When an invention is communicated from abroad the name and address of the Communicator is printed in italics.

When the abridgment is not illustrated the Specification is without drawings.

Copies of Specifications may be obtained at the Patent-Office Sale Branch, 25, Southampton-buildings, Chancery-lane, London, W.C., at 8d. each.

The first date given is the date of application; the second date at the end of the abridgment is the date of the advertisement of the acceptance of the complete specification.

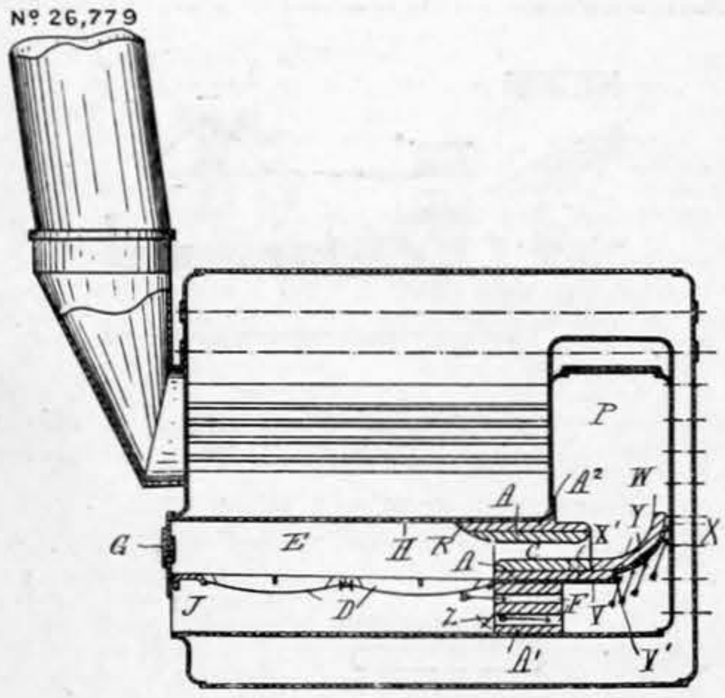
Any person may on any of the grounds mentioned in the Acts, within two months of the date given at the end of the abridgment, give notice at the Patent-Office of opposition to the grant of a Patent.

STEAM ENGINES AND BOILERS.

26,779. December 22nd, 1905.—IMPROVEMENTS IN FURNACES FOR STEAM GENERATORS, *Clifford John Johnson, of Point Chevalier, near the City of Auckland, New Zealand, and James Carlaw, also of Auckland.*

This invention relates to improvements in furnaces for steam generators of the kind in which the fire chamber and ashpit are separated from the flue or continuing part through which the products of combustion pass to the chimney by a wall or diaphragm having openings above the grate bars for the products of combustion from the fire chamber, and other openings below the grate bars for highly heated air from the ashpit to pass through into the flue, where the products and heated air mix so as to cause any carbonaceous matters in products to be burnt. This invention consists in a peculiar construction of the wall or diaphragm whereby better results are obtained. There is one figure and a section. E represents the flue tube; H the fire chamber; J the ashpit; P the flue continuing part or combustion chamber; A the wall or

Nº 26,779



diaphragm composed of an upper bridge A^2, extending to the crown of the fire chamber and a lower bearer part A^1; C, F, the passages through the diaphragm respectively leading from the fire chamber and the ashpit to the flue; D the furnace grate bars; and G the fire-box door. The top part of the bridge A^2 is extended well into the fire chamber H, and the underside of such extension is gradually sloped away, as at R, from the top level of the inlets to the fire gas passages C, to the crown of the fire chamber, so as to more gradually deflect the fire gases from the crown of the chamber; and the lower part, V, of the bridge is extended well into the combustion chamber P, the part V^1 thereof forming the floor of the passages C, being extended further into the chamber P in the form of an up-curved projection W. Passages X^1, Y, are formed through the projecting parts, and a passage X is left between the projection W. and the back of the chamber P, through which passages the hot air from the ashpit issuing through the passages F obtains access to the gaseous products from the fire chamber issuing from the passages C. The extension V and up-curved projection W of the bed of the bridge serve to prevent the furnace gases issuing from the passages C from passing downward and to cause the hot air issuing through the passages F to have an upward direction.—*May 24th*, 1906.

TURBINES.

9769. April 26th, 1906.—IMPROVEMENTS IN ELASTIC FLUID TURBINES, *George Westinghouse, of Westinghouse-buildings, Pittsburg, Pennsylvania, United States of America.*

This invention relates to elastic fluid-pressure turbines. It has been found in practice that the rotors and stators of elastic fluid-pressure turbines are liable to and do distort under certain conditions. It is essential to the efficiency of such machines to have the clearances between the relatively moving parts as small as possible in order to diminish leakage. Fig. 1 is a view partially in section and partially in elevation of a fragmentary portion of the

Nº 9,769.

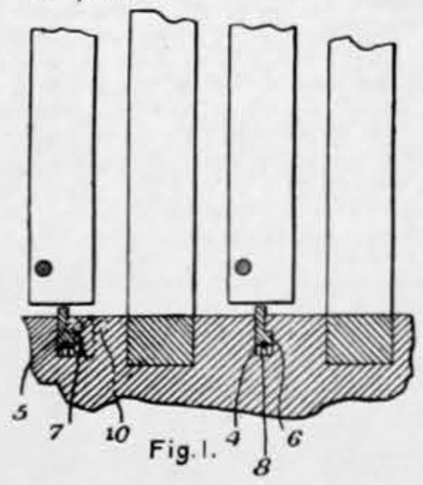


Fig. 1.

turbine equipped with this invention; in this view the blades or vanes, as the case may be, are shown unshrouded, but lashed together by any suitable means. The holding element for holding the blades or the veins, which may be either the rotor or the stator, is provided with circumferential undercut slots or channels 4 in line with the rows of blades or vanes carried by the other holding element, which may be the rotor or stator. In these slots or channels 4 a segmental ring 5 is threaded. This ring is provided with a flange portion 6, which lies within the undercut portion of the channel below the overhung portion 7, which overhung portion serves as an abutment for limiting the outward radial movement of the ring. A spring 8 of any suitable form lies within the channel beneath the ring 5 and tends to yieldingly hold the ring so that its flange 6 lies in contact with the overhung portion 7 of the channel. As the turbine casings or stators are commonly divided on the horizontal plane through the turbine axis, these ring segments 5 are easily inserted within the channels of the stator. If they are employed on the rotor, however, it will be necessary to have a section of the overhung portion 7 removable—as at 10 in Fig. 1, and the length of this removable portion will have to be slightly longer than the segments of the ring 5. This removable portion 10 may be secured in place by screws or other suitable means. It will be understood that by employing this device in a turbine the clearances beyond the ends of the blades or vanes may be reduced to a minimum, and the top edge of the ring 5 may just lie out of contact with the ends of the blades or vanes, or the shroud with which they may be provided. If distortion does occur and the blades or vanes contact with the ring, the same will yield and move outwardly to accommodate such distortion.—*June 24th* 1906.

767. January 11th, 1906.—IMPROVEMENTS IN OR RELATING TO FLUID-PRESSURE TURBINES, *Oskar Richter, of Bismarckstrasse, Munich, Germany.*

This invention relates to a combined impulse and reaction turbine for elastic fluids, and has for its primary object to provide improved means for balancing axial thrust on the turbine shaft. In this invention the high-pressure part of the turbine is formed as a partially expanded impulse turbine, the middle and lower-pressure part as a reaction turbine. The blades of the impulse part are of a larger diameter than those of the reaction part. From the point where one part passes into the other the diameter of the reaction

Nº 767.

Fig. 1.

part increases towards the end. Fig. 1 is a section; *a* is the coupling piece for the steam supply pipe, *b* the impulse part, *c* the reaction part of the turbine, and *d* the coupling piece for the exhaust outlet. The step between the impulse and reaction part due to the difference in diameters forms an annular surface *e* for completely relieving the shaft from axial thrust. The reaction part is formed with three stages, c^1, c^2, c^3, increasing in diameter, the front blades of the first two stages being smaller than the rear blades of the same. The stage c^3 carries the largest blades, in view of the increased volume and diminished pressure of the steam. In order to fully balance the axial pressure, the front side of the casing *g* is connected by a pipe *h* with the exhaust steam outlet connection *d*.—*May 24th*, 1906.

RAILWAYS AND TRAMWAYS.

15,223. July 25th, 1905.—IMPROVEMENTS IN OR CONNECTED WITH CHAIR KEYS FOR THE PERMANENT WAY OF RAILWAYS AND TRAMWAYS, George Napier, jun., of 101, Paynes-road, and Andrew Napier, of 95, Hill-lane, both in the County Borough of Southampton.

This invention relates to metal keys of that type in which the key is made in two pieces pushed apart by a wedge, or inclined surfaces for use in securing metal rails in their chairs, and has for its object to provide a simple metal key to take the place of the ordinary wood keys that can be locked in the chair and be tightened as required, and capable of easy removal. Fig. 1 shows

Nº 15,223.

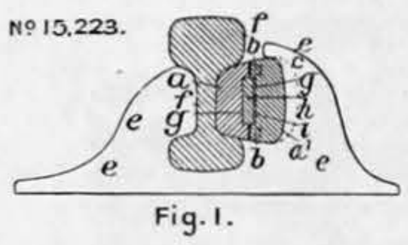


Fig. 1.

in end section a rail with chair key. Fig. 2 is a sectional plan. *a* a^1 designate the two longitudinal parts forming the metal chair key, and *b* denoted the morticed studs by which the parts *a* a^1 when placed together correspond in size and outer form to the ordinary wood key used to secure rails in their chairs. On the part a^1 is provided a lug or projection *c* at one end, and a projecting key at the other end, which fit and receive the metal of the chair *e*, and lock the key *a* a^1 longitudinally in the chair *e*. To tighten the key *a* a^1 between the chair *e* and the rail *f*, a groove *g* is formed with a slight taper on each meeting inner surface of the parts *a* a^1, and we provide a metal or other wedge *h* of size to correspond with the grooves *g* when the parts are together. One of the surfaces of the combined grooves *g*, and the metal wedge *h*, are serrated, notched, or stepped with teeth *l* so that when the

Nº 15,223.

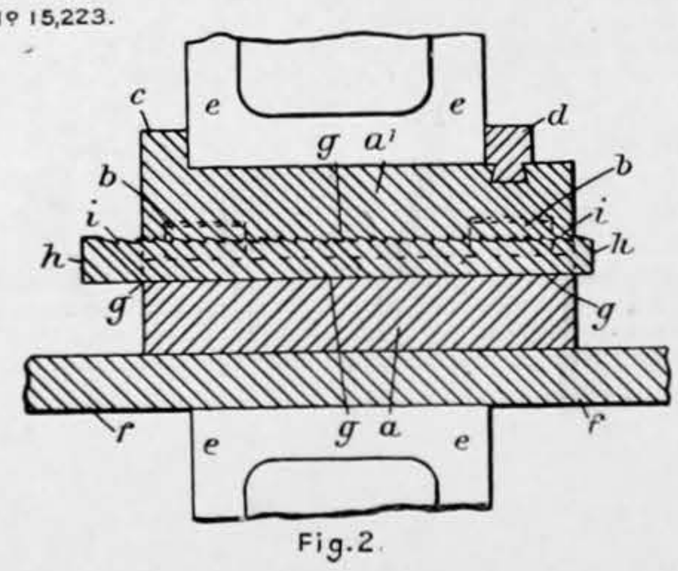


Fig. 2.

wedge *h* is driven in the teeth engage with the teeth on the surface of the groove *g* in the chair, and the parts *a* a^1 of the chair key are separated and expanded as the wedge *h* is driven in, and the rail *f* is thereby fixed in the chair *e*. When placing the key parts *a* a^1 between the chair *e* and the rail *f*, the projecting key or wedge *d* is first removed from the part a^1 of the chair key, and the chair key is placed in position and the projecting wedge *d* replaced, thus fixing the chair key *a* a^1 longitudinally in the chair *e* by the lug *c* and key *d*, then by driving in the toothed wedge *h* between the parts *a* a^1 of the key, such parts are slightly separated, and the key is tightened between the rail *f* and the chair *e*, and locked by the teeth of the wedge *h* engaging with the teeth on the surface of the groove *g*.—*June 24th*, 1906.

ORDNANCE.

17,089. August 23rd, 1905.—IMPROVEMENTS IN APPARATUS FOR TESTING THE ALIGNMENT OF GUN SIGHTS, Sir W. G. Armstrong, Whitworth and Co., Limited, and Commander Joseph Honner, R.N., all of Elswick Works, Newcastle-on-Tyne.

This invention has for its object an instrument designed to afford a ready means of testing the alignment of gun sights, at any elevation, without the aid of fixed targets on shore or on board ships. It is especially useful for broadside guns, which cannot be aligned on fixed targets unless the ship is alongside a wharf or in dock. Fig. 1 is a front elevation, and Fig. 2 a side elevation. The apparatus is carried by a muzzle plate *a* with adjusting slots or windows *b*, and having fixed to it a split tompion *c*. This arrange-

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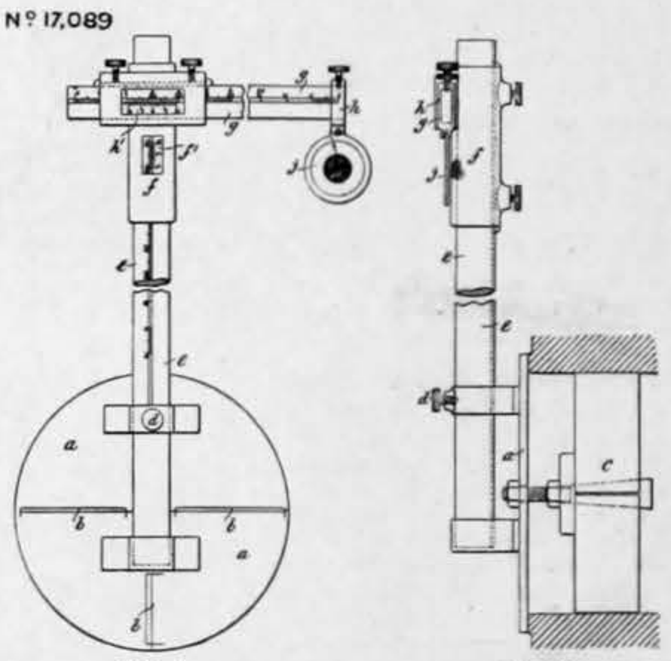

Fig. 1. Fig. 2.

ment of muzzle plate, split tompion, and adjusting slots enables the instrument, including the muzzle plate, to be used in any calibre of gun by substituting a split tompion to suit the calibre. The windows *b* allow the horizontal and vertical diameters usually marked on the muzzle of the gun to be seen, so that the plate can be accurately placed in position. Clamped to the muzzle plate *a* by a screw *d* is a vertical upright *e*, having on it a sliding collar *f*, provided with a socket in which a horizontal arm *g* is free to slide. This horizontal arm has upon it a slide *h* carrying a miniature target *j*. The vertical and horizontal arms are graduated, and the slides are provided with verniers f^1 and h^1. The horizontal bar *g* is graduated so that it can be set to enable both the right and left-hand sights of a gun or turret to be adjusted at the same time, the necessary number of targets being used for the purpose.—*June 24th*, 1906.

ROAD MOTOR VEHICLES.

16,498. August 14th, 1905.—IMPROVEMENTS IN CONTROLLING MECHANISM FOR MOTOR ROAD, AND CERTAIN OTHER PROPELLED VEHICLES, Charles Humphrey Humphreys, of Court Prior, Torquay, and Scowen, Limited, of 84A, King's-road, Reading.

This invention relates to improvements in controlling mechanism for motor road and certain other propelled vehicles, such as those running on rails and having a change-speed mechanism. As is well known in such vehicles where two or more speeds are provided, care must be taken to put the driving clutch out of action firstly, and then to change the speed step by step—that is, to change from one speed to the next, and so on by separate operations, since to change from one speed to another with the clutch in usually results in breakage of the teeth of the gear wheels, and to change from the lowest to the highest, or *vice versâ*, at once, may also result in breakage. This invention consists not only in providing means whereby the gears cannot be changed without opening the clutch, but wherein the act of so doing will alter the gear step by step when so desired in the upward movement is obtained by means of a slidable part or parts connected with the clutch and with the change speed gear, and having on its forward movement the action of a pawl or a ratchet or like step by step movement,

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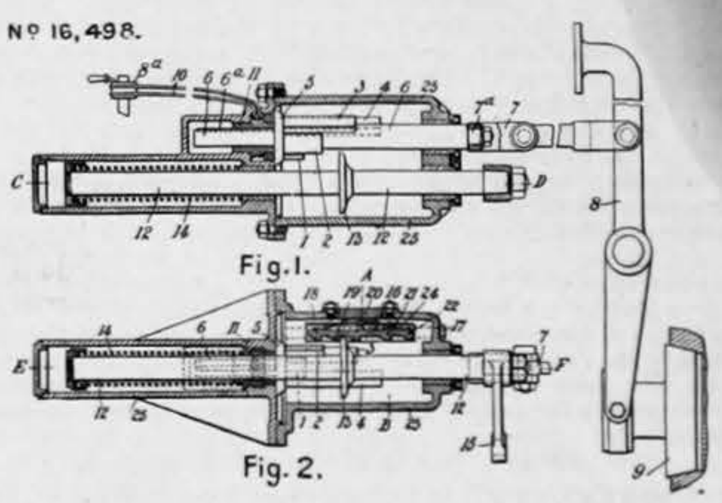


Fig. 1. Fig. 2.

which movement is utilised by the speed-setting device or indicator. Fig. 1 illustrates a part sectional side elevation of the controlling mechanism. Fig. 2 is a part sectional plan. This construction comprises a link 7 attached to or connected with the usual foot lever or pedal 8 controlling the clutch, indicated partly at 9, so that it is moved therewith. This link 7 is in turn connected with a shaft 6 having a slidable movement in a casing. The shaft 6 is a primary shaft, which has cut or formed thereon a number of steps 1, 2, 3, 4, which represent the different speeds, and also a circular collar or shoulder 5 having an inclined face, which represents the reversing movement. The shaft 6 obtains its sliding motion in the forward direction by the operation of the pedal and in the reverse direction by means of the usual clutch spring. The shaft has also a rotary movement in both directions, which may be conveniently effected by means of bevel or other gearing, or by means of a flexible connection, such as by Bowden wires 10, wound about a drum 11 in opposite directions, and having their ends secured to such drum, which is mounted on the shaft 6 upon a feather 6*a*, so that the shaft is free to slide with respect to the drum, which flexible connections are attached to the lever of a speed-setting device or indicator 8*a*. The rotary movement of the shaft with respect to the link 7 is permitted by the yoke and nut connection 7*a*. A secondary slidable shaft 12 is mounted parallel to the shaft 6, and is provided with a collar 13 or other suitable projecting part, which is adapted to engage the steps 1, 2, 3, 4 on the shaft 6, whereby the shaft 12 is actuated in one direction, movement in the reverse direction being performed by a spring 14. This shaft 12 is connected either directly or through the link 15 with the sliding pinions in the gear-box itself. Above the shafts 6 and 12 is mounted a ratchet plate 16, preferably hinged as 17, which plate is provided with a number of teeth or the

like corresponding with the number of speeds in the gear-box. Five teeth are shown, 18, 19, 20, 21, 22, and these teeth are arranged on the plate 16, so as to project into the path of the collar 13 on the shaft 12, whilst a further tooth or projection 23 having an inclined face is arranged on the plate 16 nearer to the hinge 17, so as to project into the path of the collar 5 on the shaft 6, which thereby controls the movement of the ratchet plate 16. The ratchet plate may also be provided as shown with a spring 24, which keeps it in its normal position.—*May 24th*, 1906.

PNEUMATIC HAMMERS.

23,435. November 14th, 1905.—IMPROVEMENTS IN PNEUMATIC HAMMERS, Thomas Scott King, M.I. Mech. E., of 43, Eastbourne-road, Penarth, Cardiff, and William Norris, of 20, Osborne-road, Blackpool.

This invention has for its object to provide an improved pneumatic hammer which shall be more simple and efficient in operation and construction. This invention consists in a pneumatic hammer in which compressed air is admitted to the cylinder for the purpose of raising the hammer tup, and the blow is effected by the expansion of the air which has been used for raising the tup. Fig. 1 is an elevation of a pneumatic hammer according to invention, the valve being shown in section. The hammer frame *a* is of the general form well known as applied to steam hammers, while

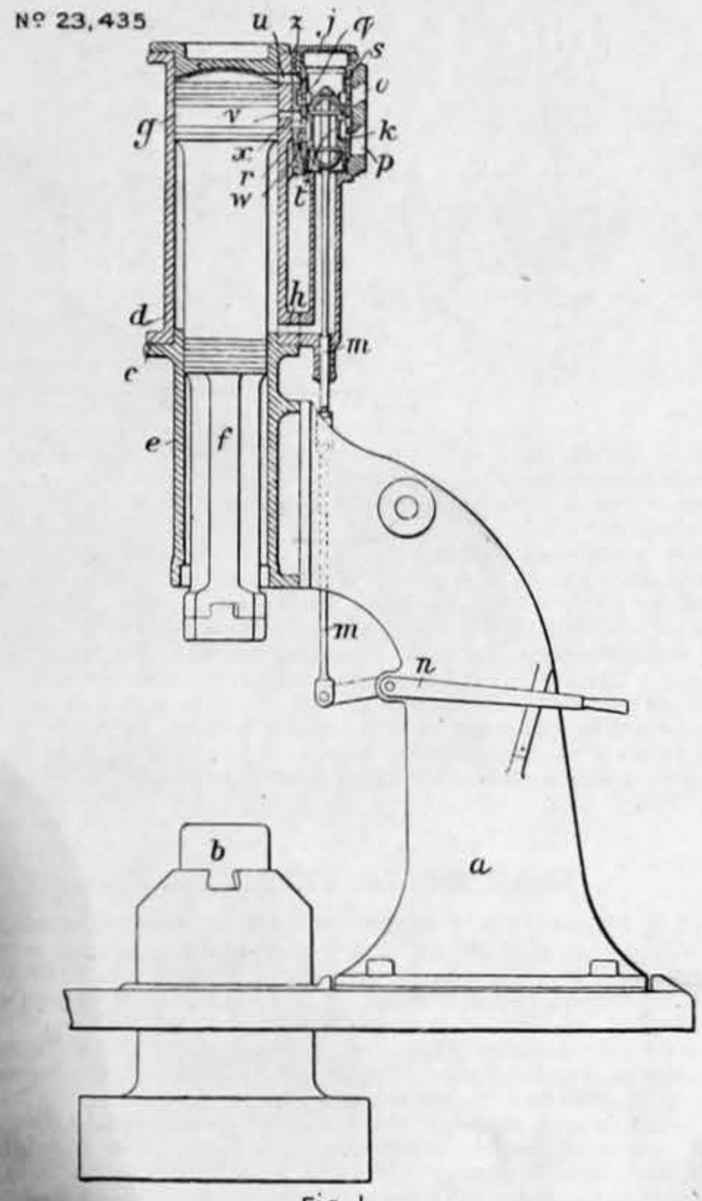


Fig. 1.

the anvil *b* is firmly founded. The hammer cylinder *c* is of considerable length, and is bored out to two diameters. The upper part *d*, of larger diameter, constitutes a working cylinder, while the lower part *e* acts as a guide to the hammer tup *f*. In the upper part there works a piston *g*, formed on the tup *f*, so that below this piston and around the tup there is formed an annular space. Into this annular space, near the lower end of the working cylinder *d*, there enters pipe *h*, leading from a valve chamber *j*, in which works a piston valve *k*, adapted to control the supply of air to the working cylinder and operated in any convenient way by hand. The valve is operated by the usual mechanism employed in connection with steam hammers—that is, by means of a rod *m* and operating hand lever *n*. The valve chamber *j* is provided with an inlet *o* and an exhaust passage *p*, both of which passages lead to annular recesses *q* and *r*, respectively formed around the valve chamber. A liner *s*, having ports cut therein, is provided within the valve chamber, while the valve *k* itself works within the liner, and is provided with a waist or part *t* of smaller diameter. The working cylinder *d* is provided near its upper end with two ports *u* and *v*, the port *u* acting as an admission port, while the port *v* acts as an exhaust. Four sets of ports *w*, *x*, *y*, *z*—*y* is not shown—are provided in the liner. The ports *w* allow the exhaust air to pass from the space around the waisted or narrow portion *t* of the valve *k* to the exhaust air outlet *p*. The ports *x* allow the exhaust air to pass from the cylinder *d*, through the passage *v*, to the waisted portion *t* of the valve. The ports *y* permit the air to pass from the inlet *o*, through the ports in the valve *k*, to the interior of the valve chamber, from which the compressed air passes through the pipe *h* to the annular space around the tup *f* for the purpose of lifting.—*May 24th*, 1906.

MISCELLANEOUS.

23,857. November 20th, 1905.—IMPROVEMENTS IN THE CONSTRUCTION OF WHEELS FOR TRAMWAY CARS, MOTOR CARS, AND OTHER VEHICLES, William Freakley, of 34, Harding-road, Hanley, and Robert Bill, of Oak Hill, Stoke-on-Trent.

This invention relates to the construction of wheels for use on railway and tramway cars, motor cars, and traction wheels for road rollers, and its principal object is to secure such a degree of resilience as to relieve the central portion of such wheels, together with the axles, axle-boxes, springs, and other connections, from the effects of shocks and vibration. Fig. 2 is a partial section and side view. A disc or body *a* of iron or steel has in the centre a boss or hub for attachment to the shaft or axle. The body *a* is provided with a number of holes *c*, called "cells," of suitable size and form, and passing transversely through the body near its periphery. Into each of such cells is fitted circular or other suitably formed blocks or rings *d* of india-rubber. On each side of the body *a* is arranged a metallic circular side plate, having a central circular hole somewhat larger than the boss or hub *b* of the

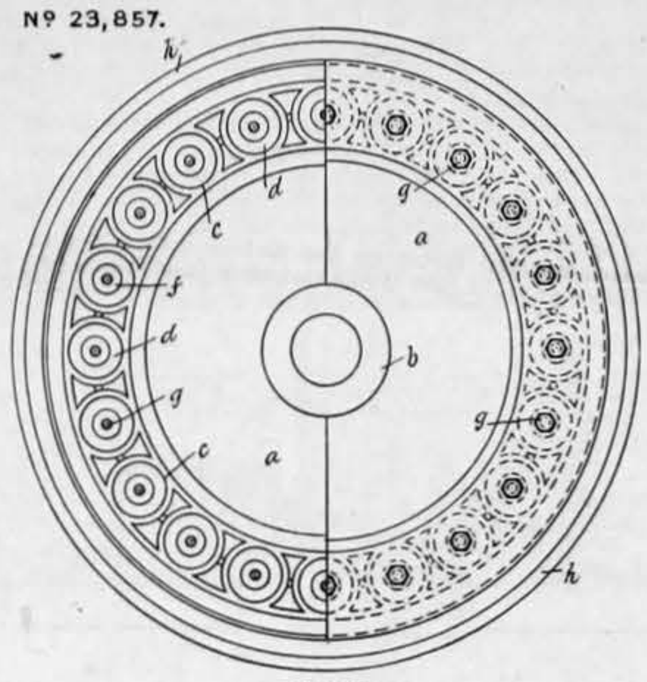


Fig. 2.

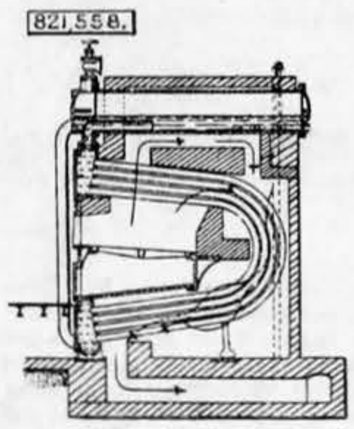
disc or body. One of these side plates is furnished with a suitable number of bosses or projections *f*, which are cast or otherwise formed upon it, each projection *f* having a central hole for the reception of bolts *g*. The positions and centres of the projections *f* correspond with the positions of the cells, and the bolt holes in the side plate *e* also correspond with the bolt holes in the bosses or projections *f*. The thickness of the disc or body *a* is slightly less than the length of the bosses or projections *f*, which are cast or formed on one side of the side plates, when gripped by the bolts *g* passing through and furnished with suitable lock nuts. The degree or extent of such sliding movement is governed by the amount of yield of the rubber rings *d* contained in the "cells." A ring of metal *h* surrounds the side plates, and has an inwardly projecting ring or part *l*, which can be firmly gripped between the side plates by means of bolts passing through holes formed in the several parts. The rim or ring *h* may at once form the tyre, or may act as a seat for a tyre of any suitable form or material.—*May 24th*, 1906.

SELECTED AMERICAN PATENTS.

From the United States Patent-office Official Gazette.

821,558. STEAM BOILER, *H. W. Wagener, Moscow, Russia.—Filed February 27th*, 1906.

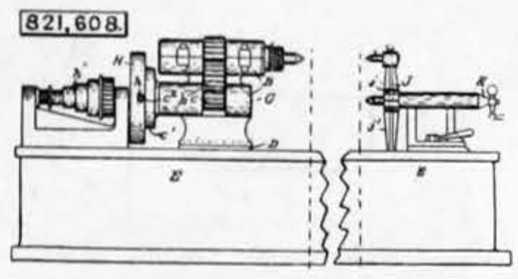
This invention is explained by the drawing. The furnace is



placed inside the group of bent tubes. The flow of the gases is sufficiently indicated by the arrows. There are eight long claims.

821,608. ATTACHMENT FOR INCREASING THE SWING OF LATHES, *A. V. Carroll, Batavia, Ohio.—Filed September 14th*, 1904.

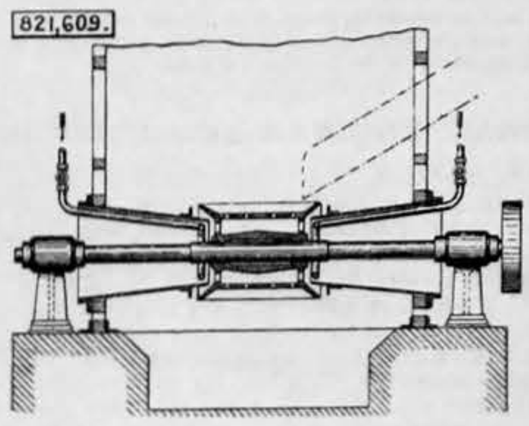
The nature of this invention is clearly set forth in the two last



of five claims, running as follows:—In a lathe, the combination of frame B carrying supplemental spindle A and shaft C; gears *a*, *b* and *c* connecting spindle A and shaft C; base plate D having grooves *d*; clamp G and bolt F for securing frame B to the lathe bed; plate *c'* carrying pins *c²*; and face plate H on the regular live lathe spindle, substantially as specified. A lathe attachment comprising a frame J having a split hub adapted to engage the dead lathe spindle; bolt *j* for securing frame J to said spindle; dead centre piece I carried by frame J; and arm *j'* constructed to have sliding connection with the lathe bed, substantially as specified.

821,609. APPARATUS FOR PULVERISING BLAST FURNACE SLAG, *H. Colloseus, Berlin, Germany.—Filed August 14th*, 1905.

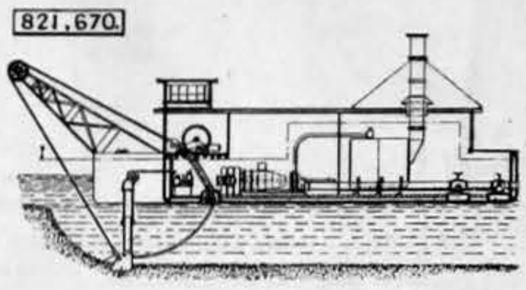
The slag is run into a receptacle, in the bottom of which is



placed a drum, which is perforated and made to revolve at a considerable speed, while air under pressure is forced through perforated rings at each end of the drum. There are eight claims.

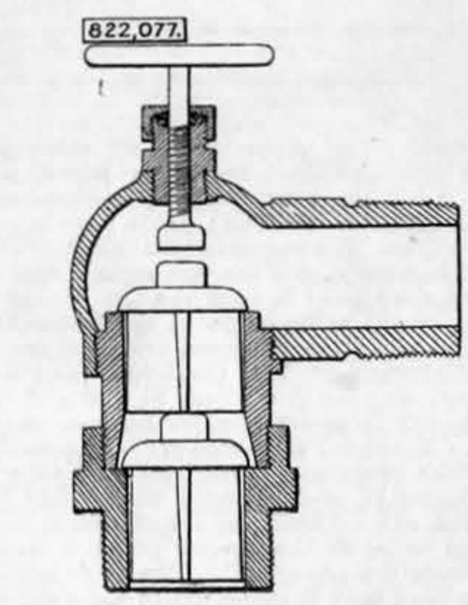
821,670. DREDGE, *L. S. Parker, New York, N.Y., assignor to The James Reilly and Repair and Supply Company, New York, N.Y., a Corporation of New Jersey.—Filed March 29th*, 1906.

This is a combination of the excavating machine or steam navvy



with a barge. The stuff raised by the scoop passes down the hollow shank. This stuff is transferred by water under pressure. There are nine long claims.

822,077. CHECK VALVE, *G. W. Rich, Memphis, Tenn., assignor of one-half to J. T. Lightburne, Memphis, Tenn.—Filed September 5th*, 1905.



This invention is explained by the drawing. It is a compact form of double check valve. There are four claims.

MOTOR LIFEBOAT.—The Royal National Lifeboat Institution have recently directed their attention to the problem of adapting the internal-combustion engine to lifeboats. The latest experiment in this direction has been made by the installation of a Thornycroft four-cylinder 24 horse-power motor in the Newhaven lifeboat Michael Henry, with most satisfactory results. The motor is auxiliary to, and not in place of, the oars usually used, but the boat as now equipped is far more handy than the usual type of lifeboat. The trials were carried out on the Thames under the supervision of Capt. Nepean, the chief inspector of lifeboats, and the average speed attained with the motor only, and with all equipment on board and ballast to the weight of a full crew, was 7·3 knots. In addition to the speed trials, capsizing trials were insisted on and fulfilled, to the complete satisfaction of the National Lifeboat Institution Authorities. These trials were to determine whether the engine casing was perfectly water-tight, and whether the motor would, as required, stop automatically when the boat was keel uppermost. If the propeller continued to revolve when the lifeboat was capsized, it would be liable to injure anyone coming in contact with it, and foul ropes, &c. The boat was completely capzised twice, the motor having previously been started in each case, and each time it stopped automatically when the boat was in an inclined position. The engine casing proved to be absolutely water-tight. The motor started easily, and ran satisfactorily after the capsizing of the boat.

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