SOUTH AFRICA FROM AN ENGINEER'S POINT OF VIEW.

(*From our Special Commissioner.*)

No. XVIII.*—THE THEORY AND PRACTICE OF THE RAILWAY SYSTEMS.

(*Continued from page 159.*)

CAPETOWN, January 1st.

The Natal Government Railways.—We now come to the Natal Government Railways, and in dealing with these I must speak with bated breath, for just now there is a fiery controversy going on on the subject of railways—a controversy so strong that even the visit of Mr. Chamberlain was hardly sufficient to subdue it temporarily. Now that he has passed the campaign is waging again as fiercely as ever, and it is on the momentous question as to whether the main line on the route to Johannesburg shall be doubled or an alternative line built. Of course it is political. All railway questions in self-governing Colonies are. And in this case it is the point on which the pending elections are to be fought. Natal voters are divided just now, not into Conservatives and Liberals, or Progressives and Moderates, or Protectionists and Free Traders, but into Double-main-linists and Alternativeists. I shall not enter into this discussion at all, beyond mentioning a few facts which should carry conviction to the outsider whose brain is not aflame with Party fanaticism. I also send a separate map illustrating this question, and a comparative diagram showing the mileage and altitudes of the two routes.

The N.G.R.'s live out of their traffic with Johannesburg. That traffic is assured to them for an indefinite period provided that they can compete with the Portuguese line from Lorenço Marques (Delagoa Bay). As the crow flies, Durban is 310 miles from Johannesburg, and Lorenço Marques 280 miles. The present railway from Durban to Johannesburg is 483 miles, and the journey is done in twenty-seven hours. From Lorenço Marques

the distance is 396 miles, and the time occupied is twenty-four hours. The C.S.A.R. are contemplating shortening the route through the Transvaal from Johannesburg to the Portuguese frontier still further; and thus, unless Natal can shorten her route, she will lose much of her traffic with Johannesburg. The alternative line proposed would run north of the existing line, forming with it a loop, with its junctions at Durban and Waschbank.

A comparison between the schemes for doubling the existing main line and constructing the alternative double line shows that the latter would shorten the distance by 50¾ miles, obviate 21 miles of curves, and reduce the maximum rise and fall by 1188ft. The maximum grade, too, of the proposed new line will be 1 in 50 instead of 1 in 30, as at present, and this will more than double the haulage capacity over the ruling gradient. These features will have the effect of reducing the time between Durban and Waschbank by six hours. As a set-off against all these advantages we find, in favour of the scheme for doubling the existing line, merely that this latter, including easing curves and gradients, will cost about half a million pounds less to carry out. As, however, with the alternative line, the profits by increased traffic and cheaper methods would probably amount to more than that figure in one year, and as without it much of the traffic will be permanently diverted to Delagoa Bay, this small extra capital expenditure is not worth considering. The secret of much of this political opposition is that the alternative line will not pass through Pietermaritzburg, the capital of the Colony. The vain endeavour to bolster up Pietermaritzburg simply because accident has made it the political capital of Natal, while Durban is the real centre of industry, commerce, and progress, may cost the Colony a heavy loss of money.

What the world wants, what Natal wants, if she wishes to make money, is to provide the best, shortest, and cheapest route between Durban and Johannesburg. As far as economics are concerned, Pietermaritzburg, in spite of its ponderous name, is of no consequence at all. It might as well be placed in the centre of Siberia as far as taking it into consideration in this matter is concerned.

It would be as reasonable for United States politicians to insist that all railways between New York and Chicago should deviate so as to pass through Washington as, as is the attempt of certain Natal politicians, to include Pietermaritzburg in the main line between Durban and Johannesburg when it has been proved that there is a far better route to be followed.

The mileage of the Natal railways running at the present moment, including that extension which penetrates the Orange River leading to Harrismith, must, I imagine, be as nearly as possible 600 miles. I give no detailed list of extensions and projects, as while this war of the routes is going on one can speak with no certainty on this head. Assuming, however, that reason will eventually prevail, and that the alternative line will be put in hand shortly, we may place work in progress and the immediately prospective lines at some 300 miles, making a total of operating and prospective lines of 900 miles.

The Central South African Railways.—We now come to the Central South African Railways, recently known as the Imperial Military Railways; and in the days of the Boer Republics as the Netherlands Railways. Though the open mileage of these is at present:—Transvaal, 889¾ miles; Orange River Colony, 439¾ miles; total, 1329½ miles only, the railways are for the time being by far the most important and interesting of all in South Africa just now. With the management of these and other South African railways I propose to deal in a separate article. Suffice it for me to say that the energies of the C.S.A.R. are being devoted seriously and with great intelligence to rectifying the defects of the old system. These are many and serious.

I have already in this article pointed out how the forthcoming short lines between Kimberley and Springfontein, and Fourteen Streams and Klerksdorp, will revolutionise certain of the important trade routes of South Africa. There are other equally important alterations in progress. At the present day there are practically no printed data concerning these lines and projects to assist the man who is looking for information; there is, in fact, no such thing as an accurate time-table which the public can lay hold of.

By the courtesy of the Commissioner of Railways, Colonel Sir Percy Girouard, I have been able to obtain all the information I required for the purposes of this article in the way of policy, mileage, and projects. Under the Boer *régime* the railway centre in the Transvaal was, of course, Pretoria, and a glance at the map will show that Johannesburg, the real centre of all things South African, is merely on a branch line. This has all to be altered. It is essential, above every other consideration, that all roads should lead to Johannesburg, and by the shortest possible routes. The first step, of course, was to transfer the general administration of these railways from Pretoria and Bloemfontein to Johannesburg. This has been done.

The two most important schemes for shortening the distance between Johannesburg and the sea will be provided for by the two new lines to be constructed from Springs to Machadodorp, in the Transvaal, and from Johannesburg, *viâ* Vereeniging and Viljoen's Drift, to Harrismith, in the Orange River Colony. A few days ago I saw in the papers that the Governor of Natal had stated that the first of the above two new lines had been abandoned. In view, however, of what I was told in Johannesburg, only a short time ago, I can hardly believe that the Transvaal will be prepared to place itself entirely in the hands of Natal when an easy method of shortening up the alternative route to Delagoa Bay presents itself. The effect of a Springs-Machadodorp line would be to replace two sides of a triangle by one. Pretoria would be excluded from the new main line between Johannesburg and Delagoa Bay, but that would be of no importance. After all, Pretoria, on its own merits, is at the present day merely a pretty little country town, and even if all the dreams of gold and diamonds that we hear of just now in connection with the place were to be realised to their full extent the existing communications between Pretoria and the outer world are extremely good, and will amply suffice.

Below is a list of the lines either under construction or in definite prospect by the C.S.A.R. at the time of my recent visit to Johannesburg:—

	Miles.
Johannesburg—Vereeniging	43
Viljoen's Drift—Harrismith	175
Sannah's Post—Ficksburg	63
Sannah's Post—Wepener, say...	28
Kimberley—Springfontein	130
Fourteen Streams—Klerksdorp	148
Krugersdorp—Rustenburg, say	30
Vanloockte — Vork (local Johannesburg gold mining line not shown on map)	16
Total	633

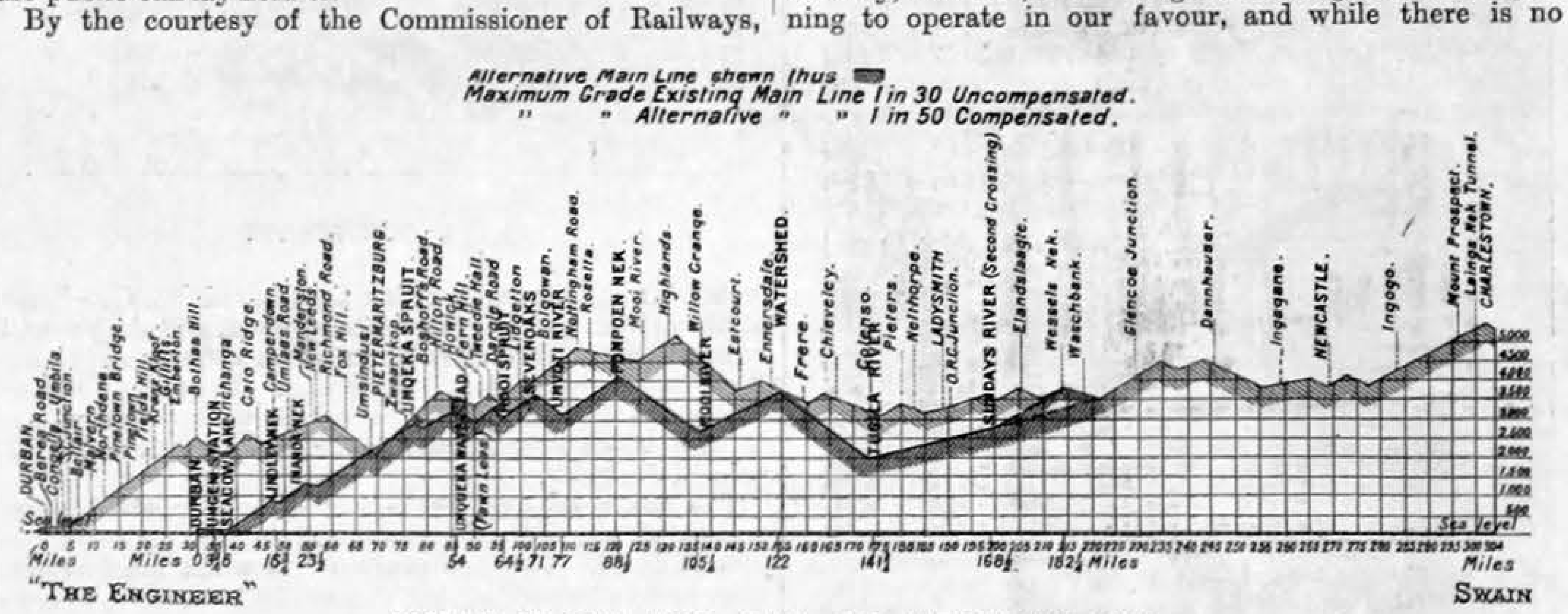
Of the smaller lines above mentioned, that from Krugersdorp to Rustenburg is for the purpose of tapping the richest tobacco growing centre in the Transvaal, while the Sannah's Post – Wepener and the Ficksburg lines open up the finest agricultural district in the Orange River Colony. All through the C.S.A.R. railway projects one notices that utilitarian motives alone are actuating the authorities. The absence of party politics just now in the Transvaal and the Orange River Colony, and the master hand of Lord Milner, make it possible for these practical schemes to go through without opposition, and the benefits will be real and lasting.

Perhaps in giving details of some of the the C.S.A.R. proposed lines I am a little previous, but one must deal with the future to the best of one's ability if information about railways is to be of practical value, and I have it on good authority that the schemes which I have enumerated above are bound to go through substantially in the form I have given them. The open and prospective lines of the C.S.A.R. amount to 1963 miles.

Conclusion.—To sum up the railway mileage of South Africa according to my most recent information, we have the following figures:—

	Open.	In progress.	Total.
C.G.R. ... ...(end of 1891)	2135	1288	3423
R.R.	1150	415	1565
Beira line (Portuguese)	183	000	183
N.G.R., say	600	300	900
C.S.A.R.	1330	633	1963
Delagoa Bay (Portuguese)...	59	000	59
Total	5457	2636	8093

With all this work going on, it would seem that there is an ample field for orders. In a previous article I have explained that nearly everything for these railways, as far as machinery is concerned, is ordered from Great Britain. When the C. S. A. R. were in the hands of the Boer Republics as little as possible was ordered from Great Britain, and the result has been that the workshops in Pretoria and Bloemfontein are replete with very weird-looking machinery from continental sources. Already, however, the change of management is beginning to operate in our favour, and while there is no doubt that the whole system of shops will have to be reorganised and re-arranged, it is quite noticeable already that there is much new plant in them which has come recently from Great Britain.



PROFILE OF THE N.G.R. MAIN AND ALTERNATIVE LINE

Our weak point in orders for railway plant in South Africa generally is, of course, rails. I have dealt with this question before, but mention it again, as it cannot be emphasised too strongly. We must, too, endeavour to meet the requirements of South African railways somewhat better than in the past in the way of delivery. This applies especially to locomotives. American locomotives are extremely unpopular on all these railways, but we must not trade too much on that fact. There is a limit to the patience even of the managers and engineers of South African railways. We talk in a general way of colonial patriotism, and what we should expect from it. I think that we get vastly more toleration, in the way of accepting long delivery and paying higher prices for British goods, from South Africa, than from any other British Colony or possession.

* No. XVIII.—first part—appeared February 13th.

VALTELLINA HIGH-TENSION THREE-PHASE RAILWAY.

No. III.*

WE have now to refer to the motor cars and locomotives. The principles of working and construction and many details were fully described in the five articles we published in the beginning of 1901, namely, upon January 25th, February 1st, 8th, 15th, and March 8th; so that a very short description in this place will suffice in connection with the detail drawings we are now able to publish. Several of the detail dimensions given in the above articles have since then been altered. Figs. 21 and 22, page 185, are the elevation and plan of the new trolley. The two contact rollers run upon one axle pole, 65in. long, of hard wood saturated under pressure with a special hard grease, the two being separated by 9in. length of insulation. Each contact roller is an electrolytic copper cylinder, 3½in. diameter by 26in. long, revolving upon hard steel ball bearings. At its outer end a collar upon the copper cylinder rubs upon, and conducts the current to, a fixed ring-block of carbon, whence it is led by a covered cable inside the tube forming one arm of the trolley frame, to the cast iron trolley base-plate, and thence again through well-earthed metal tubes to the main working switch. The covered

* No. II. appeared February 6th.

cable is kept in the centre of each such tube by being threaded through series of porcelain spheres. The trolley base-plate is insulated from the car roof, to which it is bolted, by three-lipped porcelain insulators. Each of the two arms of the trolley frame is made of two Mannesmann steel tubes. Each is 9ft. 9in. long. The frame allows considerable latitude to the cross pole carrying the rollers to tilt out of horizontal, so as to accommodate itself to want of level between the two contact wires. A glycerine cataract, marked K in the drawings, prevents violent impact of the trolley either upon the overhead line when it is raised, or upon its bearing upon the car roof when it is lowered, the former buffer action being exerted through a short chain. Each arm of the frame is independently pulled up by a pair of springs; but these springs take, through an equalising cross beam, their abutment upon the plunger of an air cylinder. It is by exhausting and filling this air cylinder that the driver lowers and lifts the trolley. In certain contingencies, involving danger, the air is exhausted automatically so as to cut off current from the motors; and the air-supply cock can be opened by the driver only if a specially cut key—of which there is no duplicate—be inserted. This same key opens the door of the main switch housing, and cannot be withdrawn from the lock except after this door has been closed. This housing contains the only bare parts of the 3000-volt transmission,

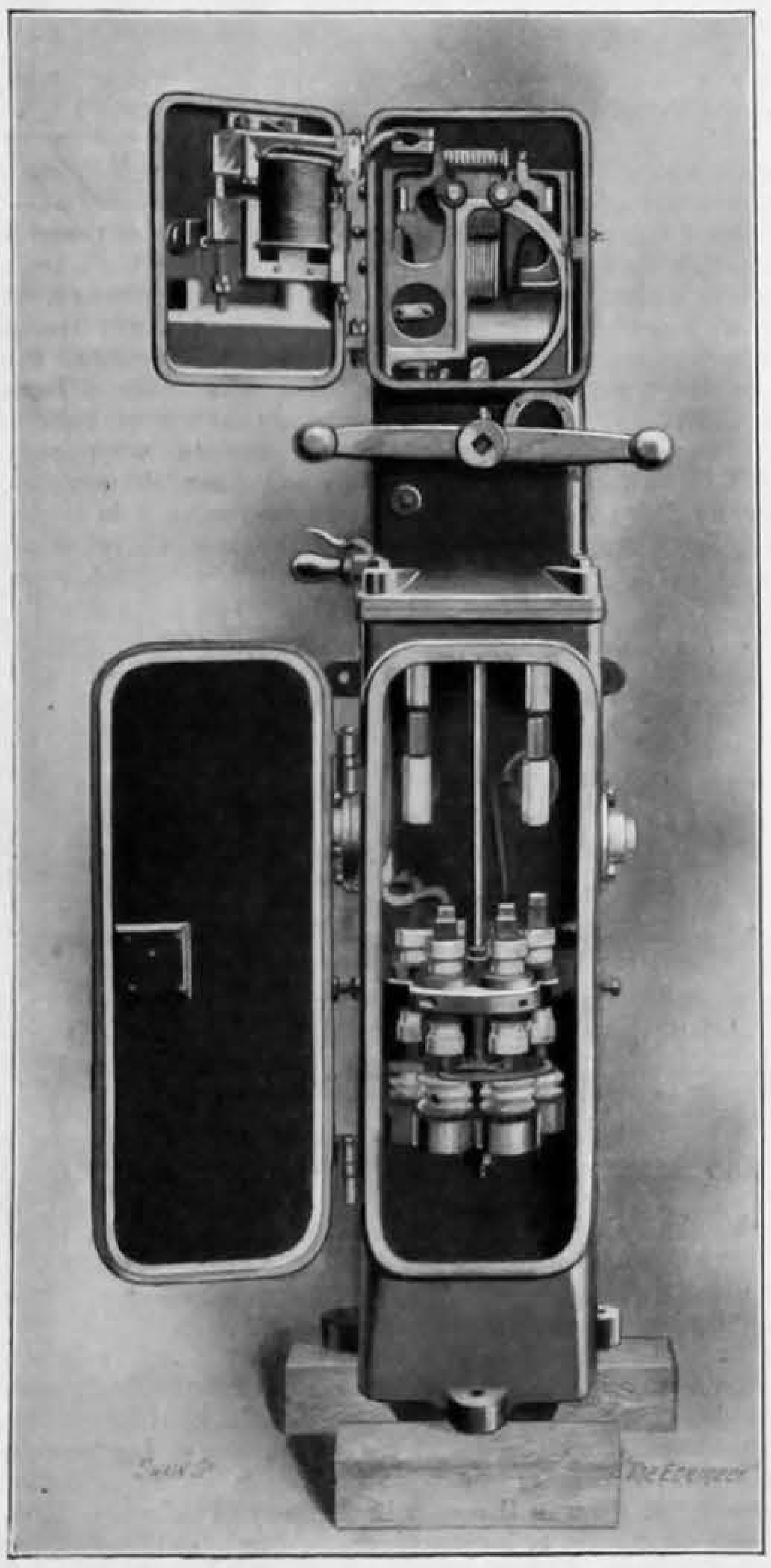


Fig. 24—THREE-POLE MAIN SWITCH

it being everywhere else permanently enclosed in well-earthed metal casings.

Each motor car and each locomotive carries two trolley frames, each used normally for travel in one only of the two opposite directions. But in passing siding switches, crossings, &c., there are wood insulators, sometimes of considerable length, inserted in one of the two contact lines; and at these places it is often useful to have both trolleys raised, one of the two always being outside the insulated length.

We have examined several of these trolley rollers which have been in use for periods varying from twelve to twenty-four months. The wooden axle has in all remained truly straight, and the copper cylinders roll on their ball races with extreme freedom. Through several miles of travel on an express train we watched closely its contact action on the overhead line. At the lower speeds there occurred no sparking of consequence; hardly any visible by daylight. At high speeds there is sparking and flashing more than one might desire. Successive flashes jump sidewise along the trolley roller, showing the existence of sudden side swing either of the carriage or of the overhead wire, and that this side swing is the main probable cause of the flashing; but there is also considerable sparking in passing suspension insulators and siding switches.

Fig. 23, p. 185, is an elevation of a motor car, in which the driver's two cabins, one at either end, one liquid rheostat R, and one driving axle are shown in section. The two rheostat boxes have external cooling ribs cast upon them. The liquid is a solution of sodium carbonate. It is gradually raised into contact with the specially-shaped iron plates by the injection of compressed air, and a full description of the mode of action will be found in our article of February 8th, 1901.

In Fig. 23 W is the Westinghouse air-brake cylinder. The air for the brakes, the rheostats, the trolleys, and the numerous manipulations which are all operated pneumatically, is stored in the reservoir F in the cabin behind the driver's box, into which it is pumped by the two-stage compressor E driven by a direct-coupled three-phase 100-volt 8 kilowatt motor, to which current is supplied by a small static transformer carried on deck. The compressor is designed for 10 atmospheres pressure; but at Valtellina 6 atmospheres is found ample, and is the pressure normally used. An automatic governor in the case marked G, in Fig. 23, controlled by the falling and rising air pressure, switches on and off the current, and

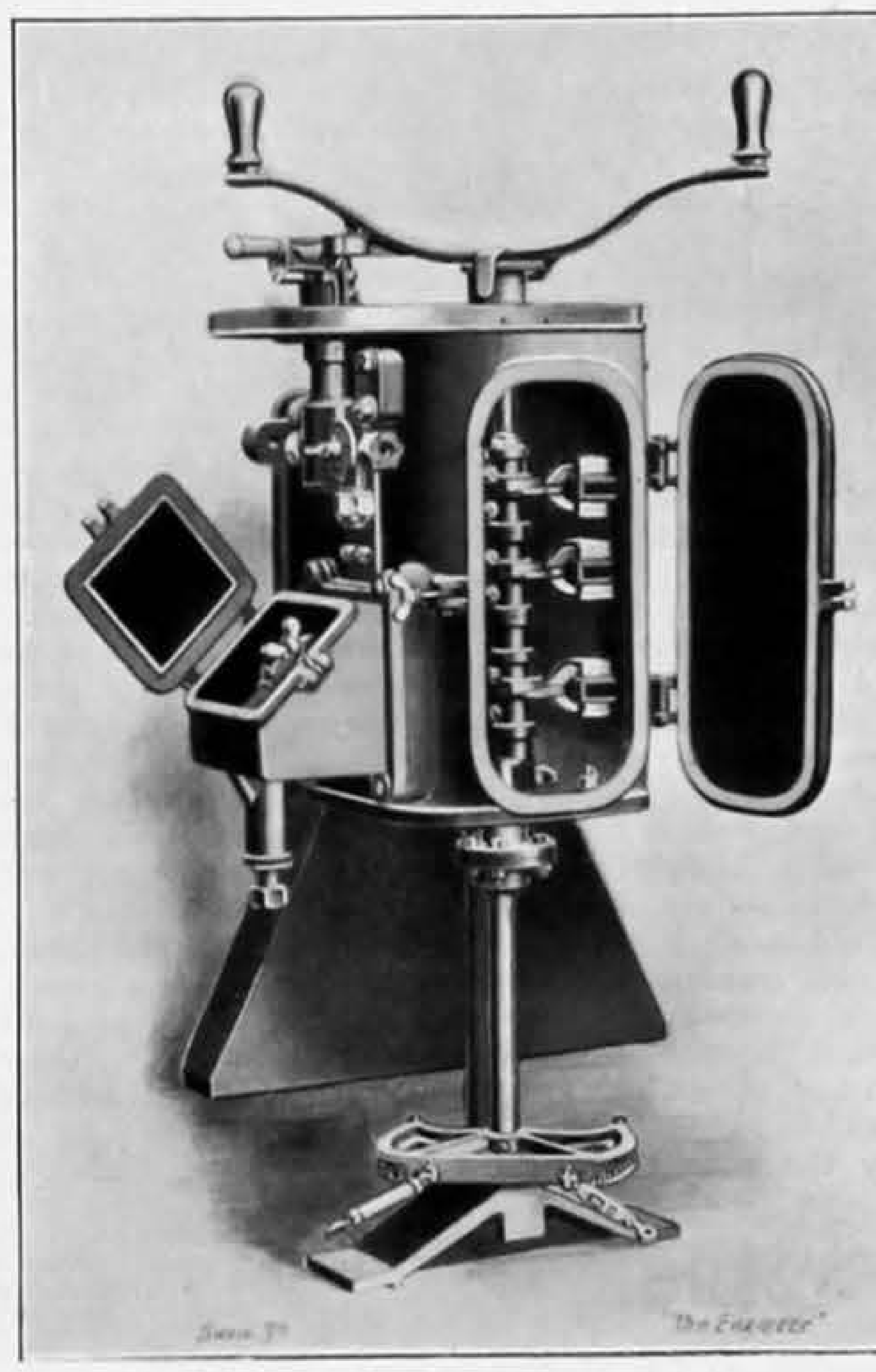


Fig. 25—CONTROLLER

maintains the pressure within the desired limits. Some of the drivers prefer to regulate by hand, and the present compressors are rather noisy and the too frequent putting them in and out of gear is annoying. They require to be run about two-thirds of the whole time of travelling. A new silent construction of compressor is being at present designed.

The main working three-pole switch—contact being broken at six points—is seen well in the photographic view, Fig. 24. The gap made by it when open is 8in. long, and as this is doubled, it is really 16in. from pole to pole. The six copper studs slide in six porcelain tubes, the end of each tube having a steatite cap for the sake of renewal. Its mechanism is described in the above article of February 8th, 1901, as is also the controller, a photographic view of which is now shown in Fig. 25. In Fig. 23 the main switch is marked B, and is seen in section at the right-hand end cabin. The controller is marked C, and is shown in section in the cabin at the left hand of the drawing. All the manipulating apparatus is duplicated in the two cabins.

The motors and all the accessory apparatus are, of course, protected by safety fuses. These are placed in

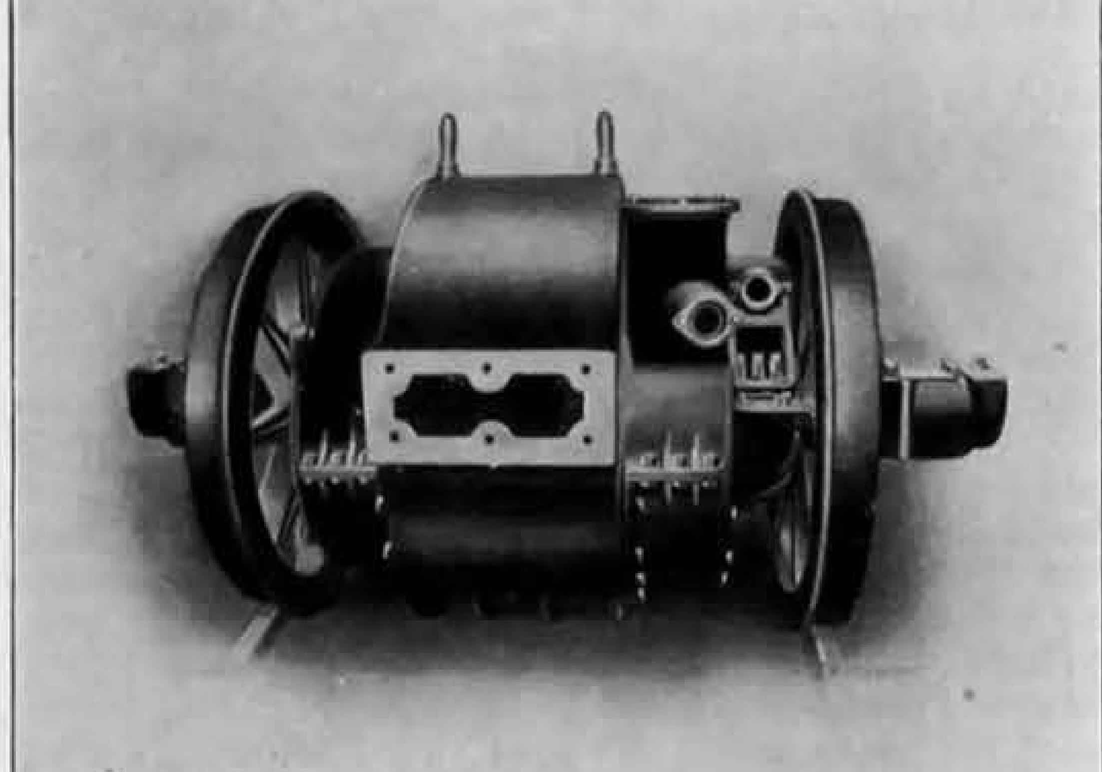


Fig. 27—PAIR OF WHEELS AND MOTOR

the box marked A. Two lightning protectors of the two-horned pattern, seen both in Figs. 23 and 26, page 185, and in Fig. 21, are mounted on the iron base-plate of each trolley.

The wheel base of each bogie truck is 2½ m. with 11½ m. between the two bogie pins. Over buffers the length is 19·14 m., and the tread of the wheels is 1·17 m. Each truck carries two motors, one on each axle. These are used in cascade up to half speed, and also in slowing from full speed to half speed. During this latter period they act as three-phase dynamos, and supply energy to the line. Except for frictional, hysteresis and C^2R losses, they would in this way convert three-fourths of the full speed kinetic energy of the train into useful electric energy. The pair in cascade exert a normal horse-power of 150 or 300 on the two bogies. For a short time they can do 400 horse-power without damage. In accelerating from half to full speed, and in running at full speed, one of each pair of motors is cut out and runs idle, while the other at full speed exerts a normal horse-power of 150. During the slowing down from half speed the braking is done by the Westinghouse air brake. It will be remembered that in cascade working, during the first period of acceleration, the rheostat liquid resistance is inserted in the rotor circuit of the second or low-tension motor, in whose stator the working tension rises only to 300 volts, this being derived from the rotor of the high-tension motor, whose current is drawn off by three bronze slip rings with carbon collectors. These collectors have each six carbon blocks, and embrace about one third of the circumference of the ring. As the rheostat resistance is gradually cut out by the entrance of the high-pressure air in the air chambers of R R, the speed rises, and the time rate of decrease of resistance is automatically varied so as to effect an approximation to uniform torque. After synchronous speed is reached, the rheostat resistance being now zero, if it be desired to accelerate further—from this half towards full speed—the second motor is cut out and the rheostat resistance inserted in the rotor circuit of the first, or high-tension, motor, the resistance being now again gradually decreased at an automatically regulated time rate. Thus the controlling is of the simplest kind, and, moreover, it is wholly effected in low-tension circuits. In fact, the hand lever of the controller has only three positions:—(1) "Half speed," in which it stands during the period of first acceleration; (2) "cut-out," or the mid position, in which the resistance is disconnected and the first rotor circuit stands open; and (3) "full" speed, for acceleration from half to full speed. Reversal of the running direction is effected by the main switch lever B.

Fig. 26, page 185, gives the diagram of the electric connections of the whole car. The explanations given above, and the notes on the diagram, make it extremely plain. The controller is shown in the cascade position, the rheostat being in the rotor circuit of the second motor. The high-tension motors are on the axles nearer the buffers; the low-tension on the inner sides of the bogies. The

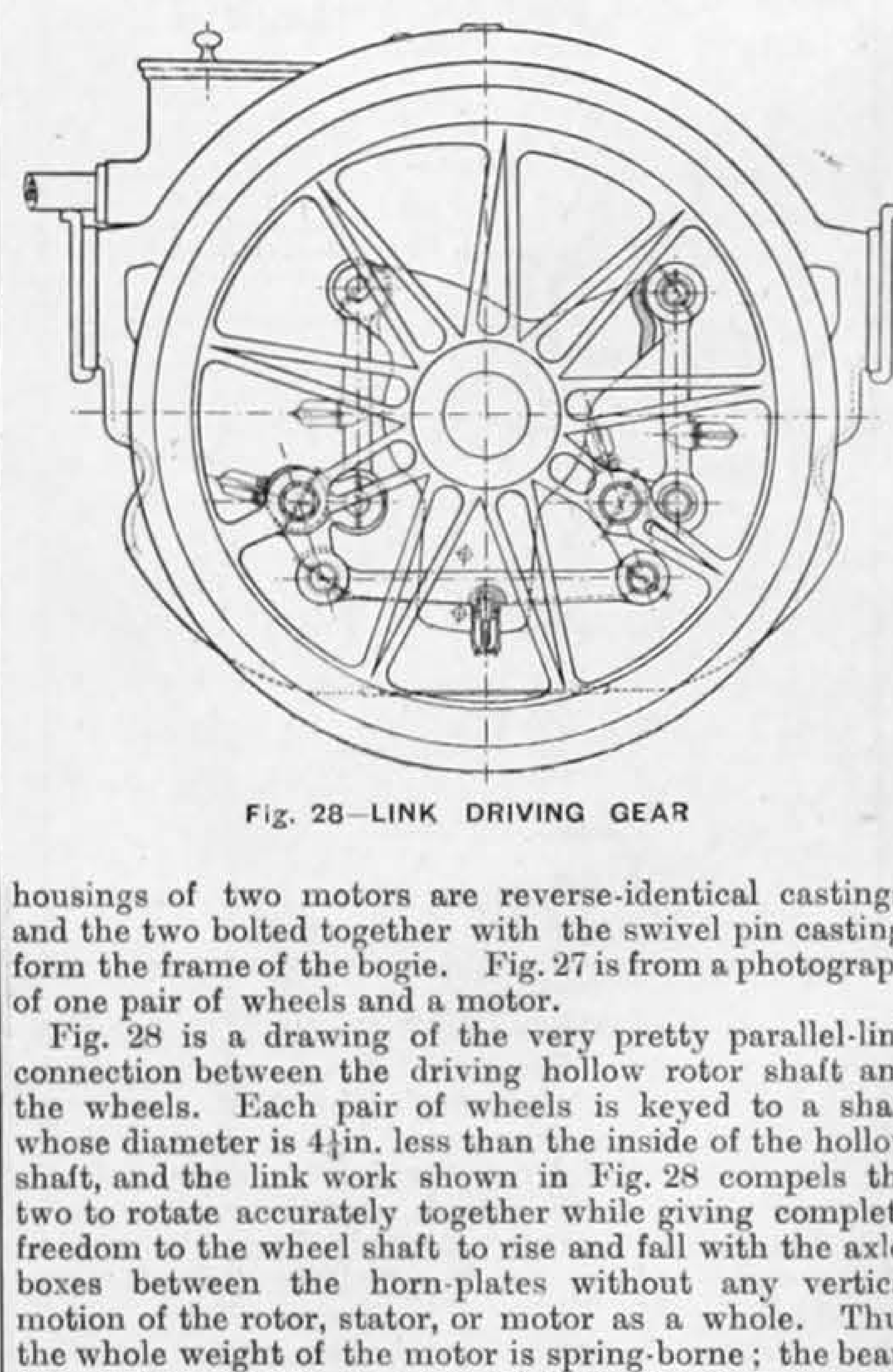


Fig. 28—LINK DRIVING GEAR

housings of two motors are reverse-identical castings, and the two bolted together with the swivel pin casting, form the frame of the bogie. Fig. 27 is from a photograph of one pair of wheels and a motor.

Fig. 28 is a drawing of the very pretty parallel-link connection between the driving hollow rotor shaft and the wheels. Each pair of wheels is keyed to a shaft whose diameter is 4½in. less than the inside of the hollow shaft, and the link work shown in Fig. 28 compels the two to rotate accurately together while giving complete freedom to the wheel shaft to rise and fall with the axle-boxes between the horn-plates without any vertical motion of the rotor, stator, or motor as a whole. Thus the whole weight of the motor is spring-borne; the bearings of the rotor shaft are fixed in the housing carrying the stator, and as small an air space between rotor and stator as is electrically and magnetically desirable is mechanically possible and as easy to obtain as in fixed plant. The limit of vertical oscillation of the wheels under the springs is the above 4½in., or rather 3½in., allowing ⅝in. per side clearance. The action of this linkage is fully explained in our article of February 15th, 1901. From Fig. 28 it may be seen that each of the three links carries a lubricator at the middle of its length, lubricating the six pins of the linkage. As these lubricators are situated nearer the centre than the pins they serve, a component of centrifugal force helps the lubricant on its way to the pins. Two other lubricators of similar pattern are mounted on the two wheel bosses where the linkage is attached to and drives the wheel. The wheel is driven by a pure torque—that is, by two equal and opposite forces producing no re-active resultant pressure upon the bearings in which the rotor runs. These bearings carry no weight except that of the rotor itself. Each rotor weighs 1½ tons. The whole load, including the weight of the rotor, is carried at the axle-box bearings.

As a two-page supplement we give drawings showing elevations and plan of the locomotive weighing 46 tons with four pairs of driving wheels 55in. in diameter. The whole is in two parts, which are identically reverse. Each part has a rigid wheel base two metres long, and the two parts are coupled together by a central 3½in. draw-pin joint with rigid attachments, re-inforced by two smaller side draw-pins with buffer-spring attachments. These connections are best seen in the side elevation and in the

THE VALTELLINA ELECTRIC RAILWAY—MOTOR COACH AND ITS CONNECTIONS

(For description see page 183)

Fig. 23. Motor Railway Carriage.

Fig. 26. Electrical Diagram of Car

Details of Trolley.

Fig. 21.

Fig. 22.

cross-section at mid-length of the locomotive. The driver's cabin is a spacious apartment, 3¾ metres long, the central portions of the walls and roofs being collapsible, while the floors of fore and aft halves are connected by a steel floor-plate hinged to the one and sliding on the other. The total wheel base of the locomotive is 6·63 metres, or 22ft., but each rigid portion being only 6ft. 7in., the locomotive travels very freely round sharp curves.

The trolleys are of the same pattern as in the motor car. At either end beyond the cabin over the end axle there is a compartment with a low sloping roof. This contains at each end a compressed air reservoir half metre in diameter, lying horizontally and transversely, and a sodium-carbonate liquid rheostat box. All four motors are alike high-tension, the cascade not being used upon the goods locomotives, and each of 150 normal horse-power, with from 30 to 40 per cent. overload capacity. The locomotive is thus of 600 normal horse-power, and is capable of drawing from 400 to 500 tons up the steep inclines of the line when the rails give sufficient adhesion. The rotors drive the wheels by the same style of parallel link gear as seen in Fig. 28, the dimensioning of the linkage being somewhat stronger in this case, as seen in outline in the two end wheels in the elevation of the locomotive. The controller and other driving apparatus is not duplicated, as in the motor car; but each manipulating lever, wheel, or handle is duplicated, so that the driver may stand at one or other end of the cabin always looking forwards in whichever direction he is travelling. During shunting work both trolleys are kept raised against the overhead contact wires. The controller gives the driver power to manipulate the four motors independently, so that one, two, three, or all of them may take power and assist in driving. To start a 270-ton goods train up the 11 per 1000 Chiavenna incline the locomotive takes 150 ampères. These locomotives have, of course, only one synchronous speed, corresponding to about 30 kiloms. per hour travelling speed.

It may be interesting to give some of our own notes of consumption upon two trains. In going northwards in an express we noted that the voltmeter in the driver's cabin went down to 2600 in climbing the 10 per 1000 incline before reaching Fiumellatte, while in starting out from the stations the current reached from 70 to 80 ampères. In a southward run on a five-coach local train, stopping at all stations, the following readings give an idea of the mode of driving; but it must be remembered that a good deal depends upon the individual driver. On this train the driver seemed inclined to do as much coasting as practicable. Theoretically, the time rate of the taking out of the rheostat resistance is automatic, but the driver was continually modifying this action by handling the air-cock, his apparent object being to steady the current at somewhere near 40.

Bellano-Varenna 9 and 3·6 per 1000 up gradients	Volts 3200 3000 2500 Amp. 0 80 80 40, 75, 25, 70, 40, 80, 0, 75, 70, 75, 40, 80, 75, 85, 80, 0
Varenna-Fiumelatte 6 and 8·6 per 1000 up gradients	Volts 3000 2800 3100 Amp. 0, 80, 40, 70, 40, 20, 50, 30, 65, 45, Volts 2900 2850 3100 Amp. 45, 45, 0
Fiumelatte-Lierna 10, 7, and 2½ per 1000 down gradients, then 10 and 6·4 per 1000 up gradients	Volts 2700 3000 2700 2900 Level Speed 60 km. Amp. 0, 87, 40, 60, 80, 20, 20, 30 Rise. Volts 2800 Amp. 60
Olcio-Mandello Level and 5·4 down gradient	Volts 2700 3100 3200 2800 3100 3000 Amp. 0, 87, 40, 0, 90, 40, 30, 40, Volts 3100 Amp. 40

The line is worked on a block system which is partly electric and automatic. In and on either side of each station is an insulated section of the contact wires which remains dead except when a train is coming into, or is leaving, the station. In coming in, if the signal is not against it, the approach of the train switches in the station section. When the train stops, it becomes again dead; and in order to start the train out the switch has to be once more closed. In travelling through each section, the train carries a metal cylindrical staff with a number of external collars, the spacing of which identifies it as belonging to that one particular section, and to it alone. To each section belongs a definite number of identical staffs. At each end of the section on the station platform stands a slotted pillar staff-holder, containing a special mechanism of simple character not liable to get out of order. There are two such pillars in each station, one for each of the two neighbouring sections. The two pillars in the two stations at the two ends of one section are connected electrically by a special wire and small battery in such a way that the two mechanisms always move and stand alike. The mechanism offers no hindrance at any time to a staff being put into the holder, and both mechanisms are moved by a staff being deposited in either of them—it does not matter which. The common position they assume depends on the combined number of staffs deposited in the two holders. When all the staffs belonging to the section have been deposited at one or other end of it, then the mechanisms have been brought into the one only position in which they allow a staff to be extracted; in all other positions their slots remain closed against such extraction. Thus, as the deposition in these holders of all the staffs belonging to the section means that the section is empty, a train driver is unable to get a staff permitting him to proceed along the section unless that section be empty. Further, to the mechanism of each pillar is attached a second small relay battery, whose circuit is closed by the action of withdrawing a staff. The current on this battery circuit operates the station switch—to close it—which gives 3000-volt tension to the insulated station section of the overhead wires; so that the driver cannot get his voltage to start away from the station without first taking his staff out of the holder. The automatic action does not extend so far as to compel the driver to take the staff away with him in his train—he may drop it on the platform, or leave it in the buffet, after taking it out of the holder—but if this were thought necessary or desirable, it would evidently be a simple matter to make the staff the only means whereby he could get command of compressed air to raise the trolley into contact with the overhead line. Again, the section may be empty, but if the last driver who has passed over it has forgotten to deposit his staff in the holder, then no other train can get on to it until this mistake has been rectified. The design of the staff-holder is ingenious; but we cannot spare space for drawings of it.

The whole cost of this Valtellina electrification is stated to have been 6¼ million lire, or about £248,000. Of this, £100,000 has been spent upon the hydraulic power works, which, it must be remembered, are capable of at least three times as much power development as it is at present called on to provide. Over £52,000 is accounted for by the electric rolling stock, while £68,000 has been spent upon the electrification of the line. The central station machinery enters the account for the remaining £28,000. The £248,000 divided by the 67 miles length gives £37,000 per mile; but if we take the developments capable of being served by the existing hydraulic works and the central station plant, the cost works out to about £27,000 per mile.

It is found that, with 9600 units generated per day as at present, the electric energy consumption is 41½ watt-hours per ton-kilometre, or 67 watt-hours per ton-mile. The total yearly central station cost is reckoned to be £1340, including wages, material, and upkeep of all the hydraulic works; while £1700 is the cost of working and keeping in repair the electric transmission. These working costs together make the cost of supplying energy to the car and locomotors 0·90 lire per 1000 tonne-kilometre, or about 1s. 2d. English money per English ton-mile gross weight.

It is said that before the electric conversion the cost of coal to the locomotives on this Lecco line was 2·35 lire per 1000 ton-kilometre, which has to be compared with the above 0·90. In the calculation of this 0·90, however, no allowance for rental or compensation for the water taken from the Adda is made, nor any interest or depreciation upon the whole capital expenditure.

THE USE OF HIGHLY SUPERHEATED STEAM.

By Professor EWING, LL.D., F.R.S., M. Inst. C.E.

THE remarkable results which have been achieved by Messrs. Easton and Co., Limited, in their development in England of the Schmidt system of using superheated steam, have directed general attention to the advantages of high superheat. A report recently published in THE ENGINEER—January 9th—describing trials which I made of an engine built by Messrs. Easton at the works of the British Xylonite Company at Manningtree, has attracted the notice of several correspondents, whose letters lead me to think that an article dealing briefly with some general points may be useful.

The main point for consideration is, of course, the economy of heat, and therefore of coal, which the use of high superheat allows us to accomplish. Now, on this point it is important to remember that there are always two factors in economy of coal, namely, the engine efficiency and the boiler efficiency. I use the words "boiler efficiency" in a sense wide enough to include the superheater. We have, in fact, to consider two distinct questions—(1) how much steam does the engine use per horse-power hour, and (2) how much coal is used in generating and superheating that steam.

Further, in judging of the real significance of an *engine* trial as to possible economy of coal, we shall find it useful to infer from the steam used what the consumption of coal would have been if the boiler and superheater conditions had been as favourable as experience in other instances satisfies us they might be.

In the Manningtree trials the consumption of steam was just 9 lb. per indicated horse-power hour when the engine was working at its most favourable load. This was steam generated at 140 lb. per square inch and superheated to 800 deg. Fah., or, say, 440 deg. above the temperature of formation. If we take the usually accepted value for the specific heat, namely, 0·48,* these 440 deg. of superheat represent an addition of 211 units of heat per pound of steam. In generating saturated steam at this pressure from a feed temperature of, say, 75 deg. Fah., the amount of heat taken up is 1149 units. Then, to superheat the steam requires 211 units more, which is $\frac{1}{5\cdot5}$ of the heat taken up in the boiler. The total heat required to generate and superheat each pound is therefore 1360 units.

Thus, under favourable conditions of superheating, we ought not to require to burn more than, say, one-fifth more coal to form each pound of the highly superheated steam than is required to form each pound of saturated steam.

There is no doubt that this can be done. To do it, however, requires that the furnace gases, after leaving the superheater at a comparatively high temperature, must have further heat extracted from them by means of a feed-heater. In my trials of a Schmidt plant near Amsterdam this was done so effectively that the furnace gases, after passing a superheater in which the steam was heated to about 750 deg. Fah., were made to give up heat to a Schmidt economiser to such good purpose that before escaping to the chimney their temperature was lowered to 347 deg. Fah. In that instance I found that to generate steam at a pressure of 140 lb., and to superheat it—to 742 deg. Fah.—required only $\frac{1}{7\cdot93}$, or 0·126 lb. of coal per lb. of steam. At Manningtree—with only a slightly higher superheat—it took 0·157 lb. of coal per lb. of steam. The main reason for this difference is that at Manningtree there was no economiser. Both from the boiler furnace and from the superheater—which was separately fired—the gases escaped at a comparatively high temperature, carrying away heat which might use fully have been saved. Moreover, at Manningtree the boiler and also the superheater were designed to serve two engines, whereas only one engine was running during the trials, and in this respect also the conditions were unfavourable to economy of coal. Further, the coal used at Manningtree was of comparatively poor quality. Its average thermal value, taking boiler and superheater coal together, was only 12,970 thermal units per lb., so that 1 lb. of it was equivalent to only 0·86 lb. of standard coal, having a thermal value of 15,000, units.† Actually the consumption of coal at Manningtree was 1·41 lb. per indicated horse-power hour, equivalent to 1·22 lb. of such standard coal; but had the conditions of boiler and superheater been the same as they were in my Amsterdam tests, this figure would have been reduced much below 1·2 lb.

Again, to realise what the results of the trial at Manningtree mean, it is useful to remember that the 9 lb. of superheated steam which were used there per indicated horse-power hour were equivalent, in the quantity of heat they conveyed to the engine, to only 10·65 lb. of saturated steam. It is this figure which should be compared with the consumption in an engine using saturated steam. And, further, the 15 lb. of superheated steam used at Manningtree per electrical unit are equivalent to 17·7 lb. of saturated steam per electrical unit. These figures, moreover, were reached in an engine of only 300 horse-power.

The trials only emphasise and confirm what has been proved before, that not only as regards consumption of steam, but as regards consumption of heat and of coal, there is a striking advantage in using high superheat. To what is this remarkable advantage due? Why is it that, by adding only one-fifth or one-sixth to the heat which the steam has already taken up in the boiler, we are able to make the steam do more than 50 per cent. additional work in the cylinder? There is, of course, a small theoretical advantage from the fact that some heat is taken in at a high temperature, but this goes only a little way to account for the very large practical advantage that follows the use of high superheat.

The answer, apparently, is that by using high superheat we escape in great part *both* of the two chief sources of loss in the action of saturated steam. These are (1) the loss which arises through alternate condensation and re-evaporation in the cylinder, and (2) the loss which arises through leakage at valves, pistons, and sliding surfaces generally, and especially through direct leakage from the steam side to the exhaust, such as occurs in an ordinary slide-valve. Of these two actions, the first is now so well known that I need not dwell on it; but the second action is not so generally appreciated. It was first, I think, brought into prominence by the researches of Callendar and Nicholson ("Min. Proc." Inst. C.E., 1898). They have shown that, however tight a slide valve may be while standing still, it leaks while running, a film of water finding its way from the steam side to the exhaust between the sliding faces. The wetter the steam the more serious does this leakage become. My attention was particularly drawn to the advantage of superheating in checking leakage of this kind in tests which I made of another engine furnished with piston valves, and using triple-expansion. There the saving effected by changing from saturated to superheated steam was enormous, and it was to be ascribed in large measure to the fact that with saturated steam the leakage past the piston valves had been great. By superheating to 575 deg. Fah. the consumption of steam in that engine was reduced for the same output by 42 per cent.

It is one of the striking advantages of high superheat that when properly applied to a rather inefficient engine it cures it of its conspicuous defects, and makes it highly efficient. It enables comparatively small engines to compete in efficiency with engines of the largest size, and it gives excellent results without the complications of triple-expansion. The engine tested at Manningtree was a two-cylinder compound.

To obtain the full advantage of superheating, it is essential that the steam should be superheated before each of the two stages in its compound expansion. The steam in the intermediate receiver, which has become saturated, or even wet, during its first expansion, must be again superheated before admission to the low-pressure cylinder. Schmidt secures this in a simple and effective manner by using the live steam, on its way to the steam chest, as a vehicle to convey heat to the receiver. The temperature to which the steam supply is superheated in the first instance is limited only by considerations of safety and durability on the part of the superheater, and may be as high as 800 deg. Fah. But before admission to the cylinder it has fallen below 600 deg. Fah., mainly by transfer of a portion of its heat to the intermediate steam, and in this way a favourable distribution of the superheat is secured as between the two cylinders, with the result that the steam remains dry, or nearly dry, in its whole passage through the engine.

On the question of durability, there is now ample experience to show that high superheat, when used as Schmidt uses it, does not involve any excessive wear and tear either of engine or of superheater. The introduc-

* This number was determined by Regnault in experiments on the superheating of steam at a low pressure, and through only a very moderate range of temperature. Its applicability to steam at such pressures as are usual in modern engines, and through such ranges of temperature as are now in question, is open to considerable doubt. Mr. A. H. Peake has recently been engaged in a research on this point, in my laboratory, and so far as his results are as yet definite, they tend to show that in any case the value of the specific heat under such conditions as we are now concerned with does not differ very widely from the value found by Regnault.

† The thermal value stated in the report has been found to be too high, on account of an error in the constant of the calorimeter. The correct figure is given here.

TYPES OF LOCOMOTIVE CONNECTING RODS

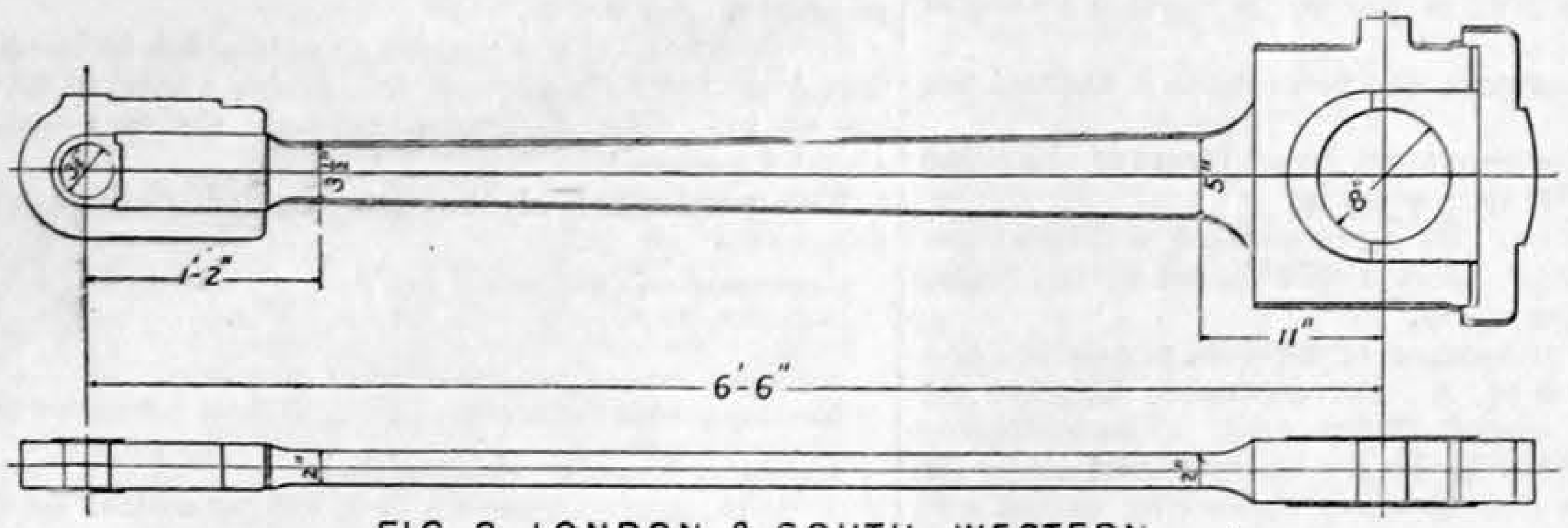


FIG. 3 LONDON & SOUTH WESTERN.

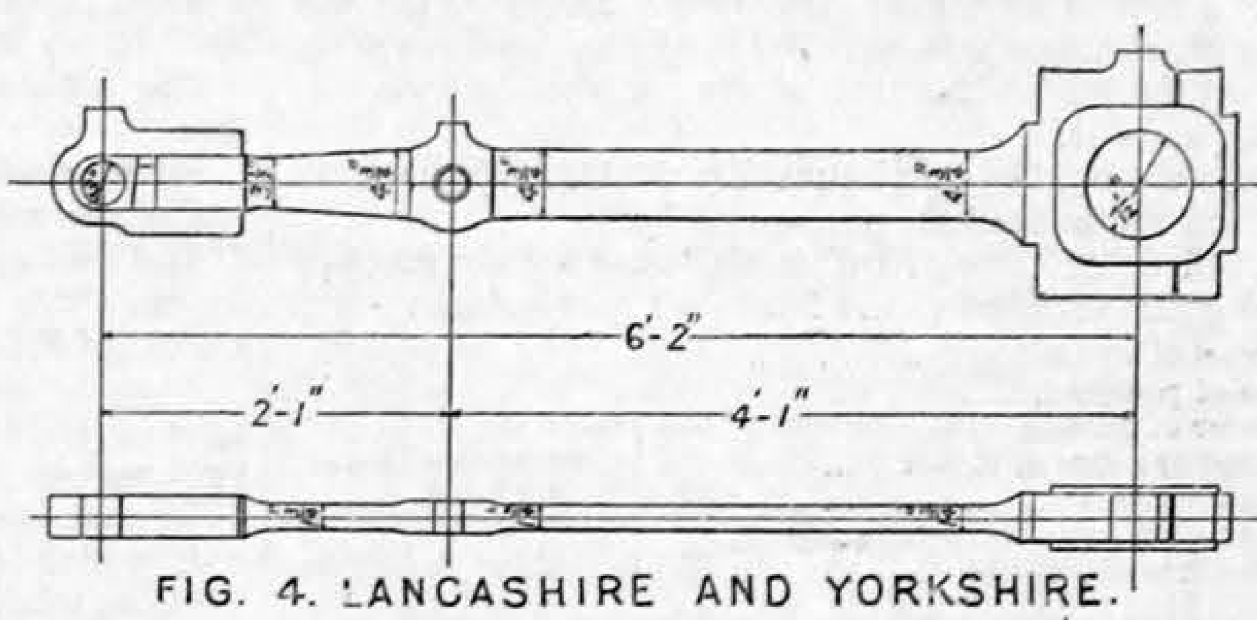


FIG. 4. LANCASHIRE AND YORKSHIRE.

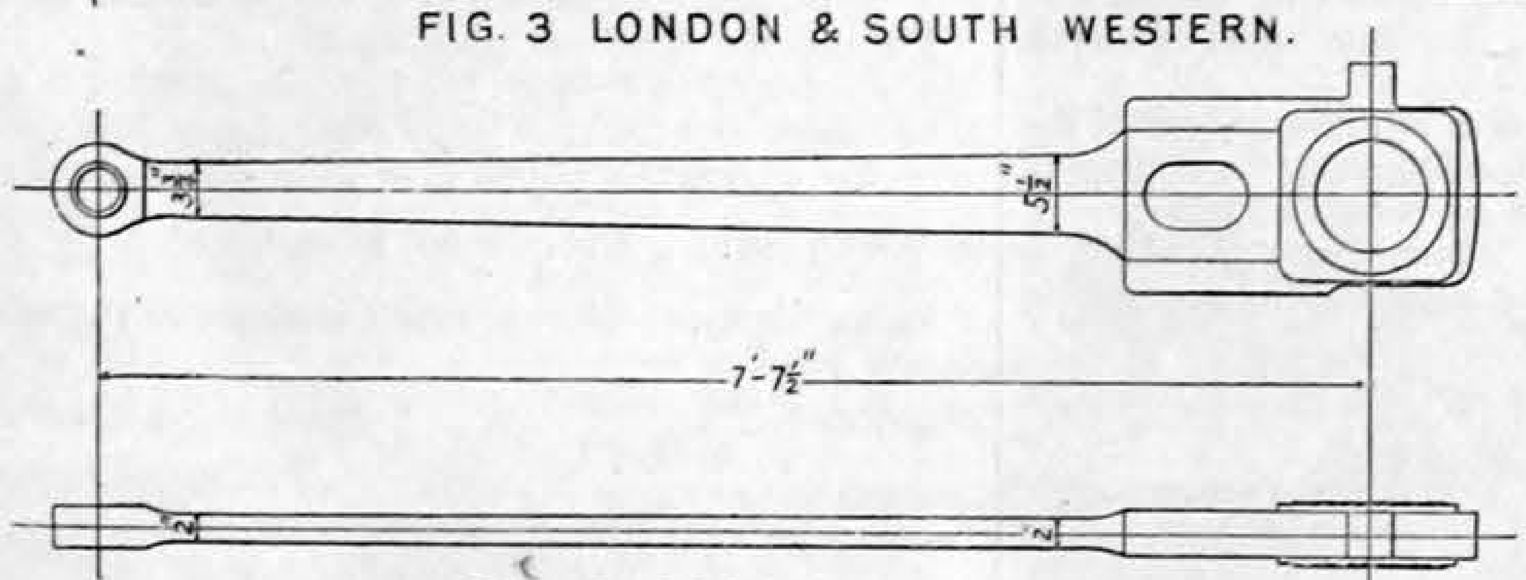


FIG. 5. GREAT EASTERN

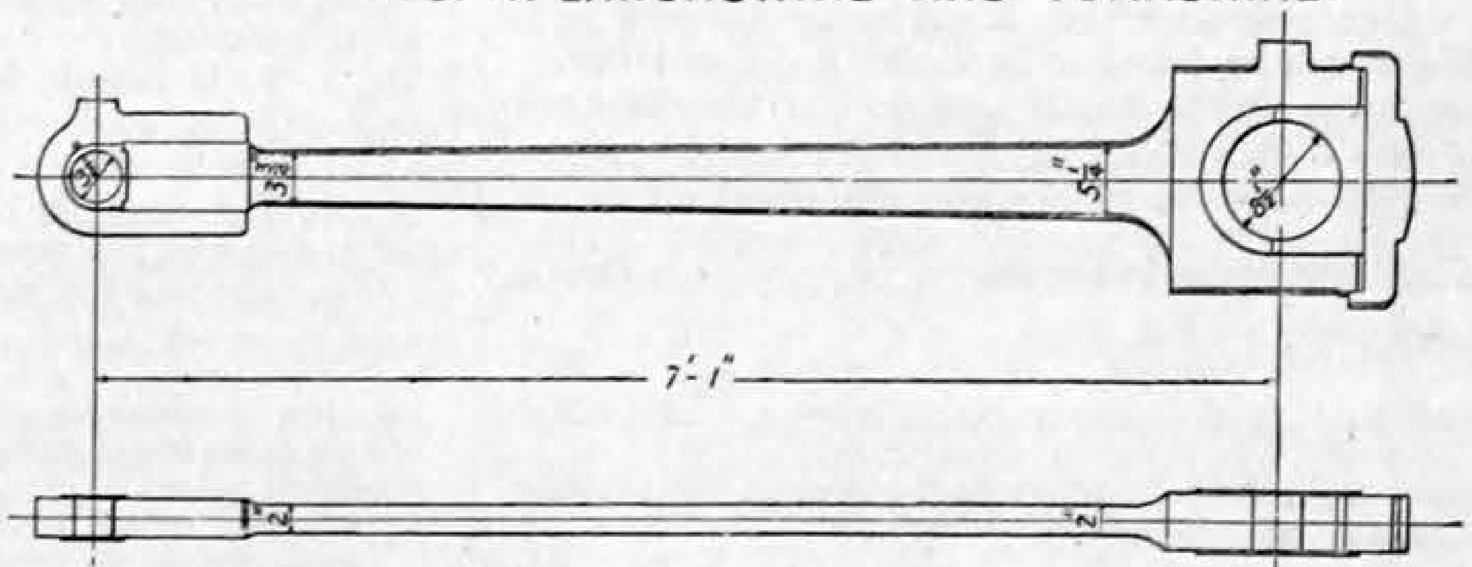


FIG. 6. CALEDONIAN.

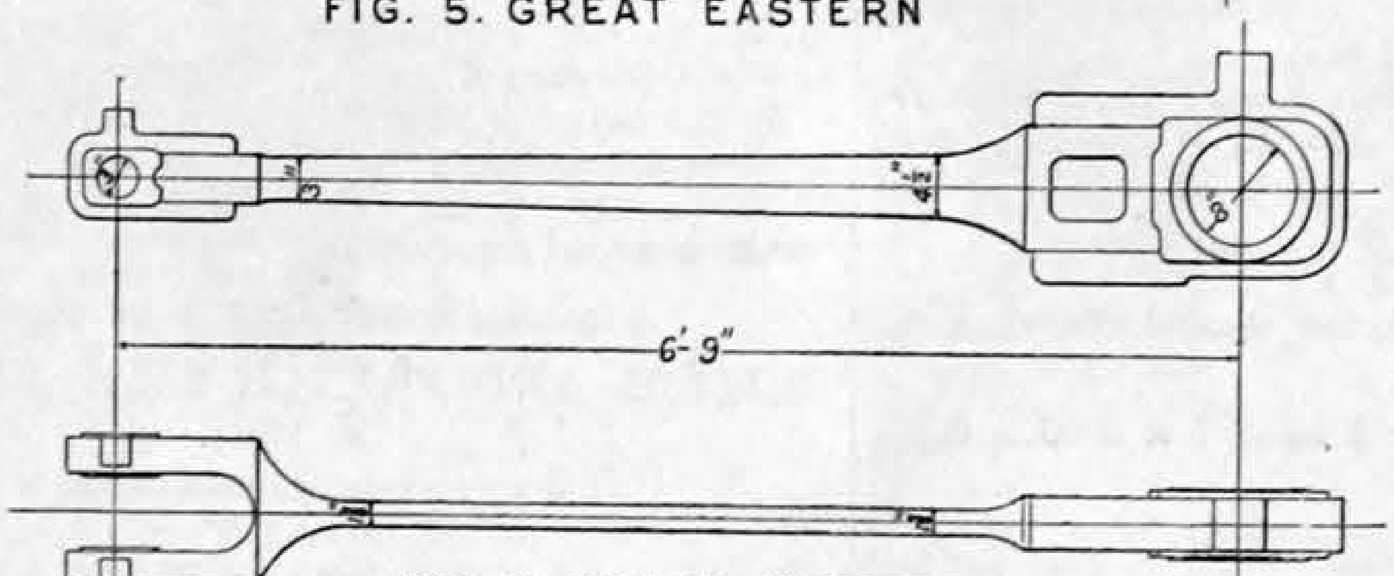


FIG. 7. GREAT WESTERN.

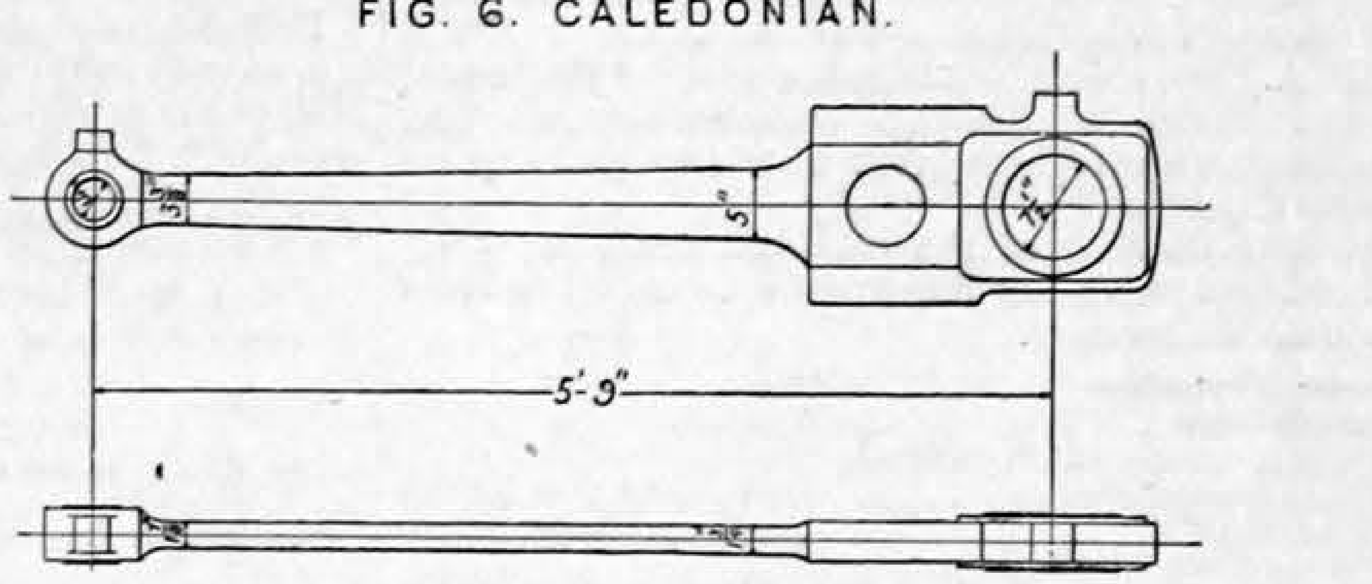


FIG. 8. GREAT NORTHERN 8 WHEELED ENGINE.

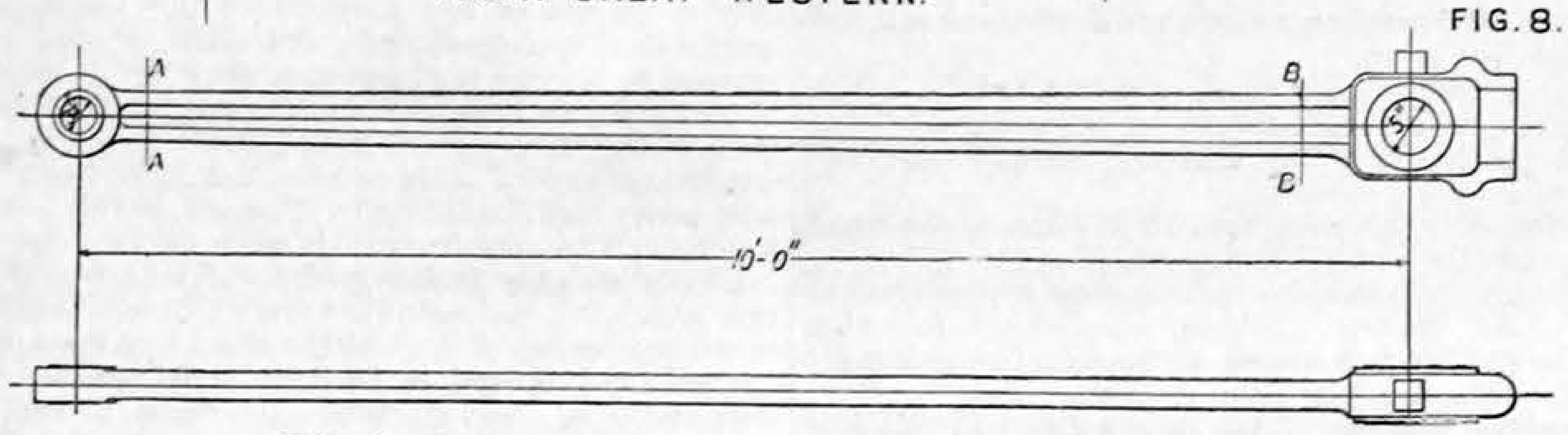
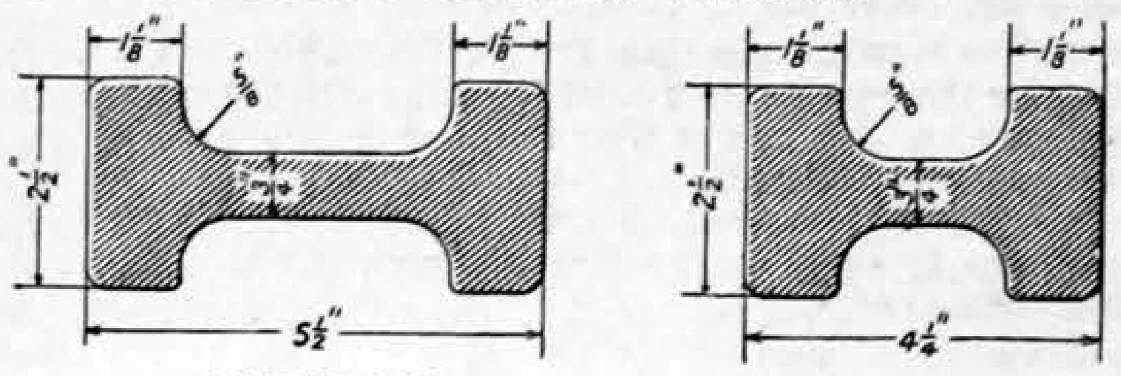


FIG. 9. GREAT NORTHERN 10 WHEELED ENGINE.



SECTION B.B. SECTION A.A.

"THE ENGINEER"

tion of Schmidt engines into England is comparatively recent, but in Germany and elsewhere they have been used long enough to demonstrate their durability. I have before me letters from various users of Schmidt plant on the Continent, who one and all bear testimony to the small cost of maintenance and absence of need of repairs during periods of use which extend in some cases to more than seven years. In more than one instance the plant has been working night and day during that time. The wear and tear of the engines are "not greater than in the case of ordinary steam engines of good quality." The superheaters "have proved thoroughly satisfactory, and no repairs have been necessary." "None of the superheater coils have up to now been replaced, and all are intact."

A great extension of the use of highly superheated steam may confidently be looked for when such facts become better known among English engine users, and when they realise not only the advantages which high superheat secures in economy of steam and of coal, but also the simplicity of the means by which this economy is brought about

CONNECTING AND COUPLING-RODS.

By P. H. PARR

No. III.*

A NUMBER of examples taken from practice will now be given. Of course, one example would be sufficient to show the application of the above formulæ, but I have been able to obtain the necessary particulars of the latest standard rods of several railway companies, and these are all included in order to give a good idea of the modern practice for British locomotives.

Mr. D. Drummond, locomotive superintendent of the London and South-Western Railway, supplies the following particulars of his latest four wheels coupled express passenger engines.

A working drawing of the connecting-rod, which is partly copied in Fig. 3, with the dimensions which have reference to the subject at present under consideration:—

Diameter of cylinders	18½in.
Stroke of pistons	26in.
Diameter of driving wheels on tread ...	6ft. 7in.
Working pressure of steam...	175 lb. per square inch.
Maximum speed	52 miles per hour.
Approximate cut-off when running at the maximum speed	12 per cent. of the stroke.

We will first find the maximum stress in the material by the use of the approximate formula (2*b*), and afterwards by the more exact equation (4).

To find the numerical values of the algebraic symbols for this rod we have $v = \dfrac{44 \times 52 \times 13}{15 \times 79} = 25 \cdot 1.$

* No. II. appeared January 23rd.

It will be noticed that when using this equation—for it is immaterial whether D and r be taken in feet or in inches, so long as the same unit is used for both—it will generally be found more convenient to take them in inches.

We have $l = 78 : r = \dfrac{13}{12} ; \zeta = \dfrac{25 \cdot 1^2 \times 12}{78 \times 13} = 7 \cdot 456$

The thrust along the rod I estimate at 6000 lb.

The steam pressure to use for calculating the thrust is most conveniently found—in the absence of an actual indicator diagram—by subtracting 15 from the boiler pressure, multiplying by the cut off expressed as a percentage of the stroke, dividing by 46, and subtracting 20. Thus for the above engine we have $(175-15) \times \dfrac{12}{46} - 20 = 22$ lb. per square inch. It is not difficult to see that this is equivalent to assuming the pressure in the cylinders at cut-off to be 30 lb. per square inch below the boiler pressure, and allowing a back pressure of 5 lb. per square inch.

To find α and β we have $A_1 = 3\frac{1}{2} \times 2 = 7 : A_2 = 5 \times 2 = 10 : a_1 = 14 : a_2 = 67$, so that $\beta = \dfrac{10-7}{67-14} = 0 \cdot 056$ and $\alpha = 7 - 14 \times 0 \cdot 056 = 6 \cdot 216$.

Putting $x = 39$ in the equation $A = 6 \cdot 216 + 0 \cdot 056\, x$ we obtain the area at the centre as 8·4 square inches, and as the rod is 2in. thick, the depth at the centre is 4·2in., and the strength modulus of the section, $Z = \dfrac{4 \cdot 2^2 \times 2}{6} = 5 \cdot 88.$

We have now all the information necessary in order to make use of equation (2*b*), and the maximum stress in the material due to bending is

$$0 \cdot 00005 \; \frac{7 \cdot 456 \times 78^3}{5 \cdot 88} \; (12 \times 6 \cdot 216 + 7 + 0 \cdot 056 \times 78)$$

= 3165 lb. per square inch.

In addition to this stress caused by bending, there is the direct stress due to the thrust along the rod, which is equal to $\dfrac{6000}{8 \cdot 4} = 714$ lb. per square inch, and the total stress (maximum) in the material is the sum of these, 3165 + 714 = 3879, or, say, 3880 lb. per square inch.

In order to calculate the stress by the aid of Equation (4), it is first necessary to find the numerical values of the remaining constants. We have—

$$R_1 = \frac{0 \cdot 288 \times 7 \cdot 456 \times 78^2}{12 \times 32 \cdot 2} \; (4 \times 6 \cdot 216 + 3 \times 0 \cdot 056 \times 78) = 1284, \text{ or, say, } 1300$$

$\delta = 8$

$\mu = 0 \cdot 07$

$$\eta = \frac{0 \cdot 07 \times 8}{2 \times 78} \sqrt{6000^2 + 1300^2} = 22$$

E = say, 26×10^6

I = 12·35

We are now in a position to use Equation (4), and the bending moment at the centre is—

$$\frac{1}{2}\Bigg[22 \times 78 + \frac{0 \cdot 288 \times 7 \cdot 456 \times 78 \times 26 \times 10^6 \times 12 \cdot 35}{32 \cdot 2 \times 6000} (6 \cdot 216 + 0 \cdot 056 \times 78) - \frac{2 \times 0 \cdot 056 \times 0 \cdot 288 \times 7 \cdot 456}{32 \cdot 2}\left(\frac{26 \times 10^6 \times 12 \cdot 35}{6000}\right)^2 \text{versin } 78 \sqrt{\frac{6000}{26 \times 10^5 \times 12 \cdot 35}}\Bigg]$$

$$\text{sec. } \frac{78}{2}\sqrt{\frac{6000}{26 \times 10^6 \times 12 \cdot 35}} - \frac{2 \times 0 \cdot 056 \times 0 \cdot 288 \times 7 \cdot 456}{32 \cdot 2}\left(\frac{26 \times 10^6 \times 12 \cdot 35}{6000}\right)^2$$

$$\text{cos. } \frac{78}{2}\sqrt{\frac{6000}{26 \times 10^6 \times 12 \cdot 35}}$$

$$- \frac{0 \cdot 288 \times 7 \cdot 456 \times 78 \times 26 \times 10^6 \times 12 \cdot 35}{2 \times 32 \cdot 2 \times 6000}\left(6 \cdot 216 + \frac{0 \cdot 056 \times 78}{2}\right) + \frac{2 \times 0 \cdot 056 \times 0 \cdot 288 \times 7 \cdot 456}{32 \cdot 2}\left(\frac{26 \times 10^5 \times 12 \cdot 35}{6000}\right)^2$$

= 880,886 − 21,088,100 − 1,166,475 + 21,391,364
= 17,675 inch-pounds.

When employing Equation (4) the various powers of E I/F should be calculated at once, and such terms as $\dfrac{2\,\beta\,\gamma\,\zeta}{g}\left(\dfrac{E\,I}{F}\right)^2$, which occur more than once, should be evaluated independently of any multiplier which may be attached. A good set of logarithmic tables is necessary, and interpolation should be resorted to in every instance in order to obtain the significant figures down to the units place. The angles should be taken accurately to seconds.

In this case it will be found that—

$$l\sqrt{\frac{F}{E\,I}} = 78\sqrt{\frac{6000}{26 \times 10^6 \times 12 \cdot 35}}$$

= 0·3371709 radians; and the corresponding angle in the usual notation is 19° 19′ 6″.

The maximum stress in the material due to bending is the bending moment divided by Z, or 5·88, which gives as a result 3006 lb. per square inch. Adding to this the direct stress caused by the pressure of the steam on the piston, which is the same as before, we obtain as the total maximum stress in the material 3006 + 714 = 3720 per square inch.

It is interesting to compare the results obtained from the two different formulæ. The stress found by the use of the approximate equation is 160 lb. per square inch more than that found by the use of (4), or the difference is about 4 per cent.

When starting, the maximum direct stress at the small end of the rod is 6614 lb. per square inch.

This rod (Fig. 3), page 187, is also used for six-wheeled coupled goods engines to the following particulars :—

Diameter of cylinders	18½in.
Stroke of pistons...	26in.
Diameter of driving wheels on tread	5ft. 1in.
Working pressure of steam	175 lb. per square inch.
Maximum speed	35 miles per hour.
Approximate cut-off when running at the maximum speed	20 per cent. of the stroke

The writer estimates the thrust along the rod to be 13,600 lb., v will be found to be 21·88, and $\zeta = 5·065$.

As the stress due to bending varies (for the same rod) directly with ζ, we have, using the stress and the value of ζ for the passenger engine as found previously :—

Maximum stress due to bending $\frac{3006 \times 5·065}{7·456} = 2042$ lb. per square inch.

Adding to this the direct stress of $\frac{13600}{8·4} = 1619$ lb. per square inch, the total maximum stress in the material is 3661 lb. per square inch.

When starting, the maximum direct stress at the small end of the rod is 6614 lb. per square inch.

Mr. H. A. Hoy, chief mechanical engineer of the Lancashire and Yorkshire Railway, supplies the following particulars of his latest heavy four wheels coupled express passenger engines :—

A working drawing of the connecting-rod, is partly copied in Fig. 4, with the dimensions necessary in order to calculate the stresses.

Diameter of cylinders	19in.
Stroke of pistons...	26in.
Diameter of driving wheels on tread	7ft. 3in.
Working pressure of steam	175 lb. per square inch.
Maximum speed	70 miles per hour.
Approximate cut-off when running at the maximum speed	30 per cent. of the stroke.
Load behind tender	200 tons.

As will be seen on reference to the figure, this rod is parallel for the greater part of its length, while the short portion, which is taper, is near to the crosshead. This being the case, it is sufficiently accurate to assume it to be parallel throughout, the effect of this on the constants being that α is equal to the constant area of the cross section of the rod, and $\beta = 0$.

It will be found that

$\alpha = 8·3125 : \beta = 0 : l = 74 : v = 30·7 : \xi = 11·76$: Z at centre $= 6·58$: F $= 24,100$: $R_1 = 1600 : \delta = 7\frac{1}{2} : \eta = 89$: I (mean) $= 15·63$: E $= 26 \times 10^6$: area at centre $= 8·3125$ sq. in.: $\frac{l}{2}\sqrt{\frac{F}{E\,I}}\ \phi = 16° 19' 32''$.

Using formula (2*b*) we find the stress in the material due to bending as

$$0·00005\,\frac{11·76 \times 74^3}{6·58} \times 12 \times 8·3125$$

$= 3612$ lb. per sq. in.

Adding to this the direct stress, $\frac{24,100}{8·3125} = 2899$ lb. per sq. in., the total maximum stress in the material is found as 6511 lb. per sq. in.

By the use of equation (4), the maximum stress due to bending is found as 3804 lb. per sq. in., giving a total of 6703 lb. per sq. in.; the difference between the two results being about 3 per cent.

When starting, the maximum direct stress at the small end of the rod is 7984 lb. per sq. in.

Mr. J. Holden, locomotive superintendent of the Great Eastern Railway, supplies the following particulars of his four-wheels coupled express passenger engines :—

A working drawing of the connecting-rod, which is partly copied in Fig. 5, with the dimensions necessary in order to calculate the stresses.

Diameter of cylinders	19in.
Stroke of pistons...	26in.
Diameter of driving wheels on tread	7ft.
Working pressure of steam	180 lb. per square inch.
Maximum speed actually recorded...	79 miles per hour.
Approximate cut-off when running at the maximum speed	25 per cent. of the stroke.

Mr. Holden also supplies the additional information that when running on an up grade of 1 in 100 with a load of 408 tons (including engine 50 tons, and tender 36 tons) the speed is 40 miles per hour, and the cut-off 40 per cent. of the stroke.

For this rod it will be found that

$\alpha = 7·17 : \beta = 0·055 : l = 91·5$: v for 79 miles per hour $= 35·86$: v for 40 miles per hour $= 18·16$: ξ for 79 miles per hour $= 12·97$: ξ for 40 miles per hour $= 3·33$: Z at centre $= 7·818$: F at 79 miles per hour $= 20,100$: F at 40 miles per hour $= 35,400$: R_1 at 79 miles per hour $= 3540$: R_1 at 40 miles per hour $= 910$: $\delta = 8·125$: η at 79 miles per hour $= 63$: η at 40 miles per hour $= 110$: I (mean) $= 18·93$: E $= 26 \times 10^6$: area at centre $= 9·686$ sq. in.: $l\sqrt{\frac{F}{E\,I}}$ at 79 miles an hour $= 16° 45' 5''$: $l\sqrt{\frac{F}{E\,I}}$ at 40 miles per hour $= 44° 47' 20''$.

Using formula (2*b*) we find the stress in the material due to bending at 79 miles per hour as

$$0·00005\,\frac{12·97 \times 91·5^3}{7·818}\,(12 \times 7·17 + 7 \times 0·055 \times 91·5)$$

$= 7706$ lb. per sq. in.

Adding to this the direct stress

$\frac{20,100}{9·685} = 2075$ lb. per sq. in., the total maximum stress in the material is found as 9781 lb. per sq. in.

By the use of equation (4) the maximum stress due to bending is found as 7792 lb. per sq. in , giving a total of 9867 lb. per sq. in.

The difference between the two results is about 1 per cent.

When starting, the maximum direct stress at the small end of the rod is 6700 lb. per sq. in.

At 40 miles per hour (2*b*) gives a stress of 1980 lb. per sq. in., while the direct stress is 3655 lb. per sq. in., giving a total of 5635 lb. per sq. in.

Equation (4) gives a stress of 2658 lb. per sq. in., or a total of 6313 lb. per sq. in., the difference between the two results being about 10 per cent. The excessive difference is accounted for by the heavy thrust along the rod, which affects the bending caused by thrust and friction, while the speed being low, the effect of inertia is much reduced.

Mr. J. F. M'Intosh, locomotive superintendent of the Caledonian Railway, supplies the following particulars of his four-wheels coupled express passenger engines :—

A working drawing of the connecting-rod, which is partly copied in Fig. 6, with the dimensions necessary in order to calculate the stresses.

Diameter of cylinders	19in.
Stroke of pistons...	26in.
Diameter of driving wheels on tread	6ft. 6in.
Working pressure of steam	180 lb. per square inch.
Maximum speed	65 miles per hour.
Approximate cut-off when running at the maximum speed	31 per cent. of the stroke.

For this rod it will be found that

$\alpha = 6·85 : \beta = 0·05 : l = 85 : v = 31·78 : \xi = 10·97$: Z at centre $= 6·712$: F $= 26,200$: $R_1 = 2370 : \delta = 8·5 : \eta = 92$: I (mean) $= 15·06$: E $= 26 \times 10^6$: area at centre $= 8·975$ sq. in.: $l\sqrt{\frac{F}{E\,I}} = 39° 50' 15''$.

Using formula (2*b*) we find the stress in the material due to bending as

$$0·00005\,\frac{10·97 \times 85^3}{6·712}\,(12 \times 6·85 + 7 \times 0·05 \times 85)$$

$= 5620$ lb. per sq. in.

Adding to this the direct stress $\frac{26,200}{8·975} = 2920$ lb. per sq. in., the total maximum stress in the material is found as 8540 lb. per sq. in.

By the use of equation (4) the maximum stress due to bending is found as 5426 lb. per sq. in., giving a total of 8346 lb. per sq. in. The difference between the two results is about 2 per cent.

When starting, the maximum direct stress at the small end of the rod is 6708 lb. per sq. in.

Mr. W. Dean, locomotive and carriage superintendent of the Great Western Railway, supplies the following particulars of his four-wheels coupled express passenger engines :—

A working drawing of the connecting-rod, which is partly copied in Fig. 7, with the dimensions necessary in order to calculate the stresses.

Diameter of cylinders	18in.
Stroke of pistons...	26in.
Diameter of driving wheels on tread	6ft. 8½in.
Working pressure of steam	180 lb. per square inch.
Maximum speed	60 miles per hour.
Approximate cut-off when running at the maximum speed	25 per cent. of the stroke.

For this rod it will be found that

$\alpha = 4·57 : \beta = 0·056 : l = 81 : v = 28·42 : \xi = 9·206$: Z at centre $= 4·436$: F $= 18,100$: $R_1 = 1440 : \delta = 8 : \eta = 63$: I (mean) $= 8·65$: E $= 26 \times 10^6$: area at centre $= 6·8$ sq. in.: $l\sqrt{\frac{F}{E\,I}} = 41° 38' 4''$.

Using formula (2*b*) we find the stress in the material due to bending as

$$0·00005\,\frac{9·206 \times 81^3}{4·436}\,(12 \times 4·57 + 7 \times 0·056 \times 81)$$

$= 4774$ lb. per sq. in.

Adding to this the direct stress $\frac{18,100}{6·8} = 2662$ lb. per sq. in., the total maximum stress in the material is found as 7436 lb. per sq. in.

By the use of equation (4) the maximum stress due to bending is found as 5325 lb. per sq. in., giving a total of 7987 lb. per sq. in. The difference between the two results is about 7 per cent. The great difference between the two results in this case is accounted for by the light section of the rod, which allows it to deflect more than the others, thus increasing the bending moment due to thrust.

When starting, the maximum direct stress at the small end of the rod is 8610 lb. per sq. in.

Mr. H. A. Ivatt, locomotive engineer of the Great Northern Railway, kindly supplies particulars of two of his engines ; first, his ordinary bogie passenger engines, four-wheels coupled ; and, secondly, his latest ten-wheeled bogie engines, four wheels coupled. The particulars of the eight-wheeled engines are as follows :—

Connecting-rod as shown in Fig. 8.	
Diameter of cylinders	17½in.
Stroke of pistons...	26in.
Diameter of driving wheels on tread	6ft. 6in.
Working pressure of steam	170 lb. per square inch.
Maximum speed	75 miles per hour.
Approximate cut-off when running at the maximum speed	33 per cent. of the stroke.

For this rod it will be found that

$\alpha = 4·462 : \beta = 0·0807 ; l = 69 : v = 36·67 : \xi = 17·99$: Z at centre $= 4·834$: F $= 22,200$: $R_1 = 2200 : \delta = 7·5 : \eta = 85$: I (mean) $= 9·622$: E $= 26 \times 10^6$: area at centre $= 7·286$ sq. in.: $l\sqrt{\frac{F}{E\,I}} = 37° 14' 30''$.

Using formula (2*b*) we find the stress in the material due to bending as

$$0·00005\,\frac{17·99 \times 69^3}{4·834}\,(12 \times 4·462 + 7 \times 0·0807 \times 69)$$

$= 5570$ lb. per sq. in.

Adding to this the direct stress of $\frac{22,200}{7·286} = 3050$ lb. per sq. in., the total maximum stress in the material is found as 8620 lb. per sq. in.

By equation (4) the maximum stress due to bending is found as 6150 lb. per sq. in., giving a total of 9200 lb. per sq. in. The difference between the two results is about 6 per cent.

The particulars of the ten-wheeled engines are as follows :—

Connecting-rod as shown in Fig. 9.	
Diameter of cylinders	19in.
Stroke of pistons	24in.
Diameter of driving wheels on tread	6ft. 6in.
Working pressure of steam	175 lb. per square inch.
Maximum speed...	75 miles per hour.
Approximate cut-off when running at the maximum speed	33 per cent. of the stroke.

For this rod it will be found that

$\alpha = 7·084 : \beta = 0·0088 : l = 120 : v = 33·85 : \xi = 9·548$: Z at centre $= 8·043$: F $= 27,300$: $R_1 = 3230 : \delta = 5 : \eta = 40$: I (mean) $= 19·6$: E $= 26 \times 10^6$: area at centre $= 7·6$ sq. in.: $l\sqrt{\frac{F}{E\,I}} = 50° 19' 24''$.

Using formula (2*b*) we find the stress in the material due to bending as

$$0·00005\,\frac{9·548 \times 120^3}{8·043}\,(12 \times 7·084 + 7 \times 0·0088 \times 120)$$

$= 9480$ lb. per sq. in.

Adding to this the direct stress of $\frac{27,300}{7·6} = 3590$ lb. per sq. in., the total maximum stress in the material is found as 13,070 lb. per sq. in.

By the use of equation (4) the maximum stress due to bending is found as 9930 lb per sq. in., giving a total of 13,520 lb. per sq. in. The difference between the two results is about 3 per cent.

BRITISH AND FRENCH TRAIN SERVICES IN 1902.

By CHARLES ROUS-MARTEN.

No. VIII.*

THE Midland-Scottish service in 1902 was accelerated only in respect of two portions of the Leeds-Carlisle length, viz., Appleby-Carlisle, 30¾ miles, booked in the summer to be done in 31 minutes, or at an average rate of 59·5 miles an hour from start to stop ; and Hellifield-Carlisle, 76¾ miles, booked from October to be run in 88 minutes, or at 52·3 miles an hour, this latter being over a very heavy road, including 15 miles on end at 1 in 92 to 1 in 100. The Appleby-Carlisle stage, on the other hand, is mostly on easy falling grades. I may remark here that although a statement has found frequent publication in the non-technical Press to the effect that the Appleby-Carlisle run is booked to be done in 30 minutes, this is pure delusion. Various trains are timed to run, from *passing* Appleby at full speed, to the stop at Carlisle in 30 minutes, but this is a totally different matter, and wholly irrelevant when the question is one of run from start to stop. As a matter of fact, it is within my knowledge, on the testimony of tried and capable observing friends, that at least thrice the run from the Appleby *pass* to the Carlisle stop has been done in less than 27 minutes.

My own best experiences from start to stop on this the second fastest timed run in Britain were (1) 28 min. 56 sec., by No. 2606—Belpaire class—with 200 tons ; and (2) 30 min. 54 sec., by No. 2781, of the same class, with 220 tons. From Hellifield to Carlisle my best runs were in 79 minutes and 81 minutes respectively, in both cases by Belpaire engines of the "2606" and "2781" classes with loads slightly exceeding 200 tons behind the tender. It will be more convenient, however, to leave the work of new Midland locomotives generally to be dealt with in a separate article, as the present series refers specially to the new services of last year.

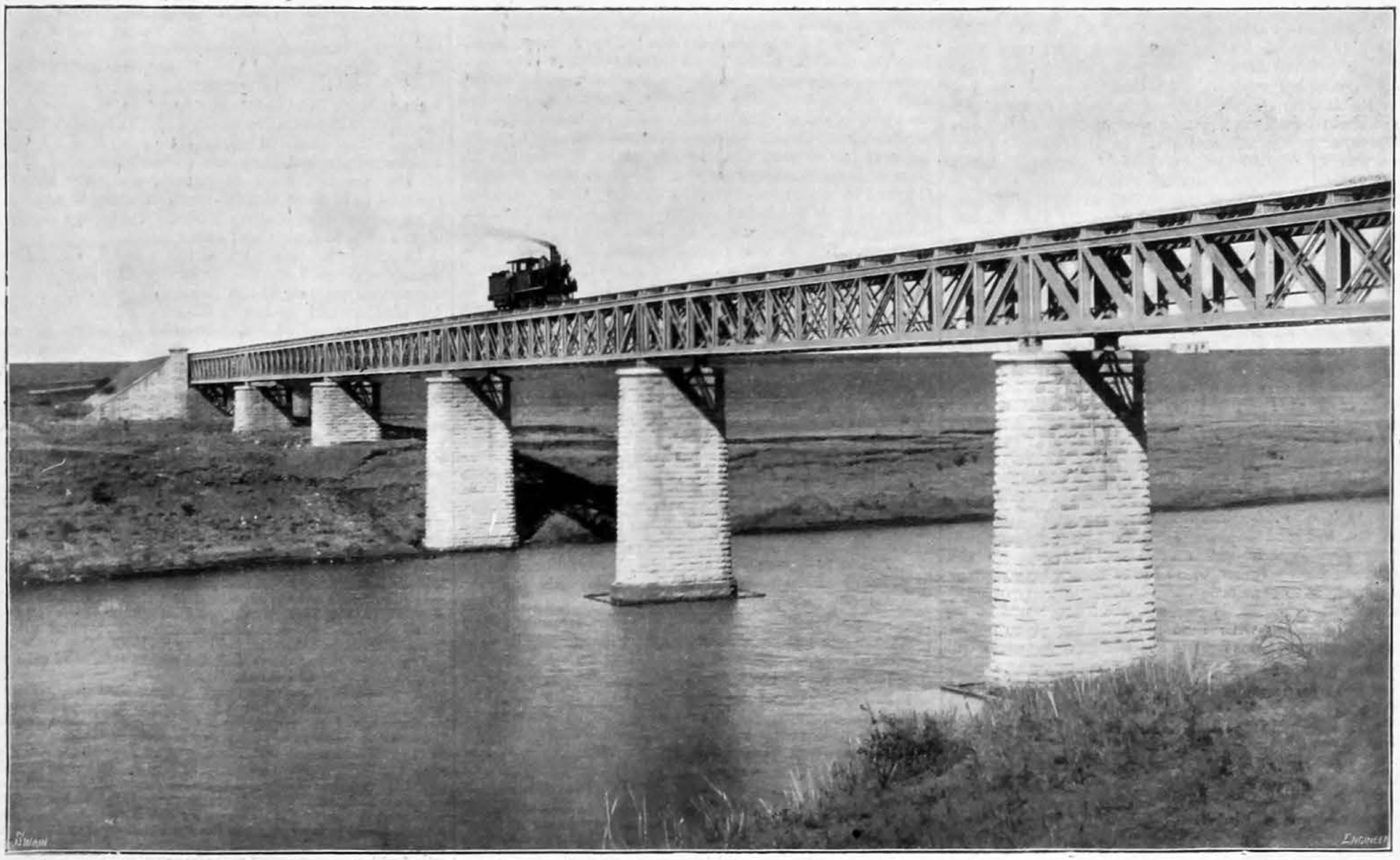
The Great Western's chief contribution to the improvements of 1902, viewed from the engineering standpoint, was the establishment of a 2 h. 20 min. service each way between London (Paddington) and Birmingham, no fewer than three down trains and one up being booked to do the 129¼ miles without stop in that time, averaging 55·2 miles an hour. Mr. T. I. Allen, superintendent of the line, afforded me courteous facilities for testing the actual performance of these trains, but on the down journey I was persistently unlucky in encountering checks, and in no case did I get results at all equal to those I had recorded under the slower timing, with the old 7ft. single-wheeler "Cobham," and the new 6ft. 8in. coupled "Atbara," each being driven by David Hughes, the well-known driver of the Royal trains in Queen Victoria's period. At present the 2 h. 20 min. trains are worked by Mr. W. Dean's 7ft. 8in. singles, which appear fully able to keep time with them both ways when the load is moderate and the road clear. On my down journey I had No. 3050, "Royal Sovereign," and seven vehicles, weighing about 160 tons, behind the tender. A good run was made along the level road to Oxford, 63½ miles, that station being passed in 67 min. 47 sec., but afterwards the run was spoiled by checks, and Birmingham was reached 4 minutes late. On former occasions, above referred to, much greater loss of time was more than made up. The return journey offered a striking contrast, as it was accomplished in 2 h. 13 min. 7 sec., or 6 min. 53 sec. under time, Paddington being reached 5 minutes early, in spite of a signal check at Culham. The time from passing Leamington was 108 min. 57 sec. for the 106 miles ; from Oxford, 65 min. 16 sec. ; from Didcot, 53 min. 19 sec. ; from Reading, 36 min. 40 sec. The driver had to ease down after Reading in order to avoid getting in too soon. It will be noticed that the complete distance of 129¼ miles was done in 133 min. 7 sec. from start to stop, or in 131 minutes net.

Coming now to the North-Eastern, I may observe that

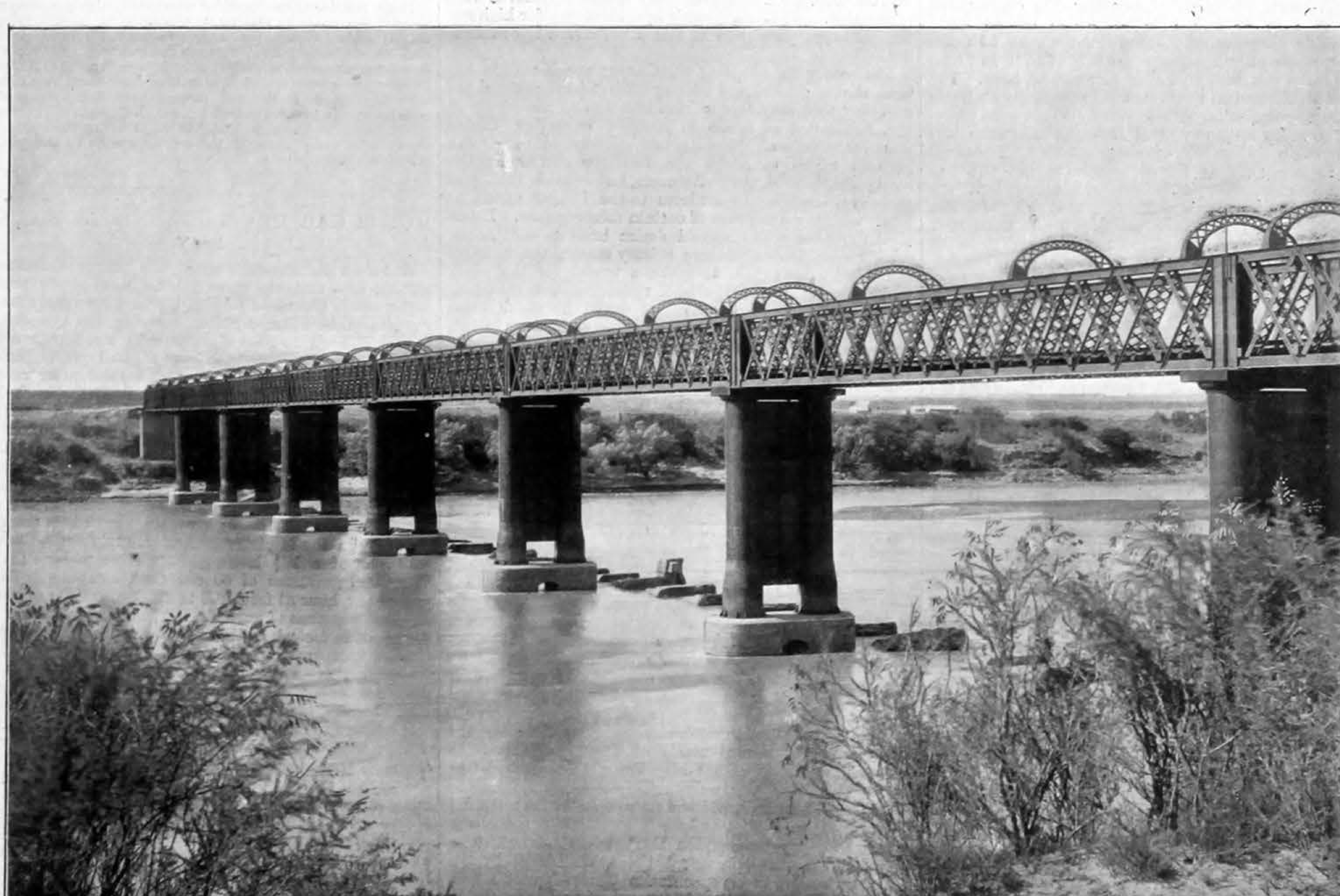
* No. VII. appeared February 13th.

SOUTH AFRICAN RAILWAYS—TWO TYPICAL BRIDGES

(For description see page 183)



VAAL RIVER BRIDGE, VEREENIGING



BETHULIE BRIDGE OVER THE ORANGE RIVER

if that very progressive line did not find occasion to introduce any brand new services of such importance as those already touched upon, yet it furnished the fastest start-to-stop booking ever yet seen in Britain, and only once surpassed in France—viz., Darlington-York (44¼ miles) in 43 minutes, averaging 61·7 miles an hour. Through the courtesy of Mr. Philip Burtt, general traffic manager, I made several tests of this remarkable run. Two or three times delays interfered, but three runs were particularly noteworthy. In two of these cases the engines were of Mr. W. Worsdell's latest four-coupled leading bogie type, with very large and high pitched boilers, cylinders 19in. by 24in., and 6ft. 9in. coupled wheels. The load in each case was reckoned as ten coaches, of approximately 170 tons. On one of these occasions the run was done in 42 minutes inclusive, or in 39½ minutes net. In the other the time taken was 42 min. 53 sec., in spite of two bad checks, which caused a delay of fully 2½ minutes. In this case Northallerton (14¾ miles) was passed in 13 min. 58 sec. from the start, Thirsk (22¼ miles) in 20 min. 49 sec., Alne (33¼ miles) in 30 min. 33 sec., and Poppleton (42¾ miles) in 38 min. 27 sec. The third trip, however, surpassed all the others, the 44¼ miles being covered in exactly 40 minutes to the second, averaging 66·4 miles an hour from start to stop, or 67·7 from platform to platform, the time for which was 39¼ minutes. According to the Darlington and York Station clocks, and to the respective officials at those stations, the time was 39 minutes, as the train left Darlington at 1.9, and reached York at 1.48; but my time was taken both by direct reading and by pressure of the chronograph button, the two agreeing. Certainly the run was a distinctly fine achievement. The engine was one of Mr. Worsdell's 1871 class, with 7ft. coupled wheels, and cylinders 19½in. by 26in.

Although the 40-minute Lancashire and Yorkshire expresses between Manchester and Liverpool are not, strictly speaking, novelties of 1902, nevertheless the increase in their number to no fewer than thirty may be said to belong to that order, and the multiplicity of such fine trains does distinctly constitute a feature not to be ignored in dealing with that period. For it must be borne in mind that not only is the distance between the two Lancashire cities 5 miles greater by this route than by the London and North-Western, and 2¾ miles longer than by the Cheshire lines, but also the Lancashire and Yorkshire route is greatly the heaviest of the three, there being several miles of gradients as steep as 1 in 91 and 1 in 94. To average 54·9 miles an hour over such a road as this on a short journey of 36 miles 47 chains manifestly demands very smart work on the part of the locomotives. But I found Mr. J. A. F. Aspinall's "1400" class well able to perform it, although undoubtedly at times they had their work cut out. It will be sufficient if I describe the best of several trial runs which I made with these trains. The load was light, approximately only 100 to 105 tons behind the tender. This, however, would be called "ten coaches" on the South of England lines. So quickly did the engine start from Victoria Station, Manchester, that Pendleton (2¼ miles) was passed in 2 min. 51 sec., or in 2 min. 28 sec. from the end of the Victoria platform. Ascending the subsequent grades of 1 in 92 and 1 in 94, which extend for a considerable distance, the speed kept up to 59 miles an hour, while up the subsequent ascent at 1 in 91 for about 4 miles the minimum was 61 miles an hour. The speed down hill and on the level was exceedingly high; in fact I timed one quarter-mile in exactly 10 seconds, representing 90 miles an hour. But although this time was most carefully taken by chronograph-stop, I cannot accept it implicitly, as I was unable to get the two adjacent quarter-miles. It is certain, however, from the time taken to cover a longer distance that this particular quarter-mile could not have occupied more than 10·2 seconds, and I see no reason to doubt that it was done in the 10 seconds as recorded. Only in pursuance of my invariable rule never to give implicit credence to a short timing like that unless corroborated by the evidence of the adjacent quarter miles, I only note it subject to this qualification. Apart from this maximum, however, I may mention that a distance of 14 miles after Walkden was run in 11 min. 14 sec. The inclusive time from Manchester to Liverpool was 40 min. 44 sec., but this included two dead stops, one lasting 2 min. 38 sec., the other briefer. So that the actual travelling time from start to stop was only 38 min. 6 sec., and allowing for the delay caused by two extra startings and stoppings, and also by an additional signal check, the net time very carefully computed is found to have been 33 min. 21 sec. I may add that the 35 miles 2 chains from Manchester to Sandhills only took 34 min. 33 sec. from start to stop, with an extra stop in the middle. This struck me as an excellent performance. Other runs were made in 39 min. 27 sec. and 38 min. 40 sec. respectively. In one of these cases the same quarter-mile already mentioned as having been apparently done in 10 seconds was covered in the still quicker time, according to my chronograph-stop, of 9·8 seconds. This, were it trustworthy, would indicate a speed of 91·8 miles an hour; but failing again to catch the adjacent posts, I can only mention it as an apparent and not authentic record. Nevertheless, the speed in each of these cases cannot have been less than 87 to 88 miles an hour, even if it did not reach the apparent records shown by the single observations.

On the whole I think it may fairly be stated that material progress has been made by several English railways in the year 1902.

Land Grant Railway across Central Australia.—There has been published by authority of the South Australian Government a lengthy report on the proposed line from Adelaide to Port Darwin, which has been compiled and edited by Mr. Simpson Newland, formerly treasurer of South Australia. The book contains, moreover, illustrations, maps, and a copy of the Act of Parliament authorising the construction of the railway.

BRIDGE BUILDING AND BRIDGE WORKS IN THE UNITED STATES.

No. V.*

CONTRACTS AND SPECIFICATIONS.

Many leading railways have adopted a series of standard plans for H-beam spans, plate girders, and truss bridges of ordinary span. Such a practice is undoubtedly of great economy for large railway systems having a great number of bridges. But while these standards are economical for the railways, they do not help the manufacturers much—except where they do a very large amount of work for one railway, as no two railways adopt similar standards, while the so-called standard plans of many roads are subject to continual modification and revision. Nevertheless, the manufacturer has a good deal to say as to the designs for structures on smaller railways. Thus, in many cases he is asked to tender for certain bridges of given spans and general dimensions, the design being left to him, but subject to the approval of the railway company's engineer. But at the very beginning of the design a difficulty presents itself. Nearly every road has a different standard system of live load, quality of steel, &c., and the design and strain sheet for a bridge on one railway will not be suitable or acceptable for a similar structure on another road, especially in view of the fact that most engineers have their own ideas and preferences, which must be considered in the design.

One of the first difficulties which the manufacturer strikes, in endeavouring to standardise his work for the designing of railway bridges, is the great number and variety of specifications as used by various railway and bridge engineers. Of late years some progress has been made towards the adoption of uniform specifications both as to loading and material, but the differences which still exist require the manufacturer to conform to very different requirements for different railways. One bridge company may have 50 to 100 different specifications on file for as many railways. This is particularly the case with the larger lines, and, perhaps, the greatest step towards uniformity so far taken is that a number of the smaller roads have gradually—and without any idea of concerted action—adopted what are known as Cooper's specifications. These were drawn up some years ago by Mr. Theodore Cooper, M. Am. Soc. C.E.—an American consulting engineer who stands at the head of those engineers who have made bridge work a speciality. They were published in pamphlet form, and have had an enormous sale since their first publication, being revised from time to time as new editions are issued, so that they are always "up to date" and applicable to existing conditions. There are two sets of these specifications—one for railway bridges and viaducts, and the other for highway and tramway bridges.

Similar specifications have been prepared by other engineers, but none have been accorded the popularity or extensive use which have been accorded to Cooper's specifications. The American Bridge Company has also a set of specifications, which were drawn up by its vice-president and chief engineer, Mr. C. C. Schneider, M. Am. Soc. C.E., who is another bridge engineer of wide reputation. This company's specifications for highway bridges were published in The Engineer a few months ago.

The reason for adopting the Cooper specifications has been that engineers and railway officers have realised the economy that may accrue from introducing uniformity or standardisation as much as possible in bridge design and construction. The great railway systems can perhaps afford to adopt specifications containing the individual ideas of their engineers, but even on such lines there is a tendency to conform to the Cooper specifications, with the exception of certain minor points. If one of the smaller roads should desire bridges built to its special specifications during a busy season, the builders would probably refuse to make a tender for the work. But if the bridge could be built under the same specifications as a number of others, it would be much more easy to get them contracted for. The conditions in this respect are at present much the same as when the movement for standard rail sections was inaugurated. Different engineers had sections almost alike, but with sufficient variation to require special rolls. This was partly because they did not know of each other's sections, partly because each desired to impress his own individuality upon his rails, partly because they failed to see that the differences were too slight to be of practical effect, and largely because they did not recognise the commercial importance and economy of uniformity. At the present time, about 75 per cent. of the rail output is rolled to the form of sections recommended by the American Society of Civil Engineers.

In the various bridge specifications to which the manufacturer is required to work, one of the most troublesome features is the lack of uniformity in live load prescribed, and one bridge company alone has a set of nearly 250 diagrams of engine loading. These specify not only exact wheel loads, but exact wheel spacings for certain classes of engines, regardless of the fact that the strength of bridges cannot be regulated to a few pounds, without the impossible work of planing or finishing the members to an absurd nicety of thickness or size. In effect, therefore, this close calculation to make a design to fit a certain engine only made extra trouble for the designer or estimator, and had no real influence upon the strength of the bridge. There is fortunately now, however, a tendency to abandon this useless refinement in engine loading, and to adopt the system used by Mr. Theodore Cooper in his specifications already mentioned. Here the spacings of the driving wheels are assumed to be constant for all types of engines, and the loads on the bogie and tender wheels are assumed to be proportional to the loads on the driving wheels. His specifications give five typical loadings. It is believed that for economical operation on railways with heavy traffic locomotives of the consolidation type—ten coupled with two-wheeled bogie—with 20,000 lb. to 25,000 lb. on each driving wheel, will be required. The engine load is followed by a distributed train load, which is usually taken as 4000 lb. to 5000 lb. per lineal foot of track. In certain cases the train loading is taken as high as 6000 lb. or 7000 lb., the latter being for structures where a large proportion of the traffic consists of trains of cars with full loads of 50 tons of coal or ore per car.

Another difficulty, almost as great as that of the loading, is the variation in requirements as to the grade of steel. Committees of several engineering societies are now engaged in investigations and missionary work, whose object is to secure the adoption of some uniform specifications as to the quality of steel for bridges and similar structures. Much might be written on both of these subjects, but they are somewhat beyond the field of the present series of papers, and they have been referred to at such length merely in order to explain the relations between bridge engineers and bridge builders in regard to both design and construction.

To conclude this part of the subject, the following extract is given from the paper by Mr. Jacoby, read at the annual meeting of the American Association for the Advancement of Science in 1902:—

The form of loading for bridges almost universally specified by the railroads of the United States consists of two consolidation—eight-coupled—locomotives followed by a uniform train load. These loads are frequently chosen somewhat larger than those that are likely to be actually used for some years in advance; but sometimes the heaviest type of locomotive in use is adopted as the standard loading. Of the railroads whose lengths exceed 100 miles, located in the United States, Canada and Mexico, only two out of 77 specified uniform train loads exceeding 4000 lb. per lineal foot of track in 1893; while in 1901 only 13 out of 103 railroads specified similar loads less than 4000 lb. In 1893, 37 railroads specified loads of 3000 lb., and 29 of 4000 lb.; while in 1901, 4000 lb. was specified by 50, 4500 lb. by 14, and 5000 lb. by 17 railroads. The maximum uniform load rose from 4200 lb. in 1893 to 6600 lb. in 1901.

In a similar manner in 1893 only one railroad in 75 specified a load on each driving-wheel axle exceeding 40,000 lb.; while in 1901 only 13 railroads out of 92 specified less than this load. In 1893 only 21 of the 77 railroads specified similar loads exceeding 30,000 lb. The maximum load on each driving-wheel axle rose from 44,000 lb. in 1893 to 60,000 lb. in 1901.

Experience having shown the great advantage of more uniformity in various details and standards relating to the manufacture of bridges, both in reducing the cost and the time required for the shop work, an effort was begun to secure more uniformity in the requirements for the production and tests of steel, which is the metal now exclusively employed in bridges.

The thorough digest of these results of scientific research and practical tests, and the preparation and adoption of standard specifications for different classes of material, are confidently expected to eliminate many old requirements which are proved inefficient in securing the results for which they were originally intended, and to incorporate in the specifications only the essential requirements by which the character of the product may be determined with sufficient precision for its actual duty.

With greater uniformity in the physical, chemical, and other requirements for steel, as determined by standard tests, the unit stresses to be prescribed for the design of bridges will naturally approach to a corresponding uniformity. To what extent this is desirable may be inferred from the fact that the application of several of the leading specifications to the design of a railroad bridge under a given live load yields results which may vary by an amount ranging from zero to 25 per cent. of the total weight.

In the revision of specifications a decided tendency is observed to simplify the design by making an allowance for impact, vibration, &c., by adding certain percentages to the live load according to some well-defined system. It needs but relatively little experience in making comparative designs of bridges under the same loading to show the advantage of this method over that in which the allowance is made in the unit stresses according to any of the systems usually adopted in such a case. Not only are the necessary computations greatly simplified, but the same degree of security is obtained in every detail of the connections as in the principal members which compose the structure.

* Article IV. appeared February 6th.

MOTOR CAR DEVELOPMENTS IN FRANCE.

No. V.*

Another thing necessary to the proper utilisation of alcohol is a suitable carburetter. Most of the positive carburetters give good results, but it is essential that the gas should be warmed before entering the cylinder. It is very difficult to start a motor with alcohol when cold, and the usual practice is to have a small petrol tank, so as to start the engine with this spirit, and, after running a few minutes, change on to alcohol. The French have given less attention to alcohol carburetters than the Germans, who, however, have only had occasion to adapt them to industrial engines such as the Marienfeld, Dürr, Kœrting, and Altmann, but where satisfactory results are obtained in the French trials a good deal of the merit must be attributed to the carburetter. This is the case with the Brouhot engine, which showed remarkable economy in the Minister of Agriculture's tests, the consumption of a 16¼ horse-power motor under full load being 233 grammes of 50 per cent. alcohol per horse-power per hour at from 198 to 208 revolutions a minute, and 340 grammes of pure alcohol at 183 revolutions. All the trials, in fact, show that the piston speed is lower with alcohol than with petrol, on account no doubt of the conversion of water into steam, and alcohol is undoubtedly superior to petrol when running at low speed. The Brouhot carburetter has a constant level chamber and a distributing chamber, at the lower end of which is a valve that is opened when struck by the exhaust valve stem. The exact quantity of alcohol necessary for a charge is thus drawn into the mixing chamber, and the gas passes around a tube heated by the exhaust and enters the cylinder at a high temperature. In automobile motors, however, the temperature should not be too high, as this would result in a complete evaporation of the water, and the cylinder charge would thus be reduced. The Brouhot carburetter, though remarkably efficient in industrial motors, scarcely seems satisfactory for motor vehicles, and in fact the solution of the alcohol problem depends very largely upon the designing of carburetters that will run as well with this spirit as with petrol.

* Article IV. appeared February 13th.

As we have seen, the most salient result of recent investigations is that the alcohol motor has special characteristics of its own which make it doubtful whether it can develop on parallel lines with the petrol engine. Its smooth and slower running gives it some of the qualities of the expansion engine as opposed to the rapid combustion of the explosion motor, and it is difficult to see how the two can be reconciled. It is true that engines can be made to run equally well with petrol as with alcohol, but they can scarcely give the highest efficiency of each. This is particularly the case with pure alcohol, which must be burned in special engines, while the carburetted product more nearly approaches to petrol in its action, though the two are still sufficiently distinct to raise the question whether makers will be able to effect a compromise in the designing of their motors so as to secure a high efficiency with both fuels. So far as makers and users are concerned, it matters little to them whether they use alcohol or petrol. They will naturally buy the cheapest fuel, and so long as petrol is more economical they will continue to employ it until such time as the State is able to reduce the price to such an extent as to render alcohol almost indispensable. Several makers certainly claim that their motors will use both fuels with equal economy, but only in one or two cases has this claim been borne out in the trials. If alcohol should be considerably cheapened, it is probable that manufacturers will have to greatly modify the designs of their engines. They can scarcely afford to abandon petrol altogether in the event of alcohol becoming more economical through the suppression of excise duties or by other means, since under certain conditions the automobilist will find it convenient to change on to petrol, and in some countries petrol must always be cheaper than alcohol. What will be the development of the alcohol question it is impossible to foresee, but it seems likely that the solution of the alcohol problem will be accompanied by further modifications in the petrol engine in the way, perhaps, of water injection, so that the two spirits will work under identically the same conditions. For industrial vehicles it would seem as if alcohol has a much wider scope, since they may be largely used in districts which produce this spirit; but, apart from the lighter types of vehicles, the French have, with only a few exceptions, made little progress in the building of freight cars. They have come to the conclusion that vehicles propelled by internal combustion engines cannot be economical unless they carry loads of 5 tons with a maximum tare of 4 tons, and such traffic is impracticable unless improvements are carried out in the roads, which are for the most part too narrow for more than one of these big wagons to pass. If the fuel could be considerably cheapened it would be possible to economically transport loads having a lower ratio to the tare, and thus the difficulties would be at once overcome; but in France it is open to question whether the State will ever be in a position to sacrifice its revenue from alcohol to the extent of allowing the spirit to be sold at such a low figure. In some other countries where the motor wagon has a specially wide field of utility, such as the Congo Free State and parts of South America, alcohol is merely a cheap by-product, and if the vehicles are reliable there is no question as to their economy. The Congo Free State Government is laying out roads for motor wagon transport, and is erecting a number of distilleries along the routes for the production of alcohol to be used as fuel. In countries like India the employment of petrol offers serious inconveniences, and alcohol is the only safe spirit that can be used. All the agricultural countries are looking carefully into the utilisation of alcohol, not only France and Germany, but also Italy, Spain, and Portugal; and in Peru an exhibition and trials are being organised on the lines of those held in Paris last year. Apart from the effect this new outlet for alcohol is expected to have upon the agricultural industry, the matter has been given further prominence by the situation of the petroleum industry. It is stated on the other side of the Atlantic that the oil "trust" is already considering whether it may not be advisable to restrict the production of petroleum spirit owing to the fact that the profits upon rectified petroleum are largely swallowed up by the heavy depreciation of the by-products on account of the huge accumulation of stocks. However this may be, there is still some doubt as to whether the supply of rectified petroleum will keep pace sufficiently with the growing demands of spirit motors to prevent an increase of price, and it is partly upon this contingency that the alcoholists base their hopes in the future of the agricultural spirit. Unfortunately for those who expect the internal combustion engine to bring about a revival in the agricultural industry, the matter has taken another turn by the synthetical production of alcohol which now seems on the point of being carried out on an industrial scale. It is claimed that chemically pure alcohol can be produced by synthesis at considerably lower cost than is possible from the distillation of beet or other produce, and thus it is feared that the movement in favour of alcohol will result in the complete discomfiture of agriculturists by depriving them of the existing outlets for their spirit. Seeing the vast interests involved, the natural consequence of this state of things would have been a strong agitation in favour of repressive laws against synthetical alcohol, and it is in the hope of forestalling any such agitation that the companies being formed in France for producing alcohol in conjunction with the acetylene manufacturers, are holding out a promise that they will take a certain minimum quantity of agricultural spirit to mix with their own alcohol, so that the agriculturists will always be assured of selling their spirit at a profitable figure. It is, however, as yet by no means proved that alcohol can be produced by synthesis on a commercial scale at such an extremely low price as is represented by experimenters. Nevertheless, this phase of the question opens up vast possibilities, and if only half of the promises now being held out by chemists are realised, the competition between petrol and alcohol must certainly terminate in favour of the latter spirit. For the moment it is by no means certain that the new alcohol can be produced on a commercial scale with the success anticipated; but whether it can or not, there is no doubt that the employment of alcohol as a fuel must have an important influence upon the designing of internal combustion engines in countries where the conditions are specially favourable to the agricultural spirit.

THE AMERICAN INTERNATIONAL EXHIBITION OF 1904.

(*By our Special Commissioner.*)

No. II.

THE area of the Exhibition at St. Louis will be about 1200 acres. The central portion, or "main picture" as it is termed, comprises the cascades, cascade gardens, ten of the main buildings, about two miles of waterway—including the basin, lagoon and canals—and about five miles of streets and avenues. In the avenues large trees have been transplanted to furnish a shade to the walks. The concave hillside forming the background will be 1600ft. across, and the cascades will be of imposing size and volume, flowing at the rate of 80,000 gallons per minute. These will be supplemented by numerous jets and fountains. The grand basin, of semicircular shape, will be 600ft. in diameter. The main cascade has a discharge of 45,000 gallons per minute from a 30in. pipe, and has fourteen falls. The first two are of 25ft. and 20ft. and the others of 4ft. to 8ft. At the first fall the water is 11in. deep over a ledge or rim 40ft. long; at the last fall the depth is 3in. over a rim 140ft. long. The two side cascades flow from 12in. pipes, discharging 18,000 gallons per minute each. These have twelve separate falls, nine of 3ft., and the others of 12ft., 15ft., and 22ft.

Each of the main buildings has been designed by a separate architect, or firm of architects, working to a given ground plan, height of eaves line, &c., as governed by the main plan. These architects form an architectural board, but they have nothing to do with the structural design or with the construction work. These architects are scattered all over the country, and as it would be difficult to get them together to discuss minor matters, a "Department of Design" was organised, at the head of which is the Chief of Design.

The chairman of the Board of Architects is Mr. Isaac L. Taylor, and as he is also Director of Works, he has but little time for purely architectural study. To him and Mr. E. L. Masqueray, Chief of Design, is left the work of elaborating and perfecting the plans, and of studying and deciding the innumerable matters of detail which are simply mentioned at meetings of the Board of Architects. The Chief of Design is, under the Director of Works, the representative of the architects, and is entrusted with studying and working out details which at foreign expositions—where distances are not so great—are attended to by the architects themselves in conference. This Department of Design, therefore, has to provide for the decoration of the grounds with monumental and landscape effects; the setting or surroundings of the buildings, so as to enhance the architectural design; the treatment of the lagoons, entrances, bridges, pavilions, and various auxiliary buildings and decorative structures. The department is in close relation with the architectural, sculpture, and landscape departments. There will be twelve bridges over the lagoons; the two connecting the main entrances of the Electricity and Varied Industries buildings, and those of the Manufactures and Education buildings, will be 80ft. wide. The others will be 50ft. wide, and all will be about 200ft. long. To this department has also been allotted the design of four large buildings: Agriculture, 500ft. by 1200ft.; Transportation, 525ft. by 1300ft.; Horticulture, 400ft. by 800ft.; and Forestry, Fish and Game, 400ft. by 600ft.

The sculptural work around the buildings, on the terraces, along the roadways and lagoons, and throughout the grounds, will be largely emblematical. Thus there will be statues of noted Indian chiefs, and groups representing Indian life and customs; the hunters and trappers; the discoverers and explorers, famous inventors and men of science, &c. The Emperor Napoleon and President Jefferson—between whom the "purchase" treaty was negotiated—will also be represented, and there will be numerous heroic groups, and figures of native animals. In the Terrace of States, above the cascades, will be fourteen allegorical statues symbolic of the fourteen States which now cover the territory of the "purchase." All this statuary will be modelled in convenient size and then enlarged, the actual figures and groups being composed of "staff," which is a mixture of plaster of Paris with hemp, moss, &c. This will be the same process as was used for the beautiful and striking statuary at the International Exhibitions at Chicago in 1893 and at Buffalo in 1901.

The buildings are of comparatively little interest from a structural point of view. At Chicago the main buildings were of steel, and the great trusses, arches, and general framework were among the specially notable features of the Exhibition. At St. Louis all the buildings will be of wood, and in one respect this was a fortunate decision. In view of the present congested condition of the steel industry it is safe to say that the Exhibition would have been delayed a year or more had steel mills and steel works to be reckoned with for material and erection. The foundations are timber piers and footings, supplemented by piling in soft ground. The main framing, columns, girders, roof trusses, &c., are all built up of wood, but iron rods are used as tension members in the trusses. A forest of main uprights, longitudinals and furring between the uprights, forms the basis for the wood or metal lathing which receives the plaster coating for the walls. All decorative work is of "staff," and acres of finished work of this kind are now stacked ready for use, being attached in place by screws. The finished work will be painted as soon as erected, and again just before the opening of the Exhibition. The buildings have a uniform height of 65ft. to the eaves line, and the colour scheme adopted is cream white or ivory white.

The water supply for fire and domestic purposes will be taken from the city mains, but the fire service will be reinforced by a lake of 6,000,000 gallons capacity at the west side. Separate systems of sewerage and storm-water drainage have been laid, the former discharging into the city sewers and the latter into the Des Peres River. There are also water pipes, gas mains, and electrical subways and conduits. In connection with all this construction, the extent and importance of which will be little realised by those who see the completed Exhibition, I give the following extracts from a paper prepared by Mr. Richard H. Phillips, chief civil engineer of the Louisiana Purchase Exhibition:—

"Since the driving of the first stake on September 3rd, 1901, many changes have been wrought in the topography of Forest Park. Upwards of 1,500,000 cubic yards of earth have been moved, not including the excavations for sewers, drains, water pipes, electric conduits, or the foundation piers of buildings. After the site had been selected and the general scheme decided upon, the first problem was to dispose of the river Des Peres, which wound its way over the ground needed for the main buildings. The total length of the river through the site was 8800 lineal feet; this was reduced to 4650ft. by building a direct underground channel."

"In order to determine the size of the channel which could safely carry the river's floods, accurate surveys were made to ascertain the area drained, the average slope of this area, and the slope of the channel. These data, with the records of high water and of maximum rainfall, determined the size and capacity of the channel. Two barrel drains, passing west and north-west through the 'Wilderness,' were also laid out and constructed. The ground thus drained was then graded and put in shape for building and landscape work."

"All the sewers centre at the pumping station, from which, by means of electrically-driven centrifugal pumps, the sewage is forced to the city sewers. Connections are also made between the sewers and the underground storm-water conduits, so that during dry weather the contaminated flow in the conduits is intercepted, and passes into the sewers. On the extreme north side of the grounds is a large automatic flush tank, periodically discharging a large volume of fresh water to flush out the sewers."

"When it is remembered that every drain, water main, gutter, conduit, road, railroad, tree, terrace, &c., and the floor of every building had to be accurately located, both as to alignment and elevation, an estimate can be made of the immense amount of instrument work that had to be done. Each grade had to be adjusted, and each of the myriads of lines of trees, gas pipes, water pipes, sewers, and electric conduits, the lagoons, roof drains, surface drains, foundations for buildings, the fountains, flower beds, walks, and various accessories had to be run so that all the work would fit properly in place without interfering with other work."

"About eight miles of railway for use in construction and in the installation of exhibits have already been built in Forest Park, and half a mile of this is on timber trestle work, some of which is 40ft. high. The lagoons provide a circuit of 7100ft. over the shortest course. Their total area is 750,000 square feet, or about 17 acres; and they contain about 19,000,000 gallons of water."

"The east end of Forest Park, outside of the Exhibition boundary, has had some changes made. The old wooden bridge near the Clayton-road has been replaced by a steel arch bridge; and a concrete arch bridge—reinforced by steel bars—has been built to carry the Grand Drive over the River des Peres. The river channel has also been straightened and cleaned out through this part of the park, so as to give free flow for water passing down its channel through the Exhibition. A steel and wooden bridge with a clear channel span of 60ft. has also been built near the park stables, to carry the heavy steam rollers used in the park. All these improvements have been made without expense to the city. The pipes, sewers, roads, &c., will to some extent be utilised by the city after the Exhibition, and in all construction work the Director of Works and his engineers have kept in mind the restoration of the park to the people of St. Louis in an improved condition."

Plans have been perfected for an "intramural" railway for the convenience of visitors to the Exhibition. At Chicago, owing to the desire to avoid obstruction of the lake view, and the impracticality of putting the line underground for so long a distance, the railway was not as convenient as it might have been. At St. Louis an electric railway will be laid out in loops to serve the buildings and other centres of attraction, as well as the outlying portions of the park, where people will be glad to rest quietly under the shade of the trees. Through the main group of buildings this line will be on an elevated structure or viaduct, but the rest of its length will be mainly on the surface.

Great stress is laid upon the decorative lighting of the Exhibition. This will include the outlining of the buildings and their architectural features by electric lights, and also the lighting of large surfaces. Beneath the cascades will be a special plant for projecting lights of various colours from behind the falling sheets of water. The Exhibition management has provided facilities for supplying an immense amount of electrical energy, part of which will be generated on the ground and the remainder supplied from a large new power plant, built by one of the electrical companies of St. Louis. The electrical energy will, of course, be used for other purposes than lighting. It includes service for every kind of commercial electrical work, for charging batteries, running direct-current and alternating-current motors, and lighting

* No. I. appeared February 13th.

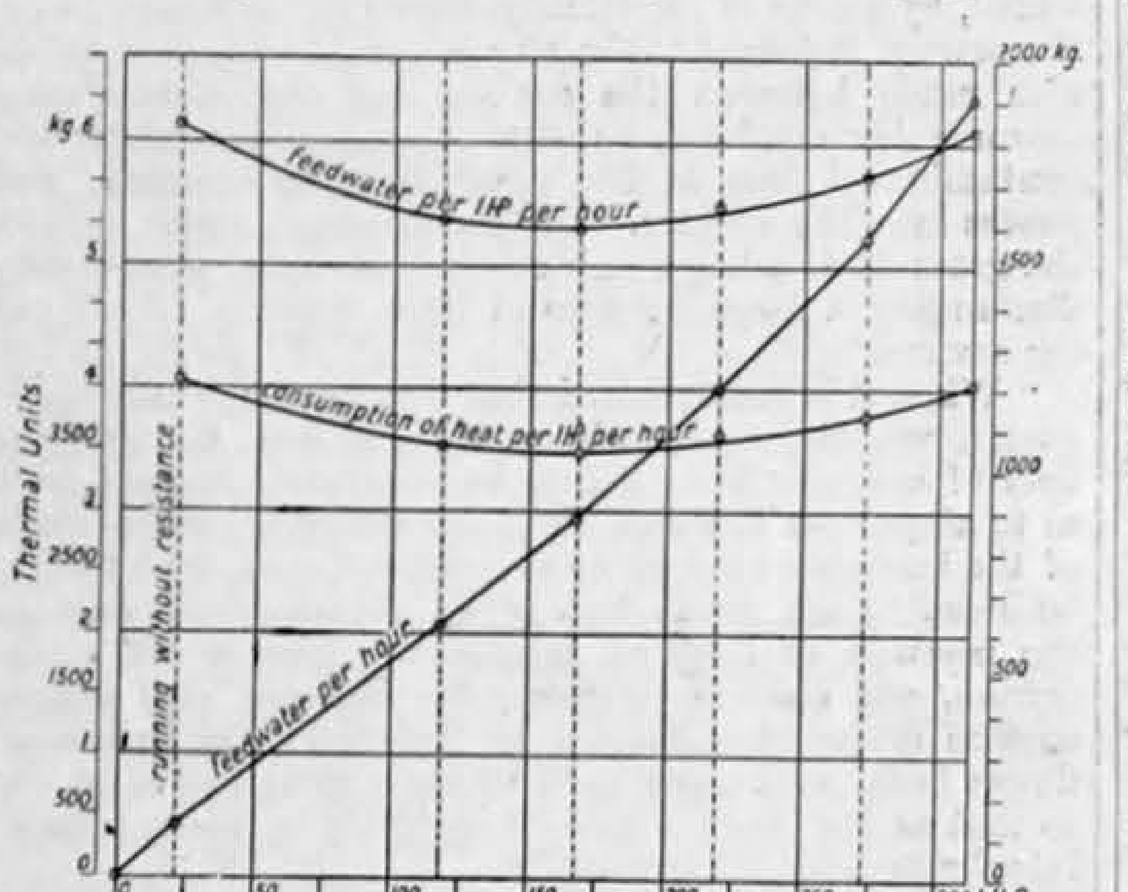
series alternating and direct current lamps, and multiple alternating and direct current lamps. This latter service presents a variety of alternating-current voltages and frequencies, as well as of direct-current voltages.

As other forms of energy are convertible to electrical energy, it is desired to permit as great a variety of processes and operations among the exhibits as possible. Provision has been made for steam, gas, and compressed air service in sufficient quantity to permit the greatest possible display of machinery in motion. For the boiler equipment of the power plant it was at first proposed to use oil fuel, but the difficulty of ensuring a constant supply of the large quantity required, at such a distance from the point of production, led to the abandonment of this plan. It is now intended to use coal, but Mr. Rustin, the chief electrical and mechanical engineer, is confident that no "smoke nuisance" need be apprehended, owing to the use of perfect combustion devices, the selection of which has not yet been concluded. A large portion of the power plant will be supplied by the exhibitors, including boilers, engines, and electrical generators and apparatus. The generating capacity to be used for power and illumination will be about 25,000 kilowatts, of which 16,000 kilowatts will be for the latter purpose.

TESTS OF A STEAM ENGINE.

IN our issue of the 11th January, 1901, we illustrated and described the engine which the firm of Van den Kerchove, of Ghent, exhibited at the Paris Exhibition in 1900. Quite recently a series of interesting trials have been carried out with an engine made by the same firm, exactly similar in construction to that exhibited at Paris, and differing only in size. These tests have been carried out under the direction of Professor Schröter, of Munich. The engine was of the horizontal tandem compound type, and it is ordinarily employed for driving a continuous-current dynamo supplying power and light to Messrs. Van den Kerchove's works. Some excellent results have been arrived at, and we feel sure that an abstract of Professor Schröter's report to the makers will be of interest to our readers.

The leading dimensions of the engine are:—High-pressure



Curve with Saturated Steam Tests I to VI.

Diagram No. I.

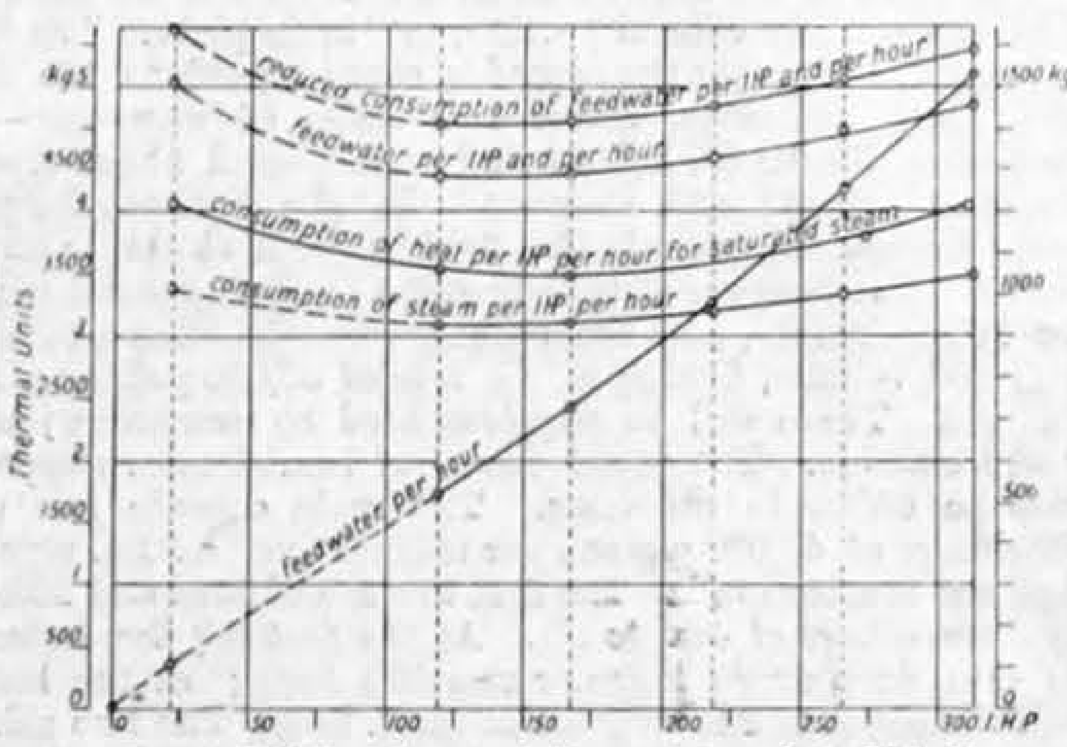
cylinder, 325 mm., say 12·795in.; low-pressure cylinder, 560 mm, say 22·047in.; stroke, 850 mm., say 33·464in. The proportion of the cylinders is 1 to 3, and the normal revolutions per minute 127. The engine is so designed that the low-pressure cylinder is bolted direct to the frame, whilst the high-pressure cylinder is attached behind the low-pressure cylinder by means of an intermediate stay. Both the cylinders, as well as their covers, are steam-jacketed. Live steam is supplied to the jacket of the high-pressure cylinder, and that of the low-pressure cylinder serves as a receiver, the steam circulating through the jackets before passing through the ports. The distribution of the steam in both cylinders takes place through four equilibrium piston valves placed in the cylinder ends. These valves move vertically. Each of the main pistons has two rings. Bolted direct to the crank shaft outside the fly-wheel is the armature of a continuous-current dynamo, which was working during the trial on to liquid resistances.

The valve gear shaft is placed horizontally, with its axis

the purposes of the trial, however, the air pump was put out of gear, and the exhaust led to a separate condenser put up for the occasion.

The primary object of the trials was to make a large number of observations with the greatest possible accuracy under loads varying from nothing to the maximum, for the purpose of noting, first, the behaviour of the engine with saturated steam and with steam superheated to 300 deg. with different amounts of expansion; and, secondly, to see how progressive superheating with a constant cut-off influenced the consumption of steam.

A horizontal surface condenser 3·57 m. long and 1·24 m. in diameter was made use of. It contained 188 square metres of cooling surface. There were 1000 ⅝in. brass tubes 3 m. long. Before the trial care was taken to see that the condenser and the various pipes were perfectly water-tight. The two pumps were worked by gearing; one circulated water from a neighbouring canal, while the other delivered the condensed water into a wrought iron tank of

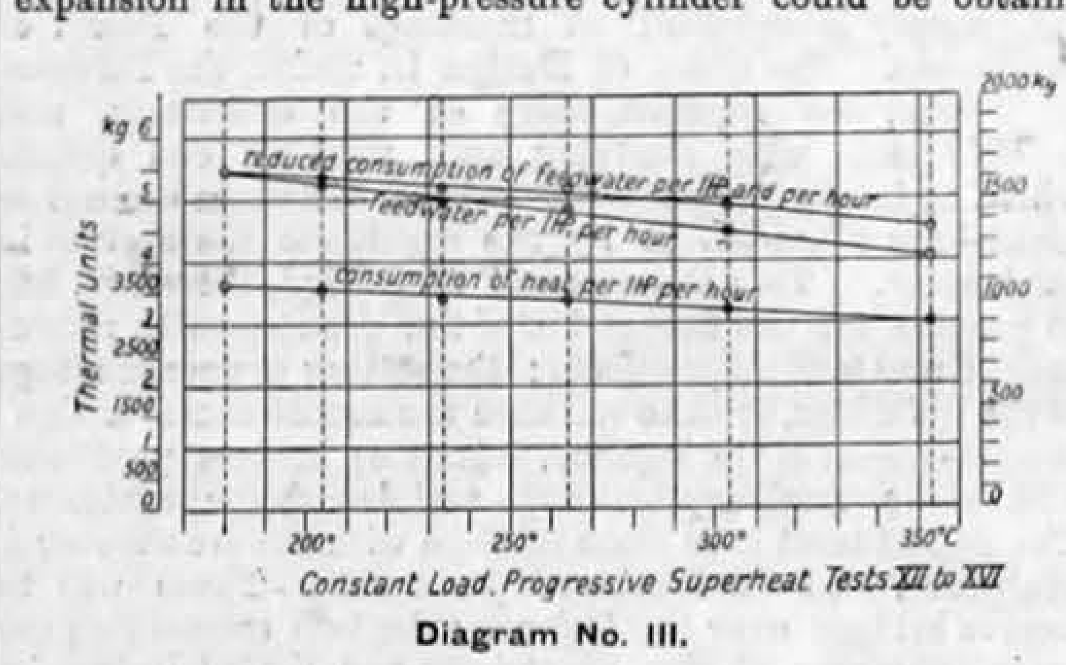


300° Cent Superheat Varying Loads Tests VII to XI

Diagram No. II.

6 cubic metres capacity, placed on a carefully-controlled weighbridge. The measurements were taken by two experimenters, who noted, by means of two chronographs, the time taken to condense 50, 100, 200 kilos. of steam and so on. To obtain a mean of a sufficient number of observations each trial lasted about one hour, and in passing from one degree of cut-off to another the next reading was not taken until everything was again in working order. During each trial a graduated vessel was employed to measure the discharge from the drains of both steam jackets after it had passed through the steam traps and coolers.

A separately heated "Maicbe" superheater, entirely independent of the boiler, was employed. It had 16½ square metres of heating surface, the grate area being ·45 square metre. With this independent superheater a number of results were obtained which would have been impossible had the superheater been in the boiler flues. Thus all degrees of expansion in the high-pressure cylinder could be obtained



Constant Load. Progressive Superheat Tests XII to XVI

Diagram No. III.

with the same temperature of steam, and very wide changes of temperature could be given with the superheater with a constant cut-off in the cylinder. The steam used was generated in a 180 square metre de Naeyer multitubular boiler having a grate area of 3·57 square metres and having 120 5in. tubes 4 m. long.

The trials were divided into sixteen separate tests. The first six of these were with saturated steam, and with varying loads as follows:—

Test No.	I.	II.	III.	IV.	V.	VI.
Ampères at 110 volts	1730	1500	1200	900	600	Unloaded.

The next five were with steam superheated to 300 deg., and with varying loads, thus:—

Test No.	VII.	VIII.	IX.	X.	XI.
Ampères at 110 volts	17.0	1500	1200	900	600

tions of the dimensions of the engine due to temperature, and care taken in calculating the springs of the indicators, which were borrowed for the occasion from the engine laboratory of the Munich University. As bearing witness to the accuracy of the various trials, Professor Schröter calls attention to the fact that trial No. XV., which lasted 5½ hours, gave, at the same superheat and at the same power, exactly the same result as trial No. IX., which lasted only fifty minutes. Further, it is pointed out that the regular form of the curves is another proof of the exactitude of the results.

While taking all ordinary precautions, and without any leakage being apparent, there was a difference between the amount of feed-water and the condensed steam of 6·6 per cent. In order to diminish this considerable discrepancy, says the Professor, Messrs. Van den Kerchove examined everything more closely, and made new comparative measurements, with the result that by overhauling the bottom water-gauge fitting on the boiler, which was out of order, the difference fell at once to 3 per cent. By continued trials, and by carefully investigating all possible causes of leakage—the tests being made in the presence of M. Vinçotte, Director of the Belgian Association for the Inspection of Boilers—a difference of 1¼ per cent. was finally obtained. This does not appear to be susceptible of reduction.

A LARGE TURRET LATHE.

THE lathe illustrated on page 193 is, we believe, the largest of its kind in existence. It takes a stock bar of no less than 5in. diameter; this, we believe, is ¼in., if not ½in. greater than can be taken by any other lathe of a similar type yet constructed. Our engraving gives a very good idea of the size and massiveness of the machine, but in an early issue we shall put before our readers drawings of the fast headstock and saddle, from which they will be able to arrive at still clearer notions of its proportions. In the present connection we must state that the machine is shown as it stood in the makers' works. When erected on its proper foundations, the deep channel or tray which forms the base is sunk several inches into the floor.

Whilst it will be more convenient to reserve a detailed description of this fine tool till we publish the drawings, a few particulars may be found useful at the moment. The lathe, then, has been designed primarily for marine engine works—Sir Christopher Furness, Withy and Co. have the first one made—and is intended for turning out bolts for connecting-rods, propeller shaft couplings, swivel pins for steering gear, and other comparatively straightforward work, which it has been found by experience is more economically turned out of a stock bar than from a forging. Of course, the lathe can be, and is, also used for chuck work on forgings. The hole through the spindle is large enough to allow a 5in. rolled bar to pass easily. The front bearing is 8½in. diameter, and the back 7¼in. diameter, the difference being made to accommodate the thrust collars. Both bearings are parallel, and have hard gun-metal liners. The spindle is driven either direct or through back gears having ratios of 8 to 1 and 24½ to 1. There are three steps on the cone, 18in., 21in., and 24in. diameter, and the belt is 5in. wide. There are two speeds on the countershaft, so that a total range of eighteen speeds is available, and of these six are changed by friction gearing. Both back and front ends of the spindle are provided with chucks, the former simply steadying the bar, whilst the latter, which has four jaws, grips the work.

The bed is a strong ribbed casting, 13ft. 6in. long, cast in one piece with the headstock. It has flat shears with square edges, 26in. wide over all. The casting of the headstock and bed in one piece is an excellent arrangement, which we are glad to note is being increasingly adopted. If for no other reason, it would justify its existence by absolutely preventing the sinful practice of moving the headstock sideways to do taper work. We need scarcely say that in large lathes the rigidity of the arrangement is the main consideration.

Of the turret we shall have more to say hereafter. It has independent screw-cutting and traversing feeds. The former is effected by a set of standard leading screws; the latter by a central shaft driving a cross shaft with steel pinions gearing with two steel racks, one on each side of the machine. The tendency to twist and bind which is present when the traverse is effected by a one-sided drive is thus entirely obviated. There is also a quick-power traverse. The feeds for the turret are twelve in number, ranging from 10 to 216 turns per 1in. of traverse.

In conclusion of the present notice, we may state that the weight of the lathe complete is 12 tons, and the floor space occupied is about 16ft. by 5ft.

COMPLIMENTARY DINNER TO SIR WILLIAM WHITE, K.C.B., F.R.S.—A complimentary dinner to Sir William White, K.C.B., F.R.S., the late Chief Constructor and Assistant Controller of the Navy, is being organised by his professional brethren, and will be

Details of Test of Van den Kerchove 250 horse-power Compound Engine.

Number of trial	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.	XIII.	XIV.	XV.	XVI.
Load in indicated horse-power	312·17	273·02	219·03	167·65	116·77	21·50	314·22	268·84	220·24	167·05	119·36	222·87	223·90	220·29	219·75	215·19
Length of trial, minutes	60·16	61·04	57·54	54·96	50·84	53·23	48·15	59·69	50·82	64·66	54·96	73·70	58·05	47·61	337·54	57·18
Total steam condensed in H.P. and L.P. jackets, kg.	206·5	184·7	154·9	121·3	90·2	19·2	32·0	43·6	37·5	32·3	23·7	112·2	82·6	57·4	—	25·1
Consumption of steam per hour, kg.	1902·0	1560·8	1197·7	885·5	523·6	131·9	1527·3	1249·3	—	728·2	515·0	1170·5	1116·2	1065·6	977·6	864·9
Consumption of steam per hour per I.H.P., kg.	6·09	5·72	5·47	5·28	5·37	6·13	4·86	4·65	4·46	4·34	4·31	5·25	4·99	4·84	4·45	4·02
Temperature of steam at introduction, deg. Cent.	180·7	180·1	180·3	178·7	178·9	Running empty.	299·6	305·8	306·4	30·43	304·6	204·3	233·6	263·4	303·1	252·8
Temperature of condensed steam, deg. Cent.	31·6	28·7	24·9	24·1	23·8		30·9	26·9	24·7	24·4	24·4	25·6	25·0	25·0	—	23·3
Equivalent consumption of saturated steam per hour and per I.H.P.	—	—	—	—	—		5·28	5·07	4·87	4·73	4·70	5·34	5·19	5·14	4·85	4·52

parallel to the centre line of the cylinders, its bearings being provided with ring lubrication. There are four excentrics, and each moves one admission valve with its corresponding exhaust valve. The trip of the admission valve is worked by a roller under the influence of a lightly-weighted governor, to which is connected a simple device for cutting off the steam in case the governor strap should break. The admission valves are closed by springs, the shock being taken up by air dashpots. There are, of course, no valve seats, the construction of the valves being exactly as shown on page 44, vol. xci.

For ordinary working the condenser is placed underneath the engine, the air pump being worked from the crank pin. This was the condition in which the engine was working a few days ago, when we had the opportunity of seeing it running. For

The remaining five were at constant power, and with progressive superheating:—

Test No.	XII.	XIII.	XIV.	XV.	XVI.
Ampères at 110 volts	1200	1200	1200	1200	1200

The results obtained are set out in the accompanying table and diagrams. It will be observed that when using saturated steam the consumption of water at the most economical cut-off was 5·28 kilos., say 11·64 lb., per horse-power per hour, while with a superheat of 300 deg. the consumption was 4.31 kilos., say 9·5 lb., and with a superheat of 350 deg., 4·02 kilos., say 8·86 lb. "These figures," remarks Professor Schröter, "have not been obtained up to the present, to my knowledge, with any engine of the same size." The rated output is 250 brake horse-power.

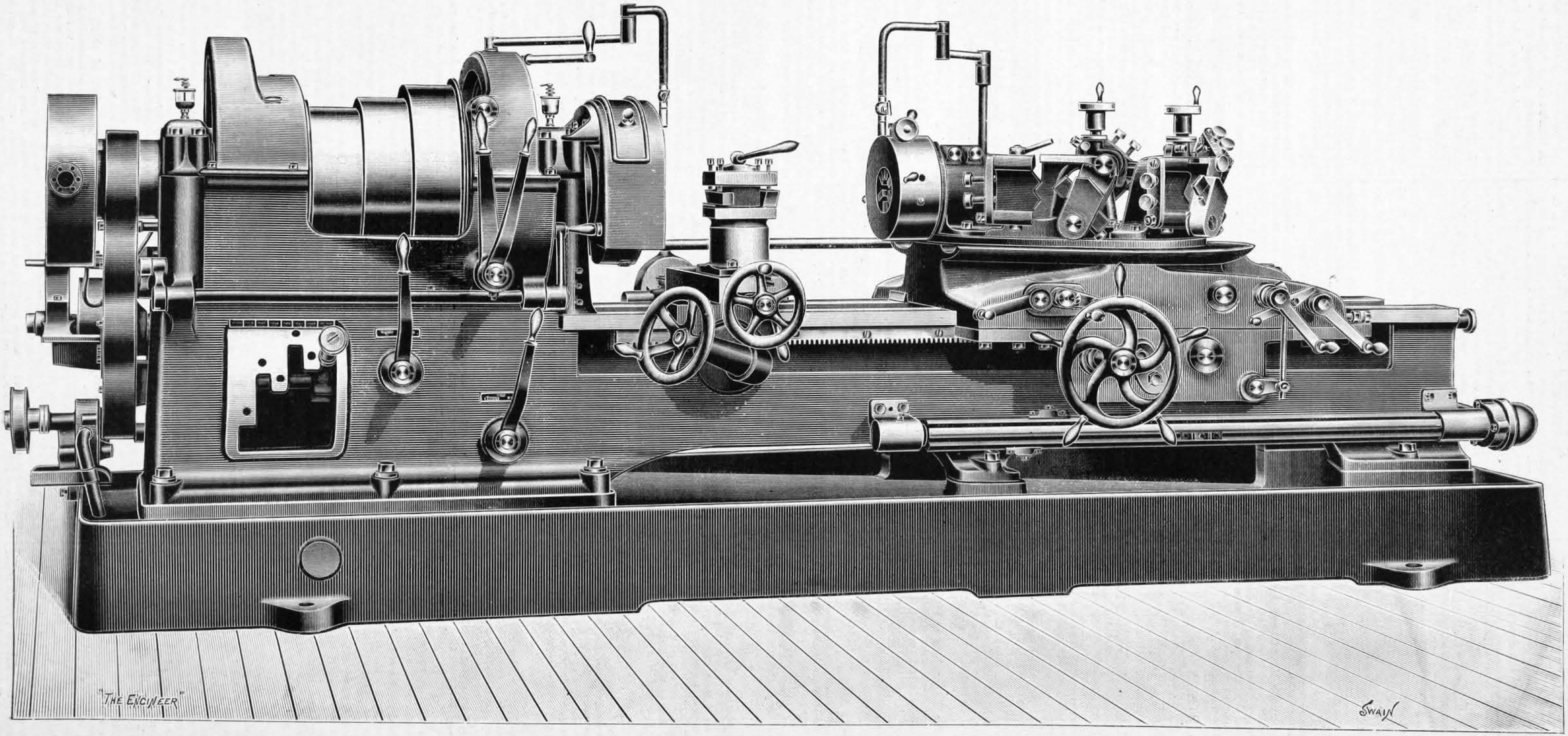
It should be added that account was taken of the varia-

held, by kind permission of the wardens of the Worshipful Company of Goldsmiths, at the Goldsmiths' Hall, on Thursday, March 26th. A large and representative committee has been formed, among whom are:—Mr. Hawkshaw, President of the Institution of Civil Engineers; Mr. Haw, President of the Institution of Mechanical Engineers; the Earl of Glasgow, President of the Institution of Naval Architects; Mr. Whitwell, President of the Iron and Steel Institute; Mr. Swinburne, President of the Institution of Electrical Engineers; the Earl of Northbrook, Lord Kelvin, Lord Brassey, Lord George Hamilton, Sir Frederick Bramwell, Bart.; Sir Bernard Samuelson, Bart.; Sir James Kitson, Bart.; Sir Lowthian Bell, Bart.; Sir Edward Carbutt, Bart. Admiral Sir John Hay, Sir John Wolfe Barry, Sir William Preece, Sir Benjamin Baker, Sir Nathaniel Barnaby, Sir George Bruce Sir John Durston, and Sir J. I. Thornycroft. Sir Frederick Bramwell, Bart., is the hon. treasurer, and Mr. Leslie S. Robertson M. Inst. C.E., 28, Victoria-street, Westminster, the hon. sec.

5-INCH BAR FLAT TURRET LATHE

MESSRS. H. W. WARD AND CO., BIRMINGHAM, ENGINEERS

(*For description see page* 192)



RAILWAY MATTERS.

THE Chicago and North-Western is the only double-track railway between Chicago and the Missouri River.

ESTIMATES made, by railroad commissions show that about 6000 miles of new steam railway were built in the United States from January 1st, 1902, to December 31st, 1902. These figures are exclusive of sidings and rebuilt mileage.

IT is reported that the Upper Silesian Railway Material Company, of Friedenshütte, has secured a contract from the Prussian State railway authorities for the supply of 3223 steel tires at 210s. per ton, and 112 wagon axles at 430s. per ton.

THE mileage of trains on the Midland Railway for the last half year was:—Passenger trains, 10,946,493 miles; goods and mineral trains, 13,579,563 miles. The total, 24,525,563 miles, shows a decrease of 425,514 when compared with the corresponding period of the previous year.

IT is stated that while some experiments were recently being carried out with an engine on the Prussian State Railways, fitted with an apparatus for superheated steam, there was a serious accident. The fire door was blown open, with the result that the fireman was killed and two others injured.

THE stock of locomotives on the Egyptian State Railways now numbers 413, with an additional 25 on order. The existing stock consists of 241 six wheels coupled, 96 four wheels coupled, 30 single-wheel tender engines, and 46 tank engines. During the years 1900 and 1901 no less than 54 locomotives were consigned to the scrap heap, and were replaced by modern ones.

LOCOMOTIVE engineers on the Chicago, Rock Island and Pacific Railroad say that the alkaline water of the southwest is "killing" scores of the engines used on this system. Sixty locomotives sent out for service on the El Paso division a few months ago have been practically put out of service owing to the damage done to the boilers by the alkaline water.

THE Sykes electric block interlocking system has been adopted by the Bombay, Baroda, and Central India Railway for its lines at Bombay. This is the first case of the use of any electric interlocking system on Indian railways. A further installation of the system is being erected at the other extremity of the Central India Railway at Delhi, and is now almost ready for operation.

IN an endeavour to break the blocking of the goods traffic, which has of late become very serious, the Pennsylvania Railway has decided to temporarily withdraw its 20-hour special between New York and Chicago. As this special has the right-of-way over everything else, freight trains have frequently been held on sidings for hours to let it pass. The company may discontinue some other of its fast trains until the freight traffic is restored to a normal basis.

THE heavy traffic on the Lancashire and Yorkshire company's system showed a decided expansion during the last half-year, the merchandise yielding £19,145, live stock £2299, and minerals £26,002 more than in the corresponding 1901 period. Parcels, &c., also improved by £3947 for the half-year. There was a decrease of 719,630 third-class and of 4226 first-class passengers, but an increase of 185,327 in numbers and of £10,577 in receipts of the second-class.

AN exceptionally fast railway run was made on the New York Central and Hudson River Railroad on January 29th. The Empire State express covered the distance between Palmyra and Macedon, N.Y., 7·29 miles, in four minutes. This corresponds to a speed of about 109 miles per hour. This performance was made in the course of an unusually fast trip, the distance between Albany and Buffalo, 302 miles, being covered in 295 minutes, which represents an average speed for the whole trip of nearly 62 miles per hour.

THE British Consul at Venice, in a report just issued, writes as follows:—"I wish to draw the attention of British manufacturers of locomotives to the fact that, about the middle of last year two steam locomotives of a new type passed through this district, and were stated to have been sent to Florence to be tested there, and to be adopted for railway traction if approved. They were made in Berlin, and their drawing power was said to be about 400 tons, travelling at the rate of about 100 kiloms.—62 English miles—per hour."

A NOTABLE addition to the great railway bridges of the world has been made in the viaduct over the gorge of the Viaur river, one of the higher tributaries of the Garonne, on the Carmaux and Rodez line, lately opened for traffic. The total length of 1510ft., including two masonry approaches each of 82ft., two cantilever side spans, and a central arched span. The crown of the arch, of 722ft. span, is 377ft. above the river level. The roadway is carried over the tops of the girders. We propose illustrating and describing this bridge in a future issue.

AN electric mountain railway is under construction in the Tyrol district of Switzerland. It is two miles long, but it is said to be the steepest line in the world, reaching to the summit of the Col de Mendel at a height of 2550ft. from the village of Kaltern. The maximum grade is 64 in 100, surpassing that of the Stanserhorn line, which formerly held the European record. Electricity is the motive power, the "cog" or geared system having been adopted. The completion of this railway will enable the ascent of the mountain to be made in just under thirty minutes, which is a reasonable speed under the circumstances.

A LARGE landslide blocked the New York Central and Hudson River Railroad for twenty-four hours from 7 p.m. on January 30th until the evening of January 31st. A few miles north of Staatsburg, N.Y., the line passes through a deep cutting in land sloping west to the Hudson River. The cutting is 50ft. deep on the east side, and this portion, for a length of several hundred feet, suddenly slid into the cutting, filling it with 20ft. to 40ft. of earth. The rock surface slopes to the west at this point, and the overlaying earth is sand and yellow clay. This material was softened by a strong thaw, and slid on the sloping surface of the rock.

SOME steam motor cars for street railway use have been built for the Compania de Tranvias de Merida, Yucatan, by the John Stephenson Company, of Elizabeth, N.J., and the Reeves Engine Company, of Trenton, N.J. The cars are only about 14ft. long, and run on a 3ft. gauge. The boiler, a vertical cylindrical tubular oil-burning boiler, about 2ft. by 2ft., is placed on the front platform. A steam pressure of 225 lb. is carried. The engine, a small compound of marine type, lies horizontally between the wheels. It has 3½in. and 6½in. cylinders of 6in. stroke, and two piston valves. The crankshaft is geared to one of the axles by a Renold chain, and a similar chain couples the two axles. The gear ratio from crankshaft to axles is about 1 to 3.

THE British Consul at Bilbao, in his annual report, states that some orders for locomotives, corridor carriages, and goods wagons have been placed by Spanish railway companies with American builders, although, in at least one instance, earlier delivery was guaranteed by British manufacturers. The Bilbao and Santander Railway Company, he mentions, has ordered several locomotives from British engineers who had already supplied others with excellent results, and he quotes the testimony of the engineer of that line that, after experience with American locomotives bought several years ago, he much prefers waiting a longer period in order to obtain British engines. The experience of the Astillero and Ontaneda Railway seems to have been similar.

NOTES AND MEMORANDA.

THE discovery of a seam of coal at a depth of about 880 yards is reported from Souchez, near Lens, Pas-de-Calais, France.

IT is reported that two Swedish engineers have made important discoveries of copper and iron ore at the south side of the Porsanger Fiord, Tromsoe, Norway.

THE monthly approximate traffic return of the Manchester Ship Canal for January states that the receipts were £33,663, against £28,696 during the same month last year.

AT Portsmouth last week the battleship Mars made a world's coaling record. She took on board 1570 tons, at an average rate of a fraction above 241 tons per hour. This is a great advance upon the record of 212 tons per hour established by the battleship Majestic a few weeks ago.

THE total production of pig iron in the United States in 1902 was 17,821,307 gross tons, against 15,878,354 tons in 1901 and 13,789,242 tons in 1900. The increase in production in the second half of 1902 over the first half of the year was 204,159 tons. The total increase in 1902 over 1901 was 1,942,953 tons.

AN idea of the large power that is used at the Marconi Table Head station for transmitting messages across the Atlantic may be obtained, says the *American Electrician*, from the fact that the sound as each signal is transmitted is so great that it is necessary to use cotton in the ears as a protection for the ear drums.

POTASSIUM cyanide is said to have been electrically made by Professor Edward O'Neill, of Berkeley, California. A hydrocarbon vapour, nitrogen from the air, and an electric arc are said to be the agents in making hydrocyanic acid, which is then combined with potash producing potassium cyanide. Whether the process will be commercially successful remains to be seen.

EVEN in America the non-technical Press can apparently make mistakes sometimes. An Ohio rural paper explains some work being carried out to high-tension transmission lines in its district as the replacement of glass insulators by those of porcelain make, because the heat of the high voltage was so great that the glass was unable to stand it.

IN Italy the whole of the industrial and agricultural machinery in use propelled by steam has a force equal to 430,000 horse-power, 95,000 horse-power of which are devoted to agriculture, and another 20,000 horse-power represent machinery connected with the Admiralty and War-office. A further 300,000 horse-power is used in land transport, and 250,000 horse-power in water transport.

SPODUMENE is found in several places in America, the richest mine being at the Etta tin mine near Keystone, South Dakota. Spodumene is a whitish crystal which resembles logs of petrified wood, having a similar grain. It is found in pockets, and is mined by open cuts. Frequently a pocket will be struck containing several tons. It is mined for its lithia values, the material containing about 5 to 6 per cent. lithia.

THE California nitrate deposits are situated in the Mohave Desert, extending from the northern portion of San Bernardino County to the southern section of Inyo County, and are 80 or 100 miles from Manvel, on the Santa Fé Railway. Some very high analyses of the mineral are reported, and it is estimated that there are about 22,000,000 tons in sight, though it is thought that these figures are likely to be revised when active mining is in progress.

IT has been discovered in Germany that aluminium is valuable for sharpening cutlery. The metal apparently has the structure of a fine stone, and possesses a good dissolving power. It moreover develops during the whetting process an exceedingly fine metal-setting substance, greasy to the touch, while showing strong adhesion for steel. The knives in a short time obtain such a razor-like edge that it is said that even the best whetstone cannot compete with the result.

DR. PUPIN, of the Columbia University, New York, has invented a method of facilitating long distance telephony over submarine cables. As explained by an American contemporary, the capacity of the cable is neutralised by the insertion of induction coils in series with the cable. The result, it is explained, is that for alternating currents of certain frequency the cables act as though they possessed neither capacity nor self-induction, but only ohmic resistance.

A REPORT to the German Minister for War records the results obtained during the autumn manœuvres with wireless telegraphy put in charge of the balloon section. The apparatus was carried by a wagon, current being generated by a dynamo driven by a benzine motor, and the distance through which messages were sent varied between 40 and 50 kiloms.—mean 28 miles—continual communication having been kept up between the general staffs, the cavalry divisions, and the chiefs of the army corps.

THE Electrotechnical Society of Switzerland has recently published figures indicating the progress of power development in that country. There are reported to be 235 distinct installations of electrical power, of which total 215, or 91 per cent., are operated by water. The maximum aggregate power available is 160,900 kilowatts, which gives an average of 680 kilowatts for each installation. The average aggregate power in use is 104,000 kilowatts, and of this total the electrochemical industry accounts for 24,000 kilowatts, or 23 per cent.

ALCOHOL motors are much used in Germany, especially for automobile purposes, the fluid, 90 per cent. pure, being sold at only about five cents per quart. The weight of the motors is only about one-half that of portable steam engines of equal power. Six to eight horse-power motors are sold for £195, 10 to 12 for about £213, 16 to 20 for about £316. Tests have been made showing the consumption about ·92 of a pound of 86 per cent. spirit, and ·81 of a pound of a mixture of one-fifth benzol and four-fifths 86 per cent. spirit, in both cases per brake horse-power per hour.

THE weight of the discharge of one round from all the guns of the United States battleships Maine and Alabama, above 6-pounders, is 5312 lb., whereas the weight of the discharge of one round from all guns above 6-pounders on the Connecticut is 7856 lb., or an increase of 47·9 per cent. Therefore, for an increase of one-third in size, there has been a gain of nearly one-half in effective battery power. Thus, if the battery power of the Maine and Alabama be considered unity, that of the Connecticut will be one and a-half; and for 30,000,000 dols. four Connecticuts can be built, with a battery power of six, and five Maines and Alabamas, with a battery power of five.

FACTS concerning the relative dimensions of modern battleships, and particularly those of the United States navy, serve to illustrate the effect of increase in size. The Alabama and Maine classes have about 12,000 tons displacement, and the Connecticut class 16,000 tons. The cost of the Maine and Alabama is about 6,000,000 dols. each. The cost of the Connecticut class is about 7,500,000 dols. each. The displacement has been increased 33 per cent. in passing from the Maine and Alabama to the Connecticut. The cost of four Connecticuts will equal the cost of five Maines and Alabamas. The weight devoted to battery and ammunition in the Maine and Alabama is 1003 tons, and in the Connecticut 1340 tons. Therefore, by increasing the displacement of the Maine and Alabama by 33 per cent., there has been a corresponding increase in the weight of armament carried.

MISCELLANEA.

A SCHEME is on foot to provide a ten-mile racing track for motor cars at Clacton-on-Sea.

THE First Automobile Speedway in America for the exclusive use of automobilists was recently completed at Lakewood, N.J. It is 1¼ miles long and 80ft. wide.

IN 1839 water power to the extent of 2147 horse-power was used in Ireland. This amount is probably not greatly exceeded at the present time. About 800 horse-power is employed for electric lighting.

IRRIGATION in Siam is apparently to be undertaken on a large scale. The King is reported to be negotiating with a certain Signor G. Grassi in relation to the construction of about 750 miles of canals and feeders for the benefit of 600,000 acres of land.

THE use of graphite has been advocated for lubricating both the cylinders and bearings of automobiles. The proposal is to mix 5 per cent. of graphite with 95 per cent. of oil. It is said that the vibration of the car is sufficient to keep the graphite from settling.

THE waterfalls of Italy have been estimated as being capable of furnishing 10,000,000 horse-power. When it is considered that Italy imports 5,000,000 tons of coal—the United Kingdom sending 4,500,000 tons of this—the importance of taking advantage of this water power can be appreciated.

AN interesting description of moving a house is given by the *Engineering Record*. The house measured 40ft. by 48ft., and was a two-storey and attic building. It was successfully carried 50ft. in one direction, 100ft. in another direction over a steep embankment, and was then lowered 35ft. on to its new foundation.

THE Board of Trade returns for January show that during the month the imports into the United Kingdom amounted to £46,226,515, against £50,142,348 in the corresponding month of last year, a decrease of £3,915,833. The exports of British and Irish produce were valued at £24,903,636, against £24,269,174 in January, 1902, an increase of £634,462.

THE number of stokers for the Navy which it was proposed last March to enter during the current financial year was 3200. So far entries have been so good that less than 400 are now required, and stokers are being rated at over a hundred a week. It is said that candidates for the rating are now coming in so freely that only the very best are being taken.

SOME fast shaft-sinking work is being done on the Rand. At the Wolhunter Mine an incline shaft was sunk, cleared, and timbered 209ft. during November last. In August last the depth sunk was 179ft.; in September 182ft.; in October 204ft. The shaft had reached a total depth of 1500ft. by the end of November. The work is being done entirely by white labour.

AMONG other unusual employments for American women, says *American Industries*, are 100 workers as "lumbermen and raftsmen," 113 wood choppers, 373 saw mill employés, 440 bar tenders, 2086 saloon keepers, 904 "draymen" and teamsters, 323 undertakers, 143 stone cutters, 63 "quarrymen," 65 white-washers, 11 well borers, and 117 stationary engineers and firemen.

THE members of the Northern United Enginemen's Association employed in engineering yards of the North-east Coast have accepted the employers' modified offer for a reduction in wages—namely, 1s. per week off rates over 26s. per week, and 6d. per week off rates of 26s. per week and under. The braziers and sheet metal workers have accepted a reduction of 1s. per week.

LAST Thursday night, at Vickers, Sons and Maxim's shipyard at Barrow-in-Furness, one of the electric batteries on board No. 6 submarine, which was being charged with gasoline, exploded. A ladder was seen to be thrown out of the conning tower, and it was found that six men had been injured. All the men were eventually got out and conveyed to hospital, where the injuries of two of them were found not to be of a serious nature, and they were not detained.

THE torpedo boat destroyer Wolf, upon which experiments extending over several months have been conducted by the Destroyer Committee in dry dock at Portsmouth, to determine certain problems with reference to hogging and sagging stresses, has been undocked, the trials having been completed. The notes taken by the officials engaged in the trials are of a voluminous character, and elaborate calculations will have to be made before any trustworthy data can be ascertained.

FIN brakes for a steamer are said to have given satisfaction on the Canadian boat Eureka, 103ft. long, with 12½ft. draught, 250 tons. Amidships on each side are vertical fins or flaps, 3½ft. by 10ft., made of ⅜in. boiler plate. The fins are hinged, and when they swing open are cushioned by water-cushion cylinders, four for each fin. We hear that from an 11-knot speed the boat was stopped with great suddenness upon opening the fins, and by using one fin was turned in its own length when going at full speed.

WHAT is believed to be the largest boom derrick in the United States is being erected at a granite quarry in Barre, Vt. The jib is of Oregon pine, 93ft. 3in. long and 2ft. 5in. in diameter. The mast is held in position by ten guys, averaging 350ft. each of 1⅝in. wire rope. The castings weigh 42,000 lb. The derrick is constructed to lift 100 tons, and although the breaking strain is 170 tons, it is said that with extra rigging it will be able to handle 200 tons. It is to be fitted with an engine with 12in. by 15in. double cylinders and of 100 horse-power.

ONE man was probably fatally hurt, and a score of others narrowly escaped injury recently by the bursting of a fly-wheel in the power-house of the United Power Company, in Wellsville, Ohio, U.S.A. The wheel, which weighs something over a ton, broke loose from the shafting while the engine was running at a high rate of speed, pieces crashing through the roof of the building. One piece, weighing about 200 lb., struck John Miller, a carpenter, who was working on the roof of a building some distance away, and other pieces did a considerable amount of other damage.

THE turbine steamer, which is being built by Messrs. Denny Brothers for the Newhaven and Dieppe service of the London, Brighton and South Coast and Western of France railway companies will, says the *Sussex Daily News*, be 282ft. long, 34ft. in breadth, and have a depth of 14ft. 6in. The vessel will be propelled by three independent Parsons compound steam turbines and two condensers; also one high-pressure and two low-pressure turbines. Steam will be generated by four single-ended return-tube boilers, the working pressure being 150 lb. per square inch, and the vessel will be over 5000 horse-power.

AN explosion of thirty boxes of dynamite occurred recently on the Torresdale filtration plant construction work, near Philadelphia. One man was killed and five were injured. The dynamite, of which there was 1500 lb., was stored in a magazine, having manure-packed walls 2ft. thick, and a local daily paper naïvely says:—"Another precaution against explosion was the heating of the magazine with steam pipes." Just before the explosion occurred the magazine was seen to be on fire. The shock of the explosion was felt 20 miles away. The man killed was pinioned beneath an overturned stove in a house 100 yards from the magazine.

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

Letters relating to Advertisements and the Publishing Department of the Paper are to be addressed to the Publisher, Mr. Sydney White; all other letters to be addressed to the Editor of THE ENGINEER.

Telegraphic Address, "ENGINEER NEWSPAPER, LONDON."

PUBLISHER'S NOTICES.

*** *With this week's number is issued, as a Supplement, a Two-page Drawing of an Electric Goods Locomotive, Valtellina Railway. Every copy as issued by the Publisher includes a copy of this Supplement, and subscribers are requested to notify the fact should they not receive it.*

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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.*

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

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

REPLIES.

AMBITIOUS.—Write direct to Lloyd's, 2, White Lion-court, Cornhill, for full particulars.

MOTOR (Leeds).—You will probably obtain all the information you require from "Electrical Engineering," by Slingo and Brooker, and published by Longmans.

A. T. A.—We have no knowledge of the existence of any competitive examination of the kind you suggest. It is possible your supposition is based on Cooper's Hill College examinations.

RUSTICUS.—It has been decided by all the leading authorities that a great central station such as you suggest, while its construction would involve the expenditure of an enormous sum, would in no way reduce the congestion of traffic.

T. M. (Eccles).—You will find a synopsis of all that is known about the flow of steam, and a list of the authorities that may be consulted, in D. K. Clark's "Rules, Tables, and Memoranda," page 893. See also THE ENGINEER, November and December, 1869.

J. A. A. (Arequipa).—We have not published any drawings of prisons, nor do we know where you can obtain them. We are not acquainted with any special treatise on the construction of markets. There are numerous books on iron roofs, but no doubt you are already familiar with these.

W. M. R.—In certain cases we do as you suggest, but it would be impossible to put in men for the purpose of comparison. As, however, the dimensions are given in the text, any one interested can always make a scale for himself which will give an adequate idea of the size of the machine as it would appear to any one looking at it from the camera.

A. CYRIL.—(1) From Messr Chapman and Hall. (2) See "Mine Surveying," by Brough (C. Griffin); "Machinery for Mines," by Davies (Crosby Lockwood); "British Mining," by Hunt (Crosby Lockwood); "Economic Mining," by Warnford Lock (Spon); "Mechanical Engineering of Collieries," by Percy (*Colliery Guardian* offices). Some of the best work will be found in the "Proceedings" of the various mining institutions.

F. M.—Multiply the area of the roof of the holder in feet by 5·24, and by pressure in inches required. This will give you the weight of holder. Subtract this weight from the actual weight of the holder and you get the amount of the balance weights. Add 10 to 15 per cent. for friction of pulleys and chains. In the telescopic holder nearly the whole weight of the lower lift may be balanced; it is the upper lift that gives the pressure, and the above calculation gives the weight required.

A. C. S. (Kew).—The defects in the engines of which you speak point to bad balancing and incompetent running-shed foremen. No locomotive superintendent who knew his business would permit engines to run with the balance beams and springs in the condition shown in your sketch. The distribution of weights was all wrong; the axle-boxes probably quite out of order. The pot-sleeper road can be made a very good one, but nothing is equal in quality to the best English permanent way.

M. (Bishopsgate-street).—The Board appointed to consider the various tenders for the bridge at Sydney chose those of three firms as being suitable. These firms were the E. and C. Bridge Co., Limited, of London; Messrs. J. Stewart and Co., of Sydney; and Sir William Arrol and Co., Limited, of Glasgow, in conjunction with Head, Wrightson and Co., Limited, of Thornaby-on-Tees. The Board recommend that these firms should be requested to send in amended tenders by the 27th ult. We have received no later information than this.

C. B. (West Kensington).—Your question is so vaguely stated that we can only guess at your meaning. (1) If the liquid is heated in a closed vessel which it does not fill, the pressure will rise with the boiling point. Steam tables are to be found in all treatises on the steam engine. (2) If the liquid is enclosed in a vessel which it quite fills, then, on heating it, what is called the "critical point" is reached, and the liquid as such disappears. We have not space to give you further information here; you will find information in Ganot's "Physics," page 354. You can see the book in the Patent-office Library.

INQUIRIES.

ALOE FIBRE.

SIR,—Can any of your readers give us the address of any firms who make machinery for extracting "hemp" from aloe fibre?
February 18th. R.

MEETINGS NEXT WEEK.

LIVERPOOL ENGINEERING SOCIETY.—Wednesday, February 25th, at 8 p.m. Paper, "Temporary Dams," by Mr. Geo. Cecil Kenyon.

ROYAL INSTITUTION OF GREAT BRITAIN.—Friday, February 27th, at 9 p.m. Discourse on "Perfumes: Natural and Artificial," by Mr. Adolph Liebmann.

BIRMINGHAM LOCAL SECTION OF THE INSTITUTION OF ELECTRICAL ENGINEERS.—Wednesday, February 25th, at 7.30 p.m., in the University Buildings (Physics Theatre). Paper, "Network Tests and Station Earthing," by Mr. A. M. Taylor.

CLEVELAND INSTITUTION OF ENGINEERS.—Tuesday, February 24th, at 7.30 p.m., in the Hall of the Cleveland Literary and Philosophical Society, Corporation-road, Middlesbrough. Paper, "The Steam Turbine," by the Hon. Geoffrey L. Parsons.

THE INSTITUTION OF CIVIL ENGINEERS.—Tuesday, February 24th, at 8 p.m. Ordinary meeting. Paper to be read and discussed, "Mechanical Handling of Material," by Mr. George Frederick Zimmer.—Friday, February 27th, at 8 p.m. Students' meeting. Paper to be read, "The Relative Advantages of Single Screws, Twin Screws, and Triple Screws, for Marine Propulsion," by Mr. E. Falk.

SOCIETY OF ARTS.—Monday, February 23rd, at 8 p.m. Cantor Lectures. Lecture IV. on "Paper Manufacture," by Mr. Julius Hübner.—Wednesday, February 25th, at 8 p.m. Ordinary meeting. Paper, "Tonkin, Yunnan, and Burma," by Mr. Fred. W. Carey.—Thursday, February 26th, at 8 p.m. Indian Section. Paper, "Gleanings from the Indian Census," by Mr. Jervoise Athelstane Baines.

THE INSTITUTION OF ELECTRICAL ENGINEERS.—Thursday, February 26th, at 8 p.m., at the Institution of Civil Engineers, Great George-street, Westminster, S.W. Papers, "The Nernst Lamp," by Mr. J. Stöttner; "Distribution Losses in Electric Supply Systems," by Mr. A. D. Constable and Mr. E. Fawssett; "A Study of the Phenomenon of Resonance in Electric Circuit by the aid of Oscillograms," by Mr. M. B. Field.

DEATH.

ON the 13th inst., at 33, Ladbroke-grove, W., WILLIAM HARRY STANGER, M.I.C.E., aged fifty-five.

THE ENGINEER.

FEBRUARY 20, 1903.

THE POST-OFFICE AND ELECTRICAL RAILWAYS.

WE have it on excellent authority that the Post-office proposes to adopt a policy as a Government department regarding the electrification of railways which appears to be quite opposed to progress. It is, of course, well known that all currents of electricity may affect each other. The Post-office possesses an amazing network of wires extending all over the country, and it is necessary for the certain transmission of messages that the wires should not be interfered with, or the currents influenced by other currents. On all sides we hear of the adoption of electricity for the purposes of propulsion. The Post authorities fear that the currents used by the railways will prejudicially affect the telegraph wires, and to provide for this contingency it is, we understand, proposed that in every Bill brought into Parliament by railway companies and others, whether for the construction of new lines or the electrification of old lines, clauses shall be inserted for the protection of the Post-office which will be very oppressive, and may, indeed, go far to stop the use of electricity on railways altogether. It is a matter of common knowledge now that the advance of electrical engineering in this country has been delayed to a very serious extent by mischievous, mistaken, and groundless legislation. There is every prospect that once more Parliament will be called upon to hamper an important industry. It is necessary that those who like progress should watch the course of events with care, and be prepared when the time comes to oppose with effect, should it be found desirable, the action of the Post-office.

When high-tension currents were first sent along Ferranti cables from Deptford to London, all the signalling arrangements of the South-Eastern Railway were upset. The transmission of messages to Paris became a matter of difficulty. The cables were carried alongside the permanent way for a considerable distance. When the trouble had declared itself, steps were taken to get rid of it, and with complete success. Obviously the Post-office authorities fear a repetition of the Deptford induction effects. We are unable to say what precise form the Post-office protective clauses will assume. The utmost secrecy is being observed, for reasons which are sufficiently evident. The general effect will be tantamount to making the railway companies double all their transmission wires. The cost of this would be considerable; but the matter does not end here. The Post-office assumes that the effect of powerful currents will not be restricted. Ten miles intervene between two towns, X. and Y. The Post-office wires extend alongside the railway, not only over this distance, but over, say, 100 miles to London. The Post-office authorities will not be content if the railway company, electrifying the ten miles, deals only with induction between X. and Y. They maintain that the whole line between X., Y. and London may be affected, and the railway company must take such measures, no matter what the cost, as may be held by the Post-office engineers to be necessary for the protection of the whole line. It is impossible to see where the limit comes in.

It will be seen at a glance that the Post-office may easily make out a very good case, which, backed up by specious arguments, would readily induce the House of Commons to sanction a very dangerous kind of legislation. That we do not exaggerate the risks is proved by the fact that the Board of Trade is flatly opposed to the Post-office, maintaining that clauses of the kind we have indicated are unnecessary and mischievous. The electrical engineers of the Board of Trade fully understand the lessons taught by the history of commercial electricity in this country, and appear to have made up their minds that it shall not be their fault if mistakes are repeated. It is not easy to see what direct action can be taken by the railway companies or the electrical engineering firms of Great Britain, who will all be affected by adverse legislation. The Post-office can, no doubt, make out a very telling statement. It can argue that the transmission of messages with speed and accuracy is so essential a feature in the national life that nothing would justify interference with it. Such a contention would go far to convert the most progressive member of Parliament, and convince him that the railway companies must be very strictly controlled in their operations. We may concede at once that the Post-office should be protected; the danger lies in the means of protection to be adopted. We have the utmost objection to legislating at large on matters affecting the commercial development of the nation. We have had a great deal too much of it. This, that, and the other interest we have safeguarded until enterprise finds the flaming sword of the law turned in every direction to bar progress. It seems to us that no difficulty need be encountered in providing for any particular case that may arise. But the insertion of clauses in an Act of Parliament which may compel a railway company to spend much money, or reject a particular system of working in order to provide for a contingency that may never arise, represents a policy entirely obstructive and unintelligent. Whether any public action can be taken in the matter we are unable to say with certainty. The Institution of Electrical Engineers will not move, because the Post-office is fully represented among its members, and besides, until the precise wording of the proposed clauses is known, it is not easy to condemn them. It is possible that the publicity we have now given to the scheme may not be without effect; and that the Post-office authorities may be induced to take a reasonable view of the position.

THE VENTILATION OF THE CENTRAL LONDON RAILWAY.

WHEN the Central London Railway—better known as "the Twopenny Tube"—had been opened for about a week people began to write to the daily press complaining that the carriages and platforms abounded in draughts; and that the temperature was too low; the ventilation was all wrong, and, so far as could be gathered from somewhat incoherent and contradictory statements, there was too much fresh air admitted to the tunnel. Londoners accustomed to the vitiated atmosphere of the Metropolitan Railway found the air in "the Tube" "too strong." Its stimulating properties were more than enfeebled constitutions could bear without discomfort, or possibly injury. Complaints of the kind were not prolonged. In their place has sprung up serious accusations. We have been told that the atmosphere in the tube is deadly, and no attempts to argue to the contrary have been met with the least consideration. It is indisputable that there is always a peculiar smell about the tube and its stations. A smell of damp earth, perhaps, rather than anything else. At last the London County Council took the matter up, and on October 8th, 1901, the Council, on the motion of Mr. Beachcroft, passed a resolution to the effect that, "in view of the extension of underground railways in London, it be an instruction to the Public Health Committee to report on the condition of the atmosphere in the tubes of the Central London Railway."

This report has now been published. We have already referred to it in our impression for January 9th in the present year. It was prepared by the medical officer and the chemist to the County Council. The bacteriological examination was made by Dr. Andrewes. The report goes to show that the public have been misled by their noses. The quality of air is not represented by the smell to which we have alluded. There is nothing deadly in the tube, nothing worse than is to be found in many dwelling houses. The defects or deficiencies in the atmosphere of the tube might take either or both of two forms—it might contain carbonic acid gas, or microbes and bacilli inimical to life. Concerning the first point, the chemical examination showed that the quantity of carbonic acid is highest in the air of the carriages, and that, contrary to what might reasonably have been expected, the largest quantity, 14·7 volumes in 10,000 volumes of air, was not found in the carriages where smoking was allowed, but in an ordinary passenger carriage. The smallest quantity found—9·6 volumes in 10,000 of air—was in an empty carriage. The air in the passages leading from and to the stations was generally better than in the lifts. On one occasion the air in the lift at the Oxford-circus station contained 15·2 volumes of carbonic acid in 10,000 volumes of air, or about four times the quantity found in the fresh air outside the station. It will be well to explain here that carbonic acid gas—CO_2—is not a poison. If it were, then no one dare drink effervescing beverages; champagne and soda water would be alike banished from our tables. Its presence is objectionable, because it reduces the volume of oxygen inhaled by our lungs, and to a small extent interferes with the oxygenation of the blood. In all this it differs from CO, carbonic oxide, which is a very deadly and subtle poison; not only killing directly by producing asphyxia, but, if the patient escapes with his life, leaving behind it most baleful effects long remaining in the system. We are happy to see that no trace of this gas has been found in the tube, or the lifts or coaches. The carbonic acid has simply been evolved from the lungs of the passengers. Nor is the result of the search for bacilli and microbes less reassuring. In summarising the results, Dr. Andrewes concludes that, while micro-organisms are present in tube air in a somewhat greater proportion—13 to 10—than in fresh air, the excess is not so considerable as to cause the tube air to compare unfavourably with the conditions known to exist in inhabited rooms generally; and although there was considerable excess of organisms capable of growing at the temperature of the body, this excess was due to "non-pathogenic sarcinæ and allied species, and no pathogenic organisms were found in the tube air." This, done into English, means that there were no germs of infectious disease found.

Several months ago the directors of the Central London Railway determined that some steps should be taken to purify the air. The trains now act as pistons, and do a good deal to change the atmosphere in the tube. It is obvious that no single fan or ventilator of any kind could be used while the numerous openings of the stations permitted air to flow in and out. There were only two methods available. One was to put a powerful fan at each station. The cost of this scheme was easily found to be prohibitive. The other was to close all openings at night during the period of two or three hours when there is no traffic, and then to change the air completely, so that traffic would begin in a tunnel thoroughly purified. Mr. Parshall proposed a scheme for putting compressed air in at the Bank end; but the engineers of the line wisely decided that the case was quite similar to that of a mine, and they followed precedent and decided to put down exhausting plant. The work has, we understand, been placed in the hands of Messrs. Walker Brothers, of Wigan, a firm with enormous experience in the ventilation of mines. A fan will be put up at the Shepherd's Bush terminus. Mr. Parshall's scheme will be confined to the use of a small compressing engine which will supply air at the extreme end of the Bank sidings during the daytime. The Walker fan will be sufficiently powerful to empty the whole tube in an hour.

It is worth while to direct attention to the falsification of the hopes formed when electricity was adopted as a motive power. "Let us get rid," it was said, "of the engine fires and we shall have fresh air." The Central London Railway has not fulfilled that expectation. An examination of an empty carriage on the Metropolitan Railway between Baker and Gower-streets gave 29 volumes of CO_2 per 10,000 volumes of air, or twice that obtained in the tube. But samples taken between the Mansion House and the Temple gave only 15 volumes—much the same percentage as that found in the tube. Nothing is said about sulphurous acid and CO, both of which we should expect to find in air charged with the products of combustion from the engine fires. It seems to be obvious that where large numbers of people congregate together, all exhaling carbonic acid gas, considerable quantities of it must be found in the air. It is very heavy, and likely to lie in a tunnel sunk far below the surface. It is satisfactory to know that perhaps the worst that can be said of the atmosphere in the "Twopenny Tube" is that it has an unpleasant earthy odour.

THE RIVERS THAMES AND LEA.

THE London County Council have long ago foretold disaster to the metropolis, if not from the absolute drying up of the rivers Thames and Lea, at all events from the serious diminution of the flow of these rivers. Every one will remember their persistent desire to minimise the value of the undertakings of the water companies by opposing all efforts towards the construction of storage reservoirs in the two valleys. All, too, will remember the large sums of money thrown away in preparing schemes and promoting Bills for procuring water from Wales. Evidence is by no means lacking that, in spite of having failed in obtaining actual control of the whole of the water supply, the Council have by no means given up their idea of eventually carrying out the Welsh scheme. One of their latest moves was to instruct their engineer to report upon "the diminution of volume of water in the Thames and Lea," which, they say, "it is a matter of common knowledge" has "during the past few years considerably diminished." This report has just been presented, and copies are about to be distributed among the members of the Council. Sufficient of the details have, however, been already made public to enable us to see that it is an ably prepared document. It shows how that, during the last twenty years or so, the rainfall over the Thames valley has been gradually decreasing, especially during the past five years; that its average is now 2¼in. less than it was on the average of the forty years from 1850 to 1889; and that, in addition to this, less water in proportion reaches the river. The same remarks, continues the report, "apply equally, although perhaps with more force, to the Lea valley." Moreover, we are told of springs drying up, and of the level of the water in the chalk falling.

We cannot see, however, that the report really tells us anything which we did not know beforehand. It is a recognised fact that we have been passing through a series of particularly dry years. It is also true that this particular portion of the island has been less lucky as regards rainfall than have been other parts. A natural consequence of decreased rainfall over a number of years is a diminution in the flow of rivers. Furthermore, it is by no means always that springs, especially those which owe their origin to chalk formations, indicate in their flow the nature of the immediately preceding season. In cases we have heard of, springs are several years behind the seasons. We do not put this forward as an actual explanation of the fact that the percentage of total rainfall which reaches the rivers is diminishing. We only say that it is not unlikely to have had something to do with it just recently, seeing that last year followed several drier years.

It is, of course, beyond the power of mortal man to foretell the seasons. It is beyond even the power of the County Council, as their engineer fully realises. He remarks that against the facts as to shortage there has got to be considered "the possibility of a long series of wet years, which may bring back the state of affairs which existed on the average during the long period mentioned." It may not be safe to argue that, because we have had several dry years, we shall in future have some wet seasons to make up for them. It is equally unsafe to argue that, because some years have been dry, those which come after may be just as or more dry. The County Council have already argued the inadequacy of the Thames as a factor of the metropolitan water supply. The reply of Parliament was to sanction a number of reservoir schemes proposed by the companies. Even without these, London has been supplied with water. With them advantage will be taken of such months as the January through which we have just passed. It was manifestly the correct thing to construct these in the first instance, and the value of property to be acquired by the Water Board is thereby enhanced.

It has always been the Council's policy to do everything to depreciate the value of the undertakings of the companies. To prove conclusively that the rivers were running dry would no doubt reduce the value to nothing. Whether or not the present report is a step in this direction, and designed to influence the arbitrators for the purchase, we must leave our readers to decide.

FRENCH NAVAL CONSTRUCTION.

THE resources of the French arsenals will this year be utilised to their utmost to make up for past delays and keep pace with the programme of naval construction. They will be at work upon no fewer than 150 vessels. Those to be put on the stocks will comprise an armoured cruiser—the Ernest Renan—four destroyers, twenty-five torpedo boats, and nineteen submarines and submersibles. Work will be continued on six battleships, six armoured cruisers, nine destroyers, seventeen torpedo boats, and thirteen submarines, and besides these it is hoped to launch two battleships, nine armoured cruisers, one belted cruiser, sixteen destroyers, nine torpedo boats, and thirteen submarines. We have already published some details of the Ernest Renan, which will have three triple-expansion engines of 38,000 horse-power, and we may add that besides the two guns of 240 mm. and twelve of 164·7 mm., she will have twenty-two quick-firing guns of 47 mm. and five torpedo tubes. Her range of action will be 12,000 miles at 10 knots and 1025 miles at 23 knots. The battleships Democratie, Justice, and Vérité, of 14,870 tons displacement, are being built in private shipyards, and though officially classed as "under construction," preparations are only now being made to put them on the stocks owing to the temporary postponement of the contracts last year by the Minister of the Marine. These squadron battleships will have a length between perpendiculars of 133·8 m. and a beam of 24·25 m. Each will have three engines developing 18,000 horse-power and driving three propellers, the two side screws having a diameter of 4·85 m. The calculated speed is 18 knots. Each vessel will have forty-eight guns, including four of 305 mm. She will have two masts, one with fighting tops containing two guns of 47 mm. and the other for signals. The armour will comprise a complete belt 28 cm. in thickness. Of the six decks two will be armoured. Another interesting type of vessel is the new submersible, which will have a length of 48·9 m. and a beam of 4·2 m. She will have two propellers driven by internal combustion engines, and the speed is estimated at 11 knots. Considering the number of submersibles being put on the stocks, it would seem as if they are preferred to the electric submarines, which latter are being largely replaced by torpedo boats. Experience at the manœuvres has shown that for the purpose of coast defence the torpedo boat can do as much as the submarine, and if the latter is to be efficient it must have a larger range of action and be useful for attack, wherefore the French are centering their attention upon the improvement of the submersible.

THE MINERVA AND THE HYACINTH.

FOR some days past an interesting trial of speed and endurance has been in progress between H.M.S. Hyacinth, with Belleville, and H.M.S. Minerva, with Scotch boilers. The vessels ran out to Gibraltar, went into harbour, proceeded to sea again, and ran until all coal was expended. They then re-coaled at Gibraltar as quickly as possible and proceeded to race home to Portsmouth. On the run home it is stated that the Hyacinth beat the Minerva until the Bay was entered. Then the Hyacinth got hot crank pins, which were, however, kept from running the white metal in the big ends by constant lubrication and the water services. At last, however, unhappily, one of the big end bolts of the port intermediate engine broke, and the Hyacinth had to finish her voyage with her starboard engine only. According to the semi-official report which has reached us, the Minerva arrived at Spithead at two o'clock on Wednesday morning. The Hyacinth had done so well that at the end of the twenty-first hour she was leading by 45 minutes, though it is claimed for the Minerva that she was so steadily lessening the distance between them that the hope was confidently entertained that she would win in the end. The Minerva eased down to 18 knots, and passed St. Catherine's in 62 hours, less two minutes, after leaving Gibraltar. She went into Portsmouth Harbour and awaits orders. The Hyacinth arrived at Plymouth on Wednesday afternoon, and went into Devonport Harbour.

BOILERS IN THE FRENCH NAVY.

THE unfortunate experience of the Jeanne d'Arc and other new vessels has at length convinced our French neighbours of the necessity of following the example of other nations in condemning small tubes in boilers upon all ships of a greater tonnage than torpedo boats. In a communication to the admirals and maritime prefects M. Camille Pelletan points out the inconveniences of this system of boiler, with its high consumption of fuel, and consequently diminished range of action, to say nothing of the superhuman work put upon the hands in the stokehold, and he announces that in all the new vessels boilers with larger tubes are to be fitted. He also insists upon the absurdity of putting vessels through their trials for short periods with the furnaces under forced draught, as this not only gives misleading results, but is certain to cause disappointment when the ship fails to steam at anything like this speed in actual practice. Consequently, the Minister has decided that in future each ship will be subjected to two trials, one of ten hours with all the furnaces alight under normal conditions, and another of three hours with only three-fourths of the furnaces at work under forced draught.

THE IMPORTANCE OF SAMPLING.

DISAGREEMENTS between the results certified to by different analysts on what is said to be the same, or rather portions of the same, material are now, unfortunately, too much accepted as a matter of fact to excite much surprise or comment when they are notified in the daily Press. That this state of affairs should exist is, it will be readily acknowledged, a somewhat unfortunate thing for the profession of analytical chemistry, and all the more as, in our opinion, the attached stigma is, in the majority of cases, quite unmerited. There can be little or no doubt that the existence of grave discrepancies in figures returned by various analysts is due to careless sampling, this prologue to analysis being, as a rule, not treated with anything like the deference which is its due, and being, as often as not, relegated to some person quite incapable of appreciating its importance. To take an average sample of, say, a load of coals, or a ton of African rubber, requires the exercise of a high degree of thought and ingenuity—that is, if the sample is really intended as representative of the bulk. Indeed, the inherent difficulties in the way of sampling such a body as india-rubber for analytical purposes have so far proved a bar to the employment of the chemist at all in its buying and selling. Of course, in many cases, notably in metallurgical work, the importance of sampling before assaying is fully recognised, though the amount of time and trouble expended in this direction shows great variations in the case of different concerns. Probably the accurate sampling of large quantities of low-grade ores has achieved greater excellence in the hands of the officials of the Rio Tinto mines at Huelva than anywhere else, the method carried out there, although of necessity laborious, being generally considered as illustrative of sampling carried to a fine art. An assay for metal may often be carried out in a much shorter time than it takes to procure an average sample, and it seems strange that the latter process is so often carried out in a totally inadequate manner, seeing that the importance of the assay depends entirely upon the representative nature of the sample worked upon. In the case of products which it is safe to assume are of uniform composition throughout, the importance of sampling becomes very much minimised, though where the body is hygroscopic different analysts may be apparently at loggerheads if the samples are not taken at the same time. In this connection we are reminded of disputes which have taken place with regard to commercial carbonate of potash. This body is sold as containing a certain proportion of alkali, say 80 per cent. to 85 per cent., and as it is of a highly hygroscopic nature it is important that the buyer should test it directly he receives it and base any claim for undue strength in this test. It is quite a common thing, however, to let a cask lie about in the yard possibly opened, and then for the purchaser to create a disturbance if analysis shows considerably under 80 per cent. It is not surprising that in such cases chemists are found to differ.

To turn to another issue, and one that touches on somewhat delicate ground, there are many cases with regard to trade products where the sampler, if he have any axe to grind beyond that of ascertaining the strict truth, may find considerable scope for displaying the powers of evil. In straightforward language, what we wish to point out is that owing to the unequal distribution of impurities in certain commercial products, the man who wishes to obtain a low or a high result in the case of any particular element can generally do so provided he is up to the trick—if the term is permissible. For instance, the alkali manufacturer knows that in the gradual cooling of a drum of caustic soda there is a tendency for any common salt present to segregate in the centre of the drum, and that a sample taken from the outer portion of the drum will show a higher percentage of alkali than one drawn from the interior. The buyer who knows his business takes good care to see that his test represents the bulk, but there are plenty of cases on record which show that the buyer is not always quite as well educated on this point as he might be, a defection which operates to his disadvantage.

Of more interest perhaps to readers of this journal is the subject of the very unequal distribution of impurities in pig iron and cast iron, a matter which should certainly not be overlooked where samples are taken for analysis in cases of dispute as to the quality of the metal, or its suitability for a particular class of work. It is now some time since Snelus published his results, showing that the elements are very unevenly distributed in an ingot; and although his figures have been confirmed and elaborated by other observers, it seems evident that there is yet a good deal to be cleared up in regard to the matter. We cannot stay to discuss the important matter of segregation of impurities in large castings, but we may emphasise the necessity of its recognition on the part of those who are entrusted with the duty of taking a really average sample in cases where dispute as to quality has arisen. It is quite conceivable that the extreme importance of taking the mean of a sufficient number of drillings, or at any rate stating the exact spot in a casting whence the drillings have been taken, might not be present in the mind of one who became connected with a case of the sort for the first time—hence our warning, which is, of course, not addressed to those who have made the subject of iron and steel analysis a speciality. There are many other cases in regard to commercial products where the samples can, if the idea of obtaining the whole truth does not predominate in his mind, utilise his technical knowledge to such effect that either high or low results may be obtained by the analyst. Granting the truth of this assertion, it will be conceded that not only is extreme care requisite in sampling, but that an expert knowledge of the material on the part of the sampler is also highly desirable.

W. HARRY STANGER.

IT is with sincere regret that we record the death of an engineer personally well known to a large number of our readers, W. Harry Stanger, of Broadway, Westminster. Only his intimate friends were aware that for some time past his health had been failing seriously, and to those who remember him robust, handsome, and scarcely past the prime of life, his untimely death will come as a shock. With characteristic courage he gave no hint of apprehension, but carried on his work practically to the last. Late in 1902 he was ordered to winter abroad, and it was thought that such a precaution would restore his health. This hope was not realised, and when he returned home the end was in sight; his death took place on Friday, February 13th.

William Harry Stanger was born on September 24th, 1847, at Pietermaritzburg. His father was the Hon. William Stanger, M.D., F.G.S., Surveyor General of Natal, and a distinguished geologist and naturalist. The son came to England at an early age, and was educated at Norwich Grammar School and at King's College, London. He served his apprenticeship at the works of the Hunslet Engineering Company, near Leeds, and was afterwards in the locomotive department of the North-Eastern Railway. Turning his attention to road traction, he was engaged for some time as instructor in engine driving at Aldershot and Woolwich, and when thus employed gave a notable demonstration of the capabilities of the Thomson road-steamer, an account of which is to be found in our columns, December 2nd, 1870. There are some of his contemporaries who can remember a certain occasion when his coolness and skill in handling this tractor were put to a full test, and both being reliable, averted what was likely to prove a disastrous accident. Returning to railway work, Mr. Stanger went to Brazil as locomotive superintendent of the Via Ferrea de Baturita, remaining there two years. On his return to England he was appointed inspecting engineer to the Crown Agents for the Colonies in 1873. In 1887 he established Broadway Testing Works for the mechanical and chemical examination of all structural materials in use by engineers. In the course of his official work, first for the Crown Agents and afterwards for the Admiralty, he was required to undertake responsibility for the quality of the Portland cement to be used in the various large harbour work now being carried out by the Government. At the time of his earliest appointment the subject was less fully understood than it is at present, and, in particular, a proper correlation of mechanical and chemical tests was little regarded. Mr. Stanger changed all that; he caused the important departments which he served to realise that the two methods of testing must go hand in hand; it is a matter of national satisfaction that by the adoption of this dual system of control those failures which have occurred in past times are not likely to recur.

The man was as good as his work. Rectitude was the keynote of his character. He was generous, and, what is better, he was just. He had a sound knowledge of engineering and a ripe experience; he was eminently practical. His sagacity and foresight enabled him to initiate an undertaking which appeared, at the moment of its inception, novel and even uncertain of success. His diligence, tenacity, and faculty for organisation enabled him to bring it to fruition. He lived to see his ideal realised, to prove that the full, impartial, and scientific appraisement by all known methods of materials of construction was not merely acceptable to the profession, but was a necessity. He had a singular power of attracting friends whose friendship was as staunch as his character. They will regret him for many a day.

DOCKYARD NOTES.

Tempora mutantur! A year ago if one ventured to assert that capped projectiles possessed much virtue or future the normal naval officer was prone to regard it as evidence of stupidity or insanity. Now things have swung round; and he who would hint that under war conditions "caps" may not do so well as on the proving ground, will be astonished to learn what an ignoramus he is.

THE "cap gospel" now runs as follows:—"At any angle up to 30 deg. a 12in. gun will now shoot into the vitals of any ship at any range. At any angle up to 30 deg. and up to about 3000 yards a 6in. gun will get through any secondary armour that is carried. At any angle greater than 30 deg. penetration will be as good as with uncapped projectiles having direct impact." Thus the gospel, to which some add that a 6in. will probably go as far through an armour wall as a 12in.

IT is only some five years ago that "armour—Harvey only, too—would keep out everything," and the gun was well-nigh played out. So whatever we obtain, we do not get stagnation in naval ideas just at present.

THIS revolution of thought is difficult to account for, because no really new facts about "caps" have come in during the last two or three years—they have penetrated the daily Press, but otherwise they have been about as good or bad as ever.

THE bottom of the Belleisle is to be armour-plated in order to acquire information as to the value of an armoured bottom against torpedo attack. To most people it would appear sufficiently obvious that the surest way to aggravate torpedo effect is to increase the resistance it will meet; but the official mind likes to feel its way now and again. It did so in Russia with a barge plated with a 4in. bottom, the bits of which have never since been found! Possibly, however, thick armour is to be tried, though we can hardly conceive that any reasonable thickness would serve better. Or it may be that an inner armour skin is to be tested, but here France has been before us without any satisfactory result. For ourselves, we regard such experiments as likely to be of little, if any, use, though were lead substituted for armour something of value might possibly be discovered. From the non-effect of explosives detonated in lead vessels, it might be argued that ductility may give salvation; but such soft bottoms would be troublesome to ships which—like some of our new cruisers—have a way of getting their present bottoms nearly red hot under the furnaces.

BOOKS RECEIVED.

The Export Merchant Shipper's Directory for 1903. *Thirty-eighth year of publication.* London: Bean and Son. Price 15s. 6d.

The Seventh of the New Volumes of the Encyclopædia Britannica, being xxxi of the Complete Work. Edinburgh: Adam and Charles Black. The *Times*, Printing House-square.

What Star Is It? Tables for Identifying Unknown Stars. By Herbert W. Harvey. London: Spottiswoode and Co., Limited, 54, Gracechurch-street, E.C. 1903. Price 1s. 2d., post free.

The Colliery Manager's Pocket-book, Almanac, and Diary for the Year 1903. Being the thirty-fourth year of publication. Edited by R. A. S. Redmayne. London: *Colliery Guardian* Company, Limited.

Electricity: As Applied to Mining. By Arnold Lupton, M. Inst. C.E.; G. D. Aspinall Parr, M. Inst. E.E.; and Herbert Perkin, M.I.M.E. With about 170 illustrations. London: Crosby Lockwood and Son. 1903. 9s. net.

The Journal of the Royal Agricultural Society of England. Volume lxiii. Being the Sixty-third Volume issued since the first publication of the Journal in 1839. *Practice with Science.* London: John Murray, Albemarle-street. 1902.

Directory and Statistics of Electric Lighting and Traction Works in Operation or Projected in Great Britain and Ireland, 1903. Edited by C. S. Vesey Brown, Assoc. Mem. Inst. C.E. Price 6s. net. London: Hazell, Watson and Viney, Limited.

The Thermodynamics of Heat Engines. By Sydney A. Reeve, Professor of Steam Engineering at the Worcester Polytechnic Institute. New York: The Macmillan Company. London: Macmillan and Co., Limited. 1903. Price 10s. 6d. net.

Johows Hilfsbuch für den Schiffbau. Zweite vollstandig umgearbeitete Auflage herausgegeben von Eduard Krieger, Marine Ober-Baurath. Mit 550 Abbildungen im Text und 6 Lithographirten Tafeln. Berlin: Verlag von Julius Springer. 1902. Williams and Norgate, Covent-garden.

Das Entwefen und Berechnen der Verbrennungsmotoren, Handbuch für Konstrukteure und Erbauer von Gas und Olkraftmaschinen. Von Hugo Guldner, Oberingenieur, Gerichtlich Vereideter Sachverstandiger for Motorenbau. Mit 12 Konstruktionstafeln and 750 Textfiguren. Berlin: Verlag von Julius Springer. 1903.

Specification for Architects, Surveyors, and Engineers, when specifying, and for all interested in Building. Division I., Professional Practice; Division II., Working Drawings; Division III., Contraction; Division IV., Municipal Engineer. Annually. No. 6, 1903. Published by the Proprietors of the *Builders' Journal and Architectural Record Weekly.* London.

Lockwood's Builders', Architects', Contractors', and Engineers' Price Book for 1903. *A Comprehensive Hand-book of the Latest of Every Kind of Material and Labour in Trades connected with Building, including many Useful Memoranda and Tables.* Edited by Francis T. Miller. With a supplement containing the London Building Act, 1894 and 1898. Price 4s. London: Crosby, Lockwood and Son. 1903.

Lathes, Screw Machines, and Boring and Turning Mills: A Practical Treatise on the Design and Construction of Turning Machines, including Lathes, Automatic Screw Machines, Boring and Turning Mills, and their Accessories. By Thomas R. Shaw. Illustrated by 425 illustrations, most of which are original and have been made expressly for this work. Price 15s. net. The Scientific Publishing Company. 1903.

THE LONDON WATER BOARD.—The London County Council on Tuesday last elected the following fourteen members as the Council's representatives on the London Water Board:—Mr. Beachcroft, Mr. Burns, Mr. H. Clarke, Mr. Cornwall, Mr. Dickinson, Mr. Harris, Mr. Idris, Sir J. McDougall, Mr. Radford, Lord Sandhurst, Mr. Ward, Lord Welby, Mr. White, and Mr. T. McKinnon Wood.

THE SEWAGE OF RICHMOND.—The Richmond Main Sewerage Board has approved a scheme designed by Mr. William Fairley, engineer to the Board, for treating the sewage of part of the united districts on the bacterial system. The works are estimated to cost £8000 without land, and the pumping is to be done by electrically-driven pumps, taking energy from the main pumping station, Mortlake; all filling and emptying of filter beds to be done automatically, the flow being equalised during the twenty-four hours.

SOCIETY OF EXPERIMENTAL ENGINEERS.—On the 7th inst. Mr. George C. Douglas, C.E., gave a lecture on "Producer Gas and Compound Gas Engines," Mr. Fred. C. Sturrock, the President, in the chair. The lecturer in his introductory remarks pointed out that the steam engine in its present form was doomed, and that power in the future was to be obtained by means of water or steam turbines and gas engines operated in conjunction with dynamos and electric motors. These prime movers would be situated at centres where energy could be conveniently obtained, such as great waterfalls, coal mines, or oil wells. Confining his attention to coal, he showed that the most economical way of utilising that source of energy was to convert it into producer gas, using it to operate gas engines directly or by means of mains leading it to manufacturing centres, where it would be used to fire steam boilers. He thought that although the best way would be to generate electricity at the pit head and convey electrical energy to consumers, it might be better for gas manufacturers in the meantime to convey the gas to the consumer, as by so doing existing plant could be used and only displaced when the owners of works found it most convenient. He also directed attention to the possibility of a means being discovered whereby electrical power could be conveyed without wires, somewhat after the Marconi system. The lecturer then treated in detail Mond's gas producer; the Duff system, as carried out by Messrs W. F. Mason, Limited, Manchester, and some others, demonstrating the difference and want of difference which pertained. Mr. Douglas gave a description of the 100 horse-power compound gas engine invented by Mr. Butler, and made by Messrs. Clarke, Chapman and Co, Limited, Gateshead-on-Tyne. He pointed out that this engine was remarkable in many ways, and that it seemed to be a distinct advance on the ordinary gas engine both for economy and reliability. After discussion, the chairman intimated that an arrangement had been made whereby the members of the Society were to have the opportunity of shortly testing the efficiency of a National gas engine,

THE COUNTY COUNCIL BILLS, 1903.

IN the coming session of Parliament the London County Council have it in view to introduce certain measures of great importance to those who are concerned with the supply of electricity within the administrative county of London. By the London County Council (Electric Supply) Bill, it is proposed, *inter alia*, to make further provision with respect to the purchase of electric undertakings by local authorities in the county of London; while the London County Council (General Powers) Bill contains certain clauses by which it is proposed to enable the local authorities who are allowed to supply electricity, to supply consumers with electric fittings.

In view of the importance of two measures, which, if passed, will ultimately transfer the entire electrical industry of London to the hands of the municipalities, it may be found useful if we advert to some of their more important clauses.

The objects of the Electric Supply Bill are (1) to enable local authorities to combine together for the purchase of undertakings which overlap the boundaries of more than one municipality; (2) to enable the County Council to purchase undertakings in certain cases, and transfer them to the local authorities; (3) to enable the County Council to purchase power supply undertakings; (4) to enable the County Council to supply electrical energy.

The necessity of conferring power upon the local authorities to combine together for the purpose of acquiring electrical undertakings has arisen owing to the fact that the area of a supply company is often under the control of more than one municipality. Again, the London Local Government Act of 1899 introduced further complications in the delimitation of boundaries. The Electric Lighting Acts of 1882 and 1888 merely gave power to a local authority, within whose jurisdiction the area of supply of any undertakers is situated, to purchase such undertaking compulsorily within a certain time, but hitherto there has been no power given to local authorities to combine in order to acquire the property of any electric lighting company in which they all had an interest. It is now proposed by Clause 3 of the London County Council (Electric Supply) Bill, that where any authorised distributors are authorised to supply electrical energy in any area of supply which extends into more than one district, it shall be lawful for all the local authorities of the districts in which such area of supply is situate to exercise in combination—subject to the provisions of the Act—the power of purchasing the undertakings of such authorised distributors after the expiration of the periods, and upon the terms and in the manner provided by the Electric Lighting Acts 1882 and 1888, or by those Acts and the special Acts relating to the undertaking of such authorised distributors, and in all respects as though the purchasing body were the local authority within the meaning of the said Acts for a district comprising the whole of the area of supply of such authorised distributors, and as if the whole of the undertaking was situate within such district.

The expression "authorised distributors" means any company, body, or person—not being a bulk company—authorised by special Act to supply electrical energy directly to general consumers, and includes any company, body, or person which is also authorised to supply electrical energy to authorised distributors. In order to ensure that all the local authorities in London may fall in with the proposal embodied in the above clause, a somewhat ingenious method has been resorted to. It is provided by Clause 4 (2), that where any local authority fails to pass a resolution in favour of a combination—which resolution is to be passed in the manner provided by Section 3 of the Electric Lighting Act, 1882—and the rateable value of the part of the district of any such local authority does not exceed a tenth part of the rateable value of the whole of such area of supply, and the local authorities of the other districts into which such area extends have passed the requisite resolutions, any such first-mentioned local authority shall be deemed to have entered into the combination, and to have passed the necessary resolution for that purpose.

It will be seen that these clauses will enable the local authorities, acting in concert, to take over all the electrical undertakings which are now in the hands of private companies. It is to be observed, however, that this power can only be exercised in respect of each company after the expiration of the statutory period relating thereto. There is no denying the fact that it greatly increases the probability of all the metropolitan supply companies becoming vested in the municipalities.

The proposed combination of local authorities is for the sole purpose of extinguishing the private companies. As soon as this object is effected, the combination, or "purchasing body," must, on being requested, transfer to any local authority making such request, and being one of the local authorities constituting such purchasing body, such part of such undertaking—not being a part within the district of any other local authorities constituting such purchasing body—as, failing agreement, may be determined by arbitration.

There is one comment immediately suggested by a study of the foregoing provisions. Supposing that a local authority, the rateable value of whose property within the supply companies' area is a little more than one-tenth the rateable value of the whole of such area, refuses to pass the necessary resolution, what is the position? In such a case it would seem that the scheme of compulsory purchase may be wrecked; but it is probable that the borough councils were consulted upon, and gave their consent to this clause before it was made part of the Bill. Nevertheless, it has all the appearance of a coercive measure, designed to advance the interests of municipal trading and to bear down the opposition of the few remaining local authorities who hesitate to embark the ratepayers' money upon costly electrical enterprise. The Bill does not stop here. The County Council itself is seeking powers of purchase. It is provided by Clause 7 that it shall be lawful for the County Council, at the request of local authorities of the districts in which the area of supply of any authorised distributors whose area of supply extends into more than one district is situate, to purchase the undertaking in a manner similar to that which may be adopted by a combination of local authorities. Moreover, in this case also, the opposition of a dissenting local authority may be overcome by means similar to those to which, in the case of purchase by a combination, we have already alluded. To put the matter in a nutshell, the County Council seek the power to act as the *via media* between the municipalities and the private companies for the purpose of effecting compulsory purchase.

Granted that compulsory purchase on this wholesale principle is desirable in the interest of the ratepayers, it must be admitted that the proposed scheme appears to be a satisfactory way of bringing it about; for it is obvious that every supply company would prefer to have its undertaking purchased all at once than to have it taken over piecemeal by different bodies. Compulsory purchase of electric lighting undertakings is no novelty; but the Bill before us also confers powers to purchase bulk supply undertakings. The expression "Bulk Company" means any company, body, or person authorised by special Act to supply electrical energy to authorised distributors, but not directly to general consumers. It is provided by Clause 9 that the undertaking of any bulk company authorised by special Act to supply only to authorised distributors having powers of supply in one district only shall, subject to the provisions of the Act, be purchaseable by the local authority of such district, subject to and in accordance with the provisions of the Electric Lighting Acts. In the case, however, of a bulk company having powers in more than one district, a combination of local authorities or the County Council may be the purchasers. It is provided, however, that in the case of the undertaking of any bulk company authorised by any Act passed before the passing of the proposed Act, the amount of purchase money and compensation is to be determined, subject to and in accordance with the provisions of the Lands Clauses Acts. It is also provided that the undertaking of the Central Electric Supply Company shall not be purchased unless the local authority purchasing the same shall at the same time purchase the undertakings of the Westminster Electric Supply Corporation, Limited, and the St. James' and Pall Mall Electric Light Company, Limited.

It is gratifying to notice that the principle of compensation for compulsory purchase is to be recognised in the case of bulk companies. Not having the Acts under which these bodies are at present working before us, we are unable to say whether there was any prospect of compulsory purchase at the time when they obtained their parliamentary powers. If this was not the case, it seems a little hard that they should now be subjected to such a risk, even though the customary 10 per cent. may be forthcoming. That the County Council are determined to exercise this power of taking over the property of power companies is evidenced by Clause 19, which provides that it shall be lawful for the Council to supply from any generating station already belonging or which may hereafter belong to them, electrical energy to any local authority, being authorised distributors, which may desire to be so supplied on such terms as may be agreed between the Council and such local authority.

The ultimate effect of the County Council (Electric Supply) Bill, to the provisions of which we have now drawn attention, is to afford increase of facilities for compulsory purchase by local authorities. With the exception of the generating stations of railway companies, used exclusively for the purpose of generating electricity for working railways, every station in the metropolis may be transferred to local authorities.

It would seem to be rather late in the day to reiterate any arguments against the policy which underlies the proposals involved in the Bill under discussion. We cannot refrain, however, from quoting a passage from a speech delivered by Mr. Sydney Morse at a meeting of the London Municipal Society, held on May 28th, 1902, where he said: "During my experience of electrical matters I have seen municipal accounts purporting to show large profits on electrical undertakings. But those accounts did not show the true expenditure. For instance, one municipality had invested £1,000,000 in electric light works, and derived a gross income of £12,000 therefrom. What were the charges in the electric lighting accounts for the services of the town clerk, the borough engineer, the borough accountant, and their respective staffs? Nil for the first two years, and £50 for the third year. A private trader cannot omit such charges from his accounts, as each business must show a profit after being debited with its full proportion of disbursements. The alleged profits of municipalities on many of these enterprises would disappear if the accounts were properly kept."

It is argued, of course, by the supporters of municipal trading that the supply of electricity is essentially a public matter. The same speaker, with a view to showing that electricity is not an article generally required by ratepayers, said: "In Salford, where there are 36,000 ratepayers, there are only 400 consumers of electric light, and a charge of £7500 per annum is levied on the whole body of ratepayers to meet the loss in this department." It is hoped that even at the eleventh hour Parliament may see its way to forbid the wholesale surrender of the electrical industry of London to the local authorities, unless some means are adopted to ensure that the ratepayers are consenting parties to the transaction.

We now pass on to consider certain other important proposals affecting the electrical world which are to be found in the London County Council (General Powers) Bill, 1903. Clause 63 of this Bill is in the following form:—"It shall be lawful for the council of any metropolitan borough being authorised to supply and supplying electrical energy to expend money upon the wiring, and fitting, and supplying with wires, fittings, and apparatus the premises of their consumers or prospective consumers, and to enter into and carry into effect agreements and arrangements with respect thereto, and to make such charges therefor, whether directly or otherwise, as they may think fit." Clause 64 provides that "any such council of a metropolitan borough may borrow in the same manner and subject to the same conditions as if such expenditure were for the purposes of the Electric Lighting Acts, 1882 and 1888, such sums of money as may be required by such council," for the purposes mentioned in Clause 63.

How the County Council comes to seek for parliamentary powers on behalf of the borough councils, and how a novel proposal of this kind finds its way into a general powers Bill, we cannot undertake to say. It will be observed that powers are sought to enable the borough councils to wire the premises, not only of consumers, but of prospective consumers. By making an arrangement with the builder of a new row of houses, it will thus be competent for the local authority to obtain a monopoly of the supply of electrical fittings to those houses, while if the local council do not themselves wish to undertake the work, they may enter into an agreement with, and practically hand over the benefit of the monopoly of their district to a contractor. Of course, it will always be competent for those who deal in electrical fittings to undersell the municipality; but in fixing their scale of charges, the local authority may always justify a low price by saying, "It is in the interest of the ratepayers." It will certainly be of interest to ratepayers who require them to obtain fittings at the lowest price; but what of the ratepayers who require no electrical fittings, whose money is to be expended upon supplying these luxuries to others? In supplying good water, in keeping the roads in good condition, in relieving the poor, local authorities minister to the public need. In our view, they travel far beyond their province when they enter into unfair competition with those who supply electrical fittings and other articles which are mere luxuries to the greater number of ratepayers.

THE OIL-CARRYING STEAMER NARRAGANSETT.

ONE of the most noteworthy vessels produced on the Clyde for some years is the oil-carrying steamer Narragansett, which was launched on the 12th inst. from the Cartsdyke yard of Messrs. Scott and Company, Greenock. Built to the order of the Anglo-American Oil Company, she is the largest bulk oil carrier afloat, the largest vessel yet built on the lower reaches of the Clyde, and one of the heaviest ships ever launched into that river; the launching weight, owing to the great strength and minute subdivision of the structure, being abnormally large in proportion to the dimensions. The launch, which was highly successful, took place at twelve noon, the naming ceremony being performed by Mrs. Usmar, wife of one of the directors of the owning company. The Narragansett is 531ft. long, 63½ft. beam, and 42ft. deep, the gross tonnage being about 11,000 tons. When completely fitted she will have a deadweight carrying capacity of 12,500 tons, of which over 11,000 tons will be oil in tanks, and 1500 tons either coal or oil fuel. Her displacement, when fully loaded, will be about 21,000 tons. Built to Lloyd's 100 A1 three-deck class, with a complete shelter deck, but with scantlings and structural arrangements much in excess of Lloyd's requirements, she is probably one of the strongest and most rigid vessels afloat, while, owing to the large number and careful arrangement of the subdivisions, she is practically unsinkable. There are eighteen thwartship bulkheads, and the compartments thus formed are further divided by longitudinal bulkheads, forming in all twenty-seven separate compartments below the main deck. These, with one or two exceptions, require to prove oil-tight, and in order to render them so the utmost care had to be taken with the fitting, riveting, and caulking. The ordeal of withstanding a pressure due to a head of water 20ft. above the main deck was satisfactorily passed in every case, and at the first application of the test, a result which strikingly indicated the carefulness of the workmanship, and of its supervision at all stages of the ship's construction. Over a million and a-quarter rivets were used in the structure, and the time occupied in building was only a little over twelve months. The Narragansett will be the most completely equipped oil carrier afloat. Unlike most of the "tankers" now in service, she has her propelling machinery amidships, which necessitated the expensive arrangement of the shaft tunnel being taken through the after oil tanks. It is circular in form, and passes through eight separate oil compartments, access to it being obtained from the shelter deck by two trunks—one at each end. The oil tanks proper are all below the main deck, and are sixteen in number—eight forward and eight aft of the machinery space. Between the main and upper decks are four smaller oil compartments, for use when the vessel may be loaded down to her summer freeboard. There are four cofferdams of oil-tight construction, and the bunkers and deep ballast tanks are also oil-tight, which will facilitate their use as oil bunkers, should it be decided in the future to adopt oil as fuel. There are two oil-tight pump rooms, one forward and one aft of the machinery space. The pumps, four in number, are of the "Snow" type, and are together capable of discharging the oil at the rate of 900 tons per hour; that is to say, the whole cargo in about twelve hours. The oil tanks are, of course, available as ballast tanks in the event of the ship requiring to make a light voyage. This is a remote contingency, however, for very complete arrangements are provided for turning the vessel into an ordinary cargo steamer within a few hours of her employment as an oil carrier. There are steam connections with all the tanks for cleaning and fire-extinguishing, and a very elaborate system of ventilation, both by fans and natural vents, has been adopted for clearing the tanks of gas. In addition to the centre line of hatches, which communicate by oil-tight trunks with the oil tanks, side hatches are fitted to the upper and lower 'tween decks, which are always available for cargo, even when the oil tanks are full. These 'tween decks are lighted by side lights, so that the vessel can, if necessary, be readily made available for carrying cattle or troops. The cargo gear on deck consists of sixteen derricks on Samson posts, and nine large and specially designed steam winches. The accommodation for a limited number of passengers, as well as officers and the crew, is complete and comfortable. There is steam heating throughout, and to avoid the risk of fire the galley is so arranged that all the cooking can be done by steam, while the electric installation has been carried out with the same object in view. Although the vessel is primarily intended for the Atlantic service, the possibility of trading in Eastern waters has been considered. All the Suez Canal Company's stringent regulations have been complied with, and the draught has been limited to permit of use of this waterway. The ventilation has been designed to suit hot climates, and awnings, teak decks, and other Eastern essentials are included in the equipment.

The propelling machinery by the builders consists of triple-expansion engines designed to indicate 5500 horse-power, and drive the vessel at a speed of 14 knots. The cylinders are supported by six "split" columns, three of which carry a circular wrought steel condenser of large cooling surface, supplied with water by an 18in. centrifugal circulating pump driven by two independent engines. The auxiliary machinery includes two sets of slow-speed feed pumps, feed-heater and evaporator; feed-filters and silent ash hoists—self-tipping—in each stokehold. All these exhaust into a combined auxiliary condenser and feed-heater, having a total surface of 950 square feet. Steam at 200 lb. pressure is generated in six large single-ended boilers, which are placed three abreast in two stokeholds. They are worked under natural draught, and the funnel, which is 15ft. diameter, rises to 100ft. above the grate bars. The shafting is much in excess of Lloyd's requirements, and the propeller, of 20ft. diameter, is fitted with four adjustable bronze blades. The vessel and machinery have been designed and constructed under the supervision of Mr. Archibald Blair, marine superintendent of the Anglo-American Oil Company. Mr. Usmar, speaking at the luncheon following the launch, said that his company was incorporated in 1888 for the purpose of distributing illuminating oil in bulk. The total importation of illuminating oil in 1888 was 1,725,000 barrels. Only fourteen years had passed since then, and the total quantity imported last year from America and Russia was 4,026,000 barrels. In all, his company now had fourteen tank steamers, and in addition a fleet of seventeen large steel sailing vessels, most of which were Clyde-built.

LETTERS TO THE EDITOR.

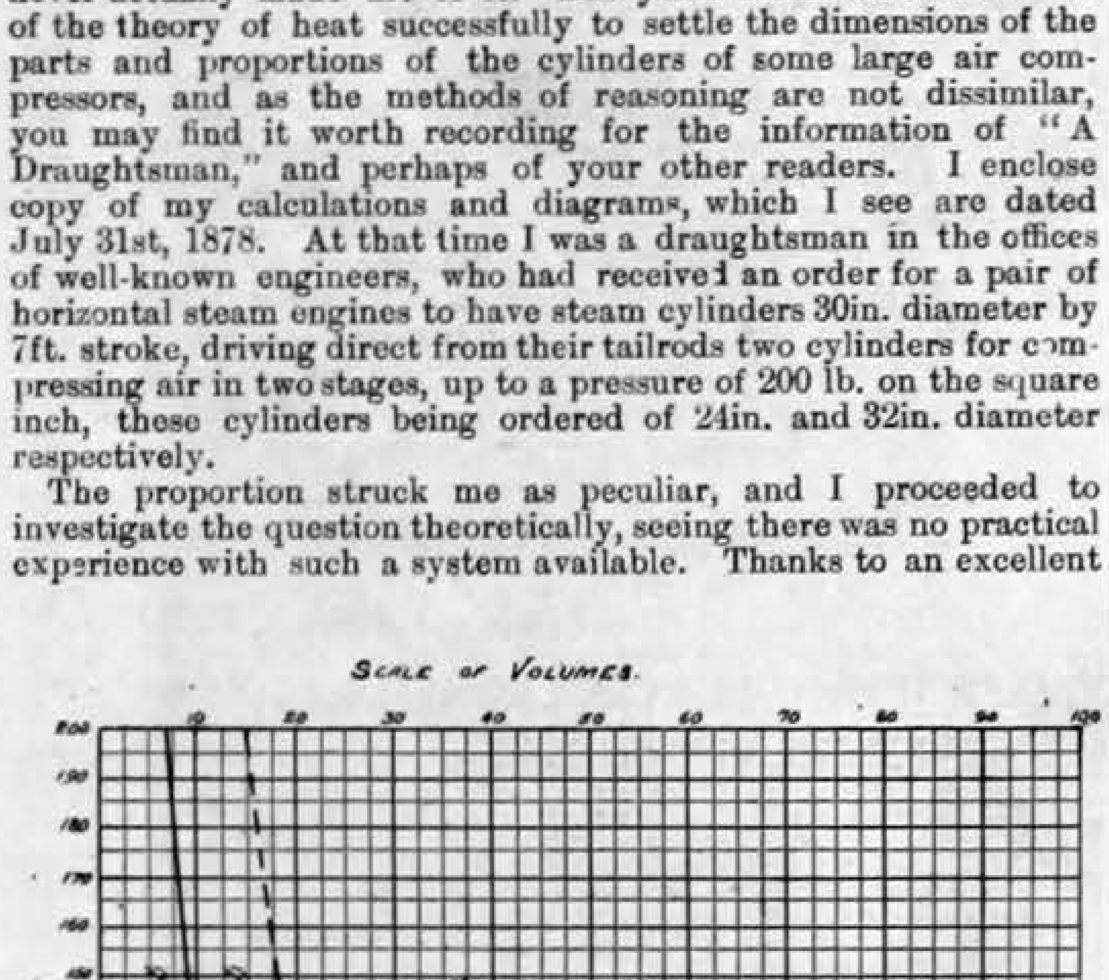
(*We do not hold ourselves responsible for the opinions of our correspondents.*)

THE USE AND ABUSE OF DIAGRAMS.

SIR,—Though agreeing with much in the article on "The Use and Abuse of Diagrams" appearing in your issue of the 6th inst.—nothing can lie like an indicator in inexperienced hands—I hope you will permit me to dissent from two sentences in that article. First, "James Watt's invention of the separate condenser was the result of mental effort, which had nothing whatever to do with mathematics," including, I conclude from the context, the theory of heat. Now, Sir, Watt himself said that his idea of a separate condenser was due to his knowledge of the discovery of latent heat by his friend, Dr. Black, during the previous year. Second, "The steam engine and the gas engine, and all the heat motors in existence, have been developed without the least regard or consideration for Carnot's function." In your issue of August 22nd, 1902, you have explained very clearly that the Diesel engine, which has converted into work a larger proportion of the heat supplied to it than has any other engine, was the result of a deliberate attempt to carry into practice the teachings of Carnot.

In your issue of the 30th ult., "A Draughtsman" very properly asks how he can apply the $\theta\phi$ diagram when designing a steam engine. I regret that when Mr. Macfarlane Gray's ingenious picture of Clausius' mathematical abstraction of entropy appeared in 1889, my energies were so fully engaged in other directions that I failed to give the new diagram the attention it doubtless deserved, an omission which I hope soon to repair, and consequently I have never actually made use of it. But years before I did make use of the theory of heat successfully to settle the dimensions of the parts and proportions of the cylinders of some large air compressors, and as the methods of reasoning are not dissimilar, you may find it worth recording for the information of "A Draughtsman," and perhaps of your other readers. I enclose copy of my calculations and diagrams, which I see are dated July 31st, 1878. At that time I was a draughtsman in the offices of well-known engineers, who had received an order for a pair of horizontal steam engines to have steam cylinders 30in. diameter by 7ft. stroke, driving direct from their tailrods two cylinders for compressing air in two stages, up to a pressure of 200 lb. on the square inch, these cylinders being ordered of 24in. and 32in. diameter respectively.

The proportion struck me as peculiar, and I proceeded to investigate the question theoretically, seeing there was no practical experience with such a system available. Thanks to an excellent



series of articles on "The Mechanical Properties of Gases," commenced in your issue of the 30th April, 1875, I was able to produce the enclosed diagram showing what would be the pressure of the air at each instant (*a*) if all the heat generated by compression were extracted by cooling water, (*b*) if none of the heat escaped at all. It was evident that in practice the actual pressures must lie somewhere between the two curves. This showed that with so large a high-pressure cylinder nearly the whole of the work would be done in that cylinder, and that the correct area for the cylinder must be something between 16⅜in. and 18¼in. diameter, and I had reason to suppose that 17in. was likely to be as nearly as possible the proper size.

Representations were made to the gentleman who had ordered these engines, and he replied that the ratios of cylinders specified were those of a small compressor he had used in his experiment, but admitted it ran very irregularly, hence his stipulation that the new engine should have a 30-ton fly-wheel; moreover, the bearings on the high-pressure side were continually heating, which is not remarkable with a pressure on one crank pin so many times greater than that on the other. There was a hesitation to accept my figures in their entirety, and the high-pressure cylinder was actually made 20in. in diameter, and the low-pressure cylinder 34in. diameter. I completed the drawings, but left the firm's service before the engines were actually constructed, and beyond the fact that they were running successfully, heard no more about them until many years later, when I accidentally came across a paper, by their purchaser, published in 1881, in which he said: "We have found, however, by experience that to have made the high-pressure cylinder one-fourth the area of the low-pressure would have give a better division of the work." That is the 17in. cylinder I had proposed. Had the engines been constructed as ordered, I feel sure the 30-ton fly-wheel would have broken the main bearing or bed-plate on the high-pressure side.

Whilst the most thorough acquaintance with thermo-dynamics could never enable any man to design a locomotive which would haul a heavy express train to scheduled time, or a set of torpedo-catcher engines which would run off their acceptance trials successfully, unless he had had considerable previous experience of such work, the knowledge required for which "slowly broadens down from precedent to precedent," at the same time if any man has to step wide from the beaten track of previous practice, he can only do so with any confidence or reasonable hope of avoiding costly blunders by first acquiring a thorough knowledge of the theory of his subject, and then such an extended practical experience of kindred work as shall ensure a courageous, as distinguished from a rash, course. The righteous horror with which the sanguine inventor is regarded by business men is due to the fact that he is almost invariably ignorant of the theory of his subject, and so of what is likely to succeed, and sublimely indifferent to the past history of very similar attempts.

Compression of air to a pressure of 200 lb. per square inch above the atmosphere, required the size of the second cylinder, the first being 32in. diameter, if both are of the same stroke, and half the work is to be done in each cylinder.

Pressures taken from the Diagram.

	Isothermally.	Adiabatically.
Final pressure in first cylinder, lb. ..	42·5	58·5
Mean ditto	19·65	29·90
Mean pressure in second cylinder ..	75·25	92·1

Isothermally $\left\{ \dfrac{\text{Area of 32in. cylinder} \times \text{its mean pressure}}{\text{Mean pressure in second cylinder}} = \text{Area} \right.$ of second cylinder to do equal work.

$$\frac{804 \times 19 \cdot 65}{75 \cdot 25} = 209 \cdot 8 \text{ square inches} = \text{area of cylinder } 16\tfrac{3}{8} \text{ diameter.}$$

Adiabatically $\left\{ \dfrac{804 \times 29 \cdot 9}{92 \cdot 1} = 261 \text{ square inches} = \text{area of cylinder } 18\tfrac{1}{4} \text{ diameter.} \right.$

To prove these ratios of cylinders will give the pressures stated as the final pressures in the first and initial pressure in the second cylinder. From the diagram we find that 100 volumes of air are compressed into 26 volumes, then $\frac{26}{100}$, area of first cylinder, will give area of second.

$$\frac{26 \times 804}{100} = 209 = \text{area of cylinder } 16\tfrac{3}{8}\text{in. diameter.}$$

$$\frac{32 \times 804}{100} = 257 = \text{area of cylinder } 18\tfrac{1}{8}\text{in. diameter.}$$

The sizes of cylinders specified being 32in. and 24in., 100 volumes of air at 14·7 lb. pressure taken into a 32in. cylinder and compressed into a 24in., gives a terminal pressure in the 32in. = the initial pressure in the 24in.; if the air is completely cooled we have $\frac{14 \cdot 7 \times \text{area of } 32}{\text{area of 24in.}} = \frac{14 \cdot 7 \times 804}{452} = 26 \cdot 14$ lb. absolute, or $26 \cdot 14 - 14 \cdot 7 = 11 \cdot 34$ lb. above the atmosphere. JOHN W. HALL.

71, Temple-row, Birmingham, February 9th.

SUPERHEATING.

SIR,—We have the pleasure to enclose herewith copy of a letter which we have received this morning from Professor Ewing, from which you will see that an error was made as regards the calorific value of the coal in his report of the trials at Manningtree. The corrected results should be as stated in Professor Ewing's letter.

EASTON AND COMPANY, Limited.
(H. K. BAYNES).

Broad Sanctuary Chambers, Broad Sanctuary, W., February 18th.

"Dear Sirs,—In my recent report to you on trials of an engine at the Brantham Works of the British Xylonite Company, near Manningtree, I gave figures for the calorific value of the coal used in the trials. Since then I have found that these figures are considerably too high, owing to an error in the constant of the calorimeter, as furnished to me. I have now determined the constant by several independent methods, and Dr. Glazebrook, F.R.S., of the National Physical Laboratory, has kindly informed me of the results of further determinations made by him. His figures and mine agree, and leave no doubt that the value originally taken requires correction. The result of this correction is to reduce the calorific value of the coal to the following figures:—

"Coal supplied to boiler furnaces .. 13,300 thermal units per lb.
"Coal supplied to superheater .. 11,900 ditto ditto

"Having regard to the proportion in which coal was supplied to the boiler and superheater respectively, these figures give 12,970 thermal units per lb. for the mean calorific power of the fuel, as used in the trials.

"The quantity of coal consumed in making and superheating the steam, namely, 1·41 lb. per indicated horse-power hour, was accordingly equivalent to 1·22 lb. of standard coal having a calorific power of 15,000 thermal units per lb.

"(Signed) J. A. EWING.
"Engineering Laboratory, Cambridge, February 17th."

[It would interest many of our readers to know how the "standard" has been obtained. The average of British coal is 14,133, of best Welsh coal 15,567. The adoption of some standard that would be universally acceptable would be an excellent thing. —ED. THE E.]

NORTHERN OF FRANCE COMPOUND LOCOMOTIVES.

SIR,—I am able to answer some of the questions of Mr. F. W. Brewer in your issue of the 13th inst. The average cut-off in the high-pressure cylinders when hauling heavy loads varies from 45 per cent. to 55 per cent. on the level or up hill when hauling the heavier loads of from 300 tons to 350 tons. The admission in the low-pressure cylinders is never more than 65 per cent., and as a rule there is not more than 60; in no case have I ever noticed no cut-off. The average running positions are an admission of 45 and 65 in the high and low-pressure cylinders respectively. It all depends upon the actual case as to whether live steam is admitted during the actual running, though, of course, there is a valve provided for that purpose; ascending certain of the grades it is occasionally used. As I was on the footplate of 2641 during the last two of the trials mentioned, I am happy to be able to give the following information:—On the 360 tons trip up the 1 in 200 out of Paris, the admissions were 52 and 65 in the high-pressure and low-pressure cylinders respectively, the regulator was wide open, the engine was worked compound entirely on this run.

With the 235 tons load up the 1 in 125 to Caffiers the admission was 47 per cent. and 62 per cent. respectively, with the regulator open about 80 per cent. Up this grade I suppose that there was direct admission of live steam to the low-pressure cylinders, but of this I am not certain, as I did not note it as having occurred at the time. In your issue of the 6th I notice that one correspondent writes to the effect that the Nord now instruct their men to keep the pressure at or near to 200 lb. per square inch. May I ask if this is official, and, if so, when it began, as I have noticed displeasure on the part of the men when the steam dropped to 213, let alone 200, per square inch. R. HOPE.

Hotel Calofornia, Cannes, February 16th.

FRENCH LOCOMOTIVES IN ENGLAND.

SIR,—As one who visited the Paris Exhibition of 1889, and had the pleasure of being introduced to the late Mr. Stroudley, may I be allowed to correct Mr. H. R. de Salis concerning the English locomotives exhibited? In addition to the Midland, South-Eastern, and London, Brighton, and South Coast—Sir Edward Blount—the London and North-Western had the Marchioness of Stafford, also a model of the late P. Stirling's 8ft. single, made by P. Stirling, junior. As for lubricants, good oil used for valves and cylinders is a coal economiser.

An old driver whom I was trained under was once asked how it was he always got the coal premium. Good oil, and plenty of it at the leading end, was the reply; and this was before sight-feed and other lubricators were brought into use. Blue ruin is a most appropriate name for what some call oil—blue ruin by name and by nature. D. ANDERSON.

Villa Selincourt, Caxton-road, Wood Green, N., February 17th.

ENTROPY.

SIR,—Judging from the various expressions of opinion as to the nature of entropy which are in circulation in the technical Press, it would be a matter of interest to know on whose definition the $\theta\phi$ diagram has been founded.

Mr. Robinson will do good service if he will tell us in what respects Mr. Willans improved his engine after he had learned the calculus. We are constantly told that such and such announcements made by those who study thermodynamics have resulted in great improvements in the steam engine. So far no one has come forward to say what the improvements are. Under the circumstances I may be excused if I ask a few questions:—(1) To a knowledge of what thermodynamic law was the invention of the compound engine by Hornblower in 1781, and by Arthur Woolf in 1804 due. So far as I am aware the science of thermodynamics had not then been born. (2) To a knowledge of what thermodynamic law was the world indebted for the Cornish engine. (3) What thermodynamic law led to the invention of the injector? (4) What improvement in the steam or any other heat engine was invented by Rankine, or Clausius, or Tait, or Clerk-Maxwell, or, to come down to modern days, by Professor Perry? H. H.

February 16th, 1903.

SIR,—May I ask you to correct a rather important typographical error in my letter in your last issue. I said—in speaking of Professor Hudson Beare's lectures on entropy—"As delivered the opening statement was 'Entropy or heat-weight or *Quantity*. Temperature: In heating water, &c. &c.'" As printed, the sentence ran:—"As delivered, the opening statement was, 'Entropy or Heat, Weight or Quantity. Temperature:—In heating water, &c." The insertion of the additional comma, and the separation of Quantity and Temperature, of course destroys the meaning.

I might add that Professor Beare had previously defined heat-weight as, "any given amount of heat ÷ absolute temperature, as will be apparent." J. W. CABLE.

East Finchley, February 16th.

[Correspondents cannot be too careful in the preparation of manuscript, when much turns on the difference between hyphens and commas.—ED. THE E.]

FOREIGN v. ENGLISH GOODS.

SIR,—We notice that the Southampton Town Council had a discussion on the advisability of accepting foreign goods in preference to those of British manufacture. As the maker of the lowest English tender of £3885 10s., which was only £92 more than the French or Belgian tender, we can only express surprise that the Southampton Corporation, who have had large quantities of our pipes, all of a satisfactory character, should have passed us for such a trifling sum. If we had been asked to reduce our tender by £100 we should have only been too pleased to have done so rather than lose the order. In all English tenders there is a clause that the current rate of wages shall be paid, and if we only paid the rate of wages which are current in France or Belgium we could have reduced our tender materially.

Where do the British working men and taxpayer come in here?

J. A. LONGDEN, Managing Director.

Stanton Ironworks Company, Limited, near Nottingham, February 12th.

AMERICAN METHODS FOR BRITISH RAILWAYS.

SIR,—In view of the outcry now being made in many quarters for reform in British railway methods, and the adoption of American ideas, may I beg the favour of a small space in your valuable columns to draw the attention of railway shareholders to the fact that an order has been issued by the Missouri Pacific management that no relative of an official shall be employed in a position subordinate to that official on the Missouri Pacific and Iron Mountain system? The motive of the order is to place all employés on an equal basis in the matter of advancement, and is an order which might very well be imitated by every railway company in this country:—"A burning grievance to thousands of efficient railway men is that by hard work they have acquired intimate acquaintance with railway details which ought to recommend them for promotion, but they are kept back so that inefficient relations of officials may be advanced."

These words appear in a New York paper relative to American railroads; but are they not just as applicable to English railways? This particular "American innovation" would at least give considerable satisfaction to a large number of the staff.

J. E. S. CHALLENER,
General Secretary, Railway Clerks' Association.

11, Bank Chambers, High-street, Doncaster, February 17th.

DIGNITY AND IMPUDENCE.

SIR,—It is very interesting to note the engraving you give of the two Yarrow engines on page 166 of your last issue. It is a pity you could not have mentioned the steam pressure and revolutions of both installations, and given a comparative idea as to cost of each and the space occupied, with the probable amount to be written off either system, for maintenance, repairs, and depreciation of each type, presuming they were both driving the same load, and under similar conditions. Also the fuel and steam that would be consumed by each per horse-power developed. The information suggested would complete the interesting comparison you have already drawn, and looking at it, it makes one think of the other items that I have suggested. H. W. ANDERSON.

Teddington, February 16th.

CRANES FOR SOUTH AMERICA.

SIR,—Referring to the electric cranes for South America, which you illustrated in your issue of February 6th, may we ask you to add to the information there given that the cranes were constructed under the supervision of Messrs. Livesey, Son and Henderson, all work being submitted for their approval; and also that the British Westinghouse Electric and Manufacturing Company was the head contractor for the whole of the electrical equipment, including the supply of the cranes, we manufacturing the mechanical part of the cranes for the British Westinghouse Company, which supplied its own electrical equipment, and with which we worked in conjunction throughout. STOTHERT AND PITT, Limited.

Bath, February 16th.

GRANITE SETTS.

SIR,—Will you kindly allow me to ask, through the medium of your paper, what the experience of your readers is in regard to the relative economy and durability of granite-laid streets for heavy traffic, composed of setts of the following various sizes:—8in. to 12in. long by 9in. by 3in.; 6in. to 8in. to 10in. long by 6in. by 3in.; or 4in. by 4in. by 6in., laid on a good concrete bed, and grouted with cement 3 to 1, or bitumen.

In Birkenhead, Liverpool, Glasgow, &c., the 4in. by 4in. by 6in. sett is extensively used, but the adoption is more limited in London. HENRY HOLT.

London.

THE UNITED STATES CRUISERS TENNESSEE AND WASHINGTON.—An error that originated in the American daily Press has crossed the Atlantic, and is worth correcting. In all cases the water-tube boiler was specified. It has been the desire of the Bureau of Steam Engineering that the Babcock and Wilcox boiler should be used. One of the tendering firms specified for a boiler which the naval authorities could not accept. It has been stated that steam turbines were suggested as the motive engines. This is not the fact. In one instance a firm suggested turbines for the dynamos, but no one mentioned main turbine engines. The contracts were awarded on the 3rd inst. W. Cramp and Sons got one cruiser, and the New York Shipbuilding Company, of Camden, N.J., the other.

THE CLYDEBANK DOCK

(For description see page 201)

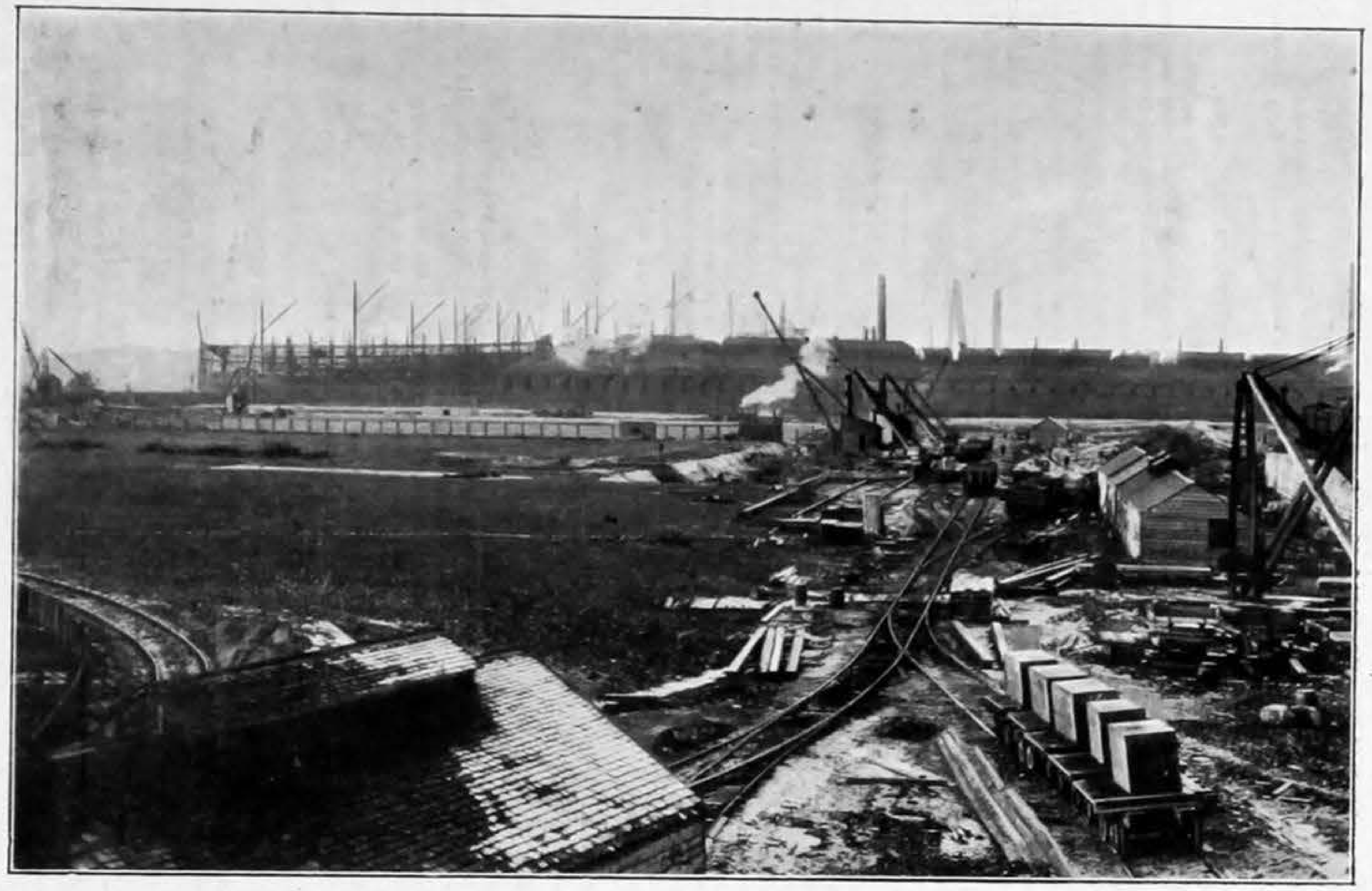


Fig. 1—DOCK SITE, SHOWING WALLS UNDER CONSTRUCTION

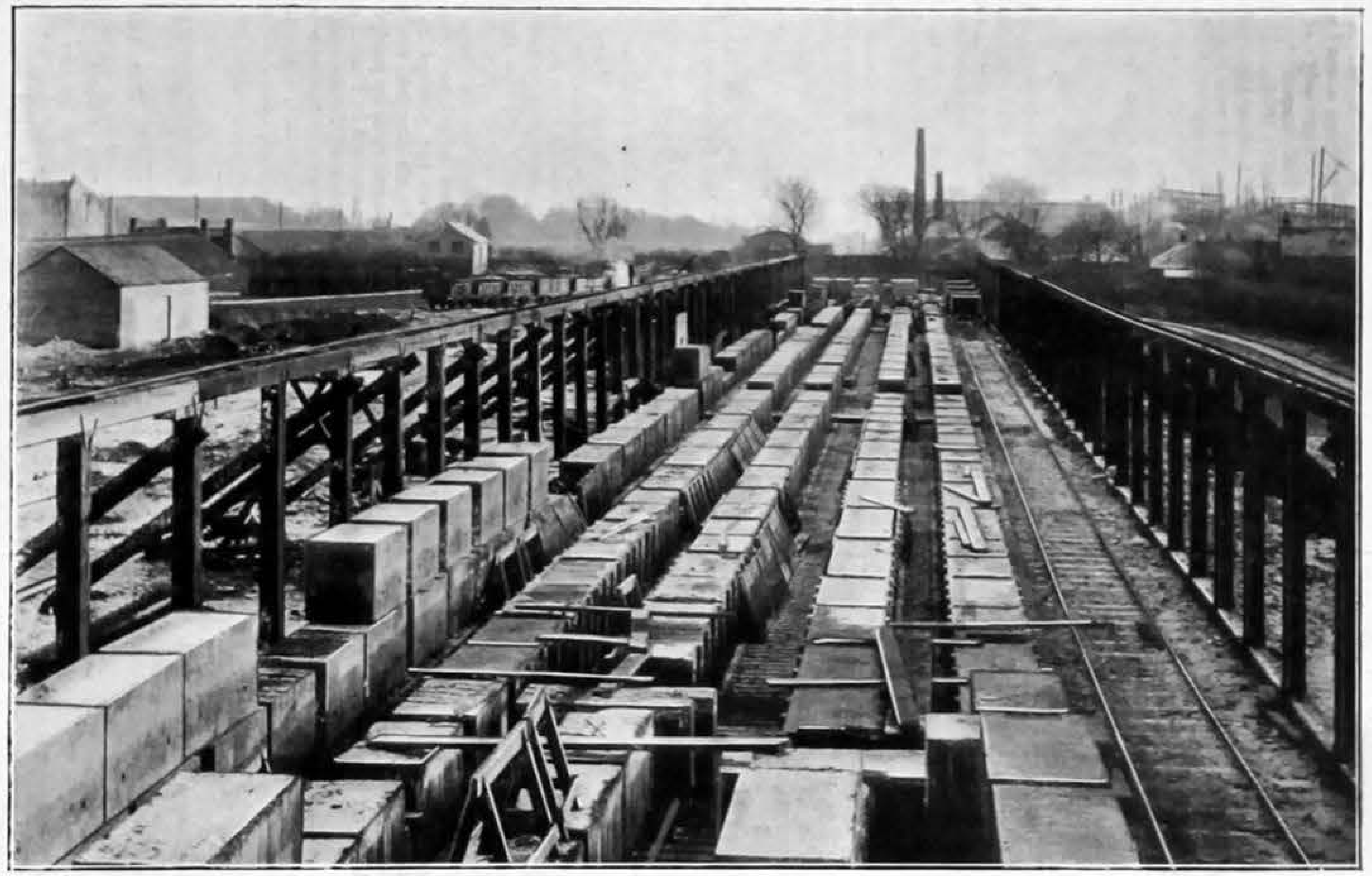


Fig. 2—CONCRETE BLOCK MOULDING PLATFORM

Fig. 3—CONCRETE MONOLITH IN COURSE OF CONSTRUCTION

Fig. 4—MONOLITH IN PROCESS OF BEING SUNK

CLYDESIDE INDUSTRIAL DEVELOPMENT.

No. III.*

APART from the two new shipbuilding and engineering establishments outlined in former articles, the other undertakings of various kinds which constitute this stretch of Clydeside, so interesting from an industrial point of view at present, may briefly be referred to. At Clydebank, opposite the river Cart, and stretching eastwards from the shipbuilding establishment of John Brown and Co. to some distance beyond that of Napier and Miller at Yoker, is the land on which the Clyde Trust is at present constructing its new Clydebank dock. The extent, general character, and progress of these new dock works were matters dealt with, along with other work of the Trust, in THE ENGINEER for September 12th last, no illustrations, however, being then available. For the purposes of the dock and the surrounding quay space and siding accommodation, the site comprises about seventy-six acres, and extends parallel to the river, its northern boundary being formed by the Lanarkshire and Dumbartonshire Railway. The dock will have a water area of 19 acres, an available length of 1800 yards of quays, and a depth of 25ft. at low water and 35ft. at high water spring tides. All the work in connection with the new dock is being vigorously carried on by the Clyde Trust's own workmen, under the supervision of the Trust's engineer, Mr. W. M. Alston, and his colleague in the outside branches, Mr. Archibald Hamilton.

On page 200 are four engravings reproduced from photographs taken within the past few weeks for the purpose of this article, through the courtesy of Mr. Alston. These illustrations are specially interesting as showing a feature in the construction of the dock which is a departure from the general practice followed in the case of most of the existing Clyde Trust docks. This is the manner of forming the foundations for the walls at the western end of the dock. Owing to the strata there being composed of muddy sand and quicksand, highly charged with water, the foundations are being put in in the form of caissons of oblong shape, 30ft. long by 21ft. broad by 31ft. deep. Hitherto, the caissons adopted in Clyde Trust practice have been circular.

These caissons, at first built of brick, but now mostly of concrete blocks, are built *in situ* on timber shoes, which are set in the trench at a level of about 6ft. below low water. The structure is then gradually sunk by means of superimposed weights, in conjunction with the work of excavating grabs, operating in a series of inside wells formed in the caissons, and this sinking proceeds until the bottom of the shoe is 54ft. below cope level. At first the shoes were wholly constructed of steel, but afterwards they were formed of pitch pine, with steel facings, the new form being much cheaper, while equally efficient. The caissons are set 4ft. apart, the joint between them being made with sheet piling and concrete. When sinking is complete each caisson is filled up with concrete and sand. Upon the sub-structure thus formed the walls are built of brick and concrete, the whole being faced with blue bricks and surmounted by a granite cope.

Referring now to the illustrations, Fig. 1 is a general view of the site of the dock looking westwards, showing a large portion of the west wall completed, and the wall being carried further south by the cranes in the distance. Nearer, and towards the right hand, may be seen the cranes working at the north wall, while in the immediate foreground are a number of trucks loaded with concrete blocks ready to be hauled to the trenches. The shipbuilding uprights seen in the extreme distance are those of the Clydebank shipyard of John Brown and Co., Limited. Fig. 2 shows the platform on which the caisson concrete blocks are moulded within wooden frames, and Fig. 3 shows the blocks forming one of the caissons in the trench for the north wall of the dock. The finished portion of this wall is seen in the distance, as well as the north-west corner of the dock, and a small part of the completed portion of west wall. Fig. 4 shows the caisson in process of sinking in the west wall trench, the caisson being loaded with cast iron weights. Suspended from the crane is one of the grabs used for excavating the material from the interior of the caisson. In the distance may be seen the portions of the west wall, building and finished; the north-west corner of the dock, and a part of the finished portion of the north wall. At the eastern portions of the works boulder clay rises to a convenient level, and there it is intended that the walls shall be of ordinary construction.

Principally intended to serve the mineral and ore traffic of the Clyde, the new dock will have an ample equipment of coal and other hoists of the newest type, electricity in all likelihood being adopted as the motive power. The hoists and the railway sidings in connection with them will be so arranged that wagons will run to and from each hoist by gravity. For unloading ore, and storing it till required, rapidly working cranes or transporters will be adopted. By recent decisions of the Clyde Trustees, the construction of the Clydebank dock is to be expedited as much as the most modern plant, and plenty of it, can effect. Doubtless with the fresh powers thus put into the hands of Mr. Alston and his staff, a short time should show a marked advance in the provision of accommodation for certain branches of Glasgow's shipping, which is recognised on all hands as being imperatively needed.

As evidence of the character of the work which Messrs. Beardmore and Co. are making provision for in their new establishment, alluded to in previous articles, reference may be made to a powerful wharf crane they have ordered from a firm in Germany. This mammoth appliance is of the cantilever type, with electric lifting and traversing gear, and is being constructed to meet a test lift of no less than 200 tons, being thus one of the most powerful cranes in the world. In going to Germany for this crane, the Beardmore firm has been animadverted upon locally as having evinced lack of patriotism, or of loyalty to local industry and skill; but few, if any, of this type of crane—fixed on by Messrs. Beardmore and Co. and their advisers as the most suitable for their purposes—and they may safely be assumed to know their own business best—have yet been made anywhere in this country; and in a matter involving such expense, it is natural that they should notwish to have anything experimental. The makers were the Benrather Maschinenfabrik Akt. Ges., which has had large experience of crane manufacture of the cantilever order, and has already six or more cranes at work in different parts of the Continent; one almost identical with the Beardmore crane, but not so powerful, being in operation at the shipbuilding works of the Howaldt firm at Kiel. Illustrations and descriptive information of this crane, and of a previously erected one at Bremerhaven, will be found on page 414 of THE ENGINEER for April 25th last. The Beardmore crane, for which elaborate foundations are now almost completed, under the direction of leading workmen sent by the Benrather Company, will consist of a tapering four-legged tower supporting a revolving vertical centre post, which carries a horizontal cantilever jib, projecting at one side about 40ft. over the post, and carrying at the extreme end a heavy counterbalance, and at the other side about 130ft. carrying a crab, which can traverse the jib from the edge of the tower to the extreme end of the arm. At this position the crab and the jib arm supporting it will be capable of lifting 30 tons, while the lifting capability about the centre of the arm will be at least 150 tons. The jib arm will thus be of such length and strength that a weight of 30 tons can be lowered or raised from a second vessel of maximum breadth lying alongside the first and nearest to the wharf side. The crab will contain the whole of the mechanism for lifting and traversing. Besides the work at the site of this large crane, and in connection with the tidal fitting-out basin, operations are proceeding elsewhere on the Beardmore territory, and in about twelve months the main features of what is intended to be a shipbuilding and engineering establishment of the very first order should be in something like shape. The contractors for most of the excavating and constructional work are Robert McAlpine and Sons, Glasgow.

To the west of the site of the Beardmore establishment, and closely adjoining it, is the land, specially acquired for the purpose, on which the Corporation of Glasgow are laying down their new sewage works to dispose of the sewage of the north-western portion of Glasgow and Partick and contiguous districts, as well as Clydebank and other residential districts. The works being constructed here were described generally in our issue for October 3rd last in the course of an article on "Glasgow's Main Drainage and Sewage Treatment," and it may here suffice to say that the works will treat the sewage by the method already in use at Dalmarnock, viz., chemical precipitation. Sludge presses will be dispensed with, and the liquid sludge carried out to sea in specially-constructed barges. The precipitation tanks now under construction are seven in number, and each 750ft. long; this great length allowing opportunity for more complete precipitation than in the shorter tanks at Dalmarnock, and effecting a saving in reduced proportion of chemical agents required for the process. In the article before referred to, a plan showing the precipitation tanks, outlet works, and tidal dock was given. The latter is, of course, designed to accommodate and afford loading facilities for the barges which will convey the sludge out to sea.

Below Shearer and Sons' establishment, and abutting on the Yoker and Renfrew Ferry-road, new foundry works have been erected by the Bull's Metal and Melloid Company, Limited, in which operations have been going on for some months past. Though for the time being mainly designed for foundry work, they are being equipped with the requisite tools for machining propellers, propeller blades, and bosses, and leaving them completely finished and ready to be fitted to shafting. Extension of the premises is provided for, the company having altogether six acres of ground situated on the river frontage, and abutting on the Renfrew Ferry-road. The works meantime consist of a general foundry 90ft. in length, and a commodious range of offices. There is one central bay 35ft. wide, and two side bays 18ft. wide. In the main bay there is an electric overhead traveller of 20 tons capacity, and in the side bays three-ton hand cranes. The height of the central bay is 25ft. under the traveller, and 9ft. above it; the side bays having 18ft. head room under the travellers. The furnace capacity is sufficient to cast solid propellers up to 19ft. diameter and nine tons finished weight. The heaviest propellers so far supplied, it may be stated, are three propellers for Glasgow-owned steamers, each weighing about 7½ tons. The boring of propellers and bosses is accomplished by a boring mill designed by Messrs. Noble and Lund, of Newcastle, while the keywaying is done by a key seater on the draw-cut principle. The motive power for the machinery and for the dynamo furnishing the lighting current is a gas engine capable of work up to 45 brake horse-power.

West of the Bull's Metal premises, and divided from them by the Yoker and Renfrew Ferry-road, as seen from the map given with article No. I. in our issue of the 2nd ult., which must also be consulted for other places mentioned in this article, is the land owned by the Clyde Valley Electrical Power Company, on which one of the three central generating stations it was authorised to construct by the Act which was obtained last year is about to be begun. For the station here, and another about to be commenced at Motherwell, in the heart of the Lanarkshire coal-field, the company has contracted with the British Westinghouse Electric and Manufacturing Company, Limited, of London and Trafford Park, Manchester, for the construction and equipment of a first instalment of the stations, which, with the relative cables and sub-stations for distribution, will cost approaching £500,000. The company's authorised area of supply covers altogether 735 square miles, and includes more than 1000 works of all kinds, and thus affords a wide field for the application of the principle of supplying electric energy from central power stations. The site for the Yoker station extends to about ten acres, and the company's Act authorises it to lay a cable under the Clyde from Yoker to Renfrew, so as to supply energy to the important burghs and industrial centres in Renfrewshire within the company's area. For some years this will obviate the need to erect the third authorised central generating station, which is on the south side of the Clyde near the "half-way house" between Glasgow and Paisley. The company has already received promises of support from many of the steel manufacturers, coalmasters, shipbuilders, engineers, bridge builders, and other users of power within the area, and in course of time there seems little doubt the use of steam as a motive power in works within the Valley of the Clyde will be very largely superseded by the more economical application of electric driving. The company's stations will also afford a ready and economical supply of electricity for tramways within the Valley of the Clyde. The various works to which reference has been made in the foregoing notes are therefore as well situated for the prospective supply of electrical power and transmission as meantime they are found to be for the provision of ordinary railway facilities. Indeed, the Clyde Valley Supply Company maintains that the network of railways in and around Glasgow, especially as regards suburban passenger traffic, must, if retained at all, eventually be operated electrically.

* No. II. appeared January 30th.

THE RAILWAY CLUB.—The Railway Club held their usual monthly meeting at the Memorial Hall, Farringdon-street, E.C., on February 12th. The chief feature of the evening's entertainment was a lantern exhibition—a large number of views of locomotives and railway scenes being thrown upon the screen. The lecturer was Mr. J. R. Shelley, the assistant secretary. There was a good attendance of members.

THE INSTITUTION OF CIVIL ENGINEERS.

THE MANUFACTURE AND EFFICIENCY OF ARMOUR-PIERCING PROJECTILES.

AT the ordinary meeting on Tuesday, February 10th, 1903, Mr. J. Clarke Hawkshaw, M.A., President, in the chair, the paper read was "The Manufacture and Efficiency of Armour-piercing Projectiles," by David Carnegie, Assoc. M. Inst. C.E.

After alluding briefly to early experiments with round cast iron shot, and the supersession of the latter by Whitworth solid punching projectiles, the author described and illustrated numerous designs for armour-piercing projectiles made since 1863. He next dealt with the material used for projectiles, and stated that improvements in the manufacture and treatment of steel had rendered it possible to make cast steel projectiles which could penetrate face-hardened steel. The modern projectile was composed of steel containing carbon, associated with one or more of the following metals:—Nickel, chromium, manganese, and molybdenum. Typical proportions of elements other than iron in shells which were air-hardened were:—Carbon, 0·80 per cent.; silicon, 0·2 per cent.; sulphur, 0·04 per cent.; phosphorus, 0·04 per cent., manganese, 0·12 per cent.; nickel, 2·00 per cent.; chromium, 2·00 per cent.

With regard to manufacture, cast steel projectiles were cheaper than forged steel, although the efficiency of the forged exceeded that of the cast. The various operations in the manufacture of forged and of cast steel projectiles were described, and details were given of various devices for chilling the point of the shell. The operations of annealing, machining, and hardening were next referred to. In present-day methods of hardening, three mediums were used, viz., water, oil, and air. These mediums differed in intensity of action, and the choice of the method to be used was determined by the composition of the material to be hardened. Each medium might also be varied, in temperature in the case of water and oil, and in pressure in the case of air. Carbon steels were, as a rule, hardened in water, or partly in water and partly in oil; nickel steels in water, in oil, or in air under pressure; chrome-nickel steels in oil, or in air under pressure; and steel having self-hardening properties by simply heating and allowing to cool in air. The author described several methods of performing these operations. The use of the pyrometer for registering the quenching temperature was referred to, and curves were given showing the rate of heating projectiles and cooling them in different mediums. The author remarked that it would be very useful to obtain, if possible, a table of hardness according to the quenching temperature; and it might be expected that, with the same material quenched at different temperatures in the same cooling medium, such a table could be obtained by ascertaining the compression, in tons per square inch, of test pieces so treated. He had experimented with this object in view, but the results obtained had not shown a uniformly increasing hardness as the quenching temperature was raised.

The subject of testing projectiles after hardening was also dealt with, and the tests applied to English and American armour-piercing shells were described. Calculation of the internal stress needed to produce such fracture in the head of a projectile as often occurred spontaneously showed the necessity for these tests. Mention was also made of capped projectiles, and the means of attaching the cap.

The remainder of the paper dealt with the efficiency of armour-piercing projectiles, and contained a brief history of the progress and development of armour plate. Illustrations prepared from photographs showing the development of armour plates manufactured in Germany during the past ten years were given, and were compared with French, American, and English plates. The effect on both projectile and plate in each trial was mentioned and compared. The value of the cap on the point of a projectile fired at normal impact was referred to; and tables were appended giving the perforation of face-hardened plates with different projectiles at different velocities. These tables showed the results of German and of American practice.

CHEMICAL INDUSTRIES AND INTERNAL COMMUNICATION.

WE have received from the Society of Chemical Industry the following memorandum on the improvement of the means of internal communication.

It is well known that the cost of internal transport in England is a great burden upon our industries, and not least upon the chemical industry. There is a growing agitation to impress the fact upon the Government that the improvement of internal transport is a matter of urgent public importance, and that the improvement of the canal system under public supervision and with the aid of public funds is the best direction for immediate action. To forward this cause, which is being taken up strongly by chambers of commerce and manufacturers in every part of the country, it is most desirable to collect accurate figures showing the incidence of freight upon several leading industries; and in the interests of each member's business, as well as the public good, the Council invites answers to the annexed questions. The figures will be treated as absolutely confidential, and only summaries without names published. In such summaries one of the main points sought will be the percentage which the total freight charges bears to the sale price of the commodity. Replies should be sent to the General Secretary, Society of Chemical Industry, Palace-chambers, Westminster, S.W.

Questions.—(1) What goods do you manufacture? (2) What is the total amount paid by you directly or indirectly for carriage within Great Britain of your raw materials to your manufactory, expressed per ton of finished products? (3) What is the average amount paid per ton of finished product for carriage within Great Britain to the consumer, the retailer, or to the port of shipment? (4) What is the average sale price per ton of your finished products? (5) Do you make any use of inland waterways; and if so, for what proportion of your total carrriage?

Notes on questions.—On question 1: If you do not wish to specify the goods made, state the class to which they belong—heavy chemicals, dyestuffs, &c. On question 2: If raw materials are delivered carriage paid, please add as nearly as you can the amount paid for carriage by the seller of the raw materials. If any of your raw materials are themselves manufactured goods, it would be of great assistance if you would add as nearly as you can the cost of carriage on the materials required to make them, or, if unable to do this, you would tell the Council what these manufactured materials are which you use as raw materials, and approximately the quantity you use per ton of finished product. On question 3: If you sell your goods f.o.r., kindly add as nearly as you can the mean freight paid by the buyer to deliver the good to the consumer, the retailer, or the port of shipment.

THE NATIONAL HARBOUR AT DOVER: THE ISLAND BREAKWATER.—Messrs. Pearson and Son are making rapid strides with their preparations for the building of the island breakwater across Dover Bay, which is to complete the Dover National Harbour Works. An iron framework of about 60ft. in height has been built in the eastern yard. This is to be taken to sea in sections, and rebuilt, where it will form the first staging from which to drive the piles and make a start with the South Breakwater, which it has been decided to construct quite independently of the Eastern Breakwater, from which it was proposed to continue the gantry work. By adopting this course it is stated that the work will be hastened forward considerably, and it will not be necessary to close the eastern entrance to the great harbour. It is estimated that the whole harbour will now be completed in between four and five years from the present date.

MANCHESTER ASSOCIATION OF ENGINEERS.

THE 46th anniversary dinner of this Association was held on Saturday at the Grand Hotel, Manchester, and there was a large attendance of members. Mr. J. H. Reynolds, in responding to a toast proposed by Mr. R. Matthews, said he was convinced that the successful competition of America and Germany was not based upon any question of tariffs but upon education. It had become absolutely essential that greater importance should be attached to scientific training in the future, but if they were going to be content that their youths should cease their education at sixteen years of age, and that their cleverest young men should simply get what they could out of evening classes, they could never hope to rival either their American or German competitors. He appealed to the engineers of the district to grant facilities to the young men in their employ to take advantage of the opportunities afforded in the School of Technology, and on his part he would recommend facilities for a selected number of young men going into the school at selected hours. If the employers would join in this arrangement themselves he was sure they would find it a very great advantage in the end.

Mr. W. J. Crossley, in proposing prosperity to the Association, said that although he felt that education was really at the bottom of the matter, and they had been shown how much depended upon it, he could not help asking why—if their American friends had made such tremendous progress in that direction—was it they kept up the tariff of 48 per cent. while we opened our doors free to them? He would be most happy to respond to the invitation thrown out by Mr. Reynolds, and to arrange for sending a sufficient number of youths to the Technical School as suggested. In conclusion, Mr. Crossley spoke strongly against the vice of giving commissions to secure interest, which was creeping into this country.

The President, in responding for the Manchester Association of Engineers, spoke of the progressive character of their members, and was glad to notice they were drawing into closer contact with the School of Technology. It was absolutely essential for their prosperity that the engineering employers in that district should take into serious account and make use of the facilities that were afforded by the Manchester Technical Schools, which were provided with the appliances for research work that were probably unequalled, and could not certainly be surpassed in any similar institution, at any rate in this country. With regard to the suggestion that engineering employers should send some of their intelligent apprentices to be pupils, so that they might be able to carry out research work in the schools, he was glad to hear that Mr. Crossley accepted the suggestion, and he hoped it would be similarly followed out by other employers in the district.

LAUNCHES AND TRIAL TRIPS.

ALICE; built by, Earle's Shipbuilding and Engineering Company, Limited; to the order of, George R. Haller, Limited; trial trip, February 13th, 12 knots; this vessel was launched on February 2nd.

UNDINE, steel screw steamer; built by, C. S. Swan and Hunter, Limited; to the order of, Roed, McNair and Co., Glasgow; dimensions, 275ft., 37ft., by 2ft. 1½in.; to carry, 245 tons cargo on light draught; engines, triple-expansion, 20in., 33in., 54in., by 36in., pressure 160 lb.; constructed by North-Eastern Marine Engineering Company, Wallsend; launch, February 10th.

OIL-CARRYING steamer; built by, Palmers' Shipbuilding and Iron Company; to the order of, Furness, Withy and Co.; dimensions, 428ft., 54ft. 6in., 32ft.; to carry, 7300 tons of cargo; engines, triple-expansion; constructed by, the builders; launch, February 12th.

WEARDALE, steel screw steamer for the coal trade; built by, Irvine's Shipbuilding and Dry Docks Company, Limited; dimensions, 230ft. 6in., 36ft., by 17ft. 2in.; engines, triple-expansion, 19in., 31in., 51in., by 36in., pressure 160 lb.; constructed by, Richardsons, Westgarth and Co., Limited; launch, February 12th.

CROSBY HALL, steel screw steamer; built by, C. S. Swan and Hunter, Limited; to the order of, the Hall Line Service of the Ellerman Lines, Limited, of Liverpool; dimensions, 375ft., 46ft. 8in., 29ft. 11in.; to carry, 6500 tons deadweight; engines, triple-expansion, 23½in., 39in., and 68in., by 48in. stroke, pressure 200 lb.; constructed by, the Wallsend Slipway and Engineering Company, Limited; launch, February 12th.

FRANCONIA, finely moulded steamer; built by, Northumberland Shipbuilding Company, Limited, Howden-on-Tyne; to the order of, Lorenzo Kasovio and Partners, Trieste; dimensions, 372ft., 48ft., by 30ft. 10in.; to carry, 7000 tons loaded; engines, triple-expansion, 24½in., 40in., 68in., by 48in., pressure 180 lb.; constructed by, North-Eastern Marine Engineering Company, Limited; speed, 10 knots expected; launch, February 13th.

EVERTON GRANGE, twin-screw steamer; built by, Furness, Withy and Co., Limited; to the order of, Houlder Brothers, Limited; dimensions, 490ft., 56ft., 35ft. 6in.; to carry, 11,000 tons deadweight; engines, twin-screw, triple-expansion, 23in., 36in., and 59in., by 42in. stroke, pressure 180 lb.; constructed by, Richardsons, Westgarth and Co., Limited; a remarkable feature about this vessel is the fact that in her construction plates 66ft. long, and weighing nearly six tons each, were employed amidships; launch, February 15th.

LILLIE, screw steamer; built by, C. S. Swan and Hunter, Limited; to the order of, the Donald Steamship Company, of New York; dimensions, 237ft., 31ft. 8in., and 16ft.; to carry, fruit; engines, triple-expansion, 21in., 34in., and 56in., by 36in. stroke, pressure 180 lb.; constructed by, the North-Eastern Marine Engineering Company, Limited; launch, February 16th.

ROYAL INSTITUTION.—On Tuesday next, February 24th, at 5 o'clock, Sir William Abney will deliver the first of a course of three lectures at the Royal Institution on "Recent Advances in Photographic Studies;" on Thursday at the same hour Professor L. C. Miall begins a course of three lectures on "Insect Contrivances;" and on Saturday, February 28th, at 3 o'clock, Lord Rayleigh delivers the first of six lectures on "Light: Its Origin and Nature." The Friday evening discourse on February 27th will be delivered by Mr. Adolph Liebmann, on "Perfumes: Natural and Artificial," on March 6th by Professor J. C. McKendrick on "Studies in Experimental Phonetics," and on March 13th by Professor Karl Pearson on "Character Reading from External Signs."

NAVAL ENGINEER APPOINTMENTS.—The following appointments have been made at the Admiralty:—Fleet engineers: P. Marrack, to the Ocean; A. E. L. Westaway, to the Vivid, for the Nile, appointment to the Duke of Wellington for the Nile cancelled; and J. T. Purkis, to the Europa. Chief engineer: E. Gaudin, to the Spartiate. Engineers: W. S. Hill, to the Spartiate; A. M. Underhill, to the Ocean; I. E. S. Roberts, to the Europa; A. E. J. Murray, to the Vivid, for the Foyle; and H. E. Rock, to the Pembroke. Assistant engineers: H. V. Gordon, E. J. Allen, H. Burt, and E. C. Green, to the Ocean; J. E. Allnatt, to the Pembroke, and to the Russell; and A. H. A. Dowman, to the Duke of Wellington, and to the Spartiate. Temporary assistant engineers: W. J. Hambly, promoted to the rank of engineer on the permanent list, and reappointed to the Mars; and T. A. Venning, promoted to the rank of engineer, and reappointed to the Mars.

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

(From our own Correspondent.)

GENERALLY speaking things may be said to be a shade better all round, more particularly in pig iron and steel. The reports of renewed buying in the North of England on American account is helping to sustain the pig iron market here.

Old members of the finished iron trade, in the course of conversation as to the new Small Size Bar Iron Association, recall the time when some twenty years ago the additional money obtained for small sizes over ordinary sizes was far and away better than now. They used to get 20s. extra on $\frac{3}{8}$, another 5s. or 10s. on $\frac{5}{16}$, and another 10s. or more on $\frac{1}{4}$. But these margins have gradually been whittled down until recently $\frac{7}{16}$ and $\frac{3}{8}$, and in some cases $\frac{5}{16}$, have been sold without any extras. The new association is getting back a little of what has been lost, but a return to the full extras of years ago is deemed to be out of the question. With regard to the basis price for ordinary sizes, that, of course, has dropped very considerably compared with some years ago. Unmarked bars are quoted to-day £6 5s. to £6 10s.; marked bars, £8 10s.; Earl Dudley's brand, £9 2s. 6d. Galvanised corrugated sheets are quoted £11 2s. 6d. to £11 7s. 6d.

Rolling-stock builders and structural engineers are proving good customers for steel. Plates are quoted £6 5s to £6 15s.; girders, £6 to £6 5s.; and angles, £5 15s. to £6 5s.

I was present at the meeting held at the Grand Hotel, Birmingham, on the 12th inst., upon the interesting subject of planting pit banks with trees, and some encouraging accounts were given by various speakers as to the good results of somewhat similar experiments elsewhere. The meeting was rather small, but what it lacked in numbers was made up in a quiet enthusiasm which bodes well for the experiment, and a strong committee was formed to get the matter started on a practical basis. Sir Oliver Lodge, who presided, is "a host in himself," as regards the furtherance of any public movement with which he is concerned, and no better chairman could have been selected. He mentioned that in 1896-97 the revenue brought into the Indian Exchequer in the form of profit from forests was eleven million rupees. There were twenty-two associations in the United States for tree planting. Sir Oliver read a letter from Professor Fisher, of the Royal Indian Engineering College, Cooper's Hill, in which the professor said he had no doubt that 14,000 acres of waste land in the Black Country could be planted successfully. The surface of the waste was chiefly disintegrated shale from the mines, and was now in some cases covered with grass and used for pasturing sheep. It would not cost more than £10 per acre, including fencing, to plant it, whilst if planted with pine, spruce, and larch, these would soon—say thirty years—yield pit timber worth about 30s. per ton. One acre would produce about 50 tons of timber, worth from £50 to £75 per acre, in thirty years. On the proposition of Mr. Herbert Stone, seconded by Professor Hillhouse, it was resolved that an organisation entitled "The Black Country Tree Planting Society" be formed, and that the qualifying membership subscription be not more than 5s. Favourable speeches were also delivered by Mr. Thomas Everton, superintendent of Walsall Park; Mr. Alex. Tucker, the Rev. Samuel Lees, and Mr. Macfarlane, who gave an account of the manner in which a spoil heap had been converted successfully into a beautiful park at Wednesbury. Mr. Herbert Stone was elected secretary, and several of those present joined the committee, so that practical good will, it is hoped, soon result. It is proposed to put in small tree plants, costing about 18s. per 1000, so that even if three-quarters of them die the loss will not be very great.

NOTES FROM LANCASHIRE.

(From our own Correspondents.)

Manchester.—The position in the iron and steel trades of this district is just now one of steadiness as regards prices; yet with a continuance of the slackness that has come over the market during the last few weeks, and with no present indication of any renewal of buying on a large scale, the outlook is perhaps in some quarters considered to be more hopeful, and certainly there is a rather more cheerful tone in many large iron-using industries. Consumers, however, are still very cautious buyers, and it is exceptional where they go beyond covering immediate requirements. Not that there is anticipation of much lower prices, cost of production being looked upon as likely to check this, but there is a lack of confidence, and consequently a preference to wait the turn of events rather than enter into forward transactions. The situation is very much the same throughout all sections of the market.

In pig iron business still mostly drags on from hand to mouth, with makers generally firm in their quotations, but where business is offering of any weight there are speculative operators prepared to quote under current rates. In finished material, either iron or steel, there is not more than a limited weight of new business giving out, and unremunerative prices continue the prevailing complaint of manufacturers.

The Manchester iron market on Tuesday scarcely brought together an average attendance, and there was again not more than an indifferent sort of business passing through. Sellers of pig iron in most cases reported only limited inquiries, and business at current rates difficult, except for small prompt parcels. For No. 3 foundry pig iron delivered in the Manchester district Lancashire makers were quoting about 56s. 6d. to 57s. less 2½, but the minimum price would represent more nearly the average figure. Lincolnshire makers, who held a meeting last Friday to consider prices, decided to make no change, and their basis remains at 51s. net, delivered Manchester. For Derbyshire iron quotations vary according to brand, but average prices may be given at about 55s. 9d. and 56s. to 56s. 6d. and 56s. 9d. net, delivered Manchester. In forge qualities business still moves on very slowly, with, however, no quotable change in prices except that Derbyshire brands are reported to be cutting below the list basis rates for Lincolnshire, delivered Warrington. No. 4 forge Lancashire remains about 51s., less 2½, Lincolnshire 50s. 2d. net, with Derbyshire ranging from about 50s. to 50s. 6d. net. For Middlesbrough iron quotations are strongly maintained at late rates, delivered by rail Manchester. Open brands are scarcely quoted under 55s. 10d., with makers quoting for special brands about 56s. 4d. net. In Scotch iron rather low cuts are reported for anything like quantities, and delivered Manchester docks Eglinton might be bought at 58s. 6d. to 59s., Glengarnock 60s. 6d. to 61s., with Gartsherrie quoted about 62s. net.

Not more than a moderate sort of business as regards new orders coming forward is reported in finished iron, both merchants and manufacturers complaining of the scarcity of orders. The smaller finished ironworks, where they sold pretty freely during last month, are still kept well engaged with deliveries on account of orders on their books, but are not securing much new business. The larger forges, which depend to a considerable extent upon the shipping trade, are but indifferently off for work and running short time. Prices remain generally without really quotable change. Delivered Manchester district Lancashire bars average £6 8s. to £6 10s.; North Staffordshire are quoted £6 10s. to £6 15s.; sheets average £8 to £8 2s. 6d.; and hoops remain at the Association basis of £7 2s. 6d. random to £7 7s. 6d. special cut lengths, and 2s. 6d. less for shipment.

In the steel trade the business giving out continues of no great weight, the orders placed being chiefly restricted to small quantities to cover present requirements. Hematites are only in slow demand, but makers decline to give way at all upon their quoted rates, which remain firm on an average basis of 67s. 6d. to 68s. net for No. 3 foundry, delivered Manchester. For local-made billets prices remain weak, and although £4 15s. is perhaps got on occasional very small parcels, makers would book anything like large orders at £4 13s. 9d. net, delivered Manchester. For bars, £6 5s. to £6 7s. 6d. are about the average figures, with £6 10s. still quoted, but only got in special cases, and common plates are readily obtainable at about £6 to £6 2s. 6d., delivered in this district.

Nothing further has been done in connection with the correspondence that has recently taken place between the Lancashire boilermakers and the associated steel boiler-plate manufacturers on the question of differential prices between Lancashire and the South of England. At the reduced rates moderate orders have been placed, but there is still no buying of any moment going on, boilermakers for the most part being very indifferently off for work, and not caring to buy beyond immediate actual wants. Delivered Manchester district the Association basis for Lancashire boiler plate specifications remains at £7 2s. 6d., with non-associated makers quoting £6 17s. 6d. per ton. Outside Lancashire boiler specifications similar qualities of plates continue to be cut very low.

Reports as to the condition of the coal trade in this district become less satisfactory. The continued exceptional mildness of the season is so largely restricting requirements for house-fire purposes that lessened time has to be worked at the pits to prevent the accumulation of stocks, and four to five days per week represents the full average that is just now being run. Although there is no actually quoted giving way in prices, sellers in many cases where they have surplus output under load which they are anxious to move, are prepared to offer temporary concessions to buyers to effect clearances.

The inland demand for iron-making, steam, and general manufacturing purposes remains moderate, but with the restricted quantity of common round going away for domestic consumption, there are more than ample supplies, and prices are becoming difficult to maintain where sellers have to come upon the open market to secure orders. The general list rates remain without quotable change, and for the most part are steady at about the prices that have been ruling for some time past; special clearance sales are, however, here and there put through at something under the current quotations, but these transactions do not represent any general or permanent giving way in prices. At the pit mouth steam and forge coals range according to quality from about 8s. and 8s. 3d. to 8s. 6d., 8s. 9d., and 9s.

A generally steady position is maintained as regards all descriptions of engine fuel, and it is exceptional where collieries have any surplus supplies. The depressed condition of the house-fire coal trade, and the consequent lessened screening of round coal, necessarily causes a corresponding lessened production of slack, and of some special sorts there is rather a scarcity. The demand for steam purposes is not above the average, and consumers have no difficulty in covering their requirements. The outlook is, however, one of firmness so far as prices are concerned, owing to the diminished production of slack, and current rates for all descriptions of engine fuel are strong at recent quotations, best slack averaging 6s. 6d. to 7s., medium 5s. 6d. to 6s., and common 4s. 3d. to 4s. 9d. per ton.

Only a very indifferent business continues to be reported for shipment, and prices are still cut low to secure cargoes, especially where collieries have surplus output accumulating, which they are anxious to clear away promptly. Delivered Mersey ports, steam and forge coals average about 9s. 9d. to 10s. 3d. per ton.

Barrow.—There is no change to note in the hematite pig iron trade, although it is generally believed it is on the eve of a new career of activity, as indications are being multiplied showing that in the early future a much fuller demand will be experienced than for some time past. Makers report in some cases they are so well sold forward that they cannot at present negotiate for any large deliveries of metal at forward dates. This condition of things is particularly the fact in the case of makers of iron who are also makers of steel, and who are depending on their own resources for a large make of crude iron. Prices show no variation. Makers still quote 59s. 6d. net f.o.b. for mixed Bessemer numbers, and warrant iron is at 58s. 6d. net cash sellers, buyers 3d. less. Sales of warrant iron are on a small scale, but the stocks held at Barrow have been reduced during the week by 1022 tons. The total stocks held in the district represent 22,093 tons, or 2210 tons decrease since the beginning of the year. The make of the district is well maintained, and 36 furnaces are in blast, being the same number as in the corresponding week of last year.

Iron ore is in good demand, and native sorts are especially active at 12s. net at mines. Spanish ores are at 16s. per ton net at West Coast ports.

The steel trade is very well off for orders in every department except that of Siemens-Martin's. Shipbuilding material generally is quiet, but Bessemer steel of all sorts is in very active demand, and rails are particularly brisk. The trade doing is on home, foreign, and colonial account, and there is life in the demand from all these sources. Prices are steady at £5 5s. to £5 10s. per ton. Hoops, billets, and merchant steel are steady.

Shipbuilders report no new orders. Some hopes are entertained that one of the two new Cunarders will be built at Barrow. The demand for new shipping tonnage is very weak, and prices are lower than they have been for years.

Shipping returns from West Coast ports show that 6559 tons of pig iron were exported last week, together with 9456 tons of steel, showing a decrease of 5211 tons of pig iron and 1934 tons of steel, as compared with the corresponding week of last year. The aggregate shipments this year have reached 46,683 tons of pig iron and 64,108 tons of steel, being a decrease of 11,228 tons of pig iron and 2024 tons of steel, compared with the corresponding period of last year.

Coal and coke are firmer, and there are much better future prospects, but prices keep low, as competition for orders is very keen.

THE SHEFFIELD DISTRICT.

(From our own Correspondent.)

SOUTH Yorkshire coal has not been in brisk demand in household sorts since last report. The chief reason is the extremely mild weather now being enjoyed for February. At the same time, although rumours of a probable reduction of 6d. per ton are circulating, we have not heard that any such lowering of values has taken place. The fact is the market seems able to absorb all that is brought to it, and very little, indeed, is going to stock. Silkstones, in the best qualities, are still fetching up to 13s. 6d. and 14s. per ton; Barnsley house, 12s. 6d. per ton for bests; seconds and nuts, from 10s. 6d. per ton.

In steam coal there is rather less doing for export. The orders from America placed eleven months ago are now being completed. Those in hand for the trans-Atlantic markets are much lighter, whilst the business done across the North Sea is diminishing, as is usual in February and March. The home business remains pretty much as usual at this season of the year, values being maintained at the old rate. Steam coal bought in the open market still fetches more than the contract price of 9s. per ton. Although the Denaby dispute still drags along the company is reported to have obtained sufficient hands to work the Cadeby pit, and may be expected now to keep figuring more largely in the official returns.

There is rather less demand for gas coal, the bright weather easing the demands upon the converters. Small coal continues in languid request, although there is rather more doing than formerly. For coke the call is fairly good, rates remaining unaltered at from 12s. 6d. to 13s. per ton for best unwashed smelting samples, whilst washed fetches from 13s. 6d. to 14s. per ton. The supply is not in excess of the market, but there are signs that coke is going to be brisker.

In the iron and steel trades reports vary considerably. There is rather less doing in crucible steel, but business, compared with the corresponding period of last year, appears to be better. Several of the firms have more furnaces at work, and men are making more time. Manufacturers complain that although the raw materials necessary for steel-making can be bought on easier terms than a year ago, coke and other necessaries keep dear, with a tendency rather to stiffen. These signs are taken as indicating early improvement. There is no great change in the iron trade, and prices remain as formerly reported.

In the engineering establishments much more work could easily be done, and there is considerable complaint in mills and forges. There is not likely to be much improvement till further Government orders are received to keep the machinery employed in manipulating the steel. Better accounts are being received in several railway material departments, notably in wagon and carriage manufacture. The effect of recent combination in the large firms is being felt by the independent concerns, as the reduction effected in working expenses and management where the principle of co-operation has been adopted in large es ablishments is difficult to meet in the case of several works outside the combination. The increasing competition in tram rails, points, crossings, and other accessories of tramway equipment, is having the usual effect of reducing profits. Much business, however, is still being done, although several of the cities and the larger towns have now obtained the bulk of the material they need.

Among the minor trades which have recently improved are those engaged in tools for mining and excavating purposes. The improvement extends both to the home and distant markets. Manufacturers state, however, that they find difficulty in obtaining materials for handling tools. The wood comes from the United States, where, through the trade being now under the control of the Trusts, prices have advanced quite 50 per cent. The principal colonial market at present for mining and excavating tools is South Africa, where the enterprise shown in establishing agencies and sending out travellers is now bringing the firms and companies the long-waited-for reward.

The directors of Messrs. John Brown and Co., Limited, Atlas Steel and Ironworks, Sheffield, intimate to their shareholders that the arrangements for the amalgamation with Messrs. Thomas Firth and Sons, Norfolk Works, have now been completed. A special meeting is called for the 24th inst., at which a resolution is to be proposed for the appointment of Mr. Bernard A. Firth a director of the Atlas Company. It will also be proposed to add to the articles of association a fresh article empowering the directors to establish local boards, local managing or consulting committees, or local agencies in the United Kingdom or abroad.

NORTH OF ENGLAND.

(From our own Correspondent.)

MAKERS of pig iron in the North of England have reason to be satisfied with the existing condition of the market. It is certainly far better than nearly all other branches of the iron and steel industries in the district, and prices are moving upward, slowly, it is true, but yet steadily, and they are not likely to get worse now that what is always a more active period of the year is at hand. And if they have been able to keep up prices over the slack winter time, they may well expect to maintain them, at any rate, if not advance them, in the spring. The warrant market has been decidedly stronger this week, the upward movement being induced partly by the rise in copper, some of the speculators in which have turned their attention to pig iron, as in the forthcoming season there may be possibilities of operating advantageously. Owing to the more active business, Cleveland warrants have risen this week to a price higher than anything reported this year, or, in fact, since the early part of December, and the difference between Scotch and Cleveland warrants, which a short time ago was 6s. 3d., is now no more than 5s. 1½d.

The situation for Cleveland pig iron makers is thus growing more favourable, and the prices of foundry qualities have been raised, until No. 1 is now at 50s., No. 3 at 47s. 9d., and No. 4 foundry at 47s. 3d., and both makers and merchants are quoting these figures. What is more significant is that the prices both of warrants and makers' iron are higher for forward than for prompt delivery. Grey forge is somewhat weak in price, as it is plentiful, and consumption is much curtailed on account of the depression in the local finished iron trade. It can readily be bought at 45s. per ton, and thus is relatively a good deal cheaper than No. 3. White pig iron is generally 6d. per ton cheaper than mottled, but the supply now is rather short, and both are quoted at the same price —44s. 6d. per ton.

The hematite pig iron makers of this district have booked a fair number of orders during the last few days, mostly on export account, and Italian consumers have bought rather freely. The make has also been reduced, which improves the position of the producers, who can realise and are not prepared to take less than 56s. for mixed numbers of East Coast hematite pig iron. Some of the merchants early in the week sold odd lots at 55s. 9d. per ton, but business at that figure has not since been possible, especially since the price of Rubio ore has been advanced 3d. per ton, viz., to 16s. 3d. per ton delivered c.i.f. Middlesbrough, more having to be paid to the Spanish mine owners, who hold the whip hand of the merchants and consumers at present. There is a good deal of complaint about the poor quality of the Rubio ore that has lately been supplied, and the ore merchant is not in a very enviable position.

This week the Normanby Ironworks Company, Middlesbrough, have blown out for re-lining a furnace producing hematite pig iron, leaving them with two at work out of four erected. This has rather tended to strengthen the local hematite iron market. It is now intended to blow in the Coatham Ironworks this week; in fact the blast is to be put on to-morrow (Saturday), and the two furnaces —which have been idle for over sixteen years—will produce ordinary Cleveland pig iron. The owners—Messrs. Walker, Maynard and Co., Limited—propose to counterbalance this reopening by blowing out some of their Redcar furnaces, which need re-lining. The local consumption of Cleveland pig iron will be increased before the close of the month by the reopening of Messrs. Dorman, Long and Co.'s Britannia Steel Works, Middlesbrough, which are a'most the largest in the district, and which have been stopped since last August in order that new machinery might be put in. The new engines and machinery have been experimentally run this week, and worked very satisfactory, so that there is nothing to hinder the early reopening of the works.

An increased number of inquiries are received from America both for Cleveland and hematite pig iron, but orders do not follow; these fall to the share of the Scotch producers, who, because they can avail themselves of the regular liners from the Clyde to America for the conveyance of the iron, can better deal with orders for small quantities, such as are now the rule. This month not a single ton of pig iron has been shipped from the Tees to America, but there is a good deal due for February delivery. There is, however, a difficulty experienced in chartering steamers. There are plenty laid up, but owners cannot see their way to put them in commission again for a single voyage, especially when freight rates are so low, and the probability of securing other freights so poor. To make up for the larger deliveries of Scotch iron to America, the Scotch consumers of pig iron are taking more Cleveland pig iron—more than, in fact, has ever before been known.

The steel railmakers are continuing to do a very good trade, and expect that the demand will become better still, taking into account the railway extensions that are projected, in India and South Africa especially. The mills in the North of England are turning out rails to their fullest capacity. Fully £5 10s. net at works has now to be paid for heavy steel rails. More inquiry for cast iron chairs must be reported, and the price has become stiffer at £3 12s. 6d. per ton net at works.

Plates and angles are in very poor request, owing to the depression in the shipbuilding industry, but it is expected that with the expected settlement of the trouble with the joiners and plumbers, the experience will improve somewhat. The output of plates and angles by the mills in the North of England cannot be even half of what it was in the busy times, as so many of the mills are altogether closed. Steel ship plates are quoted at £5 10s., steel ship angles at £5 5s., iron ship plates at £6 5s., iron ship angles at £6 2s. 6d., and packing iron at £5 10s., all less 2½ per cent. f.o.t. The rise in hematite pig iron makes the condition worse for the manufacturers of the finished material, who cannot put up their prices in proportion. Common iron bars are in quiet request at about £6 5s. less 2½ per cent. f.o.t.

In the engineering industry nearly all the men have agreed to the modified claims of the employers. The new engine works of Messrs. Robert Stephenson and Co. at Darlington are fully occupied. A few days ago they shipped the first engines which they have constructed at this establishment — four coupled bogie express locomotives for the Oudh and Rohilkund Railway in India. They are building several express engines for the South-Eastern and Chatham Railway to work the continental mail trains between London and Dover. These engines are to have cylinders 19in. diameter; heating surface, 1505 square feet; working pressure, 180 lb. The total weight of the engines in working order will be 90 tons. A contract for several goods engines for the Cambrian Railway Company has also been secured by Messrs. Robert Stephenson and Co.

The coal trade has slackened off appreciably, the cause being found in the curtailment of the American demand, the increase in which brought so brisk a time for the coalowners of this district.

NOTES FROM SCOTLAND.

(From our own Correspondent.)

THERE has been a better feeling in the iron market this week, with more disposition on the part of consumers to purchase. The business done in the warrant market has been chiefly in Cleveland iron, Scotch warrants being still confined to few hands, and difficult to dispose of. This state of matters is accounted for largely by the fact that ironmasters' prices have been tending lower, and consumers can readily obtain supplies direct from the ironworks.

Several considerations have tended towards a firmer feeling in the market, among them being an improvement in the south, and more encouraging reports regarding the state of trade in the Midlands. But our market appears to have been chiefly affected by the settlement of the wages dispute on the Clyde. It was feared a week or two ago there might be a strike, but the workmen have accepted the reduction of 5 per cent., and this has been a great relief to all concerned.

Scotch warrants are quoted 53s. to 53s. 1d. cash, and 53s. 3d. one month. Business has been done in Cleveland warrants at 47s. 7½d. to 47s. 9d. cash, 47s. 10d. for delivery in seventeen days, and 47s. 10½d. to 48s. 1½d. one month. Cumberland hematite is quoted 58s. 9d. to 58s. 6d. cash, and one month, sellers.

There is a steady business doing in Scotch hematite pigs, which are quoted 60s. 6d. per ton for delivery in railway trucks at the West of Scotland steel works.

The prices of Scotch makers' iron are fairly steady. G.M.B., No. 1, is quoted at Glasgow, 57s.; No. 3, 52s. 6d.; Wishaw No. 1, 57s.; No. 3, 53s.; Carnbroe, No. 1, 59s.; No. 3, 56s.; Clyde, No. 1, 63s. 6d.; No. 3, 58s.; Gartsherrie and Calder, Nos. 1, 64s.; Nos. 3, 58s. 6d.; Summerlee, No. 1, 68s.; No. 3, 58s. 6d.; Coltness, No. 1, 69s. 6d.; No. 3, 59s. 6d.; Langloan, No. 1, 69s. 6d.; No. 3, 58s. 6d.; Glengarnock at Ardrossan, No. 1, 65s.; No. 3, 57s. 6d.; Eglinton at Ardrossan or Troon, No. 1, 58s.; No. 3, 54s. 6d.; Dalmellington at Ayr, No. 1, 58s. 6d.; No. 3, 54s.; Shotts at Leith, No. 1, 66s.; No. 3, 58s. 6d.; Carron at Grangemouth, No. 1, 67s.; No. 3, 58s. 6d. per ton.

The shipments of pig iron from Scottish ports in the past week amounted to 7617 tons, compared with 3774 in the corresponding week of last year. Of the total, there was dispatched to the United States 700 tons, Canada 560, South America 160, India 45, Australia 185, France 60, Italy 905, Germany 41, Holland 300, Belgium 20, China and Japan 160, other countries 45, the coastwise shipments being 4436, against 2125 in the same week of last year.

The arrivals of Middlesbrough pigs at Grangemouth in the past week were larger than usual, amounting to 12,920 tons, showing an increase of 6874 tons over the imports in the corresponding week of 1902.

There are 42 furnaces making hematite, 39 ordinary, and 5 basic iron, the total of 86 furnaces thus blowing in Scotland comparing with 82 at this time last year.

Since last report the stock of pig iron in Glasgow warrant stores has been reduced about 700 tons, but the tendency to remove iron from store is rather falling away, owing to the ease with which supplies can be obtained direct from the ironworks.

The demand for finished iron and steel is slow, but it is a matter of congratulation that a dispute in the engineering and shipbuilding trades has been averted. A few fresh orders are reported to have been placed with shipbuilders, and if the freight market should begin to show a decided improvement, the likelihood is that there would be more doing in the building of merchant vessels. At present, however, shipowners have very little inducement to extend their enterprise in that direction.

Among the fresh orders just placed are 300 30-ton wagons for the Caledonian Railway Company. The order is a large one, and, as the company is anxious to have delivery as soon as possible, it has been distributed among a number of firms, these being the Leeds Forge Company, Limited; R. Y. Pickering and Co., Limited, Wisbaw; the Amalgamated Company, Limited; the Birmingham Wagon Company, Limited; Hurst, Nelson and Co., Limited; and W. R. Renshaw and Co., Limited.

The coal trade is, on the whole, in a fairly satisfactory state. The total shipments in the past week from Scottish ports were 217,454 tons, compared with 210,911 in the preceding week and 182,576 in the corresponding week of last year. There has been a falling off of 5000 tons in the exports from Fife, but this has been more than made up at other ports. The general feeling in the inland trade is slightly easier, and in some districts the output is not very readily carried away, but, on the whole, the trade is in a satisfactory condition, and prices are fairly well maintained. Steam coal is quoted at Glasgow harbour, 9s. 9d. to 10s.; ell, 9s. 9d. to 10s. 6d.; and splint, 10s. 6d. to 10s. 9d. per ton. There is a brisk inquiry for splint coal, and coal for manufacturing purposes is generally active.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

THE coal trade Sub-committees have been busily occupied of late in scheduling all information from the collieries regarding the practice observed with reference to the supply of coal to the colliers. This is for the use of the General Committee at the next meeting. One is reminded, by the mass and the difference of method, of the labour once undergone by the founder of the sliding-scale in gathering material for the formulation of his system. If the success attained by the latter be gained by the Joint Committee also, one of the stumbling-blocks will be removed. The belief in an amicable settlement is retained, though there are objections raised by the Federation to a longer settlement than that of twelve months. This, many critics consider too short for trial. In the anthracite district, from one end to the other, the suggested "combination" is a leading topic, though beginning to arouse less interest.

One authority says that prices have tumbled down considerably since the boom, and are some 6s. lower. At the pit's mouth a common quotation is 12s. per ton. This is thought to be favourable to the scheme. Best malting this week was quoted from 17s.; Swansea Valley big vein, 12s. 6d.; culm is stiffening, and is now at 4s. 9d. Steam coal at Swansea is at 14s.; house, from 14s. 6d.

At Cardiff the great complaint is non-arrival of tonnage; but one day—Friday—last week, there was an exceptionally good despatch, no less than twenty-nine vessels, some of large tonnage being sent away with over 75,000 tons. A statistician works this out as of the value of £35,000, taking small, bunker coal, &c., into consideration. Monday's prices for best steam were as low as 13s. 6d., and mid-week no improvement was shown. The only good sign was in an active forward market, and there is some expectation that better times are ahead in steam. House coal has been a disappointing market this season, and even now demand is falling. Small steam is tolerably brisk; supply greater than demand. Monmouthshire semi-bituminous dull. Patent fuel in fair inquiry, and Swansea makers are more hopeful; prices rather low. Coke industry good and prices firm. Pitwood is again suffering from large imports. The first indications of fair trade bring over cargoes from Ireland, Spain, and France, and prices drop. They are down 6d. this week, and sales vary from 16s. 9d. to 17s.

At Cardiff an improvement is shown in outward chartering, West Italian ports, Plate, Genoa, Marseilles, are all looking up. Mediterranean not brisk.

The Transatlantique Company has entered into arrangements for 175,000 tons steam coal, priced from 13s. 3d. to 13s. 7½d. Cambrian collieries have secured 100,000 tons; Naval, 50,000; and the Universal, 25,000 tons.

The Johnston line, Swansea, opened business well last week with its first clearance of general cargo for ports in Greece and the Danube.

At Dowlais it is stated that a couple of furnaces of the old type, which are now being demolished, will be the site of the most modern examples of furnace construction. Similarly in other parts of the iron districts great changes are being carried out. At Nettlefolds the new works are on the eve of starting. The blast furnaces at Landore with their new equipment are doubling the output, and at Llanelly W. Thomas and Co. have a great scheme of extension in their steel departments for which already the requirements for mills and engines are being placed. At Llansamlet another furnace is in preparation. Pig iron has gone up 3d. Rails and bars remain unchanged in price. Sheets (steel) are now up to £7 17s. 6d., and iron £8 2s. 6d. Tin-plate dispatches have been very large—117,323 boxes; receipt from works 56,863 boxes; leaving stocks down to 144,402 boxes. Buyers are pressing for reductions, which are not likely to be conceded with block tin and steel bars at present prices. The trade is only partially brisk, as Llanelly complains of slackness, and shutting down some works is in contemplation. On 'Change, Swansea, this week the further advance in block tin to £136 7s. 6d. was considered. There will be a strong effort not only to retain present prices, but, if possible, obtain higher figures. Spelter works are very busy, and Swansea Valley industries are generally in a satisfactory condition. Ten refineries in full drive at Dillwyns, Vivians, Morriston, Middle Bank, Morfa, and Grenfels are all active.

Steel rails continue strongly in evidence. At the close of the week 2000 tons went to Kurachee, with 500 tons railway iron from Cardiff; and large consignments have been going since to home destinations, principally from Newport. The vitality in the Welsh iron and steel trades continues to attract notice in various quarters: Dublin has been sending large quantities of old rails and scrap to Swansea, Belfast 350 tons old iron to Newport, and Plymouth, Portsmouth, and Southampton are supplying scrap steadily. From Rotterdam to Newport a varied consignment has come in, including the usual steel sheet bars, a quantity of steel wire, and some steel wire nails. Ironmasters in Wales are complaining of the falling off in demand for steel bar, but, fortunately, steel rails are in demand, and the large works, such as Dowlais, Cyfarthfa, and Ebbw Vale are busy with ore imports from Castro, Duddon, and Bilbao. Llanelly is complaining of deficient trade, but one day this week imported five cargoes of pig iron, one of scrap from Preston, and one of bars from Rotterdam.

The keel plate of a new armoured cruiser was laid at Pembroke Dock last week. The length is to be 480ft., tonnage 13,000, and speed 22½ knots.

The Railway Servants' Union decided a few days ago to abandon all other suggested proceedings, and to pay the Taff Vale Railway £23,000. This step is regarded with approval, and now in trades union industrial history the contest will be relegated to those of celebrated causes.

The Taff Vale directors will now have a free hand to enter as pioneers upon electric traction. I hear that they have decided to carry out experiments on one of their branches, and should it be successful, it is probable that it will be generally adopted by them. This, railway men regard as amongst the probabilities, though not in the near future.

Another new colliery company is announced, the Coronation Collieries, shares at a popular figure, one that is steadily gaining ground. Briton Ferry, Aberdare, and Tredegar capitalists.

Port Talbot, Rhondda, and Swansea Bay, and Taff Vale, all show improved revenue returns.

On the eve of my dispatch I hear of the death of an eminent engineer in North Wales in the person of Captain Benjamin Williams, who has figured in most of the lead mine operations as engineer. He was also engaged in various important tunnelling operations, both in England and Wales, by the London and North-Western Railway. He was in his seventieth year.

On Saturday evening, Mr. G. M. Stevenson, now a consulting engineer at Cardiff, who was for nearly twelve years engineering manager at the Wern Works, was presented with a costly high-speed indicator by the workmen of those works.

NOTES FROM GERMANY.

(From our own Correspondent.)

THIS week's accounts concerning demand and employment on the Rhenish-Westphalian and Silesian iron market have been tolerably satisfactory; the tone all round is firmer, and more confidence is shown in the future development of the iron industry.

A tendency upwards has been perceptible in most departments of the Silesian iron industry, and the rolling mills could obtain better prices in several instances, home consumption having decidedly improved. Girders are in moderately strong request, and the sheet mills have also been well occupied, while the heavy plate trade, though generally more lively than in former weeks, still leaves a good deal to be desired.

In Rheinland-Westphalia many works have secured orders for several months ahead, and there is increasing employment reported from most departments, only prices are still unsatisfactory. Consumption in pig iron improves. The Siegerland pig iron convention has sold 10,000 t. 20 p. ct. M. spiegeleisen to America, to be delivered till end of June of present year. Scrap iron is in languid request, while for billets and blooms a very strong demand was experienced upon the week. In girders, plates, and hoops, inquiry has been improving lately, but is still far from brisk or extensive. There is much life stirring in the wire department.

An abatement in demand could be felt on the German coal market so far as house coal was concerned. The requirements in engine fuel have been fairly large, and are likely to increase. The syndicate collieries of the Ruhr district last month yielded 400,000 t. more than during January last year. A good export in coal is being done from Rheinland-Westphalia to France and Belgium, and Rhine shipments increase.

Pig iron is very quiet and neglected on the Austro-Hungarian iron market, and there is not the slightest symptom perceptible of the usual revival and spring business. All branches of the iron and steel trade are in a very poor condition. Some of the Bohemian machine factories have secured orders from sugar mills, but these are hardly sufficient to secure moderately good employment, and many shops have been forced to restrict their operations. Also coal is in very dull request in Austria-Hungary, while coke shows a fair liveliness.

Changes of importance cannot be stated to have taken place on the French iron market; business in the Department Nord has shown some slight improvement, and in the Haute-Marne too a lively trade continues to be transacted, while in the Ardennes very little life is stirring.

The prices for coal remain exceedingly firm in France, as demand all round is strong, and the tone of the market decidedly satisfactory.

The strong tendency of former weeks has been well maintained on the Belgian iron market, and though prices are unaltered for the present, there is good reason to expect a rise in quotations in the immediate future. Girders are in animated request, and fetch 115f. p.t. f.o.b. Antwerp; forge pig, 53f. p.t., free Athus, and 57f. to 58f. p.t., free Charleroi; foundry pig, 60f. p.t., free Athus; and basic, 64f. p.t. Bars, No. 2, 135f. p.t. for inland consumption, and £5 2s. 6d. for export. Iron plates, No. 2, 135f. p.t. for home demand, and £5 4s. for export; plates in basic, 140f. p.t. for inland, and £5 8s. for foreign consumption. Scrap iron has been offered from abroad at 69f. p.t., free Antwerp, being shipped as ballast to that port.

In spite of the mild weather coal has remained very firm in Belgium, and there is, consequently, little prospect of a falling off in quotations, which ironmasters had been looking forward to. For small dry coal a slight rise has taken place already, and production up to end of September is reported to have been sold at 9·50f. and 10f. p.t. Best steam coal is bought at 14·50f. p.t., and the price for Fénu coal will be 11·13f. and 15f. p.t. till end of March of present year. Coke is firm; total make till end of second quarter has been sold, quotations varying between 18f. and 20f. p.t.

The value of the Servian general export in 1902 is stated to have been 72,103,372f., which is 5,581,413f. more than in 1900, when value of export reached the highest figure of 66,521,959f. From beginning of 1900 to end of 1902, total value of Servian export was 204,311,014f., which is, on an average, 68,109,960f. annually. From beginning of 1890 to end of 1892 value of export was 144,572,042f., which is, on an average, 48,190,680f. per annum. The increase in value of export thus amounts to 20,000,000f.

On Friday last the German Emperor, with the Crown Prince, Prince Henry of Prussia, and Princess Henry, visited the works of Ludwig Loewe at Berlin.

AMERICAN NOTES.

(*From our own Correspondent.*)

NEW YORK, February 5th.

EIGHT vessels have arrived during the past three days carrying 32,962 tons of coal. During the same time vessels carrying 19,477 tons left the other side, and orders were placed for 16,652 tons. Other large orders will be placed very soon. The scarcity of coal is a serious matter along the Atlantic seaboard. Much industry is hampered by the inability of railroad companies to make large and sufficient deliveries. Large orders have also been placed for pig iron abroad, and our dependence on foreign sources appears to be increasing. Steel billets have advanced in price, the minimum price at Pittsburg to-day being 30 dols., while sheet bars are held at from 31 dols. to 32 dols. at makers' mills. Foreign billets are influenced by the advance in ocean freight rates, because of the large tonnage engaged in the transportation of coal. Foreign iron, which had a downward tendency a short time ago, now shows an advancing tendency. Steel billets have recently advanced 50 cents per ton under a pressure from buyers, who fear any further delay in providing for summer and autumn requirements.

Steel rails are very strong, and could command higher figures, but it is contrary to the policy of railmakers to advance prices. Another tunnel is projected in the interests of the New York Central Railroad. It will be a link between this road and the Pennsylvania. It will be half a mile long, and 50ft. underground. The projected tunnel system under New York City will revolutionise transportation facilities, and result in many changes on the surface as to the disposition of freight. Railway engineers are now working on plans which have not yet been made public, looking to a very great increase in railway transportation facilities in and around this city. New York merchants are greatly concerned over the possibilities of losing commercial prestige, and they, with railroad managers, are conferring as to the best methods to adopt for the future to protect New York trade. They recognise that steamships bringing imports into this port must be able to secure promptly full outward cargoes. New York never expects a return of the tramp steamers on a large scale. They have been driven out by the cargo steamers of the White Star Line, the Atlantic Transport Company, and the steamers of the German lines. At present the New York railroads have their facilities so absolutely taxed both in regard to locomotives and cars and road beds that they cannot physically compete with other ports. Engines and cars might be added to any extent, but the trouble with New York is deficiency of road beds leading from it to the interior. The only remedy is the enlargement of the Erie Canal to a sufficient extent to compensate for what the railroads are unable to do.

Everything points to a well-sustained activity in commercial and industrial circles for months to come. Profits are declining somewhat on account of advancing raw material, but this is not a serious matter as yet. Large crops will make everything safe. Present high prices are stimulating an increased acreage of wheat, corn, and cotton. The country has survived the effects of last year's short corn crop. The railroads are everywhere congested with freight; they are making big money, and planning enlargements on a grand scale, and are entering into arrangements for supplies of iron and steel to carry out projected work.

The copper market is advancing. The total amount of copper shipped from Atlantic ports across the water was 10,936 tons. During the last week of January 3235 tons were shipped, making the shipments for the entire month 9625 tons, compared with 15,474 tons for January, 1902. Pig tin is also strong, and deliveries for consumption in this country were the largest on record, amounting to 3300 tons, while stocks were reduced 3367 tons. The quantity afloat was very large, making the total visible supply for the country over 8000 tons. Pig lead is very active, and the market closes firm at 4.12½. The American Smelting and Refining Company has reduced its price at St. Louis to 4 cents. Spelter is quiet and firm at 4.85 at St. Louis.

NEW YORK, February 10th.

The Pennsylvania Railroad Company is now seeking authority from its stockholders to increase its capital stock from 235,000,000 dols. to 400,000,000 dols. Of this increase 70,000,000 dols. will be expended in work already projected on various parts of its system. Much of this will be expended in and around New York City. All of the railroad companies are planning additional expenditures over those recently announced. Great difficulty is experienced in obtaining an adequate supply of motive power and rolling stock. Engines are being worked to death, and rolling stock is being tumbled into the scrap heap despite the intense activity at all repair shops. The railway system will be an enormous purchaser of equipment during this year. A new steel car plant of larger capacity than any now existing is to be erected near Pittsburg. The measure providing for the expenditure of 82,000,000 dols. on the Erie Canal will now be passed. New York people feel that in addition to provid ing a deep waterway to the Lakes, it will be necessary to provide extensive facilities for the handling of grain and merchandise at this city in the way of stationary and floating elevators, docks, warehouses, and other facilities, the estimated cost of which has just been announced at 14,000,000 dols. Recent figures show that returns from 168,000 miles of railroad for the past year show an increase in gross earnings over 1901 of 91,999,218 dols. The gains in gross receipt were largely absorbed by augmented expenses, due to higher operating cost, higher priced fuel, material, supplies, and wages.

The copper market is full of interest. The consumption for 1902 was the largest in the history of the trade. During the past seven months exports from the United States to Europe have been at the rate of about 11,000 tons per month. Should this rate continue for the rest of the year it will denote a shrinkage of at least 30,000 tons compared with the previous year. Pig tin market is somewhat irregular, latest quotation for spot 28·75 dols. to 28·97½ dols. Lead is unchanged at 4·12½ dols., spelter is steady at 4·95 dols., and at St. Louis 4·85 dols.

The steel market presents no features of special interest. Buyers are able to remain out of the market, having placed very large orders, but they will be eventually obliged to meet the terms of manufacturers. Production is still curtailed by causes frequently heretofore referred to, namely, deficiency of fuel. Reports from Pittsburg indicate maximum activity in all lines. Open hearth billets are 31 dols. at mill, though this price has been shaded in two or three very large transactions. Bessemer billets are scarce at 30 dols. Basic sheet bars are 31·25 dols.; open hearth, 32 dols.; beams and channels are quoted at 1·60 dols. at mill; sheared plates, 1·60 dols. to 1·85 dols.; puddle bars, 33 dols.; rails 38 dols. for standard sections; Bessemer rods, 36 dols. The demand for merchant pipe is very heavy in Pennsylvania mills; very little business is being done in iron or steel scrap; reports from Cincinnati show very little activity in crude iron. In all markets finished material is rather quiet, though an occasional large order is placed. There is a very urgent demand for machinery, and a large volume of business will be submitted during the month of March. Liberal orders are being received from England, Australia, and New Zealand. Engines, pumps, and conveying machinery are especially active, and orders for export are more frequent than they have been for months. A great deal of oil territory is now being opened up, and facilities for the handling of it will be erected, contracts for supplies now being placed. The fuel question continues to be the disturbing one; both anthracite and bituminous miners will receive an advance, the former probably 10 per cent., the latter probably 15 per cent. All the influences at work appear to indicate a higher cost in manufacturing in almost all lines. This does not necessarily involve an advance to consumers, as the margin is sufficiently broad to permit of the maintenance of current quotations.

THE NEWPORT HARBOUR COMMISSIONERS' WEEKLY TRADE REPORT.

STEAM coal market is easier, and for prompt shipments prices are lower. House coal unchanged. The quantity of coal shipped for the week ending February 14th was 58,276 tons. Foreign, 45,219 tons; coastwise, 13,057 tons. Imports for week ending February 17th:—Iron ore, 9050 tons; steel bars, 3137 tons; pig iron, 950 tons; scrap, 350 tons; boards, 716 loads; pitwood, 7663 loads.

Coal: Best steam, 12s. to 12s. 3d.; seconds, 11s. 6d. to 11s. 9d.; house coal, best, 15s.; dock screenings, 7s. 3d.; colliery small, 6s. 9d. to 7s. Pig iron: Scotch warrants, 53s. 3d.; hematite warrants, 58s. 6d., f.o.b. Cumberland prompt; Middlesbrough No. 3, 48s. 1d. Iron ore: Rubio, 14s. 9d. to 15s.; Tafna, 15s. 6d. Steel: Rails, heavy sections, £5 5s. to £5 10s.; light ditto, £6 5s. to £6 10s., f.o.b.; Bessemer steel tin-plate bars, £4 10s. to £4 12s. 6d.; Siemens steel tin-plate bars, £4 12s. 6d. to £4 15s., all delivered in the district, cash. Tin-plates: Bessemer steel coke, 12s. 3d. to 12s. 4½d.; Siemens, coke finish, 12s. 4½d. to 12s. 6d. Pitwood, 17s. ex ship. London Exchange telegrams: Copper, £57 17s. 6d. to £58; Straits tin, £135 7s. 6d. to £135 10s. Freights firm.

A RUSSIAN AGRICULTURAL SHOW.—The Imperial Moscow Agricultural Society, following the example of our own similar body, intends, we are credibly informed, to hold a show in the coming summer on its own model estates, near Moscow. The leading British manufacturers will probably be asked to exhibit examples of their work. Our trade in agricultural implements with Russia is of no little importance, and in face of the competition which we have to meet, it is desirable that no opportunity of retaining and enlarging that market should be lost.

CARBORUNDUM.—This remarkable substance is a silicide of carbon formed by the action of carbon and silica at the high temperature of the electric arc. It was first obtained accidentally by Mr. Acheson, in America, in 1891, in endeavouring to produce artificial diamonds. In fact, carborundum is neither more nor less than an artificial diamond, and therefore Mr. Acheson was in a sense successful, and doubly so if account be taken of the large and important field it may perhaps occupy in the future as a refractory material, to say nothing of its abrasive properties. Carborundum is a crystal of some beauty, combining in itself all the prismatic colours and the sheen of silk; it is nearly as hard as the diamond, quite infusible, and even proof against boiling acid. A piece white hot can be plunged into cold water without affecting it. It is prepared as a powder, to be subsequently made into a plastic paint, which is used to cover the inside of a furnace, kiln, or retort, *i.e.*, the fire-bricks, after fitting, are painted, and this thin protection is, we are told, absolutely sufficient to prolong the life of the bricks many times over. For special trades, such as cement calcination in rotary kilns, the thickness of the carborundum must be much greater, but special bricks are being experimented with for this purpose. Mr. Grant Baillie, of Charlton-road, Blackheath, S.E., has been for some time conducting experiments with carborundum, and has, we understand, been appointed sole agent for the sale of carborundum in the London district. The process of manufacture has been patented by Herr Engel, of Düsseldorf.

MECHANICAL ENGINEERING OF MODERN COLLIERIES.—At the meeting of the Birmingham Association of Mechanical Engineers held on Saturday evening at the Grand Hotel, there was a large number of members present to listen to a paper on "The Mechanical Engineering of Modern Collieries," read by Mr. Bardill, of Aston. The speaker traced the development of various appliances found necessary by the mining engineer to cope with the ever-increasing demand for fuel. In 1860 the total coal raised in the United Kingdom was 80,042,698 tons; in 1900 the total output was 225,170,163 tons. This remarkable increase was not due so much to the increase in collieries as to the increase in the number of tons brought to the surface daily, rendered possible by the better mechanical appliances at the command of the colliery manager. Thus, whilst about twenty-five years ago a daily output of coal from one shaft of 300 to 500 tons per day would have been impossible, to-day there are collieries which raise from 2000 to 3000 tons per day, mined, brought to the surface, screened, and often in the hands of the consumer on the same day. Thus, at Bolsover Colliery, no fewer than 3217 tons 5 cwt. have been drawn from a depth of 365 yards in nine hours. A week's record at the Cambrian Collieries, Clydach Vale, raised from a depth of 450 yards, was the grand total of 13,019 tons. The most difficult question in mining was how to keep pits free from water, and it was worth noting that the first use steam engines were ever put to was for draining a mine, for it was on record that in the year 1712 Thomas Newcomen erected his first pumping engine near to Wolverhampton. A pumping engine, bought second-hand in 1829, was still working in the Midlands. Coal screening had now become a great feature of the modern colliery, from twelve to fourteen different classes of coal being made at one mine, all differing in size and quality. A modern coal-screening installation was a triumph of inventive skill. The lecture was illustrated by a large number of excellent photographs thrown on a screen.

TRADE AND BUSINESS ANNOUNCEMENTS.

MESSRS. LEWIS OLRICK AND CO., of 27, Leadenhall-street, ask us to announce that they are removing to new offices in Palmerston-house, Bishopsgate-street.

THE Unbreakable Pulley and Mill Gearing Company, Limited, informs us that it has appointed as its agents in Egypt and the Soudan, Messrs. Nahman and Co., of Cairo and Place Mohammed Aly, Alexandria.

MESSRS. BEYER, PEACOCK AND CO., Gorton Foundry, Manchester, have just taken an order for thirty-seven powerful goods locomotives for the Great Central Railway. Twelve of these engines are of the six wheels coupled type with a leading bogie, and twenty-five of the six-wheels coupled class. They are to be fitted with Belpaire fire-boxes.

THE Clyde Shipbuilding and Engineering Company, Port Glasgow, have contracted with a Liverpool firm for the construction of six steamers, each 400ft. in length. As the vessels are to be delivered in a limited period, the firm will require to get two of the steamers built by other builders, but will themselves supply the six sets of engines. This is the largest order placed on the Clyde for thirty years, and will employ all the idle men in the lower reaches of the Clyde.

THE Corporation of Colchester has just recently accepted the tender of Messrs. Mather and Platt, Limited, Salford Ironworks, for a 136-kilowatt dynamo for direct coupling to a Davey-Paxman engine. This machine when working compound will give an output of 550 volts and 650 ampères at a speed of 300 revolutions per minute, and when working as shunt it will give 460 volts, 800 ampères at the same speed. The specification requires that the machine should be capable of standing an overload of 10 per cent. for two hours, or of 25 per cent. momentarily.

THE votes taken by the joiners in the shipbuilding yards of the Tyne and the Tees, who are on strike, upon the question whether they would accept the employers' modified proposals to settle the wages dispute or not were counted on Wednesday night at Newcastle-on-Tyne. The offer made was that the reduction in the wages should be 1s. per week, instead of 1s. 6d., as was originally demanded. The voting is understood to show a decisive majority against the proposals. The strike has now continued for more than three months, and the employers threaten to close all the shipbuilding yards unless the dispute is settled.

THE Radcliffe Urban District Council has just accepted the tender of Messrs. Mather and Platt, Limited, Salford Ironworks, for the supply of additional plant for the electricity works. This additional plant consists of two steam dynamos, each comprising a Browett and Lindley two-crank compound engine, and a Mather and Platt 120-kilowatt multipolar dynamo. These machines are wound to give an output of 550 volts and 220 ampères when working compound, and 480 volts and 250 ampères when working shunt, both at a speed of 450 revolutions per minute. In addition Messrs. Mather and Platt, Limited, are supplying a jet condenser with an Edwards three-throw pump, driven by an electric motor, for dealing with 15,000 lb. of exhaust steam per hour; also one of their variable stroke electrically-driven pumps for boiler feed.

CATALOGUES.

J. S. COCK, Christiania.—General catalogue in Swedish of this firm's manufactures.

JOHN ABBOT AND CO., Limited, Park Works, Gateshead.—This is the second edition of the hydraulic catalogue. It contains one hundred pages of text and illustrations admirably produced and bound. A table of contents would be a welcome addition.

THE INSTITUTE OF SANITARY ENGINEERS.—The following meetings will be held during March:—March 4th, Special Council meeting, at 7 p.m.; March 11th, Examination and Literary Committee at 3.30 p.m.; General Purposes and Finance at 4.15 p.m.; Election Committee at 5.15 p.m.; members' sessional meeting, 7 p.m., paper by Mr. L. Aglio Dibdin on "General Municipal Engineering." March 27th and 28th, Examination in Practical Sanitary Science.

SANITARY ASSURANCE ASSOCIATION.—The twenty-second annual meeting of the members of this Association was held on Monday last at the offices, 5, Argyll-place, W., Mr. Andrew Stirling, president, in the chair. In the annual report the Council expressed regret that the principle of sanitary registration of dwellings and other buildings as first embodied in the Sanitary Registration Bill promoted by the Association has not yet received the sanction of Parliament. The income of the year was £232, which, after meeting all liabilities, left a balance in hand. The report was adopted, and the retiring members of the Council, Professor T. Roger Smith and Mr. Mark H. Judge, were re-elected.

INSTITUTION OF CIVIL ENGINEERS: GLASGOW ASSOCIATION OF STUDENTS.—The fifth general meeting of the present session of this body was held in the Institution Rooms, Bath-street, Glasgow, on the 16th inst., Mr. A. Home Morton, vice-president, in the chair, when Mr. W. Foulis, jun., read a paper on "Water-tube Boilers," in the course of which he discussed the advantages and disadvantages of water-tube, as compared with the cylindrical boiler, for both land and marine purposes. The author briefly described, by the aid of a number of well-made models, the better known types of water-tube boilers, and drew attention to the advantages claimed for each type. An interesting discussion followed.

THE INSTITUTION OF ELECTRICAL ENGINEERS.—About Easter in each year, in accordance with the Articles of Association, the Council prepares a list of Members and Associate Members or Associates, to fill the several vacancies that there will be on the Council at the ensuing annual general meeting. This list must be read at an ordinary general meeting, four weeks or more before the annual general meeting. The Council now invites members to assist them in the preparation of this list by sending to the secretary suggestions of suitable names; all those so sent in will be considered by the Council, who, with this list before them, will select the names of the Members, Associate Members, and Associates, whom they will in due time nominate in the prescribed way to fill the several vacancies.

ROYAL AGRICULTURAL SOCIETY OF ENGLAND.—The following competitors have entered for the trials of wind pumping engines for the prizes of £50 and £20 offered by the Royal Agricultural Society of England. These trials will commence in the Society's new permanent showyard in London—between Willesden and Ealing—on Monday, March 2nd, being continued, at the discretion of the judges, until April 30th, 1903:—C. F. Bamford, 6, Goldington-avenue, Bedford; C. Cadle, 39, Wellington-quay, Dublin; R. L. Capell, implement agent, Northampton; Duke and Ockenden, 126, Southwark-street, London, S.E.; Goold, Shapley and Muir Company, Limited, Brantford, Canada; Hole and Roberts, Boreham-road Ironworks, Warminster, Wilts; John McBain and Son, Chirnside, Berwickshire; P. and W. Maclellan, Limited, 129, Trongate, Glasgow; J. S. Millar and Son, Annan, Dumfriesshire, four-post frame and three-post frame; E. and H. Roberts, Limited, Deanshanger Ironworks, Stony Stratford; Russell and Co., 42, Berwick-street, Oxford-street, W.; H. P. Saunderson and Co., Limited, Elstow Works, Bedford, 20ft. wind wheel and 16ft. wind wheel; H. Sykes, Limited, 66, Bankside, London, S.E.; Thomas and Son, 64, Broad-street, Worcester; John Wallis Titt, Warminster, Wilts, 30ft. wind wheel, 16ft. direct driven, and 16ft. indirect driven; R. Warner and Co., 97, Queen Victoria-street, E.C., 16ft. wind wheel and 20ft. wind wheel; T. C. Williams and Sons, Limited, London-street Ironworks, Reading. We have already given—see our issue of February 6th, page 151—the conditions under which these trials will be carried out.

THE PATENT JOURNAL.

Condensed from "The Illustrated Official Journal of Patents."

Application for Letters Patent.

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

5th February, 1903.

2746 Electric Service Main, J. R. Craig, jun., Glasgow.
2747. Propelling Ships, H. B. Beeny, London.
2748. Gas Producer, J. Fielding, Gloucester.
2749. Tobacco Pipes, W. Beal, Birmingham.
2750. Cork-drawing Machines, C. Chambers, Birmingham.
2751. Irons for Laundries, J. W. Blakey, Bradford.
2752. Device for Supporting Wreaths, A. P. Bruce, Manchester.
2753. Rotary Pulverising Harrow, W. Cottam, Manchester.
2754. Match Boxes, G. Royle, London.
2755. Expansion Valves, J. Rodda, jun., Camborne, Cornwall.
2756. Detachable Puncture Guard, H. Brooks, Stirchley, near Birmingham.
2757. Developing Photographs, R. von Goldammer, London.
2758. Rope Pulleys, W. Vick and J. F. Johnson, London.
2759. Rope-climbing Device, C. E. Knop, London.
2760. Pneumatic Boot Tree, G. Evans and J. Holmes, London.
2761. Harness for Stopping Animals, G. Soffner, London.
2762 Manufacture of Reflectors, C. H. Worsnop, Halifax.
2763. Aerated Water Machines, T. and J. W. Ritson, London.
2764. Heels for Boots and Shoes, W. Lingard, London.
2765. Slating, W. Jackson, London.
2766. Elastic Exercising Apparatus, T. Belvoir, London.
2767. Vaporisers for Explosion Motors, G. Banzhaf, London.
2768. Automatic Life-saving Apparatus, T. Andreasen, London.
2769. Studs for Horseshoes, G. Clegg, E. Fisher, N. Goodall, and A. H. Ramsden, London.
2770. Trolley Poles of Electric Cars, G. A. Baker, London.
2771. Manufacture of Sera, E. C. Bousfield, London.
2772 Motor Tractors, F. R. Simms, London.
2773. Combined Billiard Tables, F. R. Wright, London.
2774. Ratchet-operated Switches, W. Kingsland, London.
2775. Making Annealing Pots, H. Niewerth, London.
2776. Non-refillable Bottles, F. B. Aspinall, London.
2777. Bedsteads, R. Cane, London.
2778. Sand-blast Apparatus, H. H. Lake.—(*Société Des Nouvelles Machines a Jet De Sable, France.*)
2779. Case for Copying Apparatus, M. Farmer and the Oliver Typewriter Company, Limited, London.
2780. Atmospheric Gas Burners, T. Glover, London.
2781. Pump, G. Smith, London.
2782. Flooring, T. Charteris, London.
2783. Apparatus for Making Bricks, Sutcliffe, Speakman and Co., Limited, and E. R. Sutcliffe, London.
2784. Trucks for Electric Tramcars, E. Hatton, London.
2785. Pocket Corkscrews and Tools, S. R. G. Vaughan, Birmingham.
2786. Sighting of Guns, Sir W. G. Armstrong, Whitworth and Co., Limited, and A. A. Common, London.
2787. Machines for Making Lace, A. Matitsch, London.
2788. Machines for Making Lace, A. Matitsch, London.
2789. Shackles, S. S. Sugden, London.
2790. Blind Rods, J. E. Andrew, London.
2791. Cots, W. Crowther, London.
2792. Moulding Machines, W. P. and T. F. Trenery, London.
2793. Automatic Stokers for Furnaces, A. J. Boult.—(*The Luckett Stoker Company, United States.*)
2794. Caps for Loom Spindles, J. W. Schofield, London.
2795. Tires, O. Betts, London.
2796. Pianofortes, L. Loewenthal and A. C. Taunton, London.
2797. Chairs, E. Atkins, London.
2798. Trousers' Protector or Mudguard, C. Morsison, London.
2799. Hones or Whetstones, W. R. Jervis, London.
2800. Electric Bells, Y. M. Harscoët-Braouézec, London.
2801. Piano, C. Mand, London.
2802. Slabs for Building Purposes, C. Geiser, London.
2803. Ash-guards for Domestic Hearths, C. Coates, London.
2804. Elastic Substance, K. Geiser and H. Kehrli, London.
2805. Magnetic Clutches, C. Jenatzy, jun., London.
2806. Production of Water Gas, H. S. Elworthy, London.
2807. Vans for Transporting Cycles, C. MacKenzie, Liverpool.
2808. Fog-signalling Apparatus, H. F. Clayton, London.
2809. Producing Coloured Effects, O. Imray.—(*Farbwerke vormals Meister, Lucius, and Brüning, Germany.*)
2810 Means for Feeding Packing Machines, W. Rose, London.
2811. Drill, K. Happel, London.

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2812. Machine for Propelling Ships, H. B. Beeny, London.
2813. Iris Diaphragms, H. J., A. S., and G. A. Spratt, London.
2814. Exhaust Steam Feed-water Heater, S. McComb, Dundalk.
2815. Trimming Photographic Prints, H. Scruton, London.
2816. Machine for Surgical Bandages, C. Blair, Liverpool.
2817. Stopping Ships, H. W. Creetch, Douglas, Isle of Man.
2818. Machine for Filing Wood, W. R. Avenell and S. Davies, Birmingham.
2819. Improved Letter Boxes, G. E. Drake, Birmingham.
2820. Folding Chairs, B. Kaufmann, Liverpool.
2821. Mail Carts, Perambulators, &c., W. A. Tookey, London.
2822. Dynamos, T. W. S. Hutchins, Blackpool.
2823. Domestic Fire Ranges, R. W. Oddy, Huddersfield.
2824. Carriage Windows, C. McKay and A. J. Stone, Bristol.
2825. Bogie Catcher for Coal Pits, T. Dunsire, Buckhaven, Fife.
2826. Aerial Machines, G. Wellner, Manchester.
2827. Loom Shuttles, C. H. Roth, Manchester.
2828. Cisterns for Water-closets, M. Roberts, Manchester.
2829. Steam Boilers, J., J. and A. E. Thompson, Wolverhampton.
2830. Curtain Rod Raisers, F. Bumford, Newport, Mon.
2831. Pulleys for Automobiles, G. Pilkington, Birmingham.
2832. Side Saddles, T. U. Clarke, Birmingham.
2833. Apparatus for Reproducing Sound, E. Hitchon, Accrington.
2834. Treating Cloth Fabrics, J. W. Yates and G. Reekie, Manchester.
2835. Piston Expansion Valves, W. Truran, Stockton-on-Tees.
2836. Hand Trucks, P. R. J. Willis.—(*W. G. Tower and G. M. D. Southworth, United States.*)
2837. Fittings for Doors and Windows, H. Hotz, Liverpool.
2838. Heat Engines, R. Wood, Bottisham, Cambridgeshire.
2839. Corking Bottles, J. J. Chavasse and J. W. Kerr, Birmingham.
2840. Driving Wheels for Road Vehicles, E. Perkins and J. A. Rowcliffe, Manchester.
2841. Making of Gramaphone Needles, J. Morgan, London.
2842. Welts for Boots, R. Morris and H. Clarke, Manchester.
2843. Motor Chaise, G. C. Grimsdale, Enfield.
2844. Bleaching Compound, C. F. Townsend, Bromley, Kent.
2845. Holding Articles, P. Robertson and A. J. Dawson, Dundee.
2846. Blind Rollers, F. Stephenson, London.
2847. Door Knobs, G. Horne, London.
2848. Shuffling Playing Cards, A. V. Hunt, London.
2849. Electric Speed Regulator, W. A. Dutton, London.
2850. Clothes Horse, F. W. Wareing, London.
2851. Cold Cream, L. Swainson, London.
2852. Press for Copying Letters, B. C. Simpson London.
2853. Electic Lamp Holders, T. H. and T. L. Jones, Birmingham.
2854. Tension Fittings for Blinds, F. Wiseman, London.
2855. Machines for Ruling Paper, T. J. Hunt, London.
2856. Making Metal Canisters, W. A. Read, Liverpool.
2857. Ears of Trolley Wires, C. Close and J. Ramsey, London.
2858. Preventing Railway Accidents, P. Jakobi, London.
2859. Making Boards, F. L. Roeckner and W. J. Norris, London.
2860. Machines for Making Cigars, G. H. Catt, London.
2861. Machinery for Breaking up Roads, A. Coe, Ipswich.
2862. Coin-freed Ball Games, E. G. Matthewson, London.
2863. Applying Wrappers to Boxes, &c., W. Rose, London.
2864. Uniting Rails, S. M. Wixcel, Kingston-on-Thames.
2865. Electric Arc Lamps, C. Oliver, London.
2866. Heel for Boots, &c., J. C. and W. H. Harrop, London.
2867. Envelope Sealing Machines, L. Madas, H. S. Geary, and S. Neederman, London.
2868. Brake Apparatus for Guns, F. T. Fisher and F. W. C. Dean, London.
2869. Short-arm Clip, F. A. Pridmore and P. H. Nowell, London.
2870. Baby Jumpers, E. H. Turnbull, London.
2871. Valve-controlling Devices, A. G. Bloxam.—(*Wilhelmshütte Aktiengesellschaft für Maschinenbau and Eisengiesserei, Germany.*)
2872. Pulley Couplings, A. G. Bloxam.—(*Wilhelmshütte Aktiengesellschaft für Maschinenbau and Eisengiesserei, Germany.*)
2873. Gas, &c., Cooking Apparatus, C. Portmann, London.
2874. Intermediate Electric Switches, F. G. Terry, London.
2875. Convertible Mash Tun, A. J. Boult.—(*M. Henius, United States.*)
2876. Watch Cases, B. Gutmann, London.
2877. Locking Device for Gun Pivots, G. Ehrhardt, London.
2878. Dust Screen for Motor Vehicles, W. M. Fawcett, London.
2879. Clocks, A. Loebl, H. Scott, and The American Electrical Novelty and Manufacturing Company, Limited, London.
2880. Apparatus for Stacking Goods, R. Boyce, London.
2881. Shirt Wristbands, L. Cryer, London.
2882. Combined Commode and Foot Bath, E. Cooke, London.
2883. Pneumatic Tires, S. Fox, London.
2884. Method of Making Yarn, F. V. M. Raabe, London.
2885. Electric Switch or Cut-out, T. E. Slaughter, London.
2886. Boiler Furnace, E. Gearing and W. Rainforth, London.
2887. Steam Traps, P. Schütze, London.
2888. Apparatus for Punching Tickets, J. Metcalf, London.
2889. Flash-light Signalling Apparatus, J. Reid, London.
2890. Railway Switch and Semaphore Apparatus, W. A. P. Cosserat, J. P. O'Donnell, and E. C. Irving, London.
2891. Transmission Elements for Cycle Brakes, J. Kelland, London.
2892. Filing Cabinets, H. Simmons, Cleethorpes, Lincolnshire.

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2893. Waterproof Coat, J. E. Seaman and A. Jamieson, Bradford.
2894. Steering Axles for Motor Cars, W. W. Harrison, Birmingham.
2895. Travelling Trunks, R. Foxcroft, Littleborough, Lancs.
2896. Sprags for Motor Cars, W. J. S. Barber-Starkey and J. Rumball, Birmingham.
2897. Ash-pit Doors, C. Osborne and C. Aspinall, Stockton-on-Tees.
2898. Making Elastic Tires, P. A. and D. A. Martin, Birmingham.
2899. Elastic Tires, P. A. and D. A. Martin, Birmingham.
2900. Ticket Punch, A. C. Thomson and M. Fraser, Glasgow.
2901. Gasogenes, A. Bruce, Glasgow.
2902. Means of Obtaining Converging Pressure, J. E. Fletcher, L. Burrows, and T. A. Venimore, Sheffield.
2903 Switch for Electric Tramways, J. B. Crompton, Keighley.
2904. Insulators for Pianofortes, J. A. Derbyshire, Keighley.
2905. Hinged Covers for Seats, H. Baesler, Liverpool.
2906. Tobacco and Lamp Lighter, W. Smedley, Crewe.
2907. Electric Ignition, C. M. Linley and G. H. Smith, London.
2908. Method of Cutting Worm Gearing, R. Jackson, Liverpool.
2909. Lamp Reflectors, R. Jackson, Liverpool.
2910. Expanding Hoe Rakes, G. J. Garrett, Sutton-at-Hone, Kent.
2911. Promoting Combustion, O. St. L. Davies and J. Booth, Manchester.
2912. Cash Till, E. Corlett, Grantham.
2913. Healds of Looms, C. Riley, Burnley.
2914. Carburetting Device, W. H. Bird and W. H. Yates, Coventry.
2915. Connecting Lengths of Chain, W. Everitt, Coventry.
2916. Boiler Furnaces, W. J. Rollo.—(*P. S. Swan, India.*)
2917. Milk Cans, S. J. and E. Fellows, Limited, and W. H. Corker, Wolverhampton.
2918. Driving Belt Fastener, H. Mottram and F. G. Bowman, Manchester.
2919. Sheep Rack, The Kington Iron Foundry Company, Limited, and W. Williams, Kington, Hereford.
2920. Fireproof Floor for Buildings, J. Bassett, Birmingham.
2921. Operating Tramway Points, J. Crawford, Manchester.
2922. Miners' Lamps, H. M. Darrah and W. Patterson, Manchester.
2923. Shuttle Changing Motions for Power Looms, W. H. and H. H. Hacking, Bury.
2924. Preventing Over-boiling of Milk, A. P. le Duc, London.
2925. Weaving Fabrics, R. Beaumont and H. Priestman, Leeds.
2926. Push-in Valve Tap for Water, J. S. Walford, Birmingham.
2927. Treating Waste from Carding Engines, F. O. Partington, Manchester.
2928 Electric Tramway Systems, R. Zuppinger, London.
2929. Milk Cans, T. H. Hill and Sons, Limited, and T. H. Hill, Wolverhampton.
2930. Conduits for Electric Conductors, D. S. Munro, Glasgow.
2931. Feed Motions of Lathe Tools, W. B. Lang, Johnstone, near Glasgow.
2932. Cycle Carrier Clips, J. Kelland, London.
2933. Bicycle Rests, J. Kelland, London.
2934. Window Fasteners, C. E. Long and J. C. Irvine, London.
2935. Making Portable Medical Coils, J. A. Cole, London.
2936. Liquid Dispensing Apparatus, M. Masterson, London.
2937. Veterinary Speculums, R. J. Fleming, London.
2938 Controlling Flow of Gas Wells, G. R. Cheesman, London.
2939. Vulcanisation of Rubber, C. H. Gray, London
2940. Electric Lighting, M. Barr and E. le Riche, London.
2941. Water Circulating Device, W. and I. Darby, London.
2942. Wave-power Motor, D. K. Bryson, London.
2943. Teapots, L. Myers, London.
2944. Boot Brushes, K. Ray, London.
2945. Advertising Apparatus, L. M. Warburton, Sheffield.
2946. Producing Relief Decoration, H. Kerkmann, Birmingham.
2947. Securing Pens and Pencils, R. P. Green, London.
2948. Apparatus for Cleaning Threads, C. Meyer, London.
2949. Casein Solution, W. A. Hall, London.
2950. Trousers, A. G. Larkin, London.
2951. Safety Attachment for Locks, E. L. Ruggles, London.
2952. Window Stays, C. Coates, London.
2953. Wood Block Flooring, T. Charteris, London.
2954. Luminous Signs, A. F. Spooner.—(*H. Véry, France.*)
2955. Safety Device for Elevators, W. Jenkins, London.
2956. Shirt Cuff Edge Attachments, G. Craig, London.
2957. Vehicle Seats, A. Johnston and C. L. Collins, London.
2958. Measuring Liquids, H. F. Stanley and The Farringdon Works and H. Pontifex and Sons, Ltd., London.
2959. Physical Exerciser and Developer, A. Taylor, London.
2960. Making Indoxyl, A. Foelsing, London.
2961. Electrically-operated Semaphores, Siemens Bros. and Co., Limited, and L. M. G. Ferreira, London.
2962. Machines for Making Matches, S. Herzberg, London.
2963. Telegraph and Telephone Cables, G. F. Mansbridge, London.
2964. Valves, W. P. Thompson.—(*Schweizerische Locomotiv and Maschinenfabrik, Switzerland.*)
2965. Time-recording Apparatus, R. Bürk, Liverpool.
2966. Apparatus for Making Ice, W. Hartmann, Liverpool.
2967. Lifeguards for Tramcars, H. S. Conran, Liverpool.
2968. Roof Coverings for Tramcars, H. S. Conran, Liverpool.
2969. Artificial Hands, A. Daniels, Liverpool.
2970. Spoon, A. Mackey, Liverpool.
2971. Folding Table and Cabinet, L. H. Ellington, London.
2972. Clutch for Connecting Shafts, M. C. Johnson, London.
2973. Stenographic Recording System, A. C. Baronio, London.
2974. Apparatus for Sorting Corks, F. Bender, London.
2975. Bakers' Ovens, G. S. Baker and J. Baker and Sons, Limited, London.
2976. Electric Switches, E. Knipping, London.
2977. Explosive Signal Compounds, A. Brock, London.
2978. Tobacco Pipes, R. T. Sharman, London.
2979. Flushing and Cleaning Machines, A. L. Dubowik, London.
2980. Speed Regulation of Motors, E. S. W. Moore and T. L. Boyden, London
2981. Drying Potatoes, J. Y. Johnson.—(*The Aktien Maschinenbau-Anstalt, vormals Venuleth and Ellenberger, Germany.*)
2982. Springs, J. Weaver, London.
2983. Ash-pans, W. Whitaker and W. H. Wood, London.
2984. Hand-locking Levers, G. C. Marks.—(*A. A. Low, United States.*)
2985. Supporting Electric Wires, J. R. P. Lunn, London.
2986. Apparatus for Making Wines, G. Driancourt, London.
2987. Road-cleaning Machine, F. Huguet, London.

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2988. Electricity Meters, The Electric and Ordnance Accessories Company, Limited, and L. J. Aron, Birmingham.
2989. Inner Tubes of Pneumatic Tires, W. Sumner, Birmingham.
2990. Game for Teaching Music Notes, H. P. Miles, London.
2991. Producing Dyestuffs, A. Bang.—(*Dahl and Co., Germany.*)
2992. Operating Loom Healds, T. Pickles and B. Blakey, Manchester.
2993. Electric Influence Machines, A. Eckstein and H. J. Coates, Manchester.
2994. Electric Lamps, S. Horvath and J. H. Whitfield, West Green, Middlesex.
2995. Trailing-car Universal Joint, C. Heninghem, London.
2996. Engine Silencers, J. B. Dunlop and J. B. Dunlop, jun., Dublin.
2997. Spiral Grip Ship Propeller, F. C. Hurn, Cheltenham.
2998. Cycle Stands, R. Edmunds, Birkenhead.
2999. Towing Block, W. H. Warr, Great Grimsby.
3000. Axles for Road Vehicles, W. G. H. Sedwell, Bournemouth West.
3001. Utilising Waste Heat from Engines, H. Cutts, Nottingham.
3002. Puncture-sealing Device for Tires, A. Cook, Birmingham.
3003. Safety Lamp, A. Hyde, Liverpool.
3004. Piston Valves for Engines and Pumps, J. Hoyle, Manchester.
3005. Street Gullies, J. Exley, Sheffield.
3006. Balls for use in Playing Golf, T. Stewart, Glasgow.
3007. Drain Pipe Indicator, H. Dean, Birmingham.
3008. Firing Explosive Mixtures in Engines, L. C. Barker, Bristol.
3009. Affixing Stamps, E. Jones, London.
3010. Variable Electrical Resistances, A. H. Mayes, Hove, Sussex.
3011. Coat Buttons, A. V. H. Spink, Bradford.
3012. Muslin Rod Brackets, J. E. Parker, Birmingham.
3013. Discharging Sewage from Beds, A. G. Enock Manchester.
3014. Rack Pulleys, J. E. Parker, Birmingham.
3015. Bedsteads, B. C. Barton, Birmingham.
3016. Doors, H. W. Brown, Glasgow.
3017. Spring Hook, T. Leggett, Ramsgate.
3018. Ploughing Ground by Steam Engines, J. Zeman, Glasgow.
3019. Closets, M. J. and S. H. Adams, Scotswood-on-Tyne.
3020. Making Nitro-glycerine, F. L. Nathan, J. M. Thomson, and W. Rintoul, London.
3021. Cuff Button, H. Landman, Kansas City, Mo., United States.
3022. Peg-top Spinning Spindle, T. Sowden and H. Parker, Bradford.
3023. Non-fouling Composition for Hulls, C. T. W. Piper, Vancouver, Canada.
3024. Check Printers, F. Mutschler, London.
3025. Casement Stays, F. W. Adams, London.
3026. Boilers, W. P. Thompson.—(*A. Kemp-Welch, France.*)
3027. Milk-can Lids, J. Struthers, London.
3028. Machinery for Moulding Bricks, T. Parker, Roydon, Essex.
3029. Binders for Sheets of Music, A. Sharp, London.
3030. Operating Lift Gates or Doors, F. Hellewell London.
3031. Wrapping Machine, The Forgrove Machinery Company, Limited, and A. Forbes, London.
3032. Metronomes, T. Weisser, London.
3033. Transparent Writing on Glass, T. M. Ninnis, London.
3034. Centrifugal Separators, C. Herlitscka, London.
3035. Cleansing Fluids for Gas Engines, J. Hosking, London.
3036. Overcoats, A. Dunhill, London.
3037. Letter Box Attachment, J. H. Bathurst, London.
3038. Game, J. Withers and J. B. Rosevear, London.
3039. Tempering Saw Blades, W. F. Beardshaw and J. Beardshaw and Son, Limited, London.
3040. Locking Device, P. van Duijn and L. W. van Thiel, London.
3041. Elastic Tires for Vehicles, J. A. Mays, London.
3042. Electric Conduits, F. B. Aspinall and J. D. Dallas, London.
3043. Brakes, J. D. Keiley, London.
3044. Dress Hooks, S. H. Keeling and H. M. Picken, Birmingham.
3045. Nitro-cellulose Compound, H. Ensminger, London.
3046. Fire Escape, J. J. Johnston, London.
3047. Device for Draping Sleeves, M. F. Rocheleau, London.
3048. Cinematograph Apparatus, R. H. Edwards, London.
3049. Combs, F. Walmsley, London.
3050. Polishing Mills, W. O. Bailey, London.
3051. Preparation for Fining Wines, B. A. Garrod, London.
3052. Cigarettes, C. C. Parsons, London.
3053. Paper Files, E. G. Dow, London.
3054. Outlet Valve for Baths, A. W. Savill, jun., London.
3055. Refrigerating Apparatus for Milk, R. A. Lister and Co., Limited, and F. G. Phillips, London.
3056. Electric Lamps, J. B. B. Burke, London.
3057. Range Finder, J. A. F. Field, London.
3058. Apparatus for Photography, A. Popowitzky Liverpool.
3059. Studs, T. Baer, London.
3060. Petroleum, R. Haddan.—(*F. R. von Dahmen, Austria.*)
3061. Bolt Pullers, W. L. Harris, London.
3062. Variable Speed Gear, F. J. Cox, London.
3063. Paint Brushes, S. Hornsby, London.
3064. Ammunition Wagons, A. T. Dawson and G. T. Buckham, London.
3065. Device for Darning Stockings, J. T. Marsh, London.
3066. Necktie, R. Anvers, W. Harrad, T. A. Cash, and J. and J. Cash, Limited, London.
3067. Reading Divided Scales, H. Louis and J. W. Gordon, London.
3068. Finishing Metals for Lathes, F. M. McLarty, London.
3069. Mechanically Milking Animals, C. S. Padfield, London.
3070. Type Casting and Composing Machine, S. A. Bhisey, London.
3071. Joy, R. Uhrig, London.
3072. Telephone Apparatus, R. B. Ransford.—(*The Kellogg Switchboard and Supply Company, United States.*)
3073. Telephone Apparatus, R. B. Ransford.—(*The Kellogg Switchboard and Supply Company, United States.*)
3074. Telephone Apparatus, R. B. Ransford.—(*The Kellogg Switchboard and Supply Company, United States.*)
3075. Stop Valves, R. G. Brooke, London.
3076. Rotary Pump Bearings, A. G. Bloxam.—(*G. Sulzer, Switzerland.*)
3077. Hollow Glass Ware, J. L., C. V., F. J., P. R., and F. L. Arbogast, London.
3078. Pneumatic Signalling, E. C. Irving and J. P. O'Donnell, London.
3079. India-rubber Horseshoe Pad, R. H. and A. H. Coppin, Addington, Surrey.

10th February, 1903.

3080. Telephone Transmitter and Switch, B. Brander, Birmingham.
3081. Workman's Bottle, A. Stephenson, Wingate, Co. Durham.
3082. Rims for Cycle Wheels, C. von Hagen, Manchester.
3083. Roller Bearing for Lamps, A. Bahrfeldt, Manchester.
3084. Self-acting Mules and Twiners, T. Thornley, Bolton.
3085. Cycle Saddles J. B. Brooks and J. Holt, Birmingham.
3086. Harness Saddles, P. A. Martin, Birmingham.
3087. Roof Gutterings, H. Ronald, Birmingham.
3088. Tying Waist Bands, A. Hepburn, Birmingham.
3089. Solid Rubber Tires, E. B. Killen, Belfast.
3090. Manipulating Disc, G. J. Goodall, Stoke-on-Trent.
3091. High-speed Engines, A. Boyd, Stockton-on-Tees.
3092. Stud-hole Protectors, J. R. Cassidy, Burnley.
3093. Cycles, W. Findlay, Glasgow.
3094. Protectors for Gauge Glasses, G. W. Butlin, Leeds.
3095. Motor Bicycles, A. A. Taylor and H. H. Beak, Bristol.
3096. Railway Vestibule Carriages, W. S. Laycock, Sheffield.
3097. Piston Packing Rings, W. H. Wilson, Glasgow.
3098. Wheels for Motor Vehicles, J. R. Croft, Glasgow.
3099. Draining Condensed Steam, W. B. Cleverly and W. J. Tranter, Birmingham.
3100. Reversible Drawback Locks, A. Foster, Wolverhampton.
3101. Manufacturing Producer Gas, C. Whitfield, Manchester.
3102. Indicating Device for Tramcars, I. Boulton, Manchester.
3103. Wood-working Machinery, S. Dean, Halifax.

3104. CARRIERS for VELOCIPEDES, H. G. Turner, Coventry.
3105. STOVES, R. Hindle and A. Reay, Hetton-le-Hole, R.S.O.
3106. LOCKS, W. K. Kaye, Bradford.
3107. DRIVING GEAR of MOTOR VEHICLES, F. C. Noar, Manchester.
3108. PRODUCING COLOUR TRANSFORMATIONS, H. Lester, Cardiff.
3109. WASHING FIBROUS MATERIALS, H. Courteen, London.
3110. HEATING APPARATUS, A. Hill, Glasgow.
3111. SIMPLIFYING the PLAYING of MUSIC, J. Hill, London.
3112. COMBINED "REST" for BILLIARDS, H. Jackson, London.
3113. DRAWING-OFF TAPS for LIQUIDS, A. and J. Gordon, Glasgow.
3114. DOVETAIL "SNUGS" for STOVES, D. Gillies, Glasgow.
3115. WRINGING MACHINES, J. D. McCallum and A. Stewart, Glasgow.
3116. TWO-SPEED HUBS for CYCLES, H. I. Jacques, Bristol.
3117. VARIABLE GEARING for ENGINES, F. Mitchell, London.
3118. FILLING STUFF for MATTRESSES, H. Kehler, Glasgow.
3119. PURSE, T. Wilcox, Birmingham.
3120. REMOVING WATER from CYLINDERS of PAPER-MAKING MACHINES, J. White, Glasgow.
3121. PORTABLE LEG REST, F. Cartwright, Glasgow.
3122. EASELS, J. Stevenson, Glasgow.
3123. HARVESTERS for POTATOES, G. Paton, jun., Glasgow.
3124. KNIVES for SLICING BACON, A. Sambrook, Birmingham.
3125. RAILWAY COMMUNICATING APPARATUS, A. Brook, London.
3126. NUT LOCKS, A. R. Mulvane, Glasgow.
3127. BUSTLE and HIP FORM, C. H. Scott, Glasgow.
3128. VARIABLE SPEED CLUTCH, J. H. Wyatt, St. Leonards-on-Sea.
3129. BRAKE MECHANISM for BICYCLES, W. H. Smith, Coventry.
3130. CHUCK ATTACHMENT to LATHES, O. H. Stead and T. R. Smith, Birmingham.
3131. THERMO FEEDING BOTTLE, R. J. A. and P. Stone, London.
3132. MUFFLERS, W. Scheuer, London.
3133. STEAM TRAPS, R. Warriner, London.
3134. HAT for ADVERTISING, H. S. and W. E. Woodyer, Manchester.
3135. BOOT for ADVERTISING, H. S. and W. E. Woodyer, Manchester.
3136. INSTRUMENT for SHOWING the TIME, R. W. Jenkins, Hatfield Broad Oak, Essex.
3137. BOOTS and SHOES, W. Barber and J. Lawrence, London.
3138. TOASTING BREAD over a SPIRIT LAMP, E. Drew, London.
3139. FEED-WATER HEATERS for BOILERS, I. Watts, London.
3140. BAND for WALKING STICKS, T. Robinson, London.
3141. OIL LAMPS PRODUCING an INCANDESCENT LIGHT, W. Currie, Belfast.
3142. ELECTRIC FUSE SWITCHES, J. J. Stockall, jun., London.
3143. CLOTH-FOLDING MECHANISM for BOOKBINDING, F. D. Taylor and The Smyth Manufacturing Company, London.
3144. COVER for PROTECTING BOOKS, W. J. Radford, London.
3145. APPARATUS for DELIVERING CHECKS, A. Marsh, London.
3146. WINDMILLS, B. Russell, London.
3147. SUBSTITUTE for CELLULOID and HORN, The British Xylonite Company, Limited, and J. N. Goldsmith, London.
3148. IMPARTING STIFFNESS to RIBBONS, C. E. Dixon, London.
3149. STRAINING LIQUIDS, F. Bailey and F. H. Jackson, London.
3150. EXTRACTING FATTY MATTERS from BONES, W. R. Smith and E. G. Scott, London.
3151. APPARATUS for DRYING GRAIN, J. G. King, London.
3152. CUTTING PAPER, J. Deiches and W. Hartmann, London.
3153. APPARATUS for SPINNING YARN, J. Hayden, London.
3154. DUMPING CARTS, A. Laporte, London.
3155. LOCKING LAMPS in their HOLDERS, J. C. Taylor, London.
3156. VENTILATING PORTS, H. H. Lake.—(*J. W. Atlee, United States.*)
3157. FITTINGS for EXERCISING APPARATUS, F. W. Croucher, London.
3158. APPARATUS for MAKING COILS for ELECTRICAL APPARATUS, E. A. Carolan.—(*The General Electric Company, United States.*)
3159. MACHINE for BENDING LEATHER, P. Cousin, London.
3160. LAMPS, R. W. Neale, Birmingham.
3161. LADIES' UNDERWEARING APPAREL, K. Morgan, London.
3162. RHOMBOIDAL, W. N. Gething, London.
3163. ROLLING MILLS, B. Gerdau, London.
3164. SWITCHBOARDS, E. Parry, London.
3165. BRUSHES, E. R. King, London.
3166. ROLLING SHEET METAL STRIPS, G. B. Johnson, London.
3167. RAIL BONDS, W. E. Oakley, London.
3168. SCARF or NECKTIE FASTENER, E. A. Herr, London.
3169. COLOUR PRINTING, H. W. L. Hurst, London.
3170. ELECTRIC BRAKES for WHEELS, R. W. James.—(*The Algonquin Electric Brake Company, United States.*)
3171. FLASH-LIGHT SIGNALLING APPARATUS, J. Reid, London.
3172. COIN-FREED APPARATUS for ELECTRICITY, F. H. Urry and W. Haydon, London.
3173. ARTIFICIAL PERFUME, O. Imray.—(*Farbwerke vormals Meister, Lucius and Brüning, Germany.*)
3174. MANUFACTURE of ULTRAMARINE, C. F. Cross, London.
3175. ROOF STRUCTURES, H. Aikon, London.
3176. GOLF BALLS, L. E. Amedroz, London.
3177. PREVENTING CHIMNEYS CRACKING, E. Burzlaff, Reading.
3178. PRESERVING WOOD, S. E. Haskin, London.
3179. MANUFACTURE of IMITATION HORN, R. Rausch, London.
3180. MACHINES for CLEANING COTTON, R. E. Evans, London.
3181. MAKING of WRENCHES, C. Landeker and F. Albert, London.
3182. MANUFACTURE of ORTHOAMIDOPHENOLSULPHO-ACID, R. B. Ransford.—(*L. Cassella and Co., Germany.*)
3183. TELEGRAPHY, R. B. Ransford.—(*The Delany Foreign Company, United States.*)
3184. MULTIPLE-CYLINDER ENGINES, B. M. Young and W. G. Murray, London.
3185. DISH COVERS, A. Lawrie, London.
3186. RAILROAD TRACKS, T. J. Middlebrooks, London.
3187. SPEED GOVERNORS, A. J. Riley and J. Warry, London.
3188. CUTTING IVORY, C. Traeger, London.
3189. MINERAL SALTS, E. Langheld, London.
3190. MATTRESS, J. R. Nolon and F. R. James, London.
3191. PHOTOGRAPHIC SHUTTERS, A. J. Boult.—(*H. Ernemann, Germany.*)
3192. CENTRIFUGAL MILK and CREAM SEPARATORS, A. J. Boult.—(*The Ramesohl and Schmidt Aktien-Gesellschaft, Germany.*)
3193. SPEED INDICATORS, A. J. Boult.—(*O. G. and H. C. Glöckner, Germany.*)
3194. SMELTING of ORES, E. H. Schwartz, London.
3195. ELECTRICAL MEASURING and INDICATING INSTRUMENTS, E. Du Bois, London.
3196. PRODUCTION of PHOTOGRAPHIC PICTURES in NATURAL COLOURS, J. Szczepanik, London.
3197. THERMAL STORAGE for STEAM AUTOMOBILES, W. J. Davy, London.
3198. ARC LAMPS, J. A. Rignon, London.
3199. ELECTRICAL TRANSMISSION of POWER, O. D. Lucas, London.
3200. OBTAINING MEASUREMENTS from DIVIDED SCALES, W. Love, London.
3201. CENTRIFUGAL CREAM SEPARATORS, W. P. Thompson.—(*E. Garin, France.*)
3202. CENTRIFUGAL CREAM SEPARATORS, W. P. Thompson.—(*E. Garin, France.*)
3203. AUTOMATIC PRESSURE REDUCING VALVE, H. S. Elworthy, London.
3204. TROLLEYS and TROLLEY POLES, A. L. Tyerman, Liverpool.
3205. MANUFACTURE of SOAP, P. C. D. Castle, Liverpool.
3206. MANUFACTURE of MOTHER of PEARL, P. C. D. Castle, Liverpool.
3207. RETAINING LADIES' SKIRTS in POSITION, H. B. Harris, Liverpool.
3208. MINERAL WATER BOTTLE BOXES, J. Edwards, Liverpool.
3209. SADDLES for VELOCIPEDES, R. Couëtoux, Liverpool.
3210. TABLE for PHONOGRAPHS, A. A. Bergman, Liverpool.
3211. GASOLINE GAS MACHINE, J. T. Wood, United States.
3212. GENERATOR for GASOLINE GAS MACHINES, J. T. Wood, United States.
3213. SAFETY BRAKES for ELEVATORS, F. Houle, United States.

11th February, 1903.

3214. FLOWER HOLDER, W. J. Cross, Birmingham.
3215. CLUTCHES, F. S. Willoughby, Manchester.
3216. SPRAY CARBURETTERS, A. L. Oram, Birmingham.
3217. LOOM SHUTTLES, W. Lord, Manchester.
3218. HAMMOCKS and HAMMOCK CHAIRS, W. Cutler, Birmingham.
3219. PREVENTING ACCIDENTS from OVERHEAD TROLLEY WIRES, J. Titley, Birmingham.
3220. VENTILATING SHAFTS, Hardy and Padmore, Limited, and J. Southall, Worcester.
3221. LAVATORY BASINS, A. Sherwin, Hanley.
3222. ADJUSTABLE LOOP GUARD for HATS, J. Deeks, London.
3223. HYDRAULIC APPARATUS, J. C. Etchells, Manchester.
3224. LOCKS for DOORS, L. W. Sharpe, Manchester.
3225. MAKING of PLASTER of PARIS, W. Brothers, Manchester.
3226. HANGERS for OVERHEAD TROLLEY WIRES, A. Richardson and W. H. Allen, Manchester.
3227. KNIFE CLEANERS, E. Roberts, London.
3228. COMBINED HUB and AXLE-BOX, W. Kenyon, Southport, Lancs.
3229. DELIVERING MATCHES, A. Jamieson-McGregor, Glasgow.
3230. GOLF BALLS, J. H. Roger, Glasgow.
3231. SCARFS, G. E. Mycroft, Nottingham.
3232. MIDDLINGS PURIFIERS, R. J. Fowler and G. Briddon, Manchester.
3233. GAS FITTINGS, T. Gregson and R. Ramsbottom, Manchester.
3234. CLOSET FLUSHING CISTERNS, J. Wood, Manchester.
3235. STEAM ENGINES, W. Thom and E. A. Pickup, Manchester.
3236. TREATING HIDES for TANNING, S. K. Felton, jun., Manchester.
3237. SOCKET FASTENING for SCARFS, T. Dymond, Southampton.
3238. CATCHING ANIMALS, F. C. Lynde, Withington, Manchester.
3239. CLEANING PIPES, J. F. Phillips and W. Sutton, New Ferry, Cheshire.
3240. PICKING UP PING-PONG BALLS, J. Rogers, Birmingham.
3241. SLEEVE LINKS, F. Marson, Birmingham.
3242. REGULATING FEED CURVES on SCUTCHERS, E. Walter, Germany.
3243. GAS-LIGHTING DEVICE, H. Clauss and W. Schmandt, Glasgow.
3244. ELECTRIC IGNITION, A. Eckstein and H. J. Coates, Manchester.
3245. SPRING CHECK NUTS and RINGS, R. Lindsay, Dundee.
3246. RAZOR PASTE, S. F. B. Knowles and F. G. Cole, Brixham, Devonshire.
3247. DAMPING PAPER, P. E. Trainer, Gorton, near Manchester.
3248. INTERCHANGEABLE SPEED GEARS, C. T. Crowden, London.
3249. LUBRICATION of MACHINERY, T. Clarkson, London.
3250. GUARDS for SELF-PROPELLED CARS, J. W. Mellor, London.
3251. CLIPS for the STEMS of HANDLE-BARS, E. W. Bohle, Birmingham.
3252. LIDS of DISHES and BOXES, E. A. Jones, Birmingham.
3253. HARDENING STEEL, E. A. Down, Loughton, Essex.
3254. PREVENTING TIRES SKIDDING, C. A. Hunton, London.
3255. TIRES for WHEELS of VEHICLES, W. M. Edwards, London.
3256. SCALES, H. Hausrath, London.
3257. AUTOMATICALLY WEIGHING GOODS, H. Hausrath, London.
3258. HOLDING DEVICE for COLLARS, J. Hueber, London.
3259. ADDING and RECORDING MACHINE, W. H. Pike, jun., London.
3260. AFFIXING STAMPS, J. R. Turner and M. Stimpson, London.
3261. TAP for CORKED BOTTLES, T. S. Paynter, London.
3262. TUMBLING BLOCK, J. Inches and J. Huteson, Grimsby.
3263. VENTILATORS, Ewart and Son, Limited, and F. J. D. Hülinghurst, Wendover, Bucks.
3264. MACHINE GUARDS, E. Williamson and F. A. Schmidt, Tunbridge Wells.
3265. APPARATUS for RECORDING DISTANCE, G. E. Prince, London.
3266. APPARATUS for PRODUCING SOUND VIBRATION in WATER, H. H. Lake.—(*Submarine Signal Company, United States.*)
3267. STUD, J. de Koningh, London.
3268. FIRE-EXTINGUISHING APPARATUS, A. E. Percy, London.
3269. SEALING BOTTLES, W. P. Thompson.—(*G. S. Gilchrist, Argentina.*)
3270. MANUFACTURE of GLASS ARTICLES, P. T. Sievert, Liverpool.
3271. GRINDING APPARATUS, B. Graf, Liverpool.
3272. MATURING SPIRITS, F. Boyling, London.
3273. PICTURE FRAMES, A. Woodgate, London.
3274. ELECTRICITY METERS, Theiler and Co., London.
3275. FOLDING MACHINES, A. Brad, London.
3276. FISHING REELS, T. R. Preedy, London.
3277. GROUPING GAS PURIFIERS, H. Allen and B. D. Henley, London.
3278. GAS PRODUCTION and DISTRIBUTION, B. H. Thwaite, London.
3279. CLOCK CASES, G. F. Bley and H. Williamson, Limited, London.
3280. TROUSERS PROTECTOR, W. G. Walker and W. Bryan, London.
3281. CONTROLLING LIFTS, H. Hein and Möller-Holst, London.
3282. FILM CARTRIDGES, Kodak, Limited.—(*W. B. Cline, United States.*)
3283. PACKING for STUFFING-BOXES, W. Kollermeyer, London.
3284. DRIVING GEAR of VEHICLES, J. A. McMullen, London.
3285. BOILER, J. B. Prudhon, London.
3286. RACK for HOLDING LINEN, &c., G. Greiff, London.
3287. COVERS or STOPPERS of VESSELS, J. Maiden, London.
3288. ILLUSION DEVICES, H. H. Lake.—(*A. A. Welsh, United States.*)
3289. DIVIDING COMPASSES, T. Stang and H. Gullestad, London.
3290. DEVICES for SUSPENDING CURTAINS, W. J. Poole, London.
3291. WINDOW SASHES, W. S. Sturges, London.
3292. TREATING BARK, C. E. Stephan, London.
3293. HINGE, T. J. Hubble, London.
3294. ARTIFICIAL STONE, J. Purvis and T. Rouse, London.
3295. PRESSES, T. Conley, London.
3296. APPARATUS for HEATING, J. E. and J. E. Bennett, London.
3297. RECTIFYING and TRANSFORMING CURRENTS, G. Bamberg, London.
3298. TELESCOPIC LADDERS, &c., J. W. Pearson, London.
3299. NEEDLES for SEWING MACHINES, W. L. Webster, London.
3300. OVERHEAD SEWING MACHINES, W. L. Webster, London.
3301. WASHABLE WALL PAPERS, E. F. W. U. Grabau, London.
3302. RECIPROCATING PUMPS, F. C. Haste and C. W. Milne, London.
3303. TOYS, F. A. Antenpohl and L. Weigand, London.
3304. FRICTION WHEEL SPEED GEAR, M. Güttner, London.
3305. AUTOMATIC HINGES, C. Philippi and H. Maurer, London.
3306. FEED PUMP for STEAM GENERATORS, L. Friedmann, London.
3307. COKE OVENS, The Otto-Hilgenstock Coke Oven Company, Limited.—(*C. Otto and Co., Germany.*)
3308. MAKING BRICKS, O. Imray.—(*Carborundum Company, United States.*)
3309. RELEASING BRAKE LEVERS, A. Beaugeois, London.
3310. BRAKE for ROLLING STOCK, A. Beaugeois, London.
3311. LINING of AXLES, W. H. Tomson and W. G. Hanna, London.
3312. FASTENING WIRE FENCING, J. Harrison and N. C. Cockburn, London.

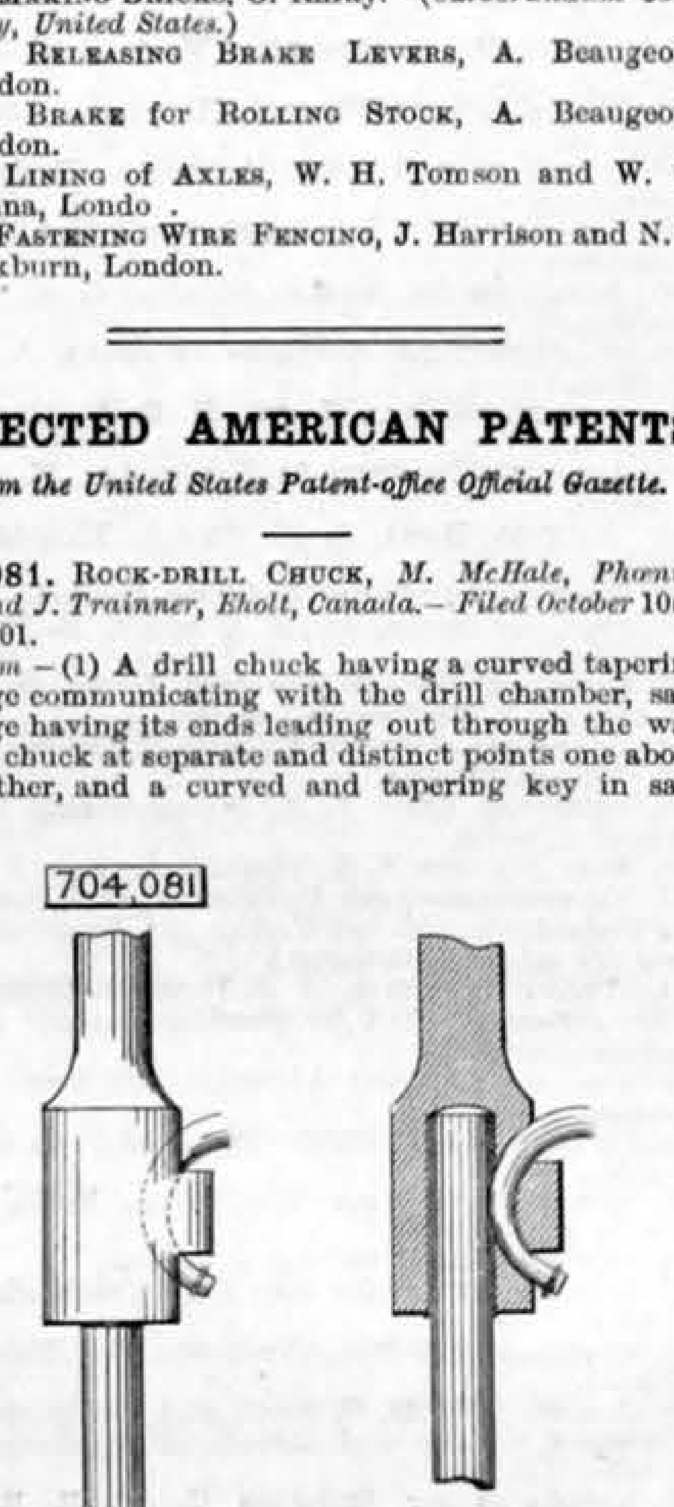
SELECTED AMERICAN PATENTS.

From the United States Patent-office Official Gazette.

704,081. ROCK-DRILL CHUCK, *M. McHale, Phœnix, and J. Trainner, Eholt, Canada.—Filed October 10th, 1901.*

Claim.—(1) A drill chuck having a curved tapering passage communicating with the drill chamber, said passage having its ends leading out through the wall of the chuck at separate and distinct points one above the other, and a curved and tapering key in said

704,081

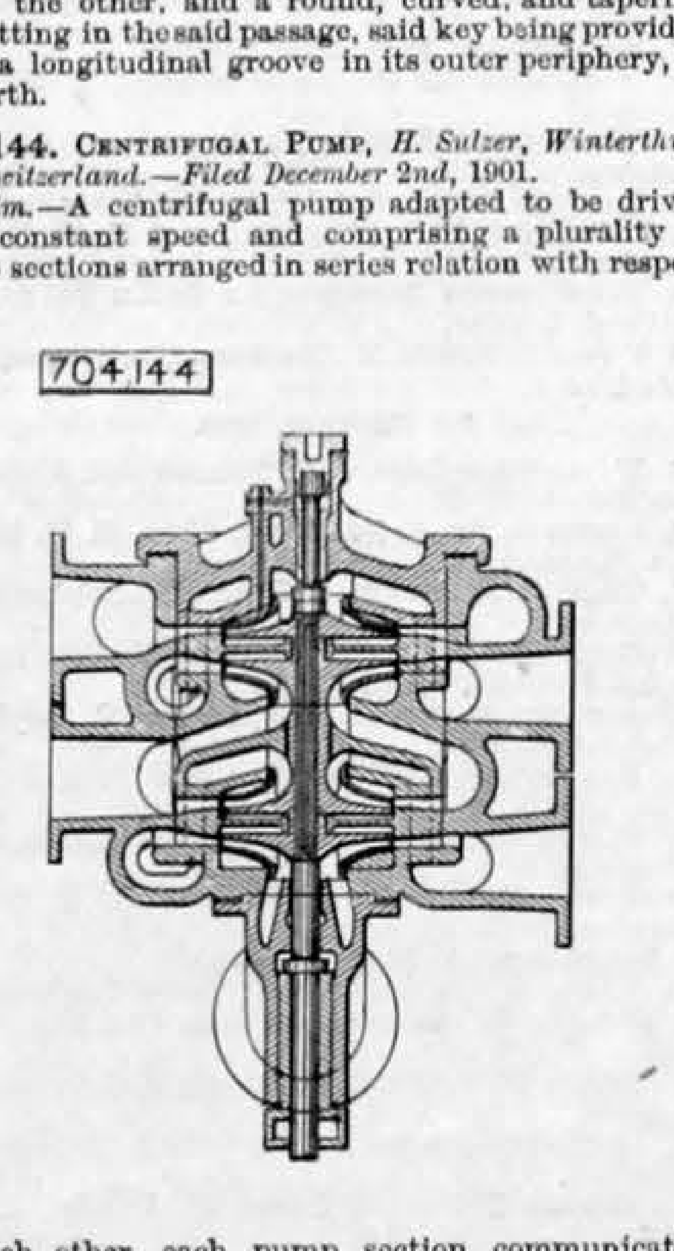


passage, as set forth. (2) A drill chuck having a curved tapering passage communicating with the drill chamber, said passage being circular in cross section and having its ends leading out through the wall of the chuck at separate and distinct points, one above the other, and a round, curved, and tapering key fitting in the said passage, said key being provided with a longitudinal groove in its outer periphery, as set forth.

704,144. CENTRIFUGAL PUMP, *H. Sulzer, Winterthur, Switzerland.—Filed December 2nd, 1901.*

Claim.—A centrifugal pump adapted to be driven at a constant speed and comprising a plurality of pump sections arranged in series relation with respect

704,144

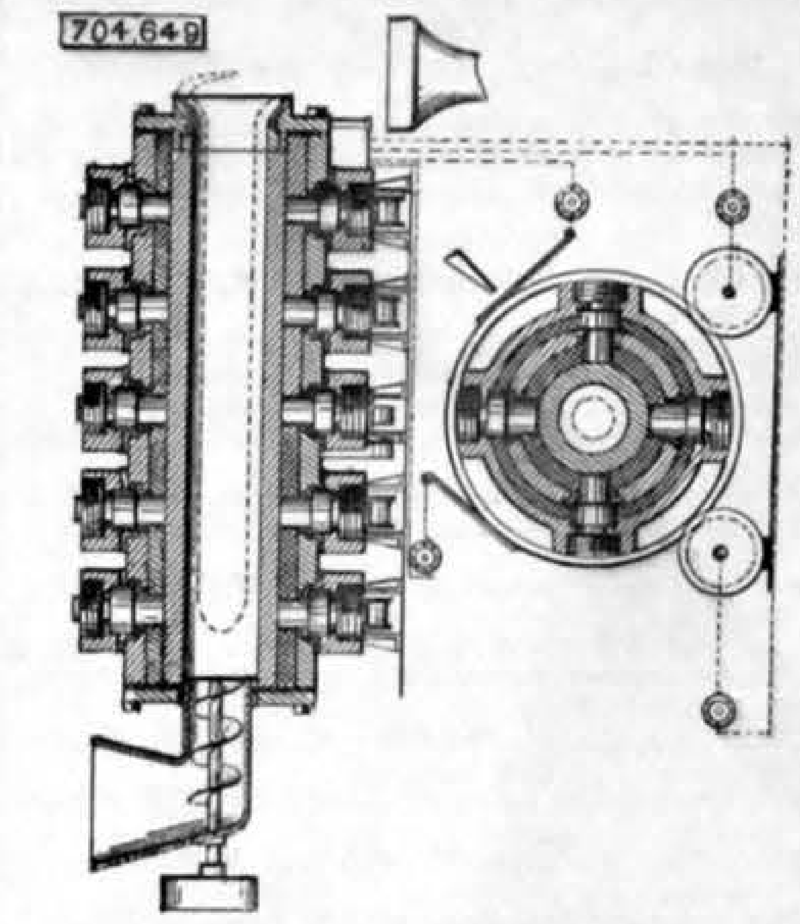


to each other, each pump section communicating independently with the outlet, whereby by opening one or the other of such communications the lifting power of the pump may be varied without varying its speed, as and for the purpose set forth.

704,649. ELECTRICAL FURNACE FOR TREATING HIGHLY - REFRACTORY SUBSTANCES, *H. Maxim, Brooklyn, N.Y.—Filed October 30th, 1901.*

Claim.—(1) In an electrical apparatus for making calcium carbide, an electrical circuit, a carbide conductor included in said circuit, whereby said conductor is maintained incandescent, means delivering carbide-forming materials to the heating field, and means uninterruptedly moving the calcium carbide from the heating field as fast as formed. (2) In an electrical apparatus for making calcium carbide, an electric circuit, a carbide conductor included in said circuit, whereby said conductor is maintained incandescent, and means continuously moving the calcium carbide from the heating field as fast as formed. (3) In an electrical apparatus for making calcium carbide, an electric circuit, a carbide conductor included in said circuit, whereby said conductor is maintained incandescent, means moving the calcium carbide from the

704,649

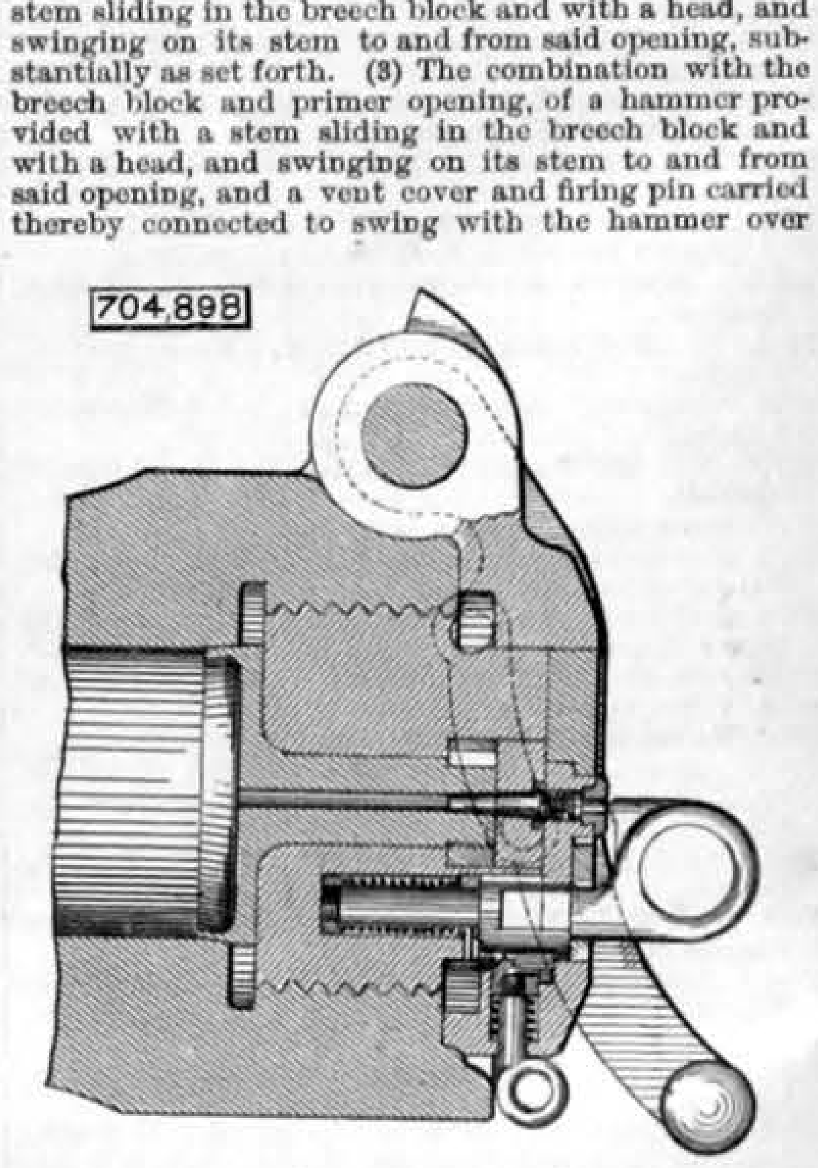


heating field as fast as formed, and means supplying carbide-forming materials to the heating field.

704,898. BREECH MECHANISM, *J. F. Meigs, South Bethlehem, and S. A. S. Hammar, Bethlehem, Pa.—Filed July 31st, 1900.*

Claim.—(1) The combination with the breech and breech block provided with sectional threads or collars, of a frame carrying the breech block and having a recess, a guide rod extending along the recess, a rack bar mounted to slide on the guide rod, and a lever connected to operate the rack bar, substantially as set forth. (2) The combination with the breech block and the primer opening, of a hammer provided with a stem sliding in the breech block and with a head, and swinging on its stem to and from said opening, substantially as set forth. (3) The combination with the breech block and primer opening, of a hammer provided with a stem sliding in the breech block and with a head, and swinging on its stem to and from said opening, and a vent cover and firing pin carried thereby connected to swing with the hammer over

704,898

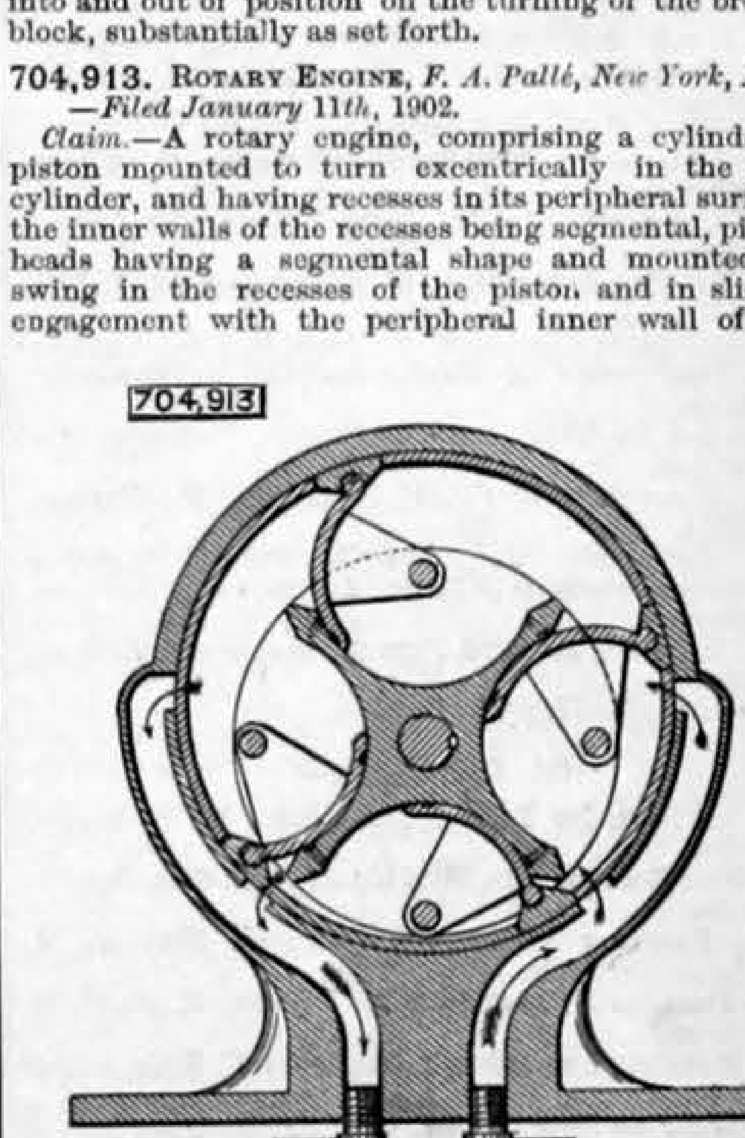


and from the opening, substantially as set forth. (4) The combination with the breech block and primer opening, of a hammer provided with a stem sliding in the breech block and with a head, and swinging to and from said opening, a vent cover and firing pin carried thereby connected to swing over and from the opening, an extractor, and means for operating the same on the movement of the vent cover, substantially as set forth. (5) The combination with the breech block and primer opening, of a hammer provided with a stem sliding in the breech block and with a head, and swinging to and from said opening, and means for mechanically swinging the hammer on its stem into and out of position on the turning of the breech block, substantially as set forth.

704,913. ROTARY ENGINE, *F. A. Pallé, New York, N.Y.—Filed January 11th, 1902.*

Claim.—A rotary engine, comprising a cylinder, a piston mounted to turn eccentrically in the said cylinder, and having recesses in its peripheral surface, the inner walls of the recesses being segmental, piston heads having a segmental shape and mounted to swing in the recesses of the piston, and in sliding engagement with the peripheral inner wall of the

704,913



recesses, each piston head having side arms fulcrumed on the sides of the piston near the periphery thereof and at the centre of the recesses, blocks mounted to slide on the inside of the rim of the cylinder, each block having a hinged connection with a corresponding piston head, the said cylinder being provided with ports in its rim at opposite sides thereof, and channels leading from said ports, a pipe leading from each of said channels and connected with a supply pipe, the said pipes being each provided with a valve, and exhaust pipes each connected with one of the said pipes at a point between the valve and the connection of the pipe with the channel, the said exhaust pipes being each provided with a valve, as set forth.