A Seven-Day Journal

The Gas Industry and the Coal Stoppage.

It is of some interest to discover to what extent the gas industry is succeeding in preserving the prescribed standards for its chief product in the present fuel emergency. The legal standards which our gas supplies must attain are not, as some seem to suppose, temporarily in abeyance. All that has happened is that under the Emergency Regulations, 1926, the Board of Trade has issued certain directions to gas undertakings, and has absolved the undertakings from fulfilling their statutory or other obligations in so far as the directions referred to prevent them from making gas of the prescribed quality. The quarterly reports just issued by the Gas Referees, showing the quality of the gas supplied by the companies in the metropolitan area, reveal the fact that according to the reports received from the official gas examiners, all the companies, with one exception, have succeeded in fulfilling their statutory obligations. The exception is the Wandsworth, Wimbledon and Epsom District Gas Company. The calorific value of the gas supplied by this company during the quarter showed an average value of 451·4 B.Th.U. per cubic foot, as compared with a prescribed average value of 470 B.Th.U. On five days the calorific value of the gas supplied was found to be deficient for two hours or more to an extent exceeding 6 per cent. of the prescribed value. Ordinarily, this failure of the company to fulfil its obligations would entail the infliction of a penalty, but in the present circumstances the Chief Gas Examiner has annulled the adverse reports received. For the preceding quarter, a period covering two months of the coal stoppage, the Wandsworth Company was also alone in failing to reach its prescribed quality. During April the average calorific value of its gas was 470·3 B.Th.U., but in May and June the effect of the stoppage was seen in a drop of the average value to 463·7 B.Th.U.

The City and Guilds Engineering College

On Thursday of last week, October 21st, his Royal Highness the Duke of York performed the opening ceremony in connection with an extension of the City and Guilds Engineering College at South Kensington. When the Imperial College of Science and Technology was formed in 1907, it was realised that the City and Guilds College, which became part of the larger organisation after a separate existence of twenty-three years, would require a considerable extension to its buildings in order to cope with the increasing demand for engineering education. By the munificence of the Goldsmiths' Company, the new building was begun in 1909, and was completed shortly after the outbreak of the war, at a cost of over £80,000. During the war the building was occupied by the military authorities, and after the war financial stringency prevented the building from being brought into use for educational purposes. Now, however, it has been found possible to equip the new building with valuable and up-to-date apparatus, and at last to make effective educational use of it. In addition to £20,000 spent by the Governing Body of the Imperial College on equipment for the new building, the Clothworkers' Company has undertaken to contribute £4000 a year for a number of years to meet the cost of research. The new building includes laboratories devoted to hydraulics, railways, motive power, strength of materials, and structural engineering, and a boiler-room specially fitted for instructional purposes. The old and new buildings of the City and Guilds College form a complete unit, providing undergraduate instruction for 500 students, postgraduate instruction for between 50 and 100 students, and opportunity for research.

The Loss of H.M.S. Valerian.

On Friday, October 22nd, H.M.S. Valerian was on her way from the Bahamas to Bermuda, when at about 7.30 a.m. she was overtaken by a hurricane of great violence, the wind reaching a speed of 136 miles an hour. At 8.30 a.m. she reported that she was hove-to five miles off Bermuda. No further reports were received from her, and she failed to answer her wireless telegraphy call. H.M.S. Curlew, which was also approaching Bermuda at the same time, was ordered to search for her, and at dawn the next day H.M.S. Cape Town was sent to assist in the search. The Cape Town succeeded in picking up nineteen survivors, who reported that the Valerian had sunk at 1 p.m. on the 22nd. The search was continued until nightfall on the 23rd, and was then abandoned. The official list of those lost contains the names of four officers and eighty-one other ranks. No information as to the cause of the disaster has up to the moment of writing been published. The Valerian was one of 72 sloops built under the war emergency programme for the purpose of mine sweeping, guarding convoys, and other duties. After the war about twenty of these vessels were retained in the Navy. The Valerian and vessels of her class were single-screw ships, with a displacement of about 1500 tons. The lost vessel had a length of 267ft., and a speed of 16½ knots, and carried two 4in. guns, four three-pounders for defence against aircraft, and two pom-poms. Like all the other war-time sloops, the Valerian followed mercantile practice, and was built under Lloyd's Survey by a firm which, up to the outbreak of the war, had not been in the habit of constructing war vessels. The class comprised vessels that were recognised as not being very handy, but it was believed that they could stand up to any weather.

The Late Sir J. W. Szlumper.

With the death at Richmond on Tuesday, October 26th, of Sir James Weeks Szlumper, there has passed, at the ripe age of ninety-three years, an engineer associated with the earlier history of railway construction in this country, particularly in Wales. After serving his articles with a London firm of engineers, he was appointed in 1859, at the age of twenty-five, assistant to Mr. Hamilton Fulton, the engineer of the Manchester–Milford railway. Fulton died in 1861, and Szlumper succeeded him, but the project was eventually abandoned. Later, he was associated with the construction of the line from Aberystwyth to Carmarthen, the Barry Railway, the Cardiff–Ogmore line, the Vale of Glamorgan line, and the Pontypridd, Caerphilly and Newport Railway. In addition to this railway construction work in Wales, he served as engineer to the Piccadilly Tube Railway. He joined the Institution of Civil Engineers in 1864. He was an elder brother of Lieut.-Colonel A. W. Szlumper, chief engineer of the Southern Railway.

A Large Floating Bridge.

On Saturday, October 23rd, the new Seacombe floating bridge was officially opened by Lord Derby. It replaces the two hydraulic lifts at the Seacombe ferry and should considerably facilitate the handling of the cross-river goods traffic between Wallasey and Liverpool. The new bridge, which has been constructed by the Cleveland Bridge and Engineering Company, Ltd., of Darlington, to the designs of Messrs. Wilton and Bell, of Westminster and Liverpool, has an overall length of 599ft. 8in., with a maximum width of 56ft. 6in. It carries three roads, which are designed to meet the requirements of foot passengers, of light and fast-moving traffic, and of heavy and slow-moving vehicles coming both on to and off the ferry staging. The actual bridge structure comprises five floating spans, which are linked to each other and to the shore and the staging by six suspended spans. Each of the floating spans is borne by a nest of eight steel pontoons, which are furnished with timber ground sills, which are supported on concrete sills when the tide falls. The cut inside the river wall consists of an opening 77ft. in width with concrete walls at each side, which rise to a height of 34ft. 5in. above the foundation level. The construction of the cut for the bridge was carried out by Nott, Brodie and Co., Ltd., of Bristol. At extreme low water the bridge has a maximum slope of 1 in 22, while it is designed to be approximately level throughout a tide rising to 29ft. above bay datum at Liverpool. The bridge is claimed to be the largest of its type which has up to the present been constructed.

German Shipping Amalgamation.

It is reported from Germany that the Hamburg-Amerika Line has absorbed the Deutsch Austral and the Cosmos Lines. The chairman of the directors of the Hamburg-Amerika Line has stated publicly that the capital of that company will be increased by two and three-quarter million pounds, bringing it up to six and a-half million pounds. It is understood that out of this new capital £900,000 will be required for the acquisition of the Deutsch-Austral Line, and £600,000 for the acquisition of the Cosmos Line. The shareholders of the three companies will be offered shares to the value of three-quarters of a million pounds. Mortgages amounting, it is reported, to a million pounds still remain upon the Stinnes ships acquired by the Cosmos Line, and it is probable that a large portion of the new capital will be expended in paying them off.

Shipbuilding Employers' Federation.

At the annual general meeting of the Central Board of the Shipbuilding Employers' Federation, which was held in Edinburgh on Friday, October 22nd, Mr. John Barr, of Vickers Ltd., Barrow-in-Furness, was again elected the president for the ensuing year. This re-appointment was not unexpected, and it is a special tribute to the excellent work which has been done by Mr. Barr in connection with the Joint Committee of Inquiry into shipyard conditions and foreign competition, the report of which Committee is still engaging the attention of the shipyard unions. The vice-presidents for the year are Mr. J. T. Batey, of R. and W. Hawthorn, Leslie and Co., Ltd., of Hebburn-on-Tyne; Mr. A. J. Campbell, of William Beardmore and Co., Ltd., Dalmuir; Sir Andrew R. Duncan and Mr. J. H. Edwards, of the Middle Dock and Engineering Company, Ltd., of South Shields. Mr. A. L. Ayre, of the Burntisland Shipbuilding Company, Ltd., Burntisland, was appointed chairman of the Conference and Works Board of the Federation, with Mr. W. A. Henderson, of D. and W. Henderson and Co., Ltd., of Glasgow, as vice-chairman. The reports received from the various shipbuilding centres showed that the work under construction is the lowest since 1909, and although a certain amount of work is being held up owing to the coal dispute, there is little prospect of any general improvement on the settlement of the strike. It was decided by the meeting that negotiations along the lines of the joint report should be still continued with the shipbuilding unions, and a further meeting with the union representatives is expected to be arranged at an early date.

The Kelvin Medal.

The Kelvin Gold Medal, established in 1914 as a part of a memorial to the late Lord Kelvin, was awarded on Tuesday night, October 26th, to the Hon. Sir Charles Parsons by Sir William Ellis at the meeting of the Institution of Civil Engineers assembled to hear Senatore Marconi's James Forrest Lecture. This award is the third that has been made, Dr. W. C. Unwin receiving one in 1920 and Professor Elihu Thomson another in 1923. The medal is awarded every three years as a mark of distinction for engineering work in the field with which Lord Kelvin was identified. Before it is awarded the world's principal engineering institutions are consulted, and the final selection is made by the officers of eight of the leading British technical societies. In responding on Tuesday night, Sir Charles Parsons incidentally referred to his experiments on the production of artificial diamonds. His research work in that direction had, he said, extended over many years, but success had not been achieved. Nobody so far had succeeded in making artificial diamonds, but, Sir Charles said, the field had not been fully explored, and the achievement was not impossible.

The Liverpool Electricity Supply.

At the opening meeting of the Liverpool Section of the Institution of Electrical Engineers, the new chairman, Mr. P. J. Robinson, delivered an address on the extensions that have recently taken place at the main Liverpool generation station. During recent years the increase in the supply from the Liverpool stations has been abnormal, for apart from the steady increase in the demand for current in the Liverpool district, the stations have absorbed the electrical supply of some of the neighbouring parts. During the period of 1920–1925 the output increased from 86,335,510 to 172,044,686 units, and the maximum peak load rose from 38,317 to 73,614 kilowatts. In 1922 it became necessary to consider the question of extending the generating plant, and various proposals were received. Finally, it was decided to extend the main station, where there is sufficient space for 100,000 kilowatts of plant. The new section of the station has been laid out for five 25,000-kilowatt units, and the turbine room is designed so that 40,000-kilowatt machines can be installed at a later date. The first set installed is a 25,000-kilowatt "Erster-Brunner" tandem-cylinder machine, manufactured by the Metropolitan-Vickers Electrical Company, and is capable of giving 25 per cent. overload for two hours. The boiler-house contains six units, each capable of evaporating 60,000 lb. of steam per hour at a pressure of 285 lb. and a total temperature of 700 deg. Fah.

The Coal Stoppage.

Wednesday of this week, October 27th, was the day designed by the Miners' Federation Executive for the renewed stoppage of work in every coalfield in the country, for the withdrawal not only of those miners, now exceeding a quarter of a million in number, who have gone back to the pits, but also of all the safety men at every colliery. The attempt to induce the men again to desert their employment began on October 7th, but three weeks of oratorical and other means of persuasion produced little effect. Fluctuations there have been in the numbers descending the pits, but they have been more than made good, and, on the aggregate, the roll has steadily increased, until on Tuesday, the day preceding the intended stoppage, it reached 253,465, the highest figure touched since the dispute began. The Midland districts, where the executive's campaign has principally been conducted, returned a higher number than any other. On Wednesday when, according to the intentions of the leaders the mines should have been completely deserted, the number descending the pits producing coal rose still higher, attaining a total of 260,635, the increase again being most marked in the Nottingham area. Rumours continue to circulate regarding the Government's intention once again to intervene in the dispute. A deputation from the Trades Union Council waited on the Prime Minister on Tuesday to discuss the dispute and its settlement, but it speedily became evident that the Government was not to be influenced to depart from the policy of non-intervention which it has now adopted.

The Motor Car Show.

No. II.*

In our introductory remarks on the Show in last week's issue reference was made to the number of new six-cylinder cars. They are almost equally divided between British and continental makers. In addition to those already mentioned, cars in this class are also shown by the Aster Engineering Company, Austin Motor Company, Lagonda Ltd., Lea and Francis, Ltd., Standard Motor Company, Ltd., and Vulcan Motor and Engineering Company, Ltd. The new "sixes" by continental makers are the Amilcar, Ballot, Darracq, Delage, Donnet, Lorraine, Minerva, Panhard, Renault, and Voisin. In addition to the above there are three new American six-cylinder cars. In nearly all cases the cylinders are cast in one block and detachable heads are used. Six cars have sleeve valves. The Aster engine is of 3468 c.c. capacity and is rated at 23·9 horse-power. It has single sleeve valves of the Burt McCollum pattern. The new Austin is rated at 23·5 horse-power with a bore and stroke of 79·5 mm. and 114·5 mm. respectively, and the valves are mounted on either side. The Austin crank shaft is carried in eight bearings, and the chain which drives the cam shaft is fitted at the rear end. A gear-box with four forward speeds is provided. The Lagonda is a 16–65 horse-power engine with a capacity of 2389 c.c., the valves being operated by a push rod from a cam shaft situated in the crank case. The crank shaft has seven bearings. The bore and stroke of both the Lea-Francis and Vulcan engines are the same, namely, 60 mm. by 100 mm. They have inclined overhead valves operated by two overhead cam shafts. The Lea-Francis car is rated at 13·4 horse-power. The valves are housed in hemispherical combustion chambers and the sparking plugs are placed centrally. The crank shaft is carried in four bearings, and there is forced lubrication from a pressure pump placed in the sump. Ignition is by high-tension magneto. The clutch and gear-box are in one unit with the engine and there are four forward speeds and a reverse controlled by a right-hand lever. The gear ratios are 16·6 to 1, 9·9 to 1, 7·7 to 1, and 4·55 to 1. The clutch is of the single dry plate type and the final drive by spiral bevel gearing. The body shown at Olympia is an open 4–5 seater.

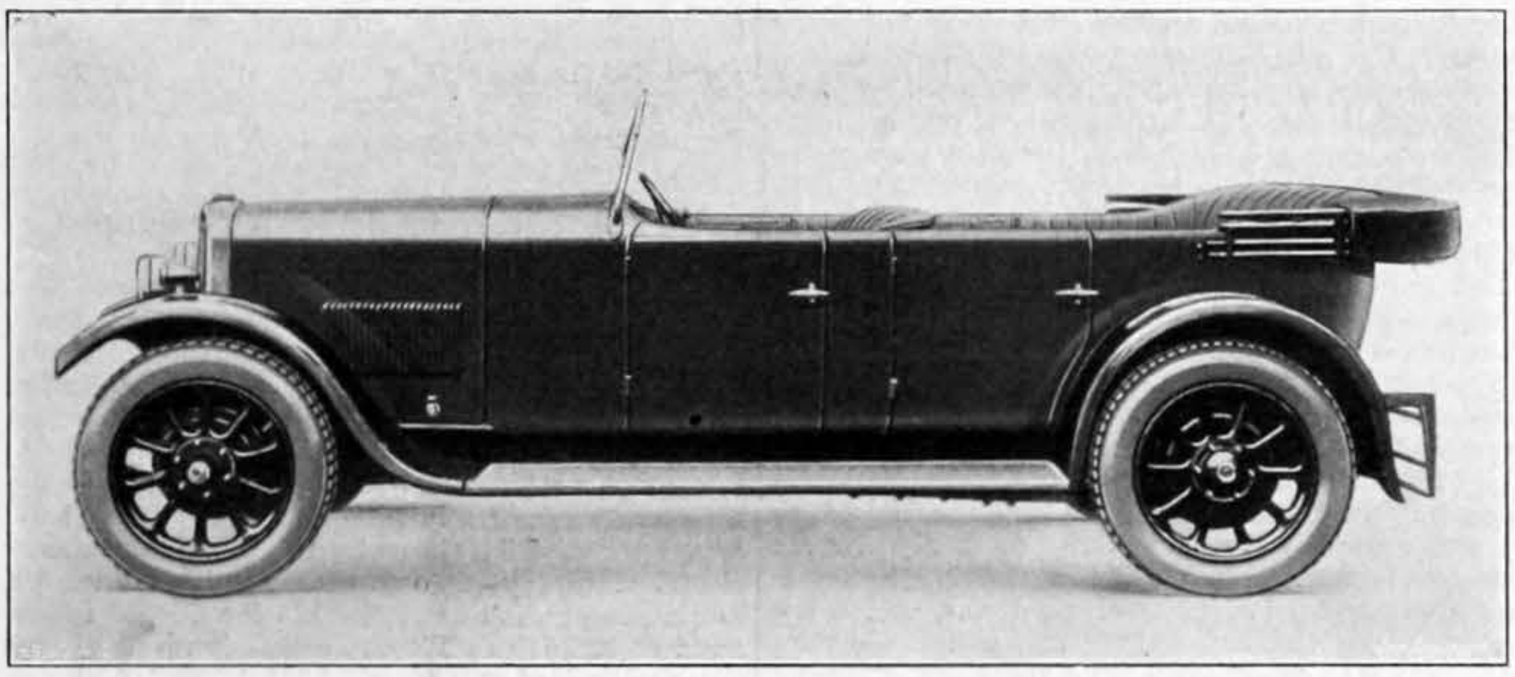


FIG. 11—SIX-CYLINDER 16 H.P. SUNBEAM CAR

16 Horse-power Six-cylinder Sunbeam.

Another very attractive newcomer in the six-cylinder class is the 16 horse-power Sunbeam car, which we illustrate in Figs. 11 to 13. The Sunbeam Company, for the first time, is not represented by a four-cylinder car. In addition to the 16 horse-power car, this year's exhibits include cars of 20 horse-power, 25 horse-power, and 35 horse-power, the last named having an eight-cylinder power unit. The 16 horse-power car, which we illustrate, embraces features of special interest, not the least of which is the adoption of battery and coil ignition. The overhead valve engine has cylinders 67·5 mm. bore by 95 mm. stroke, the cubic capacity being 2033 c.c. and the Treasury rating 16·95 horse-power. The cylinder block, which is of cast iron, is formed integral with the upper half of the crank case, and the cylinder head, which is detachable, is arranged so that the water may get directly to, and entirely around the seats of its overhead valves. Aluminium alloy pistons, each with three compression and one scraper rings, are employed. The timing gears are housed in a circular casing formed at the forward end of the crank case, and the water pump, with its drive housing, is formed also as an integral part of the main casting. The bottom half of the crank case is in aluminium. The valves are operated by push rods and overhead rockers, the rods being actuated from the came shaft, which is at the base of the cylinders, by overhead tappets. There is an end-to-end inspection plate, through which these tappets can be examined. The lubrication of the engine is of the full forced-feed type with a gear type pump, which is driven by helical gear off the crank shaft, on which there is a vibration damper. A steel gallery pipe cast into the crank case, and running directly fore and aft, distributes the oil under pressure to all the main and cam shaft bearings. There is a relief valve to deal with any excess of pressure in the oil system, and any oil passing through the valve is discharged back again into the sump.

The clutch is of the single plate type, the driven member being a light duralumin disc. The four-speed gear-box has a right-hand gate change. The gear-box casing is an aluminium casting, the engine, clutch and gear-box forming a unit. The four-wheel braking system, which is fitted as standard to this model, consists of one pair of shoes in each drum. The foot-brake pedal brings all four sets of shoes into action simultaneously. The hand brake lever is connected to the brake shoes operating on the rear wheel drums, and the brake-rod connections are jointed in such a manner that these brakes remain unaffected, so far as increase and decrease of actuating pressure due to rear spring deflection is concerned.

A 12-volt Rotax electrical equipment is standard, energy being derived from a dynamo of 10 ampères capacity. The electric starter is carried in a housing formed integral with the gear-box.

The chassis frame is formed of two side members of deep channel section with four channel section cross members and one tubular cross member at the rear. The rear springs, which are of the cantilever type, are 47in. in length, and are directly under the frame side members, so as to permit the use of lighter frame and spring connections. The front springs, which are semi-elliptic, are 38in. long, and are also directly under the front end of the frame side members. The petrol tank, which is carried at the rear of the chassis frame, has a capacity of 12 gallons. The petrol feed to the Claudel Hobson carburetter is by means of an Autovac mounted on the dash under the bonnet. The radiator is of the new Sunbeam "Vee" type, and it is connected by trunnions secured to the upper flange of the chassis frame.

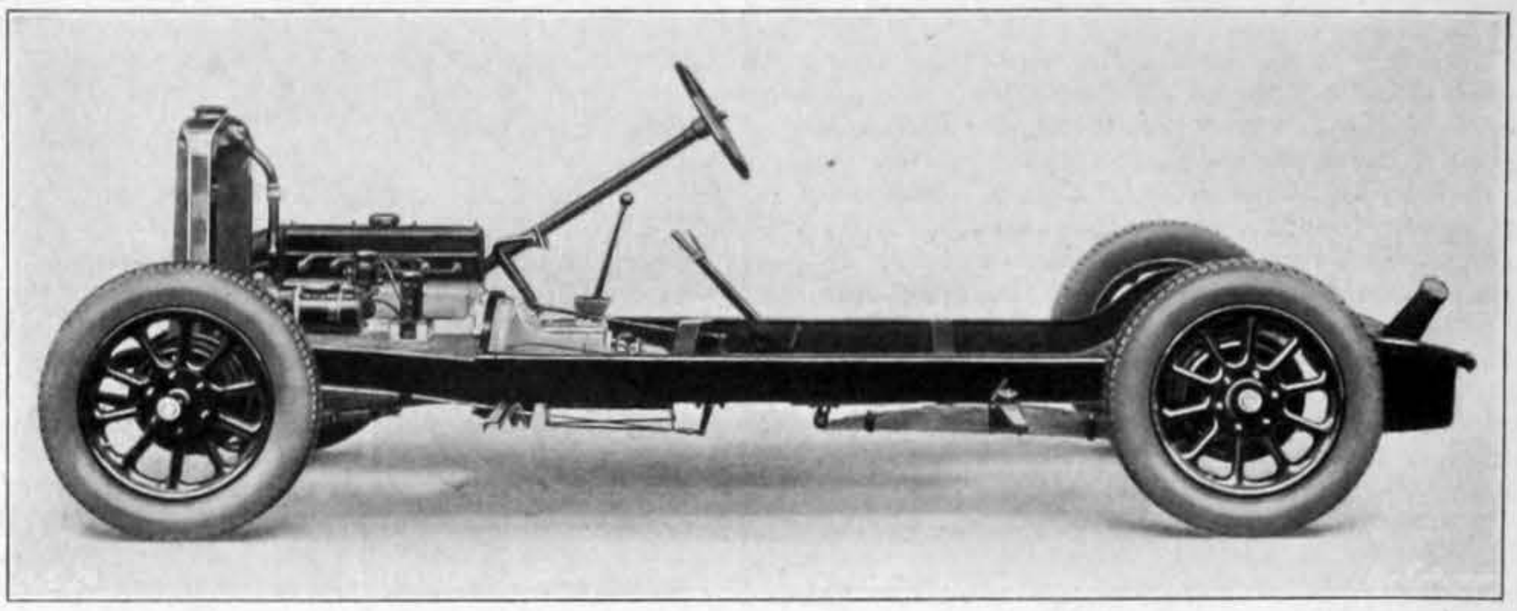


FIG. 12—CHASSIS OF SIX-CYLINDER 16 H.P. SUNBEAM CAR

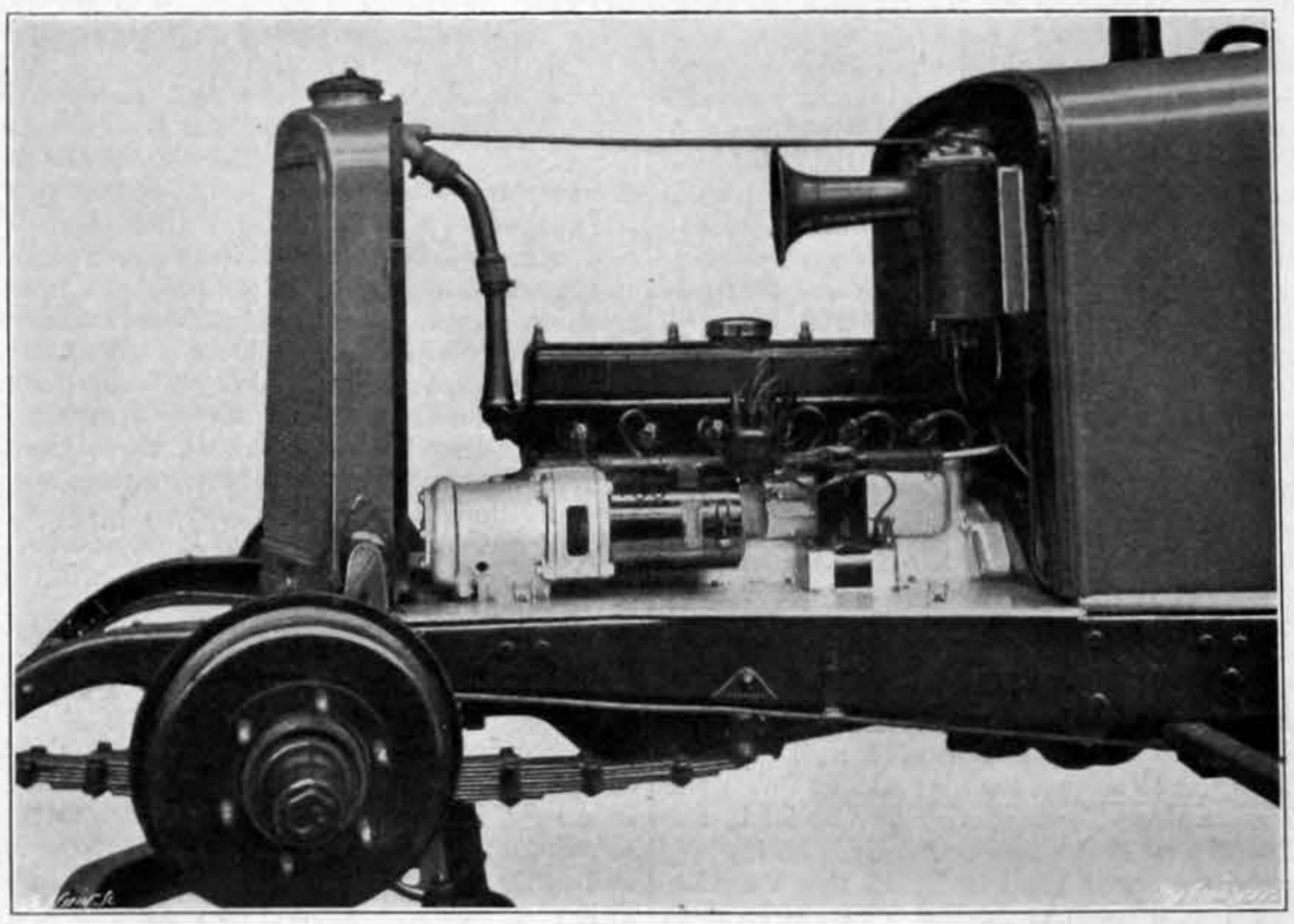


FIG. 13—POWER UNIT OF SIX-CYLINDER 16 H.P. SUNBEAM CAR

braking system, which is fitted as standard to this model, consists of one pair of shoes in each drum. The foot-brake pedal brings all four sets of shoes into action simultaneously. The hand brake lever is connected to the brake shoes operating on the rear wheel drums, and the brake-rod connections are jointed in such a manner that these brakes remain unaffected, so far as increase and decrease of actuating pressure due to rear spring deflection is concerned.

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One Hundred Pound Cars.

In order to meet the demand for even cheaper motoring than has hitherto been possible, two firms are attempting to produce cars at a price which has up to now baffled the industry, and it will be interesting to see what success attends these efforts. On the stand of British Ensign Motors, Ltd., 66, Victoria-street, London, S.W. 1, is shown a miniature car of British manufacture for which orders are being booked at £100 each. No revolutionary features have been introduced in the production of this vehicle. The tiny engine is of the monobloc type with bore and stroke 56·8 mm. and 100 mm. respectively—a somewhat larger engine than that of the 7 horse-power Austin. The cubic capacity is actually 1020 c.c. and the R.A.C. rating 8 horse-power, while the brake horse-power at 3300 revolutions per minute is given as 23. The cylinder head is detachable and the valves in the head are operated by push rods and rockers. The pistons are of cast iron and the lubrication of the main crank shaft and cam shaft bearings is effected by a gear pump which forces the oil through the drilled crank shaft. The ignition is by coil and the cooling by fan and thermo-syphon. The car has a live rear axle but no differential gear, the final drive being through spiral bevel wheels. The clutch is of the multiplate variety, Ferodo and metal, and the gear-box has three forward speeds and a reverse. Four-wheel brakes, electric starter, and electric lighting, together with spare wheel, tire, hood, screen and all-weather equipment are all included. The body is a two-seater of pressed steel with an occasional seat in the rear. The car weighs 11 cwt., the wheel base is 8ft. 4in., and the track 3ft. 11in.

The other car marketed at £100 is shown by Waverley Cars, Ltd., Willesden, London, N.W. 10.

* No. I. appeared October 22nd.

The power unit in this car is composed of two horizontally-opposed water-cooled cylinders with a bore of 75 mm. and stroke of 102 mm. Ignition is by means of a distributor and coil. The motive mechanism is placed at the back of the car and is easy of access. Instead of a gear-box there is a disc of large proportions, which drives another disc arranged at right angles to it by friction. The pressure of contact is automatically adjusted as required, and the rate of progression is regulated by movement of the driven disc across the face of the first motion disc. At the end of the transverse shaft on which the driven disc slides is spiral gearing, which imparts motion to one of the rear road wheels. The weight of this car is approximately 7 cwt. and it will seat two or four persons.

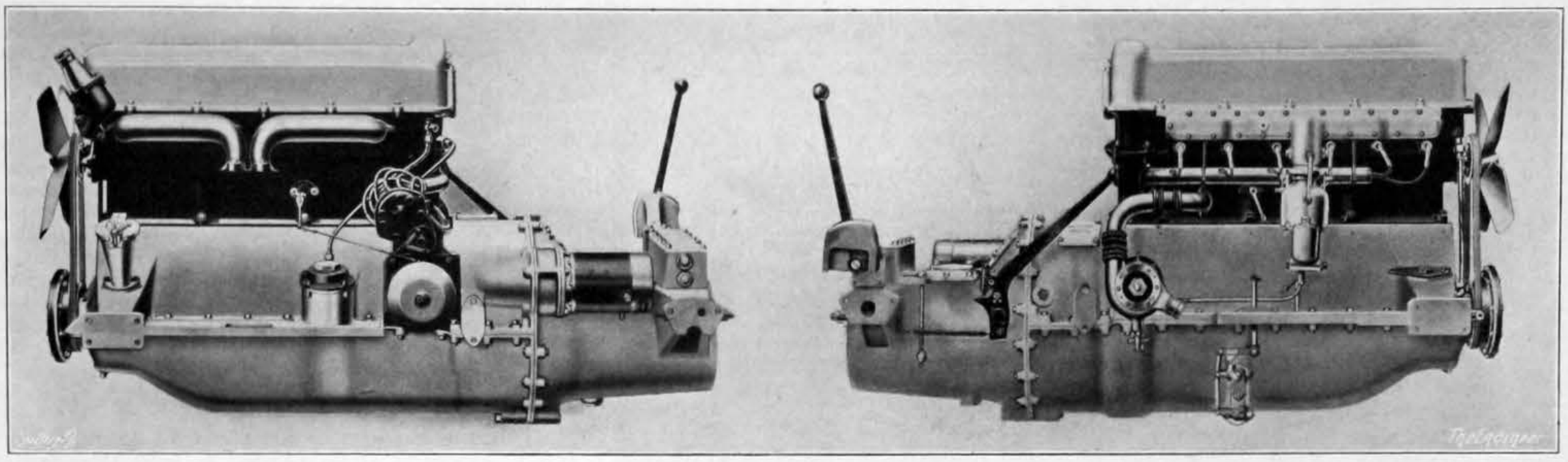


FIG. 14—SIDE VIEWS OF 23 H.P. SIX-CYLINDER LANCHESTER ENGINE

LANCHESTER.

The Lanchester Motor Company's exhibits always command attention on account of their excellence of workmanship and originality of treatment. The company is represented by cars of two powers, namely, 40 horse-power and 23 horse-power, the latter being the latest development of the 21 horse-power car, the bore and stroke of which have been increased to 78·7 mm. by 114 mm. The 23 horse-power car has six cylinders, overhead enclosed valves and valve mechanism, and the cylinder head can be detached without dismantling the valve gear. Unlike the larger car, with its epicyclic gear, this model has the sliding gear-box with four speeds and a reverse, the box being integral with the power unit. The worm-driven back axle is still retained and the four-wheel braking system is a Lanchester patent. The engine has Watford magneto ignition. Views from both sides of the engine are given in Fig. 14.

MORRIS.

The Morris firm is showing cars of three powers instead of two as heretofore, and has made several changes in the design of the new models. The most obvious change is in the shape of the radiator, which is flat-fronted and gives a more pleasing appearance to the car as well as providing a greater water capacity, and hence better cooling of the water in the cylinder jackets. The suspension has also been altered by using semi-elliptic springs. Another feature of equal importance is a pressed steel dash, which, besides forming a rigid cross-brace for the chassis, carries a petrol tank of 7 gallons capacity, and forms a mounting for the new instrument board on which all the dials are grouped. Other important new features in the Morris chassis this year are improved brakes, adjustable steering rake, and reach of the clutch and brake pedals. The 11·9 Morris Cowley specification includes a four-cylinder water-cooled engine, 69 mm. bore by 102 mm. stroke, thermo-spyhon water circulation, magneto ignition, forced lubrication, multiplate cork clutch running in oil, three-speed unit mounted gear-box, and spiral bevel final transmission. The 14–28 Morris Oxford has an engine with a bore of 75 mm. and 102 mm. stroke, Treasury rating 14 horse-power, thermo-syphon water circulation, side-by-side valves, forced feed lubrication, multiplate clutch, three forward speeds and a reverse, internal expanding brakes on all four wheels, and spiral bevel final transmission. The new brakes. The chassis of this car is of much more rigid construction than are the 11·9 and 14–28 horse-power cars, and gives the impression of being designed for a different class of work. Illustrations of 11·9 and 14–28 horse-power saloons are appended in Figs. 15 and 16.

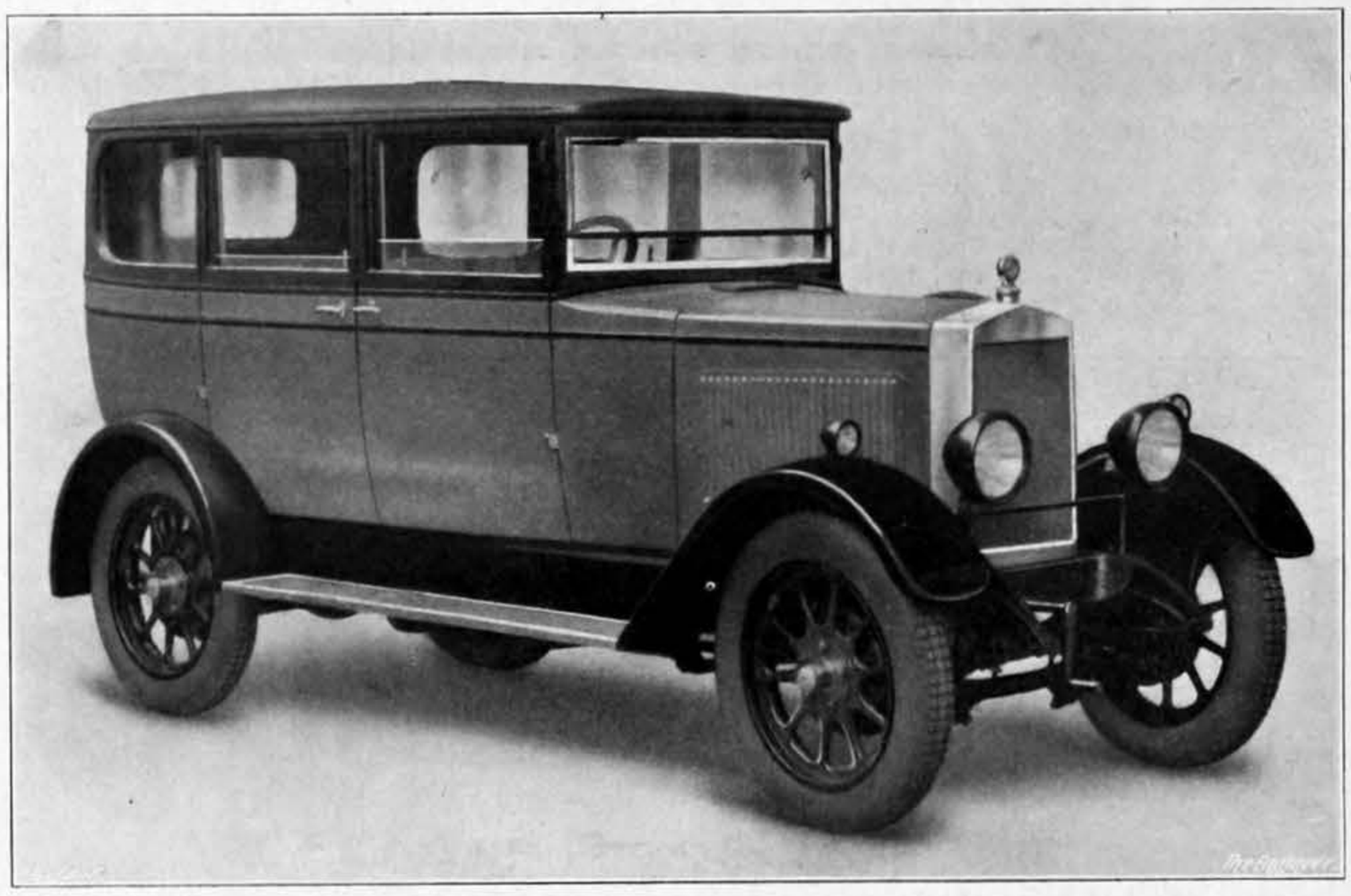


FIG. 16—14-28 H.P. MORRIS SALOON CAR

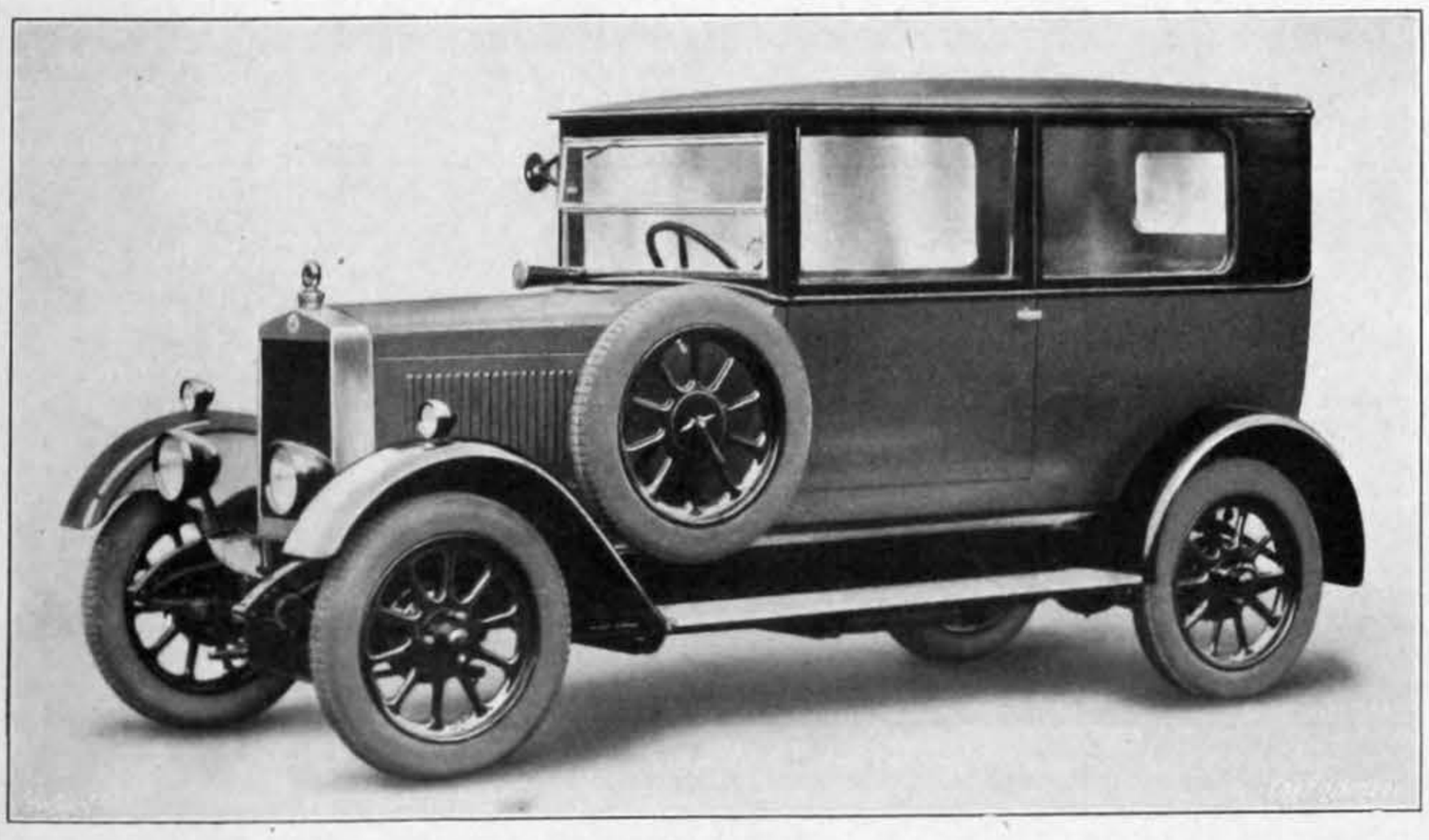


FIG. 15—11·9 MORRIS SALOON CAR

THE TROJAN.

Leyland Motors, Ltd., show three of their well-known Trojan cars, which are claimed to be the simplest in the world—a claim that is difficult to dispute if the number of moving parts in the engine is taken as the basis of comparison. The engine has been modified somewhat this year without departing from its main principles. The bore of the four horizontal cylinders is 2½in. and the stroke 4⅝in., the cubic capacity being 1488 c.c. The chief alterations are that the inlet ports have been so redesigned and enlarged, that the balance of the crank shaft has been improved, and that the compression in the crank case has been increased. In addition to these improvements the connecting-rod big ends are now fitted with roller bearings. The cars exhibited include a three-door four-seater touring model on balloon tires, a four-seater utility car on "solids," and an exhibition chassis sectioned to show the working parts. The car is still rated at 10 horse-power.

CROSSLEY.

This Manchester firm is not showing any new models, but there are many interesting features in the 18–50 horse-power six-cylinder car which made its first appearance at last year's Show. The six cylinders are cast monobloc and have a bore and stroke of 69 mm. and 120 mm., the cylinder capacity being 2692 c.c. The pistons are of aluminium and the overhead valves are operated by push rods and rocker levers, all being totally enclosed, while the means for adjustment are accessible. The crank shaft has four main bearings and is drilled for the supply of oil under pressure to all parts. The inlet pipe is heated automatically by the exhaust gases and the dynamo and magneto are driven in tandem by a chain

which is capable of adjustment for wear. A dynamo and magneto platform provided enables the dynamo to be removed and the magneto moved forward to its place in the event of failure of the former. The lubricating oil pump is submerged in the sump and is driven by spiral gears from the cam shaft. The high-

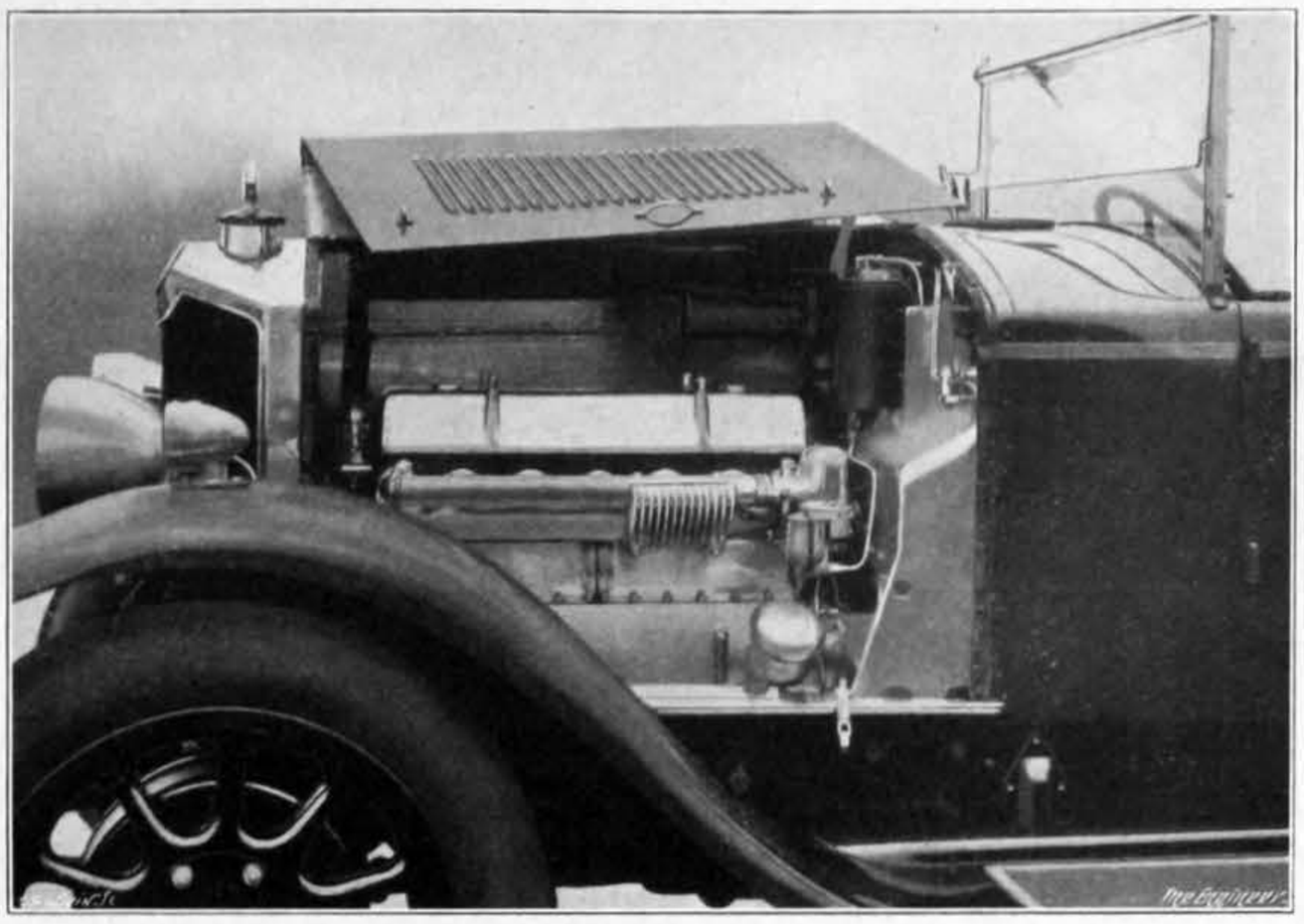


FIG. 17—SIX-CYLINDER 18-50 H.P. CROSSLEY ENGINE

tension magneto is driven at three-quarter engine speed by a flexible coupling with fine adjustment. The cooling is by means of a pump driven from the cam shaft and the temperature is controlled by means of an automatic thermostat. There is a single plate clutch with fabric friction discs, easily adjustable.

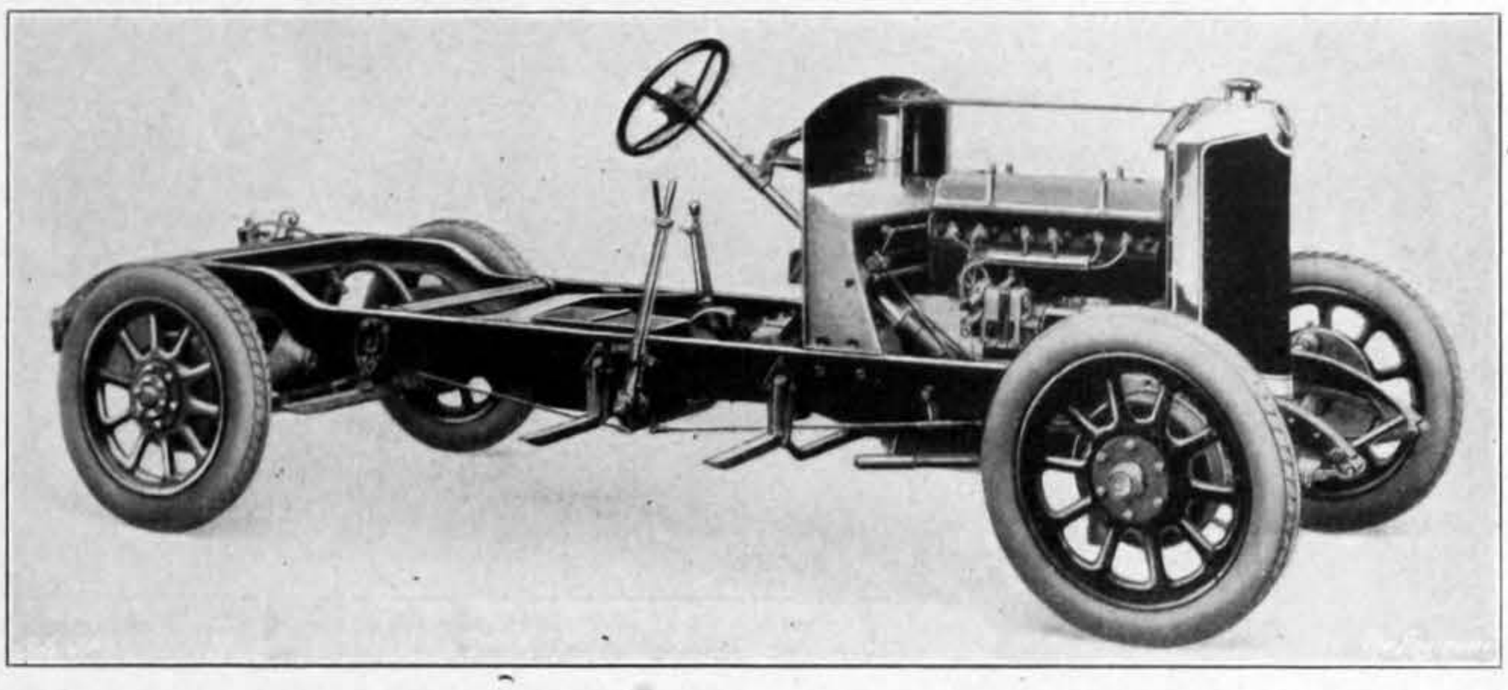


FIG. 18—CHASSIS OF SIX-CYLINDER 18-50 H.P. CROSSLEY CAR

The steering gear is well designed. It has a worm and complete worm wheel, adjustment being provided by means of an excentric bush which forms the bearing for the worm wheel. The worm can also be adjusted without dismantling the steering gear.

The gear-box is bolted direct to the crank case and gives four speeds forward, operated by a right-hand lever. The final drive is by spiral bevel gear and the rear axle is of the semi-floating type. The main frame is of exceptional strength and has four cross members with additional stays at the front and rear. The suspension is by means of semi-elliptic springs directly under the side members of the frame and shock absorbers are fitted. All brakes are of the internal expanding pattern, the four brakes being actuated by a foot pedal. Those on the front wheels are of the Perrot type. In addition to the above there is a hand brake, which operates only on the rear wheels by means of a separate set of shoes. Views of the engine and chassis are given in Figs. 17 and 18. In the view of the engine the means for warming the induction pipe near to the carburetter is shown very clearly.

The Argyll.

The prominent feature of the Argyll car since the year 1911 has been the single-sleeve valve engine, built under the Burt M'Collum patents, and the new models still retain this essential part. The 12–40 horse-power chassis has an engine which has been designed to give higher revolutions and greater acceleration than in previous cars. Four-wheel brakes have been adopted, and to accommodate them the front springs and their attachments have been re-designed to take the additional stresses. The sleeve valve has a number of specially shaped ports at the upper end and a single universal driving connection at the lower end. Each sleeve is operated by a short cross shaft consisting of a disc with an excentric pin on the end engaging in this universal joint at the bottom of the sleeve. These discs are driven by skew gears from the valve shaft, which is the equivalent of the cam shaft in a poppet valve engine. When the discs rotate, the excentric pins impart to the sleeves a combined vertical and horizontal motion, the universal joints allowing the sleeves freedom to rotate partially on their axis. The resultant path of the sleeve is elliptical. The cross shafts run at half engine speed and the ports in the cylinders are therefore only uncovered by the corresponding ports in the sleeves once in a complete revolution of the valve shaft or two revolutions of the crank shaft. The whole of the valve mechanism is enclosed and runs in oil, and although the weight of the sleeve is greater than that of poppet valves, less power is required to operate it, because there are no springs to overcome. Another point of advantage in this engine is that the pistons on both compression and firing strokes are travelling in the same direction as the sleeves, thus reducing friction. The 12–40 horse-power car has four cylinders, 71 mm. bore and 103 mm. stroke, the R.A.C. rating being 12·5 horse-power, while at 3200 revolutions per minute the engine gives 42 brake horse-power. The compression ratio is 5·5 to 1. The sleeves are made of a special steel alloy and the pistons are made of aluminium alloy. Marles steering gear is fitted, and the transmission is through a single steel disc through a four-speed gear-box, open tubular propeller shaft with flexible disc joints to a full floating axle and spiral bevel gears. The smaller 12 horse-power car has a similar type of engine, 68 mm. bore and 103 mm. stroke.

The Imperia.

Although it is not quite new, having been in use on the European Continent for several years, the Imperia car, which is shown by the British makers, G.W.K., Ltd., Maidenhead, will certainly awaken the interest of seekers after novelty in motor car design. An ingenious modification of the sleeve valve engine is the most noteworthy feature of the Imperia car. The engine is of the four-cylinder vertical monobloc type with a bore and stroke of 66 mm. and 80 mm., the cubic capacity being 1094 c.c. and the

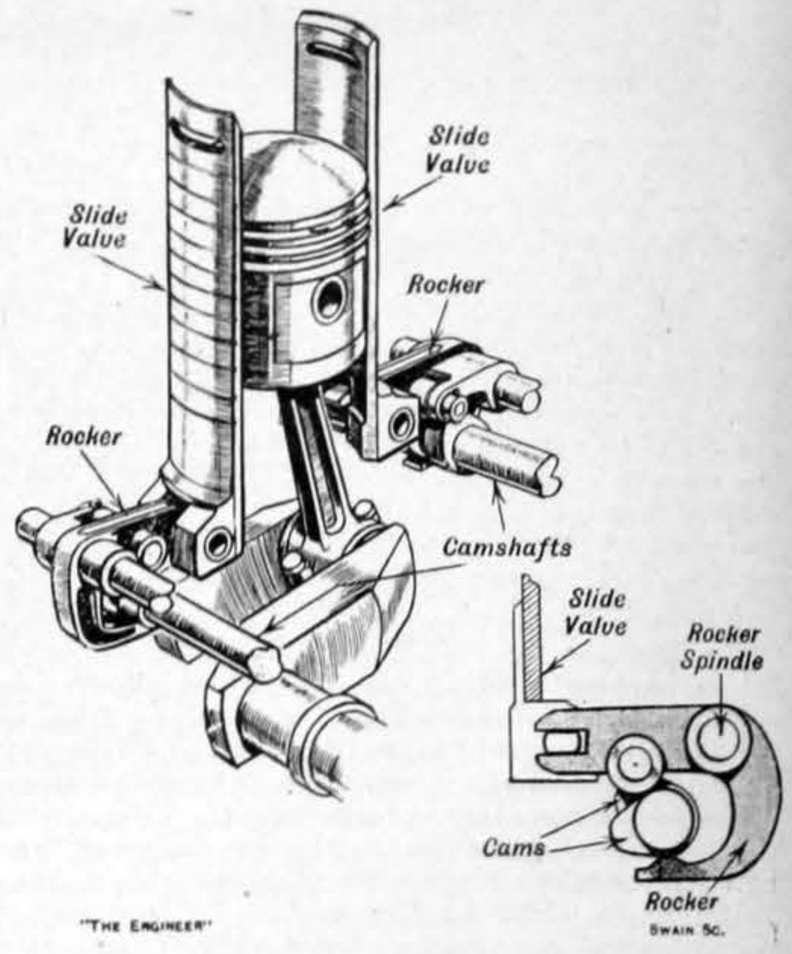


FIG. 20—VALVES AND VALVE GEAR OF IMPERIA CAR

R.A.C. rating 10·4 horse-power. The brake horse-power at 2500 revolutions per minute is 24. The special feature is the valves, which form segments of the cylinder. There are two slide valves to each cylinder as shown in Fig. 20, and these valves reciprocate in the cylinder wall owing to the action of two cam shafts and a rocking link, and in so doing alternately open and close inlet and exhaust ports, thus giving a clear passage for the gases. The valves and mechanism are lubricated under pressure, to ensure silence of motion and to prevent wear. The cylinder block is detachable from the crank case and the engine is suspended at three points on rubber blocks.

Austin.

Apart from the introduction of a new six-cylinder car rated at 23·5 horse-power the Austin Motor Company, Ltd., has made no striking departures in the design and construction of its three well-known models—the 20, 12, and 7 horse-power cars. The engine of the new car has cylinders 79·5 mm. bore and 114·5 mm. stroke, the total cylinder capacity being 3400 c.c. The engine has water pump circulation, forced lubrication and magneto ignition, while the gear-box is of unit construction with the engine and gives four speeds with a ball change. There are four internal expanding brakes, and shock absorbers are fitted to both the front and rear axles. A view of the 23·5 horse-power chassis is given in Fig. 19, which

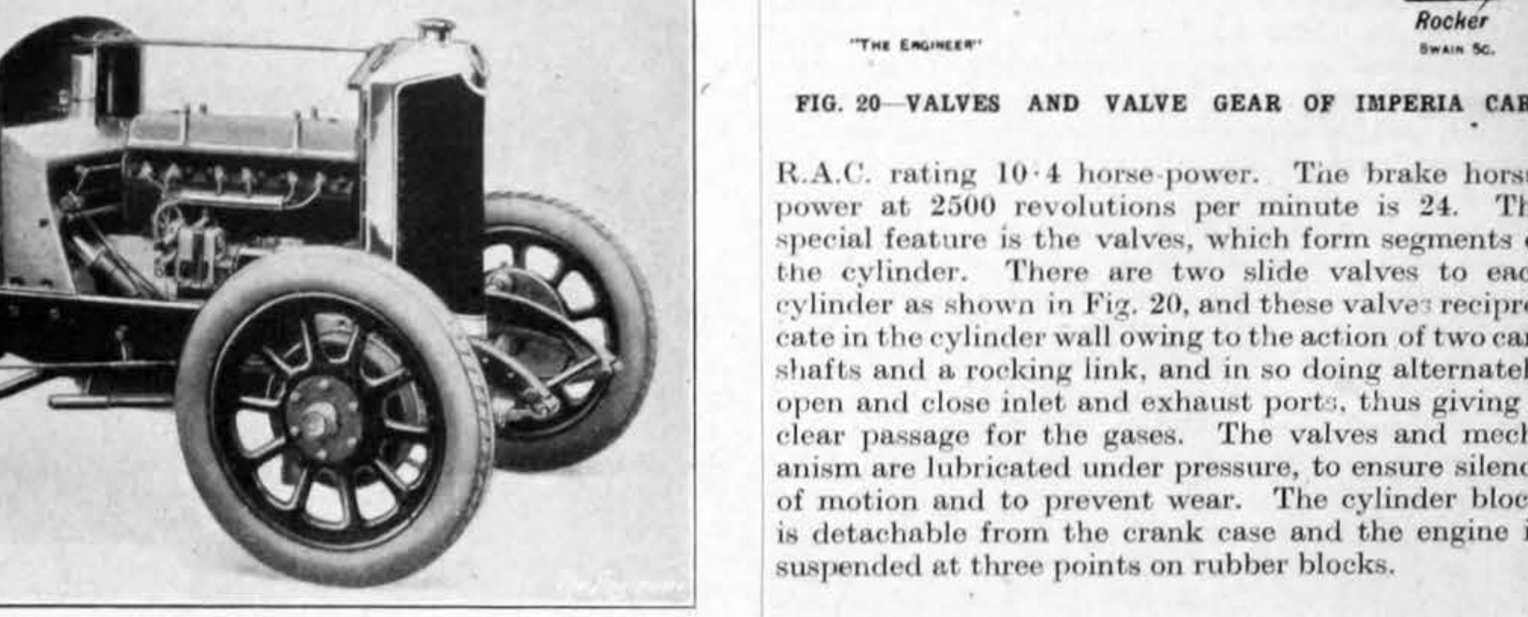


FIG. 19—CHASSIS OF SIX-CYLINDER 23·5 H.P. AUSTIN CAR

shows the simple and straightforward lines on which the whole has been constructed.

The Alvis.

The Alvis Company has achieved a high reputation for the great amount of power which it obtains from its engines, and which accounts for the successes that the Alvis cars have had in sporting events. The 12–50 horse-power chassis has an engine with four cylinders cast monobloc, 69 mm. bore by 113 mm. stroke. The pistons are of aluminium alloy, the poppet valves of cobalt-chromium steel, actuated by a special design of push-rod mechanism, and connecting-rods of alloy steel, specially lightened and fitted with anti-friction die-cast bearings. Forced lubrication is provided throughout. A polar inductor magneto is used and the clutch is of the single plate pattern. Four speeds and a right-hand change are used in the gear-box. The cardan shaft is tubular and of exceptionally large diameter, with universal roller bearing joints at each end. The rear axle is an aluminium casing, and the final drive is by spiral bevel gears of nickel-chrome case-hardened steel. Four-wheel brakes operated by the foot pedal and rear-wheel brakes operated by a hand lever are of the special design of the Alvis Company. The springs on the front and rear wheels are semi-elliptic and of exceptional length, those on the rear being underslung.

In what is known as the accessories portion of the Exhibition Drummond Brothers, Ltd., Guildford, have on view a special range of machine tools for garages. These include a 6in. centre screw-cutting lathe with gap bed, hollow mandrel, compound slide rest, and milling and gear-cutting attachments. There is also a 3½in. centre lathe of improved design which will take 1ft. 4in. in between the centres. This tool has the familiar cantilever bed, which enables it to be bolted down on any uneven floor without distortion, and a patented tool-holder with height adjustment relative to the lathe centres. This gives a range of movement of about ⅜in. The tool is clamped firmly in its square hole, and one quick movement of the spanner on the clamping bolt locks the holder in any position. The remaining exhibits by this firm are a milling machine with a tilting table, a sensitive radial drilling machine for power or treadle driving, a hand bench drill, and a hand lever shaper.

Institution of Mechanical Engineers.

EXCERPTS FROM THE ADDRESS BY THE PRESIDENT, Mr. WILLIAM REAVELL.

The air compressor itself is made to-day in many forms, from the hand pump, of which perhaps the commonest type is the bicycle pump, to power-driven machines of various types, depending upon the volume and pressure required.

For small machines the single-acting type with one, two or more cylinders is usual practice, though the horizontal straight-line compressor of double-acting construction is common in America and is occasinally built here.

This single-acting type persists until a size is reached where the greater cost of the moving parts of the double-acting type is offset by the fact that in that type both sides of the piston are used, and therefore for a given cylinder diameter twice the volume is dealt with per revolution. This size varies in practice with the pressure.

Above 500 to 600 cubic feet per minute and for pressures of 60 lb. to 100 lb. per square inch, the double-acting type is usually adopted, and is of the two-stage, intercooler type. This construction is continued as the volume required increases, till a size is reached which enables the turbo-compressor to be constructed at a lower cost.

For lower pressures and vacua, rotary machines are being increasingly used. This type is suitable at pressures which are found to be too high for the pressure fan, and it is made from the smallest sizes up to volumes for which the turbo type begins to take its place.

The multi-stage turbo begins to replace the rotary compressor and the double-acting, two stage compressor at different volumes, depending upon the pressure to be obtained. It will be obvious that, in dealing with turbo machines, variations in volume through a considerable range are obtained by merely increasing the width of the throat-way in the impellers, but as the pressure required increases, this can only be dealt with by adding another compression stage, *i.e.*, another impeller and casing. Consequently, when low pressures are required the turbo type will beat the piston type in first cost at lower volumes earlier than if high pressures are required, as in the latter case more stages, *i.e.*, more impellers and casings, are required. Therefore, it is a question of pressure rather than volume which determines the size of machine at which it is more economical to use the turbo instead of the piston principle.*

Progress in the immediate future may be in the direction of increasing the peripheral velocity of turbo-impellers, as suitable higher tensile steels are produced at reasonable prices.

As the increase of pressure per stage which can be obtained rises as the square of the peripheral velocity of the impellers, it will be obvious that higher peripheral speeds mean that a fewer number of stages could then be used with the turbo machine, and the effect of this on the reduction of cost means that, under such conditions, the turbo machine may replace the reciprocating machine for lower volumes than is at present the case.

* * *

Theoretically, the ideal way of using compressed air efficiently would be one in which the air is first compressed adiabatically, no attempt being made to extract the heat by water jackets or coolers, and the heated compressed air would be immediately used in an air engine placed beside the compressor, the air being used expansively down to the temperature at which it was originally admitted to the air compressor.

In practice, such cases rarely occur, and owing to the fact that air is usually used at some distance from the compressor, it is generally cooled to atmospheric temperature by the time it reaches the point of application. The effect is to reduce the original available volume of air by the time it enters the air motor, so that in the ordinary way not only is there loss due to the non-expansion of the air in use, but there is this added loss due to diminution in volume.

Some of this loss can be efficiently recovered by using a reheater near the point of application of the compressed air. This will often be found to be useful where pneumatic picks or drills are used in open quarries. If the air is to be used expansively, a reheater must be used. The reheaters may be fired by coal, coke or oil. Reheaters are not as a rule used to recover the heat energy in order to use the air expansively, but rather to increase the volume of air at the same pressure, so as to enable a greater number of tools to be used from a compressor of given size. They are, however, not frequently met with in practice.

It is obvious that if an attempt is made to use cold compressed air expansively, the expanding air will fall rapidly in temperature, resulting in trouble due to the freezing of the moisture in the air, which may cause blockage of the air ports by the ice which would be formed.

Perhaps the best-known illustration of air being used expansively is in the air-lift system for raising water. In this case the superincumbent weight of water above each globule of air is gradually reduced as the column of water is rising to the surface, and the reduced pressure of air due to expansion of each air globule or bubble is equalled by the reduced weight of water above it. No trouble in such a case arises from freezing, because the expanding air bubbles are prevented from falling considerably in temperature by the circumambient water.

* * *

In modern tunnelling the compressed air equipment forms a most important part of the plant employed. In connection with the construction of the various London tube railways, compressed air is used for injecting the grouting behind the cast iron segmental lining. The lime or cement is placed in a cylinder and mixed with water. The cylinder is connected to holes in the tunnel lining by means of a flexible pipe and nozzle. Air is then admitted above the mixture in the cylinder, and by that means the grout is blown into the space in the lining. The shield used in tunnelling work, and originally due to Greathead, is driven forward by hydraulic pressure, but the pumps which supply this pressure are themselves operated by compressed air. Where the strata through which the tube is driven are water-logged, compressed air is used for holding the water back, the section under construction being closed off and protected by air locks.

Compressed air is also used to-day for cutting in heavy clay by means of the pneumatic spade, which will deal more efficiently and quickly with the clay to be removed than the older method of the pick-axe and shovel. With the higher cost of labour in America, the use of compressed air for open trenching work has been developed more quickly than in this country, and it is claimed that the average quantity of material moved is about five times as much with the pneumatic tool.

* * *

The locomotive-torpedo is said to have been invented in the 'sixties by M. Luppis, an officer of the Austrian Navy, and developed experimentally by Mr. Robert Whitehead, the engineer of a factory at Fiume. After the Austrian Government had experimented for some years, the British authorities paid a sum of £10,000 for a description and an inspection of the machine, and in 1870 on the Medway Mr. Whitehead exhibited a torpedo to British officers. It was 14ft. long, propelled by a pneumatic engine worked by air at a pressure of 600 lb. per square inch, and attained a speed estimated at 8 knots.

The pressure to which the air vessel in the torpedo is stored to-day is 2500 lb. to 3000 lb. per square inch, and the engines are mostly of the four-cylinder "Brotherhood" type. Americans use air turbines, and in some types horizontal engines are used. In the modern torpedo the issuing air from the storage chamber is used to support the combustion of oil, and the heat is used to evaporate water and superheat the steam formed. The steam and the products of combustion, plus the nitrogen, pass on to the engine. The combustion takes place in a small chamber between the reducing valve and the engine. Under these conditions the power developed reaches 250 horse-power, and the combustion chamber and fittings to achieve this only weigh about 5 lb. A measure of the advantage gained by this method will be obtained from the fact that when cold air was used the consumption was roughly 75 lb. per air horse-power per hour, while with the modern combustion system the consumption falls to 15 lb.

In the larger ships the transmission of messages is also by means of compressed air, pipes about 1½in. diameter being used, the pressure of air for dispatching the carriers being 2 lb. to 3 lb. per square inch.

In submarines compressed air is stored in a number of reservoirs at about 160 atmospheres pressure, which can be recharged by motor-driven air compressors. The air is used for charging and ejecting torpedoes, but its principal use is for expelling water from the ballast tanks when the vessel is submerged and it is desired to rise to the surface. To economise in the use of the high-pressure air, low-pressure blowers are also fitted, which, as soon as the conning-tower hatch is opened, are started and complete the explusion of the water from the ballast tanks.

* * *

Another important use for compressed air is that of raising water from deep wells by the "air lift." Though invented in the eighteenth century and actually used in Germany at that time, it was not until late in the nineteenth century that it came into anything like general use.

The air lift pump in its simplest form consists of two pipes which pass down below the surface of the water in the well. The larger pipe is open at both ends and forms the water discharge or "eduction" pipe, and the smaller pipe is connected with the larger one near the bottom. As the larger pipe is open, the water in this pipe stands at the same level as that outside. Compressed air is forced down through the smaller pipe, and this, mixing with the water inside the larger pipe in the form of bubbles, has the effect of reducing its density so that the head of "solid" water outside the pipe can support a greater head of the mixture inside, with the result that the water rises in the pipe and overflows at the top, where it discharges into a tank.

It is, of course, necessary in designing an air lift to select a suitable depth for the pipes to give the most efficient result. There are no generally accepted rules for the design of air lifts, as so many variable factors are involved that it is practically impossible to calculate exactly the yield of any air lift before it is actually installed. Most text-books dealing with compressed air give some formulæ for determining the various factors, such as the sizes of pipe to be used and the "submergence" or depth to which the pipes must be immersed in the water for a given lift; but in practice the engineers who specialise in this work design their installations by the result of their experience with conditions as nearly as possible similar to those under consideration.

The air pressure at starting is simply that due to the head of water above the junction of the air and water pipes, but in ordinary wells the water-level drops as pumping proceeds, until the point is reached where the water flowing into the well just balances the quantity which is being pumped out. This has the effect of reducing the working pressure required for the air, until this point has been reached. This drop in level has to be taken into account in deciding the depth of "submergence" which it is generally agreed should not be less than about 50 per cent. of the total length of pipe up to the point at which the water is discharged, this being reckoned with the water at its lowest level. This is the chief difficulty met with in designing air-lifts, as the exact amount by which the level will drop can only be determined by pumping out the quantity of water required and measuring the resulting difference in level.

While it is not claimed that air-lift pumping is the most efficient method of raising water from a deep well, there are so many advantages in the system, that when all costs, including upkeep, are taken into consideration, it generally proves to be a cheap method in the end for moderate lifts.

In the case of a deep well pump of good design, the actual power expended in raising water will probably be a little less than in the case of an air-lift, but overhaul and repair may be much more expensive, owing to the working parts being in the well and, therefore, inaccessible, while in the air-lift there are no parts in the well except the pipes themselves, and the air-compressor which contains all the working parts in the system is installed on the surface where it can easily be attended to and kept working at its maximum efficiency. There is, therefore, no deterioration by corrosion of parts which have to work under water, and also no danger from frost, as any water in the "eduction" pipe falls back into the well when pumping is stopped. Sand or other foreign matter,

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* At this point Mr. Reavell exhibited a very small machine driven by a $^1/_{30}$ horse-power electric motor which was capable of giving a delivery of air compressed to 5 lb. per square inch or by a simple reversing of the connections of creating a vacuum of a like amount. This machine, it was stated, was being largely employed for laboratory and other work and was found of particular value in surgical work in which it had been the direct means of saving 50 per cent. of the time spent on many operations.

including acids or chemicals, will not interfere with its working, as they do not come into contact with anything except the pipe.

Many patents have been taken out for special forms of foot-pieces for air-lifts, all designed with a view to breaking up the air into the smallest possible bubbles, as this tends to reduce the slip of the air bubbles through the water and thus increases the efficiency of the system, since it is the buoyancy of these bubbles alone which supplies the motive force for working the pump. This slip of the bubbles is one of the chief causes of loss of energy in the air-lift, the other being the friction of the water on the sides of the pipe.

To make the sum of these two losses a minimum must be the aim of the designer. If the velocity of the water in the pipe is increased, the loss due to slip is decreased, as less time is allowed for the bubbles to slip, but, at the same time, the loss due to friction is increased, and it is only by experiment that the best proportions can be determined.

* * *

A system is now in use by means of which a hydraulic forging press is supplied with the water under high pressure by means of an accumulator which is loaded by high air-pressure instead of by weights.

The hydraulic cylinder of the accumulator is turned on the outside, and works inside another cylinder containing a small quanity of oil, on the surface of which high-pressure air is admitted. This air is supplied from a relatively large air receiver in which the high pressure is maintained by a small air compressor.

The object of the large receiver is to maintain the air pressure above the hydraulic ram at as nearly a constant pressure as possible, and in practice it is found that it is maintained within about 5 per cent. The leakage of air is very slight indeed, owing to the oil seal in the cylinder, and, further, the air compressor is only used for altering the pressure when different hydraulic pressures are required.

One advantage of the system is that the hydraulic pressure can thereby be quickly reduced or increased to suit the size of the pieces which are being forged, and this effects a considerable economy when forging light pieces, because the hydraulic pressure can be regulated exactly to suit the weight of the work. Another advantage is that it renders the hydraulic press itself much more rapid in action. This is due to the fact that if the accumulator is weighted with metallic ballast, the total weight on the hydraulic accumulator cannot be arrested quickly, whereas the forging press comes to a sudden stop at the end of its stroke and thereby a big overload is experienced in the pipe, on the valve, and the various joints in the hydraulic circuit. With the air ballast accumulator the kinetic energy in the accumulator moving parts is enormously reduced, and the overload on the piping line is hardly noticeable. Further, the system much reduces the cost of the heavy foundation work which is otherwise required under the accumulator.

In paper-making machinery the use of air-pressure jets is not very commonly known. One of the most difficult problems in paper mill operation is to reduce the amount of "broke" or spoilt paper incidental to the modern, fast-running machines. The use of compressed-air devices is stated to enable speeds of from 1100ft. to 1200ft. per minute to be maintained in modern American and Canadian mills.

In this system the first use of air is when the moist paper is taken from the bottom couch to the first felt. A narrow strip of the moist paper is separated longitudinally from the remainder of the width of the paper by the use of the water knife, *i.e.*, a jet of water blowing on to the moist paper coming over the machine wire. This strip is lifted up by air-pressure from a nozzle below, and carried on to the first felt. Another air-jet blows it on to the second felt, and so on through the three or four presses. From thence, by air jet, the strip is blown over to the first steam-heated drier and thence through each consecutive group. When this narrow strip has reached the last drier the water-jet is fed across the moist paper as the latter is travelling forward, by which means the strip is widened until the full width of the moist paper is passing through the machine, being lifted at each stage by the air-jets. When a complete reel of paper has been produced, air is again used. The operator directs the jet of air down on the drum, which splits the sheet right across the drum. A new spindle has been previously lowered into position and the loose end of the paper which has just been split off winds round this. The completed reel is then lifted off and the new spindle moved into the position thus vacated, where it remains until in turn it is completed.

It is reported by the National Federation of Iron and Steel Manufacturers that, owing to the continuance of the coal stoppage, the number of furnaces in blast was again reduced during September, and at the end of the month only five remained in operation, compared with 147 on the eve of the stoppage. The production of pig iron therefore declined to 12,500 tons, compared with 13,600 tons in August and 539,100 tons in April. Steel production amounted to 95,700 tons, compared with 52,100 tons in August and 661,000 tons in April.

Models and Analogies for Demonstrating Electrical Principles.

No. XII.*

While the models illustrated in Figs. 103 to 108 are of more interest to cable manufacturers than to anyone else, and are not intended for educational purposes, they are worthy of consideration. They

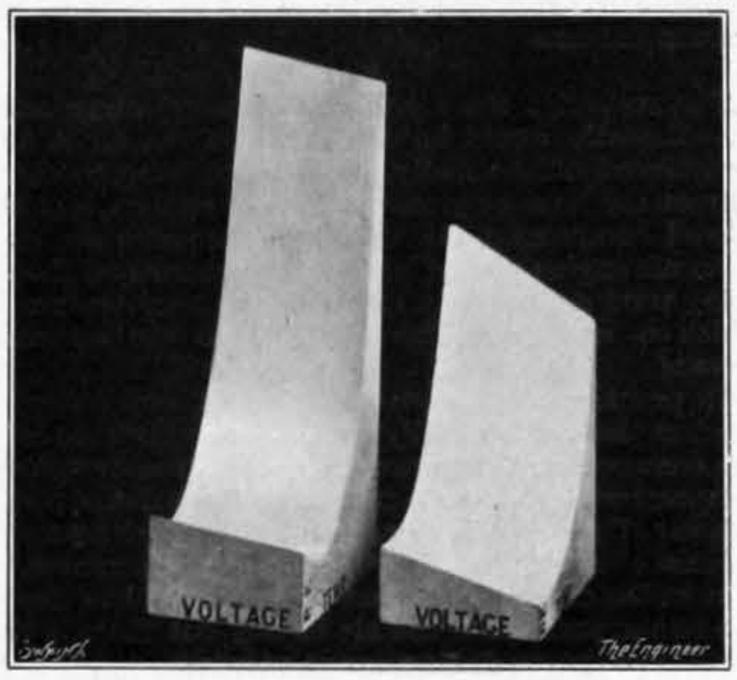


FIG. 103—MODEL SHOWING POWER FACTOR, TEMPERATURE AND VOLTAGE

were originally described by Mr. Percy Dunsheath, of Henley's Telegraph Works, Ltd., in his paper on "Dielectric Problems in High-voltage Cables," read before the Institution of Electrical Engineers on November 5th, 1925. In view of the dependence of power factor on the two variables, temperature and voltage, and the need for a quick method of comparing the results on a number of cables, Mr. Dunsheath has found it convenient to employ solid diagrams for plotting the results. The values of

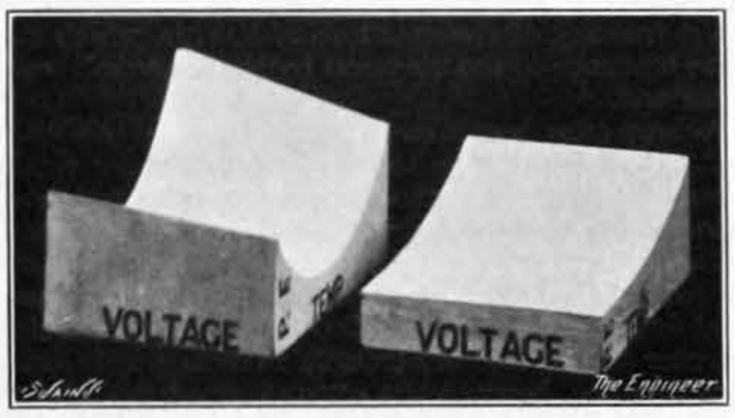


FIG. 104—MODEL SHOWING POWER FACTOR, TEMPERATURE AND VOLTAGE

power factor at any one voltage are plotted against temperature, and the curves so formed are cut out of five-ply wood, ¼in. thick. Similar curves are produced for each of the other voltages employed in a series of tests, and when they are assembled the resulting block gives a bird's-eye view of these particular electrical properties of the cable. In the determination of the effects of modifications in materials or manufacture when carrying out research work on cables, a comparison of two or more such

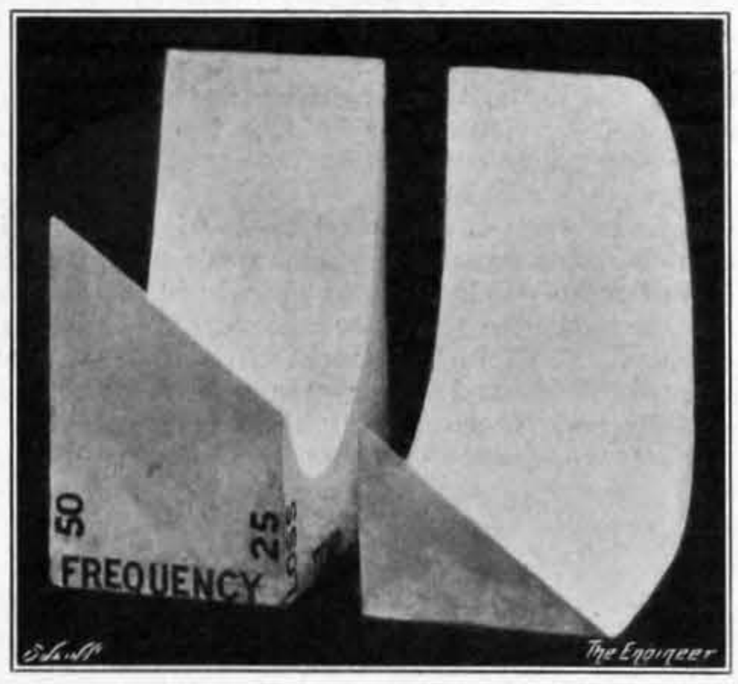


FIG. 105—MODEL SHOWING DIELECTRIC LOSS, TEMPERATURE AND FREQUENCY

blocks is much easier than the comparison of masses of figures.

The models—Figs. 103 and 104—show four sets of results plotted in this way, and demonstrate the wide variation in shape of the solid power factor voltage temperature diagram, which may be affected by alterations of materials and processes. The lower values and flatter curves in Fig. 104 are obtained by

* No. XI. appeared October 22nd.

the use of special compounds. The use of similar solid diagrams is also helpful in forming an idea of what happens to the characteristics outside the range actually tested. The left-hand block in Fig. 105, for example, shows a model used to demonstrate the variation of dielectric loss with temperature and frequency, the results being based on 25-cycle and 50-cycle tests. The right-hand block in the same figure shows the probable variation of loss with a frequency of 25 cycles downwards to direct-current conditions. The model—Fig. 106—shows the manner in which the power factor varies with frequency and temperature, the left-hand block being based on actual test results, and the right-hand block being a



FIG. 106—MODEL SHOWING POWER FACTOR, TEMPERATURE AND FREQUENCY

suggestion as to how this quantity varies at the lower frequencies.

It has been customary for many years to speak of the breakdown strength of a cable as though it were a definite constant characteristic. But anyone who has had experience of cable testing knows that a voltage applied suddenly produces results quite different from one applied slowly, and it has consequently been usual for some time to specify duration pressure tests of fifteen to thirty minutes, in addition to quick breakdown. Only quite recently, however, has the exact relationship between breakdown voltage and time of application called for detailed study, one factor leading to investigation of the matter being the failure of super-tension cables in operation many months after their installation, notwithstanding that they passed the most stringent tests before leaving the factory and when they had been laid.

The time effect is quite a new phenomenon, and

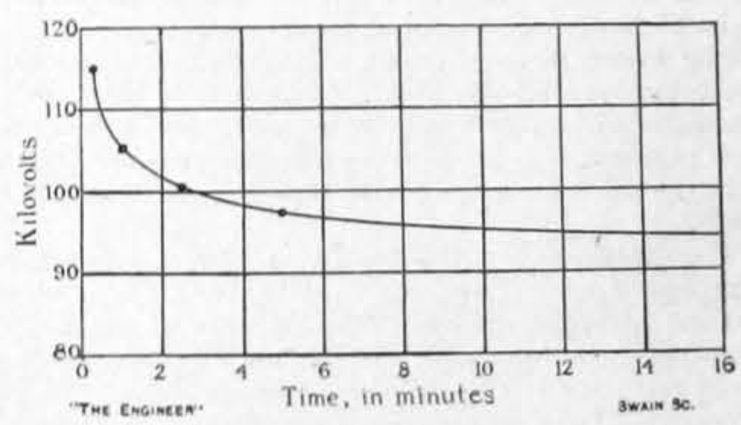


FIG. 107—TIME VOLTAGE CURVES

so far very little has been published on the subject. Mr. F. M. Clark has shown, however, that if a fibrous insulating material such as impregnated paper be subjected to a succession of voltage applications below the value to cause failure, and the dielectric is allowed considerable time for recovery between the applications, its power of resisting a straight breakdown test may be very much impaired. This is a discovery of considerable importance in the operation of cables, for it means that indiscriminate high-pressure tests may seriously affect the life of the cable under working voltage. It also means that a succession of pressure rises due to surges or lightning on connected open lines, although individually resulting in no

failure, may make the cable progressively less able to withstand such voltages.

Developing these ideas, Mr. Dunsheath has made it a practice for some time past to produce time voltage curves for all cables made under research conditions with a view to augmenting the information obtained in other tests. The method adopted is to cut up a uniform length of cable into six or eight pieces, each

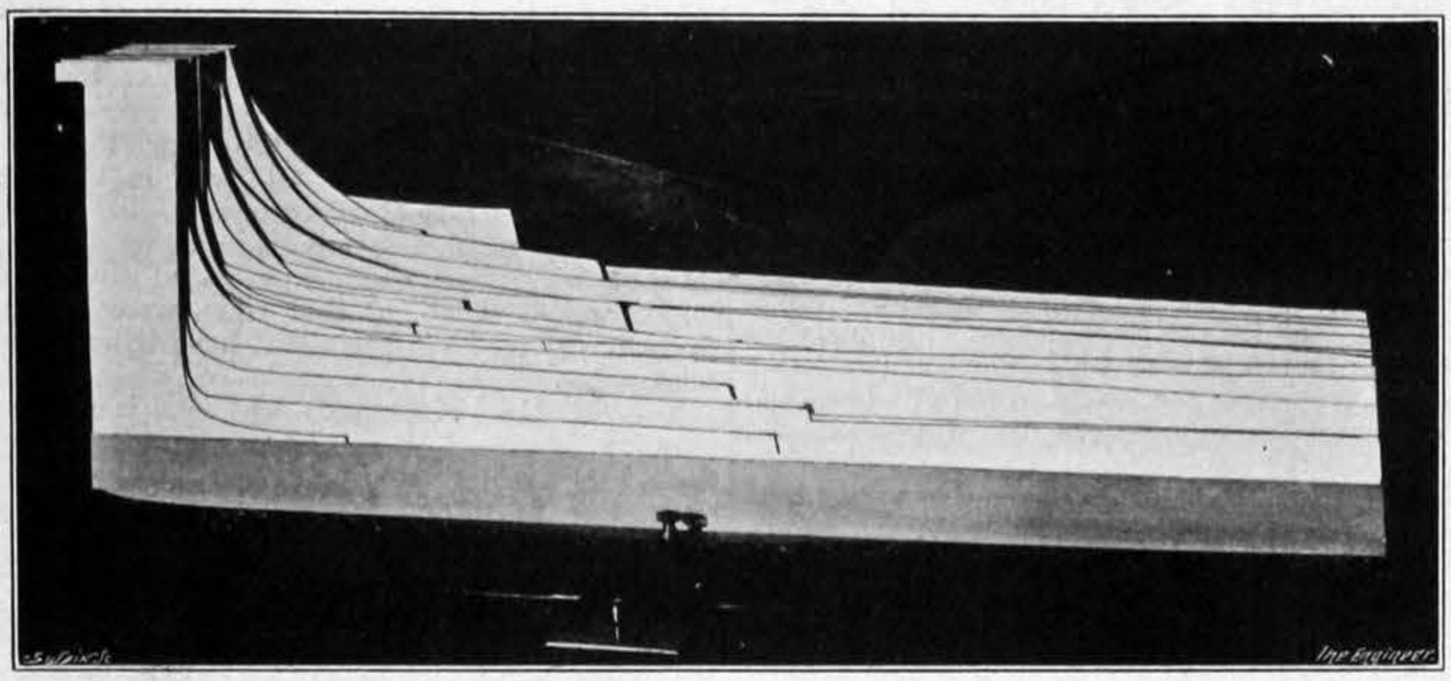


FIG. 108—COLLECTION OF MODELS OF TIME VOLTAGE CURVES

5 yards long, and to apply a quick breakdown voltage at a definite rate of increase, and then apply 90, 85, 80 per cent., &c., of the value so obtained to the remaining pieces in turn. The time during which the piece holds the voltage is recorded, and as the lower the voltage the longer the time, plotting the results gives a curve as shown in Fig. 107.

The slope of the curve is very steep for short

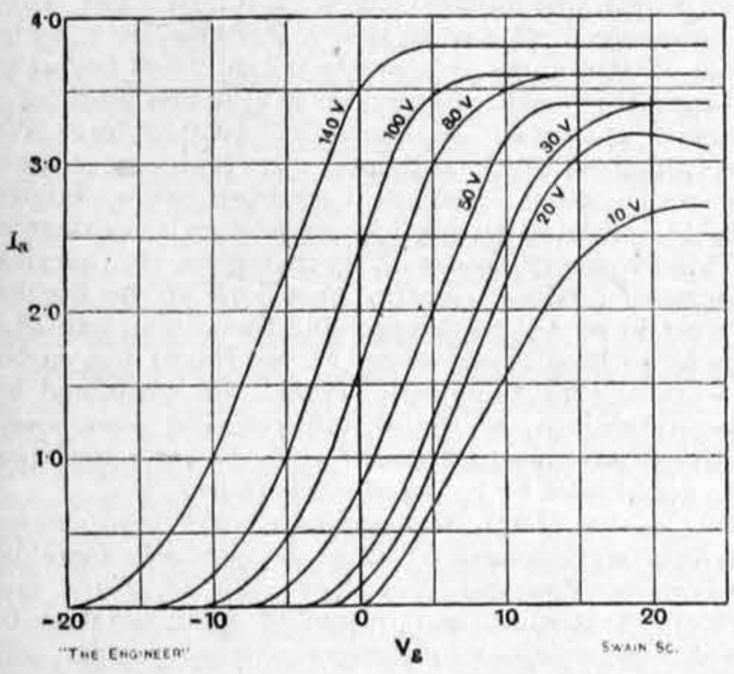


FIG. 109—GRID-VOLTS-ANODE CURRENT CURVES

times, and gradually flattens out until quite a small reduction in the voltage adds enormously to the time that a cable will stand up under it. Fig. 108 shows a collection of curves produced in this way for experimental cables made up in the investigation of different materials and processes. As an indication of the order of the figures obtained, a good modern 30,000-volt cable will hold 75,000 volts, three-phase, at

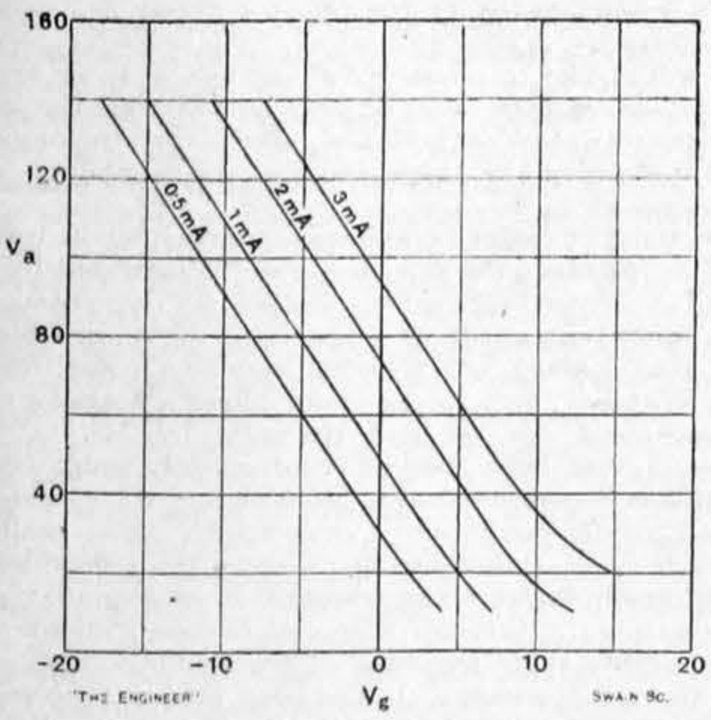


FIG. 110—GRID-VOLT ANODE-VOLT CURVES

normal temperatures for fifty to sixty hours before failure. It is not clear from these curves whether they ultimately flatten out to a definite voltage or continue to fall at a decreasing rate for ever. By plotting the results in another way, however, the conclusion is reached that a given cable has a definite voltage below which it would hold up for ever. This method is described in Mr. Dunsheath's paper.

Although we have dealt with a valve characteristic model designed by Professor C. L. Fortescue, reference should be made to an interesting article on "Valve Characteristic Surfaces," by Mr. E. H. Harwood, published in the *Wireless World* of August 11th. In order to visualise the working of a three-electrode valve or triode and to ensure efficient operation, the use of some sort of characteristic is necessary, the most common met with being the anode current grid volt curves, which are generally given with a constant filament temperature and a variable anode voltage. If the triode is being considered as a generator of oscillations, however, these curves become a little awkward to use, because of the fluctuations of the anode voltage, and a case is met with in which three variables occur—the anode current, dependent, and two independent variables the grid and anode voltages. Expressing these as symbols, with a constant filament temperature which is assumed in all cases in Mr. Harwood's article.—$I_a = f\ (V_g,\ V_a)$, where I_a represents the anode current, V_g the grid volts, and V_a the anode volts.

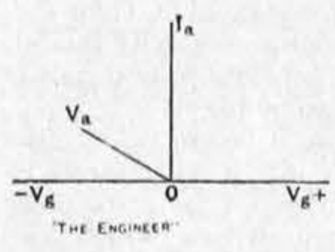


FIG. 111—ANODE - VOLTS, CURRENT AND GRID VOLTS

Just as we can represent the relations between two variables by means of plane curves, so it is possible, as already shown, to represent three variables by means of a surface. It is obvious that a triode has a characteristic surface, and in the article under consideration an endeavour is made to show its form. The use of the characteristic surface of a triode may assist in a physical conception of its working, more especially when used as an oscillator.

The usual grid-volts-anode current curves are of the form given in Fig. 109, these being the curves for an ordinary Mullard "Ora" bright emitter valve. As the anode voltage is increased, the family moves to the left, and at low anode voltages there is a distinct falling off of anode current owing to the increasing counter attraction of the grid. The characteristics may be drawn in a different form, *i.e.*, that showing

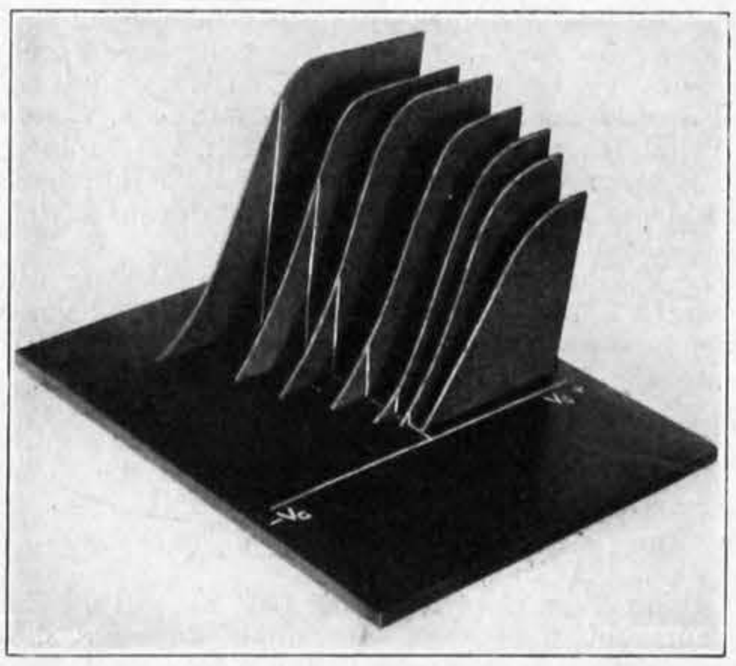


FIG. 112—DEVELOPMENT OF CHARACTERISTIC SURFACE

the relation between grid volts and anode volts. The arbitrary constant for the family is then the anode current, and these curves are shown in Fig. 110 for the triode mentioned. These sets of families of plane curves can be combined into one characteristic surface. Imagine the three co-ordinate axes to be erected mutually at right angles, as shown in Fig. 111. These will represent the axes of the three variables, I_a, V_a and V_g, respectively. Planes representing the variation of I_a with V_g for a constant anode voltage will be parallel with O I_a and O V_g, and their curved surfaces will be of the shape of the usual I_a–V_g characteristic. Thus the curve for a value of $V_a = 20$ will be placed back along the O V_a axes by a distance representing 20 volts. In this way any number of these planes may be put in, and the appearance is that shown in Fig. 112. In order to secure definition, all positive grid voltages beyond 24 are neglected.

If desired, similar planes parallel to O V_g, O V plane may be put in representing change of V_a against V_a with constant anode currents. These planes will intersect the previous ones at right angles. Evidently the surface embracing all the curved edges of the planes is the characteristic surface required. The greater the number of planes taken the more nearly can the true surface be judged. A convenient method of determining this surface is to fill in the spaces between the planes with paraffin wax or plaster of Paris and then mould up to suit the edges of the planes.

An illustration of the characteristic surface for the

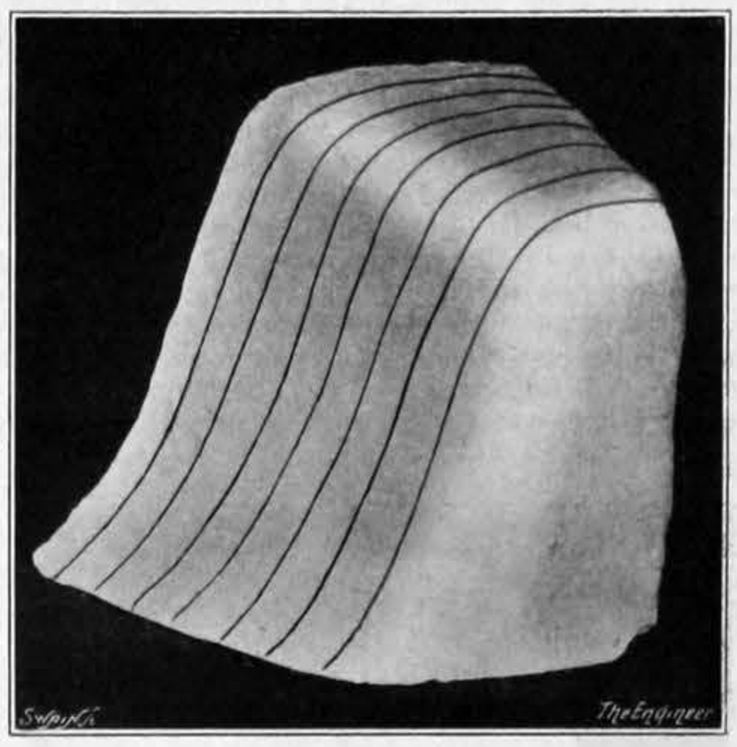


FIG. 113—MODEL OF CHARACTERISTIC SURFACE

Mullard "Ora" previously mentioned is given in Fig. 113.

Three main features are apparent from the observation of the model, as shown in Fig. 114. They are (A) The zero anode current plane, which extends away indefinitely to the left, joining the body of the model by a line roughly at 45 deg. to the I_a, V_a axes. In this region the influence of the steady anode potential is not sufficient to overcome the repulsive action of the negative grid, and no anode current flows. This cut-off effect naturally becomes non-existent when the grid becomes positive. (B) The useful working surface, which emerges from the zero anode current plane and is inclined to all axes. It is this surface which is commonly used in amplifiers, and which should therefore be as plane as possible in order to avoid distortion of the input. With a positive grid and two values of anode voltage this working surface

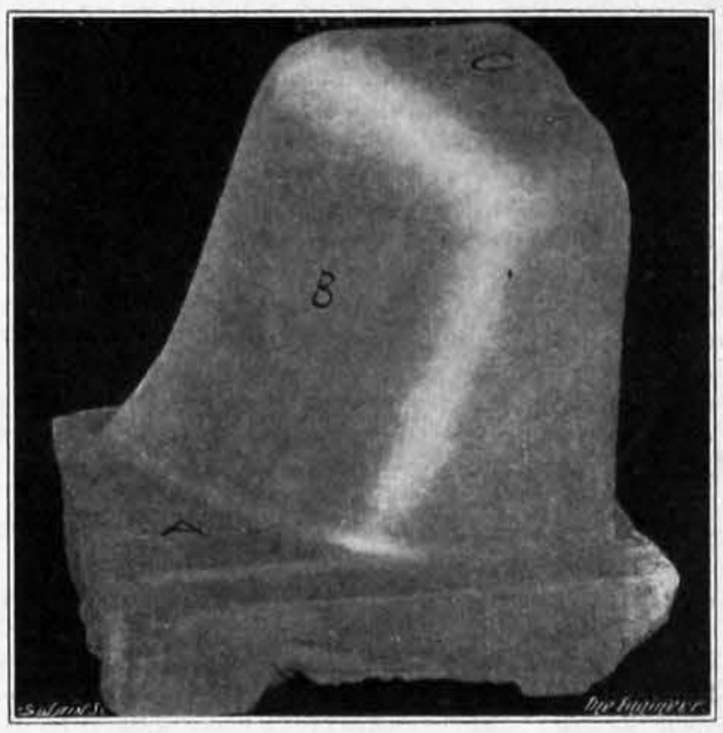


FIG. 114—MODEL SHOWING AREAS INTO WHICH THE CHARACTERISTIC SURFACE MAY BE SUB-DIVIDED

departs from its more or less plane form and turns almost parallel to the V_g–I_a plane. With very small values of anode potential this region merges into the grid voltage axis. Rectification by means of the curvature of the characteristic is usually carried out on the bend uniting the zero anode current plane to the working plane, and the sharper the junction between these planes the greater will be the change in mean anode current through the recording device. (C) The saturation area. When the anode becomes so strongly positive that all the electrons emitted from the filament are attracted to it, no further increase of anode potential can possibly increase the filament-anode flow of electrons. In other words, the saturation current corresponding to that particular filament temperature has been reached. The greater the negative potential on the grid the greater is the value of anode voltage necessary to secure saturation. The working plane is joined to the saturation area by

means of a curved surface similar to that joining it to the zero anode current plane. If desired, this top curve may be used for rectification in a similar manner to that of the bottom curved surface. In rectification the anode potential remains sensibly constant and the use of a characteristic surface is quite unnecessary, since all the working is concerned solely with one plane of the characteristic.

It is fairly obvious that, provided the working surface is plane and no grid current is allowed to flow, undistorted wave shape amplification will be obtained

Grid current flows, in general, when the grid becomes positive, and hence the surface to the right of the zero grid volts axis can be rejected for undistorted amplification. It is now necessary to fix the static points within the plane working surface, so that the application of the signal does not cause the characteristic point to wander round the top and bottom curved surfaces, *i.e.*, it is necessary to limit the anode current range, which, in turn, is governed by the grid voltage swing. The initial static point is fixed by the steady grid bias and anode voltage. The effect of grid bias is here seen to be in getting the static point away from the forbidden grid current area. Excess of negative bias is, however, as bad as the lack of it, for in that case the static point will have to shift lower down the working plane, and hence distortion will ensue owing to the signal sweeping down the lower bend. With resistance capacity amplifiers the working trace will fall away from the characteristic curves for the particular anode battery voltage, for as I*a*

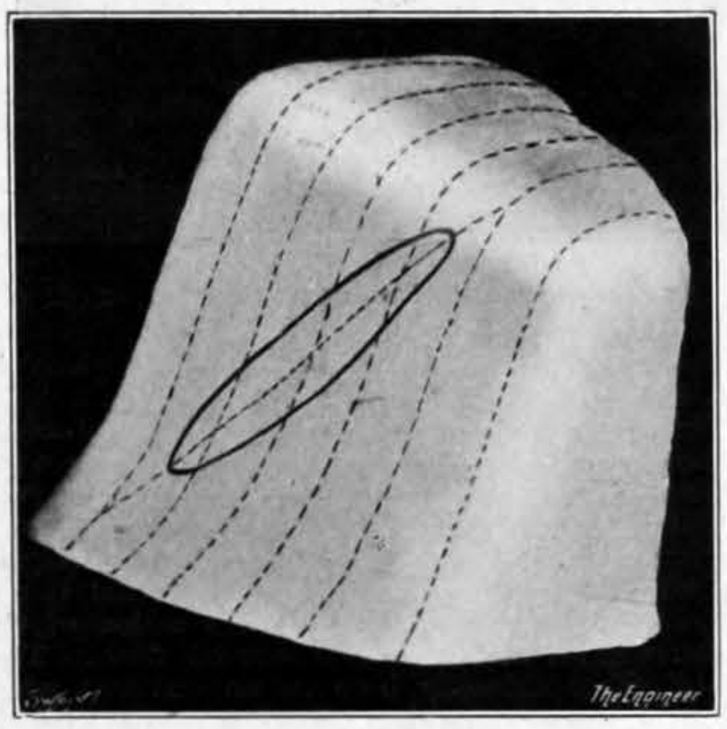


FIG. 115—CHARACTERISTIC ELLIPSE OF A VALVE OSCILLATOR

increases so does the drop on the anode resistance increase, and hence the effective anode voltage will decrease. The representative point will thus gradually shift to lower anode characteristics as the anode current increases.

With an oscillating triode somewhat similar conditions prevail. As the oscillation passes through each cycle, so the effective anode voltage varies owing to the drop on the inductance of the oscillatory circuit. Hence we should expect to get a working trace similar to that for a resistance coupled amplifier. That would be the case if the oscillatory circuit had no resistance. Any resistance in the main oscillating circuit, however, introduces into the anode current a small out-of-phase component, and the anode current is then not quite in phase with the anode volts. This makes the representative point describe an ellipse on the characteristic surface similar to that indicated in Fig. 115.

Let it be assumed that the static potentials of grid and anode are such that the representative point is in the centre of the working plane. Any small disturbance will then set up oscillations which will increase in amplitude until the point moves off the plane part. This limiting action can occur in three ways :—(1) By the elliptical trace going into the saturation area ; (2) by the ellipse reaching down to the zero anode current plane ; (3) by the ellipse cutting into the "small anode potential" surface (at the front of the model).

To get as large an oscillatory current as possible, the grid must have a fairly large negative bias. The avoidance of grid current is not usually very important. These simple observations may easily be extended, but sufficient has probably been said to indicate a possible alternative to the usual characteristic plane curves, and one which, for certain conditions, may be better.

The outstanding conclusions arrived at by the Peat Committee of Canada were that the only methods or processes which could be economically employed for the manufacture of peat fuel were those employing air-drying, that the climate conditions in Ontario and Quebec were favourable for the manufacture of peat fuel for 100 days during the summer season, and that the commercial production of this form of fuel, on a large scale, could be conducted on many of the bogs which had been examined in detail, and which were favourably situated with regard to centres of population and transportation facilities.

Radio Communications.*

By Senatore GUGLIELMO MARCONI, G.C.V.O., D.Sc., LL.D., Hon. M. Inst. C.E.

In the very early days of "wireless," when electric waves were first beginning to be employed for practical purposes, we only spoke of wireless telegraphy, but with the advance of the art electric waves have been more and more widely utilised, not only for wireless telegraphy, but also for wireless telephony and broadcasting, direction finding at sea and in the air, for the control of mechanisms at a distance, such as targets, torpedoes, flying machines, and other similar devices used principally for war purposes, and, more recently, also for the transmission of pictures and facsimiles, and television.

I hope you will not think me too visionary if I say that it may be possible that some day electric waves may also be used for the transmission of power, over moderate distances, should we succeed in perfecting devices for projecting the waves in parallel beams in such a manner as to minimise the dispersion and diffusion of energy into space.

I think we are still far from being able to say that wireless is based on well understood foundations, unless, of course, we should go back to the arrangements used in the past, which, to my mind, have become more or less obsolete. There is no doubt that, speaking generally, radio engineers four or five years ago thought they knew much more about the subject than we think we know to-day. I am convinced, however, that now the whole theory and practice of long-distance radio communication is undergoing a most radical and beneficent change, or what we might be quite justified in terming a revolution.

The upsetting of so many pet theories is having the welcome result of increasing the efficiency and usefulness of wireless telegraphy to an enormous and almost unhoped for extent, whilst at the same time opening up what may prove to be fertile fields for research and disclosing an entirely new horizon to our view.

Commercial long-distance wireless telegraphy has been carried out up to very recently exclusively by stations employing wave lengths from 8000 to about 30,000 m. and using several hundreds of kilowatts at the transmitting end. Their cost is something of the order of £500,000 each, but considering that their speed of transmission is not very high, their cost and their running expenses, which necessarily include interest on capital outlay, depreciation and power consumption, have been found to be high.

Ten years ago, during the war, I began to consider the possible alternative which might be offered by an exploration of the capabilities for point-to-point communication of those electric waves which had never yet been used for practical radio-telegraphy—that is, waves only a few metres in length, and I was particularly attracted to this line of research because I was, of course, well aware that with these waves, and these waves only, it would be possible to project most of the radiation in a narrow beam in any desired direction, instead of allowing it all to spread in every direction.

I was greatly impressed by the advantages which such a system would possess, if found workable, through the saving of energy which might result, and also by the possibility of reducing tapping or interference together with mutual interference between stations, even if working on very small differences of wave length.

During April, May and June of 1923, a systematic series of long-distance tests was carried out over varying distances between a small experimental transmitting beam station at Poldhu in Cornwall, and a receiving station installed on the s.y. Elettra.

A wave length of approximately 92 m. was employed, and it was soon ascertained that the Poldhu signals could be clearly and reliably received during daylight up to distances of 1250 nautical miles.

The Poldhu sending station was at that time using about 12 kilowatts in the aerial. The night signals came in always with great strength and regularity up to the maximum distance to which the yacht was able on that occasion to proceed, which was as far as the Cape Verde Islands, situated 2320 nautical miles from Poldhu, and the strength of the signals received there left no doubt in my mind that the practical range of the signals was very greatly in excess of that distance.

I think I am right in saying that up to that time the general impression prevailing amongst most technical experts in regard to the behaviour of short waves was :—

(1) That their range during daytime would be very short.

(2) That the night ranges, although occasionally considerable, would be exceedingly variable and freaky, and therefore altogether too unreliable to allow these waves to be of any use for long-distance commercial working.

(3) That any considerable stretch of intervening land, especially if mountainous, would seriously reduce the distance over which it might be possible to communicate.

The 1923 tests, carried out between Poldhu and the Elettra, had the result, however, of completely convincing me and my assistants that the above impressions or conclusions were quite wrong in so far as they concerned waves of about 100 m. or less, for we observed :—

(1) That the daylight ranges proved to be very much greater than had been anticipated.

(2) That the night ranges were reliable and not variable or freaky, besides clearly indicating that the possible distances which could be covered would be very much greater than anyone, including myself, had been led to expect.

(3) That intervening land and portions of continents did not constitute an obstacle to the propagation of these waves.

Moreover, a fact more or less expected was also observed, and this was, that even in the tropics, atmospheric electrical disturbances, or X's, were always very much less troublesome when receiving on short waves than those experienced with the much longer waves which, at that time, were being used exclusively for all practical long-distance radio-telegraphy.

The variations of strength, and what is now termed "fading," were proved to be very much less serious than I had anticipated, and results obtained over even the maximum distances could always be repeated during the many weeks these tests lasted.

These tests were continued in February and March, 1924, with the object of determining the maximum practical range of these waves, independently from any advantage to be gained by the use of reflectors or directional methods, and we found that, whilst the day range of a 92 m. wave was about 1400 nautical miles at that time in the North Atlantic, good communication could be established during the dark or semi-dark hours with the United States, the Argentine and Australia, that is, across world-wide distances.

In August and September, 1924, further tests were carried out over varying distances with four wave lengths of 92 m., 60 m., 47 m., and 32 m. respectively. These tests enabled me to discover the important fact that over long distances the daylight range of practical communication steadily increased as the wave length was reduced below 92 m., the 32 m. wave being received all day at Beirut in Syria, over a distance of 2100 miles, whilst the 92 m. wave began to fail over this track, which is mostly across land, at a distance not much in excess of 1000 miles. We naturally presumed, and later experience confirmed our anticipation, that still shorter wave lengths would be affected by daylight to an even lesser degree.

This discovery, apart altogether from its practical importance, raises scientific questions of the highest interest in regard to the possible theoretical explanation as to how these waves travel round the earth. It is clear that the results cannot be explained by mere diffraction, as the signals received over world distances are many thousand times stronger than they could ever be by mere refraction.

In October, 1924, transmission tests were carried out on a wave length of 32 m. to specially installed receivers at Montreal, New York, Buenos Aires, and Sydney (Australia), and it was at once found to be possible to transmit messages when utilising only 12 kilowatts or less at the transmitter to New York, Rio and Buenos Aires, even when the whole of the great circle track separating these places from Poldhu was entirely exposed to daylight.

With Australia, however, it is only possible to have a complete daylight track for two or three hours at a time, and, furthermore, the scientific aspect of the test is complicated by the fact that the waves have several ways of getting round, with comparative ease, if they can get there at all, as a large portion of Australia is not very far from the antipodes of England. The Australian tests showed, however, that it was possible to get through for about 23¼ hours out of the 24.

I would like to point out that most of these very long-distance tests were carried out without the use of reflectors at either end, and merely with the object of ascertaining the range and general capabilities of these waves.

In the first beam experiments carried out in Italy and in England, the reflectors were constituted by a number of vertical wires parallel to the antennæ and spaced around it on a parabolic curve, of which the transmitting or receiving antennæ constituted the focal line, but in the more modern stations an arrangement devised and patented by Mr. C. S. Franklin has been more advantageously employed.

In this arrangement the antennæ and the reflector wires are disposed so as to constitute grids parallel to each other, the aerials or antennæ being energised simultaneously from the transmitter at a number of feeding points, through a special feeding system, so as to secure that the phase of the oscillations in all the wires is the same. It has been proved by calculations and confirmed by experiments that the directional effect of such an arrangement is a function of its dimensions relative to the wave lengths utilised. A similar system of aerials and reflecting wires is used at the receiving stations.

As already pointed out, it had been proved long ago by calculations, confirmed by experiments, that the directional effect of a radio reflector is a function of its dimensions in relation to the wave length employed. Hence it follows that the dimensions of the aerial and reflectors can be reduced proportionately to that of the wave length, and therefore the cost and

* The Institution of Civil Engineers. The Thirty-second "James Forrest" Lecture, October 26th, 1926.

space occupied is much smaller for wave lengths of, say, 20 m. than for wave lengths of, say, 90 m.

In the spring of 1924 a sub-committee of the Cabinet was appointed for the purpose of considering proposals made by the Marconi Company for the employment of the short-wave beam system for Imperial communications, and on July 2nd of that year an agreement was entered into between the Post Office and the company for the construction of wireless stations on this system capable of communicating to and from Canada, South Africa, India and Australia.

The English beam transmitting stations for Imperial communication, completed or still in course of construction, are :—

At Bodmin, for working with Canada and South Africa, and at Grimsby, for working with Australia and India, the corresponding receiving stations being at Bridgwater and Skegness.

Moreover, another beam station is in course of erection at Dorchester, for working to the United States and to South America. Arrangements and agreements were also completed for the construction of similar corresponding stations in Canada, South Africa, Australia and India.

The Bodmin and Bridgwater stations have now been taken over by the Post Office, and the new service was opened to the public last Sunday midnight, the 24th inst.

These results have been of the greatest possible satisfaction to myself and my co-workers, because they go to prove that our faith in the new system, which we have held for years in the face of much scepticism and criticism, was not altogether misplaced.

The working of these beam stations has already shown some further very interesting results, some of which are perhaps novel in the history of long-distance wireless. One of these is in regard to atmospheric disturbances, or X's. I think we all know that "atmospherics" have all along been the bugbear of wireless, but we have noticed that with these types of stations they have been very much less severe than in any other long-distance receivers with which we have ever had experience. Thunderstorms in the vicinity of the receiving station do not cause much interference, unless—and it seems to be a rare occurrence—they should be inside the angle of receptivity of the receiving reflector and not too far off.

I feel confident that the disturbances usually known as "atmospherics," as apart from "fading," have ceased to exist as a serious hindrance to the working of high-speed radio between England and Canada. I fully realise that this is a bold statement, but I feel pretty confident I am right in making it.

Another "fading" period of a few hours' duration, which a newspaper wrongly attributed to "atmospherics," occurred during yesterday's severe storm. We have not yet been able to ascertain to what causes it may be attributable. It may even have been due to some insulation fault. It is, however, obvious that we cannot expect an entirely new system to be perfect from the very start.

The variations, or rather, the "attenuation" of signal intensity, now termed "fading," has been a marked feature of long-distance radio transmissions, especially when short waves are employed, and although in my experience "fading," appears to be worse with wave lengths between 200 m. and 1000 m., it has sometimes occurred on the 26 m. wave, which is utilised by the beam stations working between England and Canada.

According to the experience of myself and my collaborators, the use of reflectors has the advantage, which perhaps is common to all sharply directional systems, of diminishing "fading." This is brought about partly no doubt by the great increase of the received signal strength which is obtained by the utilisation of this directional system, and which thereby increases the margin of readability of the received signals. It is, however, a fact that "fading" does to a certain extent still exist on the Bodmin–Canada circuit, and, on certain occasions, has even cut off all communication between the two stations. Two such bad periods of "fading" occurred on September 20th and on October 14th. Both these bad periods coincided with the appearance of very large sun spots and intense Aurora Borealis, and at the same time telegraph lines, especially in Canada, and cables were thrown out of action or their proper working was greatly interfered with. I, however, noticed that during these bad periods signals could be received across the Atlantic by using still shorter waves of the order of 15 m. in length, and also that the working of ordinary long-wave stations was not interfered with. As I have already pointed out, waves as short as 15 m. or less can be received across long distances better by daylight than during night-time, and we also know that very long waves are not affected by daylight on the North Atlantic track. The conclusion I come to from these observations is that during the days when sun-spots and Aurora Borealis were noticed, conditions, due to ionisation of the atmosphere at a certain height resulting in a lowering of the ionised stratum, equivalent to what I might term "intensified daylight," were prevalent.

Provision has been made for the use of two waves of different length at the beam stations, and a shorter wave will be tested and used during any exceptional conditions of the nature to those I have referred to, whenever they appear to interfere with transmission on the 26 m. wave.

Before concluding this address, I would like to put before you a few considerations in regard to what I believe to be the relative value of short *versus* long waves for long-distance radio communications.

We all know that the ether is becoming very congested over a considerable range of wave lengths, and it may be well roughly to figure out the number of possible wave lengths or channels which can be used without danger of mutual interference. If we assume that long waves may be classed between 5000 m. and 30,000 m., and short waves between 5 m. and 100 m., then by applying the basis of the rule adopted by the Government Committee which has drafted the British proposals for the next International Radio Conference, we find that 3700 wavebands or channels will be practicable, and permissible for the short waves between 5 m. and 100 m., but only 90 for the long waves of between 5000 m. and 30,000 m.

It should also not be lost sight of that very high speeds of working appear to be only possible if short waves are employed, whilst with the lower frequency of the long waves speeds of the same order are quite unattainable.

The high power long-wave stations in this country, which at present are carrying out a commercial wireless telegraph service to and from the United States, are capable, I am advised, of transmitting and receiving each way under normal conditions at the same time at an average speed of twenty words per minute for a daily average of eighteen hours. But the beam stations on their official tests have already proved capable of sending and receiving at the same time at an average speed of at least 100 words a minute for eighteen hours per day, which represents at least five times the traffic which could be handled during the same time by the long-wave stations, although these last employ at least ten times the electrical power used by the short-wave stations.

These figures are, I feel sure, sufficient to show you that the whole art and science of radio-transmission is undergoing at the present time a most profound process of evolution.

There is also another interesting economic feature in regard to long distance services by means of short waves with respect to cables which should not be overlooked.

With cables the capital cost of the cable itself increases in simple and direct proportion with its length, but in experimenting with short-wave wireless it has been noticed that it is possible to send messages to Australia with an even smaller amount of electrical energy than is necessary to send them to Canada, and therefore at a probably lower cost, or, alternatively, with greater speed and efficiency.

The tests between England and Canada have already shown that the use of beam aerials and reflectors at both ends has resulted in a signal-strength which Mr. Franklin estimates to be normally some 100 times greater than that obtainable with non-directional transmitting and receiving aerials utilising the same power.

The results obtained have convinced me that a good directional system is the system of the future for point-to-point radio-communication over long distances throughout the world, and it is most gratifying to me that the British Government and the Governments of the principal Dominions and of India have given me an opportunity of endeavouring to prove it.

I would like to add that I do not think that the beam system is by any means limited to wireless telegraphy. I feel confident that it can be utilised for placing wireless telephony on a much more practical basis than it is on at present, besides helping the systems of picture and facsimile transmission, including television. Even for what is called broadcasting I believe it will result in enabling programmes and speeches to be transmitted to large portions or sectors of the United States, Canada, South Africa, and Australia, with much greater strength and accuracy than is possible with the existing systems of broadcasting.

I wish to be able to say, before concluding, how much the perfecting and establishment of the beam system owes to the skill and perseverance of many engineers and experts, but in the first place to Mr. C. S. Franklin on the scientific and technical side ; to Mr. R. N. Vyvyan, engineer-in-chief of the Marconi Company, on the engineering side ; and to Mr. A. G. Mathieu for his special work on short-wave receivers.

We are yet, in my opinion, a very long way from being able to utilise electric waves to anything like their full extent. This will be the work of future engineers, and with the continual advance of civilisation, it will become more necessary in the future than it has been in the past.

According to Messrs. C. S. Pope and C. L. McKesson, of California, their investigation into the mixing of concrete seem to indicate that any increase in time of mix for any mixers now in common use between one minute and some undetermined time more than two minutes and less than five minutes is of no particular value so far as increase in strength is concerned. In general also, the larger batches had average compressive strength 10 per cent., or more, less than that of the batches corresponding to the rated capacity.

"Time is Money."

By K. PERRY-KEENE (The Austin Motor Company, Ltd.).

Is England decadent ? From time to time we hear this question whispered, if not loudly spoken. Never ! She may move slowly following the recent world upheaval, but she still possesses all the attributes which tend toward not only the creation of a greater empire, but a continued development thereof on sound economic and political lines.

England and the Empire are possessed of combined areas of the world which exceed the area of the United States of America several times over. Those areas contain abundant mineral and other supplies suitable for the support of intensive manufacturing. England itself, whilst having all these supplies to draw upon, is well situated internally. Factories are at no great distance apart ; transport, both by road and rail, is easy, whilst the British workman can hold his own with any of the world's operators.

Skill, factories and ample supplies being available, what factor is missing which retards England's commercial activities, and enables rivals to filch trade in which she has long been supreme ?

Apart from the local effect of debased currency of other nations, which undoubtedly gives them a temporary advantage over our manufacturers, the obvious difficulty at the moment is lack of confidence as between employer and employed. It is unfortunately true that certain employers in the past have so used their power against those engaged by them that the outcome has been retaliation, and the gradual adoption of a defensive attitude by labour as a whole, followed by low output. These methods, if persisted in, can obviously only end in the capture of English trade by more enlightened nations. Now, which way lies salvation and a solution of the kingdom's economic problems ?

If confidence were established, and if it were wholeheartedly recognised that "Time is Money," a very great step would have been taken in the right direction, provided that labour be rewarded in due relation to time saved. Upon such a basis many economic problems become common to both employer and employed, and interests consequently flow in one direction. More time saved tends towards lowered costs, lowered price to the consumer, greater volume of trade, greater employment accompanied by greater distribution of wages and salaries, together with larger individual earnings and withal profits to ensure the stability of the undertaking and to safeguard the livelihood of all those engaged in it, whose united efforts have built it up and maintain it.

The effective awakening of the workers' interest in the problem of saving time can best be brought about by giving him an immediate and fitting reward for extra effort put forward, the amount being directly proportioned to that effort in quantity terms, no matter what grade of labour is represented. Hand and brain working together then promptly produce higher individual wages in response to increased output, whereas the idler can at best only look forward to his day rate, even if his services are retained.

If the production force of an undertaking is remunerated upon the quantity of output which it is its duty to produce—quality being fully considered and insisted on—and the selling force upon the amount of turnover reached, diverse interests fall mutually into line and direction, and the maximum effort is forthcoming.

Psychologically sound, this method is the counterblast to the older ones which undoubtedly produced a spirit of repression and *laisser-faire*, unknowingly perhaps, but most effectively.

"Theory," you say. "What about practice, that is the test." Let us follow the evolution of the Austin Motor Company, of Longbridge, which passed through very difficult times shortly after the termination of the Great War, but has made one of the most remarkable recoveries to prosperity ever recorded in the annals of commercial enterprise. Such methods as those described were instituted there in 1922, and have been progressively successful. All production is viewed in terms of minutes elapsed, all wages as minutes occupied, time being the prevailing factor in all calculations and lay-outs, and time saved the basis upon which all grades of labour can increase their individual earnings ; the effect in this direction being prompt and evident in the next succeeding pay packet.

The "fair time" basis is set up in the planning department, and is an allowance in minutes for the particular operation in hand, which before becoming current is demonstrated in practice as being the time an average operative would occupy in completing it. Thereafter the time allowed is positively fixed, and the worker is encouraged and allowed to save as much time as possible, and is paid by way of bonus for the whole of the minutes that he may be able to save. This gives an opportunity for both mental and physical capacity, not only in actually doing the work, but in making local preparation so that loading and unloading of jigs, &c., is accomplished in the least time, and supplies already near the machine are arranged and handled with a minimum interruption to flow.

The works executive see that ample supplies are forthcoming, and the possibility of earning and retaining any remuneration he is able to attain to through savings is a sufficient incentive to the worker to make

large output effective with the minimum of supervision.

From the mechanical point of view, co-operation as between executive and worker tends to utilise any item of plant at or near its ultimate capacity to the benefit of all, the worker receiving remuneration on time saved and the company upon oncost saved, the one in exchange for effort put forth and the other for organisation and the proper provision of facilities to enable the work to be done.

Truly, a happy position—higher wages for the worker, more profits for the undertaking, and substantially reduced list prices for the purchaser of its products. That this is so is best illustrated by the following comparisons ranging over three years :—

	Per cent.
Increase in turnover	209
Increase (average) in worker's output efficiency	73
Increase in individual earnings	108
Increase in profits	93
Decrease in cost to purchasers due to lowered list prices and added equipment	62

Thus has been created a market that did not previously exist ; the very material lowering of price accompanied by increase of intrinsic value bringing the products within reach of purchasers who did not previously expect to obtain such quality at so low a price, and were not in effect catered for with products moderate in first cost, and sufficiently cheap in upkeep to make their extended use a positive economy. This policy automatically creates that great desideratum for a nation of manufacturers—consumption of products on a large scale.

An analysis of such methods shows the following main features :—

(*a*) Time in minutes is the basis of all calculations and operations relating to production.

(*b*) Basic time allowances are positively fixed and guaranteed to the workers, and any time saved is credited to their account for payments. Maximum pressure is used to see that in each individual case the earnings are high.

(*c*) Definite planning is resorted to in the case of each and every operation ; nothing is left to chance, planning covering the whole range of operations and movements from rough material to saleable products.

(*d*) With a view to creating confidence and enthusiasm, maximum earnings are encouraged and expected. The effect of large output and lower incident of oncost is explained to all and sundry, and is understood and appreciated.

(*e*) A daily efficiency account is in operation against each worker and machine, so that results can be continually measured and immediate steps taken to correct any retrograde movement which can be instantly observed and located to—

(1) Executive or supervision faults.
(2) Bad material.
(3) Unsuitable equipment facilities.
(4) Unsuitable operator.

(*f*) Both working and commercial elements have a direct and immediate interest in the progressive success of the undertaking, poor performance being promptly followed by small remuneration, and large output and sales by a proportionate increase of pay.

In actual practice the following methods are pursued :—

(1) A manufacturing programme is laid out covering periods which, after close scrutiny, prove to be convenient having regard to the possibility offered by the world's market for any one complete season.

(2) Each period is resolved into terms of turnover, which upon analysis disclose, amongst others, the following particulars :—

(*a*) The expected load upon the plant and process facilities.

(*b*) The number of employees necessary to carry out the scheme.

(*c*) The volume of purchases required.

(*d*) The quantity of products per minute or hour which must be delivered from each machine or section.

(*e*) The expected cost of production in view of the lay-out employed, and the quantity to be handled. This cost includes both shop and financial charges.

Further subdivision results in a complete plan of action which absorbs every minute of each working day for all the manufacturing sections comprised in the undertaking, eliminating completely any loss of time through waiting for jobs or order of procedure.

Labour is divided into various grades, according to capacity, each having its own basic rate of remuneration, and every lay-out of operation stipulates which classification must be employed for that particular work. Whilst the programme is in execution output efficiency of each grade of labour, coupled with the facilities provided, is continually surveyed. Unless a bonus approximating to 100 per cent. is earned, an employee's service is unlikely to be retained, as that percentage is looked upon as a minimum rate of efficiency.

At the same time, the collective efficiency of each section is continuously scrutinised, both from the point of view of basic output and its inclusive costs after bearing all shop and financial charges. Consequently, if any section fails to carry out its allotted task it is immediately known, and steps can be taken to rectify matters. Quantity control and its balancing is constantly checked through the medium of an analysing machine, which groups all daily results against their respective sections, immediately locating "pluses or minuses," giving the executive a clear view of the position and the power of immediately dealing with any matter which tends to depart from the programme laid down.

Jigs and tools are continually inspected by a perambulating section, whose duty it is to pass over to the tool-room anything that may fail to maintain standard output or accuracy. Plant is dealt with in the same manner, and units which require more than local attention are removed for periodic overhaul.

The same principles that apply to output obtain in the tool-room ; times are set for each job, the worker being paid additional remuneration upon any savings made. Finished stores are reduced to a minimum and negligible quantity used for balancing purposes only, everything possible being delivered to the erecting tracks as assembled units. Store quantities are chiefly dictated by the question of economic batches, that is, which number of parts shall be produced at one tool setting over and above those required for immediate use.

Owing to the system in use for inspection of jigs, tools and plant, very little trouble is experienced in practice through failure of any one machine to produce its correct quota.

Changes of design must always be kept in view ; to which end the plant selected is by no means of the one-purpose type. To maintain the correct balance of output quantities, the worker is not necessarily employed all the time upon the same job or product, but immediately the correct quota for any period is completed, is moved on to other work for which a job ticket is ready ; therefore, no waiting time occurs. Failure of plant is provided for in the case of numbers of machines of a like type by keeping one or more in reserve, and in that of special units, in addition to such replacement parts as may be available, every care is taken by minute inspection to anticipate any possible breakdown ; furthermore, the company's facilities for repair and replacement are so organised and complete that no serious difficulty has ever arisen in this direction.

What is the price of operating such a scheme ? In the above case, the whole executive side of production, planning, buying, costing, making up and payment of wages, and also of necessary drawings for jigs, tools and smaller parts, costs an average of 0·681 per cent. of net sales. An insignificant figure, but an illustration of how, if increased and sufficient production is attained, volume of oncost need never be feared, as the incident is low and cost per piece is greatly reduced.

An interesting finding ranging over a considerable period is the continued drop in cost arising from broken or wasted tools and scrapping of material. In the case of the first, the average charge has retired 37 per cent., and in the second 31 per cent., an example of mutual interest, satisfactory to employer and employed alike, savings in this direction directly affecting the pockets of both.

The relation of capital expenditure to results obtained is always of great interest. The system in vogue tends to employ all plant and facilities to maximum capacity, thus directly saving purchase of additional plant which would have been necessary under previous conditions.

An example selected at random may be quoted. Operator "A" working under previous conditions —a good man on a good machine—earned some £4 weekly for a long period ; left to carry on under new methods, but with the same time allowance, his earnings approximate to £12 weekly, whilst the cost of parts produced—same man and same machine —have receded from 13s. 9d. per unit of 100 items to 8s. 3d. Bad time-setting, you may say. Even if this can be successfully argued, the fact remains that the cost per piece has been reduced to a point which anyhow is economic, whilst good faith has been maintained with the worker. A cut in price would certainly have meant reversion to the previous cost or worse, and obviously at least one more machine and operator would have been required, but in that case the market would not be reached, owing to too high cost of production.

The results that are described above have been attained upon a quantity production basis against an enormously competitive and changing market. What about the "single entity" type of manufactory, making such things as one large marine engine, half a dozen locomotives of a special type, and so forth ? Provided the turnover in sight and the number of man-hours contained therein are large enough to remove the complete line of operation from the realms of experiment, there is the opportunity of creating a spirit of confidence and helpfulness amongst the workers, if thoroughly capable planning is in evidence, so that saving of time can fructify to the fullest extent.

We hear much of Capital, and also of Labour ; but not nearly enough of the third great factor that, together with the first two, should lead on to success —that is, Management.

The most perfectly equipped plant and facilities soon become useless in the face of bad management, whereas quite a mediocre concern will develop and prosper under an executive that is capable of seeing where opportunities lie, and how to use them. The intensive competition of to-day leaves no room for the director or manager of the old-time casual type, attending to business when convenient. Only those who are prepared whole-heartedly to study daily managerial problems, continually shifting as they do in the modern commercial kaleidoscope, are likely to survive and take their place in the van of progress and success. Let all of us recognise that "high wages," as such, have no meaning, and can only end in the bankruptcy of industrialism, unless accompanied by maximum production, which creates expanding markets through low cost and economic selling prices. High wages earned through time economised spell prosperity for all ; that way lies security for industrial Britain.

Ford's Five-day Week.

So many strange ideas about American industry are held in this country that it is good for us to see sometimes what sane industrialists in that country think of the position. We print therefore a leading article which appeared in the *Iron Age* of October 14th, 1926.

Announcement of the Ford Motor Company's intention to put its great manufacturing plant on a five-day operation per week started an outpour of economic discussion. This would not have happened if the management had not put out explanations of its intention ; for the Ford Motor Company is not the first producer to go on a five-day period, or for that matter a three-day or a two-day. The simple interpretation of its proposed action and explanatory remarks is that the sale of Ford cars has been declining in the face of the competition of the General Motors Company and other producers, that the Ford plant could no longer be operated wisely at full capacity, and that its management in explaining its retraction made a virtue out of a necessity. In the light of this fact, we need not concern ourselves with some collateral, cryptic remarks in respect to wage rates, &c.

The mischief of the Ford declaration emanated from the widespread public interest in everything relating to Henry Ford and his business. There is no other industrial enterprise that is so widely known and consequently is so influential. William Green and his cabinet guiding the American Federation of Labour promptly rose to the occasion and announced that the five-day week would be one of the aspirations of that labour union. In passing, it may be mentioned that several branches of the building trade in some districts have been for a long time enjoying a five-day week, which has been contributory to the high cost of building houses and the continuing shortage of housing available on decent terms.

The idea that American industry has become so improved in its mechanisation and organisation, or is likely to hit on such further improvements in the next few years, that labour in five days out of seven instead of six out of seven will be sufficient, is buncombe. Dr. W. R. Ingalls, in a recent contribution to the *Annalist*, estimated the American income in 1925 at 72·9 billions of dollars, or 1584 dollars per worker, compared with 69·5 and 1531 dollars in 1924 and 71·9 and 1613 dollars respectively in 1923. These estimates of the national income are substantially in tune with those of the National Bureau of Economic Research and the Federal Trade Commission in so far as those authorities have gone, 1921 being the last year for the former and 1923 for the latter.

Dr. Ingalls expressed himself unable to see the evidence of increased productivity per worker that propaganda has practically made a matter of general belief. He considers that the increased national income is rather correlated with increasing population and the high post-war price level.

Coming down to things of every-day observation, no one would dream that the railroads, farms and retail shops of the country could be operated on a five-day basis and give us the service that we must have. It is probable, on the other hand, that there are many over-built and over-manned manufacturing industries that could be operated on reduced time. It is simply a question whether part of their capacity shall be used full time or their whole capacity part time. If an industry be permanently in that situation, its surplus capacity ought to be discarded and its surplus *personnel* diverted to other work. If an industry be not over-built and over-manned—building, for example —curtailment of working time means simply shortage of product and eventually serious economic evil.

We are just now getting much strange economic opinion, which by its illusory plausibility is sowing the seeds of trouble. There is preached the economy of consumption, meaning that the people should be egged on to produce and immediately to consume as much goods as possible. Recommendation is made on that ground in favour of a five-day week. With the additional day of leisure it is assumed that everybody can burn more gasoline, participate more extensively in amusements, &c. This philosophy entirely disregards the need for producing capital goods and more of the durable things of other natures.

We do not believe the new economic theory will really replace the old one. To a large extent it came out of "Alice in Wonderland," and its "wise cracks" are reminiscent of those of the Walrus and the Carpenter.

The development of the Vizagapatam Harbour is being carried out in stages. The first section of development includes the building of a wharf, 1600ft. long and capable of accommodating three or four steamers, the mooring of two vessels in harbour, and accommodation for an oil jetty for tankers and oil steamers. The wharf also will be provided with necessary cranes and railway sidings. The cost of this work is estimated at Rs. 193 lakhs. Orders have been placed for a large suction dredger, a rock breaker and a dipper.

A Large Coal-Shipping Machine or Car Dumper.

STEAM and electrically operated machines for unloading coal directly from railway wagons into the holds of steamers are employed at many American ports, both on the seaboard and on the Great Lakes, and with the increasing size and capacity of the coal wagons these machines have been increased in size and improved by the application of various devices to control and regulate the handling of the wagons, with a view to enhancing the speed of loading and the economy of operation. Railway coal wagons of 50 tons capacity are common in American rolling stock equipment, and many railways having a large coal business employ 100-ton wagons. Others are introducing wagons of 120 tons load capacity and 40 tons deadweight, making a total of 160 tons for each loaded wagon. In the coal trade weights are reckoned by gross tons of 2240 lb. It is evident that the mechanical unloading of such wagons is a problem for the engineer and the manufacturer.

The most powerful "car dumper" machine yet built is that installed this year at Toledo, on Lake Erie, for the Ohio Central Railroad, which is a subsidiary line of the New York Central Railroad system. This great machine embodies features of special importance and interest. First, it is operated electrically; secondly, it is the first car dumper having the generator field system of control instead of rheostatic control; thirdly, it is designed to handle and unload—or dump—coal wagons of 120 tons load capacity and 160 tons total weight; fourthly, it can dump these huge wagons at the rate of forty per hour. Direct current at 250 volts is used for all operations. This machine was designed and built by the Wellman-Seaver-Morgan Company, of Cleveland, under the general supervision of Mr. J. A. Stocker, chief engineer of the Ohio Central Railroad. The general view—Fig. 1—shows a steamer lying at the coaling wharf, with its bow near the unloader, which is in the act of dumping coal into the triangular pan, as may be judged from the cloud of dust. At the right is the incline for loaded wagons going to the "dumper"; at the left is the incline down which the empty wagons run to a reversing station, which diverts them back to the railway yards. A plan of the coal-shipping plant is given in Fig. 2.

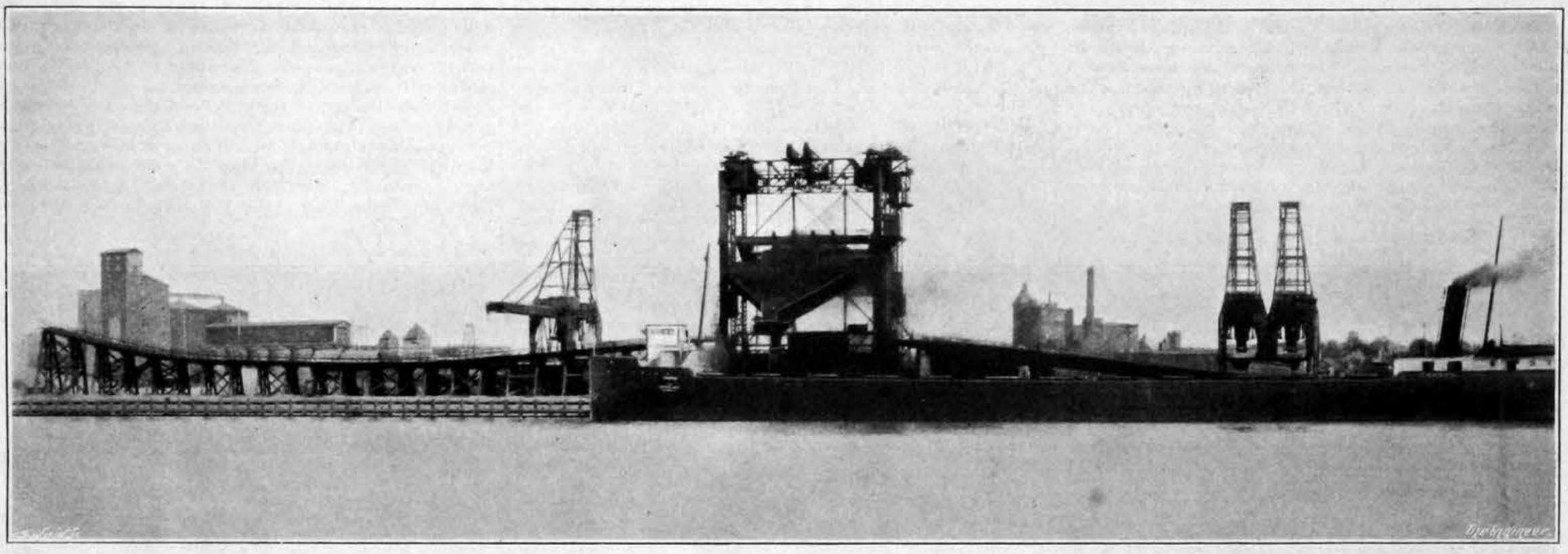


FIG. 1—COAL-SHIPPING PLANT AT TOLEDO ON THE OHIO CENTRAL RAILROAD

In general, the operations are as follows:—From the coal yards each wagon in turn runs down a gradient of 1 in 75, under control of a brakeman, who stops it over a pit at the foot of an incline of about 1 in 8. In this pit is a small push car or lorry—known colloquially as a "mule" or "barney"—which travels on a narrow-gauge line of rails that rises to the level of the standard-gauge track and extends up the incline between the rails of the latter track. The "mule" car is hauled up the incline by cable and electric haulage system, pushing the coal wagon before it and landing the wagon on the platform or cradle of the car dumping machine.

This cradle is a large lifting platform operated in a steel tower by means of cables. When the cradle begins to rise the wagon is automatically locked or clamped in place. At a certain height, which varies according to the size or freeboard of the vessel being loaded, the cradle revolves horizontally around bearings in the front columns of the tower, thus overturning the wagon. Attached to these front columns in sliding shoes is a girder, adjustable vertically, carrying the wide end of a triangular pan which extends over the vessel. This pan is adjusted to any height and angle by the girder at the inner end and by suspension cables at the narrow outer end. With these cables the pan can be raised or swung on its bearings so as to clear the works and rigging of a steamer. At its upper end the pan is as wide as the largest railway goods wagon. From the smaller end of the pan is suspended a chute or pipe of rectangular section, which is telescopic, and is lowered into the hold, so that the coal flows rather than falls from the pan. At the bottom is a trimmer furnished with a travelling belt, which throws the coal across the hold, and which can be revolved horizontally around the chute in order to throw the coal in any desired direction. Normally, the chute hangs vertically, but it can be swung transversely of the ship so as to discharge at any position in the width of the hold.

When the coal wagon has been emptied, the cradle returns to its horizontal position, and is then lowered to the level of the railway track at the top of the incline, which is about 33ft. above the water or 25ft. above the wharf. As the wagon is pushed out of the cradle by the next loaded wagon, the empty wagon runs down a gradient of 1 in 15 into a switchback or reversing station, where it is brought to rest by an ascending gradient of 1 in 40, ending at a buffer stop. This gradient starts the wagon in the opposite direction, and automatic points direct it on to a line with a falling gradient of 1 in 50, down which it travels to the railway yard, where trains of empty wagons are made up for return to the coalfields.

Speed of operation is particularly important, as coal is shipped from ports on the lower lakes to be stored at ports on the upper lakes as a winter supply for distribution through the North-western States. The navigation season is only about seven months, the Mackinac Straits being closed by ice during the remainder of the year. Many large steamers, 300ft. to 600ft. in length, are employed in this service, many of them carrying iron ore south-bound and coal north-bound. It would be impracticable to transport by rail the great amount of coal required, while the cost of such transportation would be prohibitive.

To return to the dumping machine, the main structure or tower is 108ft. high, 36ft. wide between front and back columns, and with the front columns 70ft. apart, giving a dumping clearance space of 64ft. between them. The receiving pan is 43ft. long between the tower and chute, with a width of 64ft. at the upper end, tapering to 5ft. at the discharge end. The telescopic chute has a minimum length of 13ft., and can be extended to 28ft. At its inboard end the pan is supported by a girder 70ft. long, which has a vertical travel or adjustment of 24ft. on the face of the tower, being operated by motor-driven screws. These screws are mounted in brackets on the faces of the columns, thus eliminating danger of interference or damage by the coal wagons.

A feature which contributes to easy and economical operation is the over-balancing of the cradle, which is so arranged that the power required to hoist a loaded wagon is practically the same as the power required to pull down the cradle and empty car. This arrangement reduces the amount of power necessary for operation and also reduces the peak loads which occur during the cycle of operations. Two drums are used for the cradle hoisting ropes, and each drum has ropes leading to both ends of the cradle. In case a drum shaft or gear should fail, the ropes on the other drum are of sufficient strength to hold and operate the cradle.

Pivoted counterweights on the cradle operate the clamps which hold the wagon while being dumped. The clamps consist of cast steel beams supported by hook castings which travel in guides on the back of the cradle, leaving the dumping side free from obstruction to the flow of coal. Further, with the guides on the back of the cradle they are not readily clogged by dust and coal, and can be kept well lubricated.

These counterweights are attached to pivoted arms which hold up the clamps while the cradle is seated. As the cradle is lifted from its seat, the clamps descend to engage the top of the wagon, and rest upon it until the cradle has reached the end of its vertical movement and has rotated through an angle of about 50 deg. At this point the counterweight arms connect automatically with the clamping cables which hold the wagon in place while it is being dumped. When the cradle returns to the 50 deg. position, the counterweight arms release the clamping cables. Finally, as the cradle approaches its normal seated position, inclined guides deflect the counterweights and cause them to raise the clamps clear of the wagon. All these clamping devices are mounted directly upon the cradle.

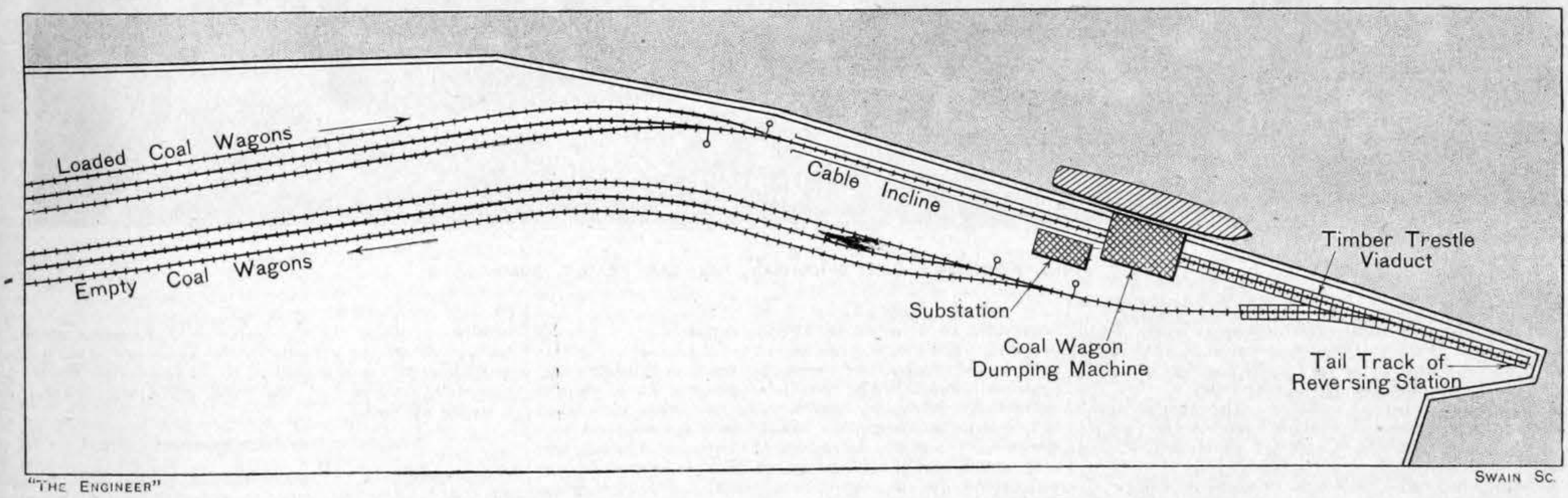


FIG. 2—PLAN OF COAL-SHIPPING ARRANGEMENTS AT TOLEDO

As the cradle is seated at a level of 25ft. above the wharf, the space beneath is utilised to house the machinery for the cradle hoist and the "mule" haulage. The cable hoist for the pan is mounted in a separate building at the rear, while the motor which operates the screws regulating the pan girder is on a platform in front of the machine. With its electric control and automatic features the machine requires only two operators. The main operator, in a cabin near the top of one of the front columns, controls all movements of the cradle and "mule" car; the other man, in a cabin carried at the outer end of the receiving pan, controls the position and movements of the pan, and the discharge chute with its trimmer.

The view in Fig. 4, page 472, shows the main structure, with a wagon standing in the cradle at the top of the cable incline, with its double set of rails. At the front of the structure is the elevated cabin for the main operator. At the left is the receiving pan, from the end of which projects the telescopic trimmer, and in front of which is the

cabin for the second operator. It will be noted that the deck of the steamer consists of a series of hatches separated by narrow strips of deck plating over the frames and below the coamings of the hatches.

In Fig. 6 the cradle is raised and rotated, discharging coal from the wagon into the receiving pan. A loaded coal wagon is standing at the foot of the cable incline, and behind it may be seen the top of the "mule" or push car. Fig. 5 is a rear view of the dumper and its machinery house. At the right is an empty wagon on the 1 in 4 gradient of the reversing station. Fig. 3 shows the cradle hoist with its motors and drums.

In the "mule" haulage system, automatic electrically controlled points are installed to divert the descending "mule" on to a depressed track, enabling it to pass under a coal wagon standing over the "mule" pit at the foot of the cable incline. The mule car then runs to the rear end of the pit. When it is started forward again, another set of points diverts it to a line of rails which rises to the same level as the standard-gauge track, and brings the car up against the rear of the wagon waiting to be taken up the incline to the cradle.

Automatic electric switches control this haulage system. Thus the "mule" car is accelerated as it rises from the pit, slows down to engage the rear of the coal wagon, accelerates again as it pushes the wagon up the incline and then slows down and stops as the wagon enters the dumping cradle. A device interlocked with the cradle stops the mule and wagon near the top of the incline, if the cradle is not seated in position to receive the wagon. Similarly, on the return trip the automatic limit switches accelerate the speed of the mule on the incline, slow it down to pass the points into the depressed track, again accelerate it and then slow it down and stop it in the lower part of the pit. The mechanism for the two sets of points is interlocked with the haulage mechanism, so that the points are always in proper position. Although all these operations are automatic, the main operator can control them if necessary by means of a switch which provides for manual control.

In hoisting the cradle, it is held in vertical position by crossheads which travel in guides on the main columns of the structure, and also by rollers under the cradle which ride against the columns. On the adjustable pan girder are hooks which engage with pivot pins on the front of the cradle when it has reached the limit of its vertical travel. Further winding in of the cradle cables thus causes the cradle to tilt by rotating around these pins, the rollers then leaving contact with the columns. Automatic features of the cradle hoist control are operated by a limit switch of the travelling-nut type. By means of this switch control, the cradle when started accelerates in the vertical travel, slows down as it engages the hooks, accelerates in rotation, and then slows down and finally stops at the dumping position. It then starts and accelerates in reverse rotation, slows down as it disengages from the hooks, accelerates in lowering, and then slows down before coming to a stop on its seat.

In lowering, the final slow-down and stop always occur at the same point, so that the control limits are placed in a fixed position on the structure. In rotating, however, the automatic control must operate with the pan set at various heights. To meet this condition, a differential gear is introduced, connected by gearing to the cradle hoist and the pan girder screw adjustment mechanism. Thus, as the girder is raised or lowered, it shifts the travelling nuts of the limit switch correspondingly, putting them in such position that the controls will operate when the cradle engages the hooks.

The cradle hoisting mechanism—Fig. 3—consists of two cast steel drums with parallel shafts and geared to a single pinion on an intermediate shaft between the drums. The bearings for these shafts are mounted on a cast steel bed-plate anchored to a concrete foundation. The pinion shaft is extended to take the motor gear, which is of the double helical type, and meshes with two motor pinions connected to the hoist motor shafts by flexible couplings. There is a hand-operated emergency brake on the intermediate shaft, and each motor has an electrically operated service brake which is applied automatically as soon as current is cut off from the motor. The drums are set with their shafts at right angles with the face of the wharf, and each drum has ropes leading to opposite ends of the cradle, as already noted. Ropes for the counterweights are wound upon the drums in reverse direction to the hoisting ropes, so that they unwind as the hoisting ropes wind on in raising the cradle. In this way the counterweights assist the motors in revolving the drums, and thus reduce the peak loads on the motors.

For this cradle-hoisting mechanism there are two motors of 450 horse-power each, driven by separate direct-current generators in the electric sub-station. These motors are controlled by the Ward-Leonard system of adjustment of the generator fields by magnetic controliers operated from the cab by means of a small master switch.

The mule haulage system has a drum with a single herring-bone gear meshing with two driving pinions, each connected to a motor of 450 horse-power by a flexible coupling. Each motor has an electrically operated service brake, and manually operated emergency brakes are provided outside of the flexible couplings. These haulage motors are driven by separate direct-current generators in the same manner as the cradle hoist motors, and have the same system of generator field control. The mechanism of the pan hoist consists of a drum geared by two reductions of spur gearing to a motor of 295 horse-power provided with rheostatic control, which may be operated by a master switch in either one of the operating cabs, but only one switch can be operated at a time. For this mechanism there is an electrically operated service brake on the motor and a solenoid emergency brake, which may be operated from either cab. The latter is so arranged that the emergency brake must release before the service brake releases.

Sub-station equipment includes three identical generating units, together with the alternating-current and direct-current switchboards, meters and other apparatus. Each of the power units consists of two 375-kilowatt, 250-volt direct-current generators directly connected to a single 1100-kilovolt-ampère synchronous motor operated on 6600-volt, three-phase, 60-cycle current. One of these units is for operating the cradle hoist and the other for operating the mule haulage. One of the generators of the third set is used for motor field excitation for the synchronous and direct-current motors, as well as for the operation of direct-current auxiliaries. The second generator of this set is a spare or reserve which can be connected in series with the exciter, to supply power at 500 volts if desired. All electrical equipment is of the General Electric Company's design and manufacture.

With regard to the generator field system of control as applied to the cradle hoist and mule haulage, it is explained by the builders of the machine that the two cradle hoist motors, for example, have their armatures electrically tied together by a loop circuit of heavy copper, this loop being connected at all times, except in case of emergency. Speed and direction of the motors is governed by the value and direction of the generator field current, the field of the motors remaining constant on a given direction of operation. In this way, while the energy applied to the cradle motors may reach peaks amounting to 3500 ampères at 500 volts, under normal operating conditions the generator field current will never be in excess of 28 ampères at 250 volts, and as the generator field only is controlled, the equipment is thus reduced to units of small capacity.

When a small amount of excitation is applied to the generator field, a current is induced in the armature loop circuit, producing a torque at the motor, the force of which depends upon the value of the current. Both current and torque will increase to a point at which the motor armature will begin to rotate and generate a counter electromotive force which tends to reduce the loop current. This condition quickly reaches a point of equilibrium where only enough current flows to produce the necessary torque to overcome the resistance of the drive, and the motor will rotate only fast enough to produce the proper counter electromotive force to hold the loop current at its proper value. It is apparent that by manipulation of the generator field excitation, which is very small and easily handled, the rotating speed of the motor can be controlled very accurately, and that the speed is practically independent of the load. Reverse direction is obtained by simply reversing the generator field current, which, in turn, reverses the current in the armature loop, without disturbing the motor fields. In all the earlier electricaliy operated machines of this kind rheostatic control was used throughout.

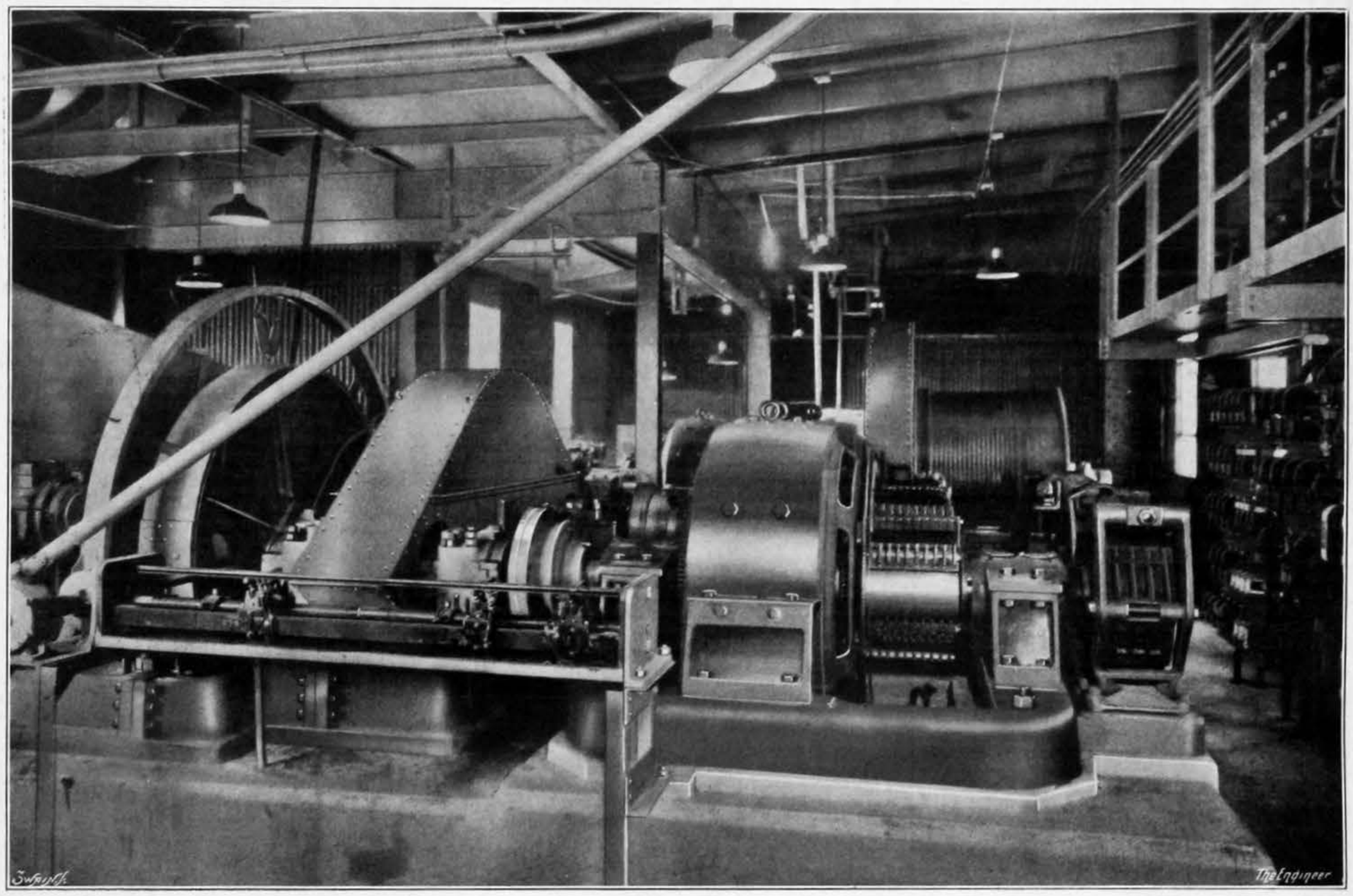


FIG. 3—MACHINERY FOR OPERATING THE CAR-CRADLE HOIST

Bituminous Coal.—An International Conference on Bituminous Coal is to be held at the Carnegie Institute of Technology on November 15th–18th, and it is understood that the representatives from England and the subjects of their address at the congress will be:—Dr. C. H. Lander, Director of Fuel Research of the Department of Industrial Research, "The Present Status of Low-temperature Distillation of Coal in England;" Dr. R. Lessing, consulting engineer, London, "Coal and its Mineral Matter;" Mr. Geoffrey M. Gill, consulting engineer, London, "English Developments in Carbonisation of Coal in Gasworks;" and Mr. Harald Nielsen, Sensible Heat Distillation, Ltd., London, "The L. and N. Process." Dr. Friedrich Bergius, of Heidelberg, Germany, will speak on "The Transformation of Coal into Oil by Means of Hydrogenation," and General Georges Patart, of Paris, inventor of a process for making methyl alcohol from coal, will discuss "The Production of Methyl Alcohol from Coal." The purpose of the sessions is to consider new uses for bituminous coal and to present the results of recent investigations of coal that are concerned with improved methods of utilisation and combustion. Much of the interest among Americans in the plan to discuss the possibilities of manufacturing substitutes for petrol from coal is traceable to the recent report of the Federal Oil Conservation Board to President Coolidge that only a six years' supply of petroleum remains in the proven sands of the United States. Other problems to be covered at the conference will include the discussion of complete gasification of coal, high-temperature distillation, low-temperature distillation, coal tar products, power, smokeless fuel, fertilisers, &c.

Railway Matters.

A LENGTH of 9898 yards of the cable tramways in Melbourne, in Chapel-street and Toorak, is to be converted to electric traction at a cost of £113,653.

THE line of the Egyptian State Railways between Luxor and Assuan is narrow gauge; north thereof to Cairo it is standard gauge. The former 144 miles are now being converted to standard gauge, and, when completed, it will be possible to run through trains between Cairo and Assuan.

THE recent death of Mr. William Hood removes one of the last of the pioneers of American trans-continental railway builders. He helped to build the Central Pacific across the Sierra Nevada in 1867 and eventually became the chief engineer of the Pacific system of the Southern Pacific Railway. His outstanding work there of recent years was the construction of the Lucin cut-off and the causeway across Great Salt Lake.

THE collision of May 26th at Caulfield, on the Victorian Government Railways, mentioned in this column on September 3rd, was found by a court of inquiry to be due to the fault of the driver. The man was subsequently tried by a criminal court, but acquitted. On the grounds that that disposed of the case, the Labour Party carried a vote in the Legislative Assembly last week condemning the Government for sending the man before the Railway Board for disciplinary action.

THE fact that a signalman was found dead in his box at Carnforth recently prompts the remark that such an unfortunate event would not lead to an accident, even although the signals happened to stand at "clear." That is due to the fact that before a train is sent forward from the next box in the rear, it must be accepted on the block instrument. The failure to receive any response to the block signals from the signal box applied to, would lead to inquiry before another train was allowed to proceed.

ADDRESSING the Indian Railway Conference on October 7th the chairman, Colonel Walton, of the North-Western Railway, spoke very highly of the results of the changes made since the report of the Acworth Committee. There had been good results, too, from improvements introduced on the initiative of the companies themselves. Owing to better operating and improved facilities there was now a quicker return of wagons, and consequently a surplus stock. The pooling of local locomotives, reduced coal consumption and the fitting of vacuum brakes to all goods trains had been money well spent.

IN view of the suggestion that the railway bridge over the Thames east of Blackfriars might be converted into a road bridge, and that the railway traffic to and from Holborn Viaduct and St. Paul's stations could be carried in a tube, we would point out that there is other traffic, and probably of greater value, than that created by those two stations. Access to the south of the Thames is obtained thereby by the London, Midland and Scottish and the London and North-Eastern, and the variation in level between the lines they use at Farringdon-street and of a tunnel under the Thames would call for gradients that probably would be prohibitive.

THE railway census, of which we made mention on October 8th, showed, as we then said, a reduction from 702,062 to 689,264 in the number of railway servants. In view of the grouping of the railways such a drop is to be expected; in fact, it is surprising to find that in one grade there is an increase, *i.e.*, the number of carters and van guards has risen from 21,888 to 23,148. The most noteworthy reductions are under four heads, and it is easy to understand two of them—the drop from 119,137 to 116,388 in shopmen and of 32,140 to 29,982 in labourers—but the fall of 66,480 to 63,588 in permanent way men and of 11,114 to 9192 in the number of engine cleaners is more difficult to account for.

IN his presidential address to the Railway Students' Association on October 21st, Sir Ralph Wedgwood said, on the subject of road motor competition, that such traffic as that from large London stores over the Home Counties was best left to private enterprise; but that was only a small part of the traffic now on the roads. A large proportion of the remainder was traffic which the railways could handle, but in order to obtain it they must give a dispatch equal to that given by their road competitors. To do that there must be more through wagons, more express goods trains, and, in particular, more braked goods trains. The competition of road motors in interurban and rural traffic must, Sir Ralph added, be met by frequency of service.

THE Southern Railway is evidently living down the reproaches that were being levelled against it a couple of years or so ago, and thus our anticipations at that time are being realised. An illustration of the new order of things is to be found in the arrangements operative in foggy weather. Trains to and from Addiscombe, Hayes and Bromley North will use Charing Cross Station only, whilst the Dartford and Orpington trains will run into and out of Cannon-street. Such a selection has been determined upon because, by that means, the trains do not cross each other at Metropolitan Junction box which lies between Charing Cross and London Bridge. Should a passenger find himself at the wrong station, he will go by any train to London Bridge, where he can join his proper train.

SOME six or so years ago the Great Eastern Railway made several reforms in the operation of some of its suburban trains into and out of Liverpool-street Station. Speaking at a railway meeting at Gateshead on October 21st, Mr. R. Bell, assistant to the chief general manager, London and North-Eastern Railway, said that the result was twenty trains per hour over each track, and it was doubtful whether any former steam-worked railway, now electrically operated, could show similar figures. Mr. Bell brought out, furthermore, the objection against suburban electrification, that owing to the space required for motors an eight-car train provided seats for only 640 passengers, whilst a steam-worked eight-coach train would seat 950. An electric train required 5 minutes for the men to change ends; that was little saving as compared with steam services, as now operated at Liverpool-street.

Notes and Memoranda.

ACCORDING to Mr. E. V. Perrow the cost of pumping water from the Broken Hill Mine, Rhodesia, is 1·406d. per 1000 gallons raised 100ft. The pumps are electrically driven and supplied with current from a steam plant.

IRON stains sometimes occur where contact takes place between marble and steel work. An effective treatment for this type of stain consists in applying a solution of sodium citrate followed by sodium hydro-sulphite in the dry form, and covered with a paste made of whiting and water.

HYDROGEN sulphide is probably the most toxic gas associated with crude oil. Hydrocarbon (petroleum) vapours themselves are harmful to the human system, but hydrogen sulphide, when present, is usually more important from the standpoint of health and safety. These conclusions were reached in an investigation of the toxic gases encountered in the transportation and refining of high-sulphur petroleum carried out by the American Bureau of Mines.

WHEN tin was a commodity which hardly repaid the cost of getting, rough and ready methods were employed in Cornwall in the crushing and washing of the ore, and a good deal of tin was lost into the streams and finally carried out to sea. It deposited itself among the sands of the bays, and at several points on the coast the receding tide leaves black streaks of tin particles on ridge after ridge of the beaches. At Portheras these ridges are, according to the *Ironmonger*, now being carefully raked, and the black deposit passed into buckets, which are carried by an aerial ropeway to the head of the cliffs, where the contents are sifted and milled by special plants before being despatched to the smelters.

ACCORDING to the *Industrial Australian*, a machine has been invented by Mr. W. A. Preston, of Brisbane, which, it is claimed, can pick cotton ten times as fast as the hand-picker; in other words, it can gather 700 lb. of cotton in a day of eight hours. The machine, which can be erected on a truck drawn by a horse, consists of a 2½ horse-power oil engine, which drives an air compressor. The air is compressed in a metal tank to 100 lb. per square inch, and carried by a fine tube to the hand-piece, delivering the air into the jacketed portion of the tube. As a trigger is pressed a jet of air is driven down the tube, causing a draught or suction from the other end. It is this partial vacuum which pulls the cotton from the boll. The compressed air carries the cotton through the tube and hose into the bale.

THE coal of Baffin Island, according to Dr. Weeks, who visited the place in 1924, is well exposed in a cliff on Salmon River, and is regarded as of Tertiary age. Two main seams, each 3½ft. thick and 16ft. apart, are found. It is the coal from the lower seam that is being utilised by the Hudson's Bay Company. When freshly dug it breaks into irregular lumps, which are dull black with here and there a bright surface, and which show nothing resembling a cleavage plane. After being sacked and left some months in the open it shows a tendency to crumble. The crumbling is not so great as in the coal from the upper seam. An air-dried sample gave on analysis:—Moisture, 14·2 per cent.; ash, 5·0 per cent.; volatile, 23·4 per cent.; fixed carbon, 57·4 per cent.; calorific value, 10,300 British thermal units.

THE following account of an unusual form of mining incident is given in the *South African Mining and Engineering Journal*. On the morning of July 24th, 1926, on the Sub-Nigel Mine, the skipman and his two natives entered the skip on the surface and rang down to the twenty-first level. When the engine drum had lowered about 90ft., the driver noticed slack rope. He took up the slack, waited two minutes, and raised the skip slowly to the surface. On examination it was found that a natural spring of water, issuing from the side of the shaft, had frozen on the runners, forming a layer of ice about 60ft. long and 1¼in. thick, which had been sufficient to stop the skip. The shaft is vertical and downcast, and the particular compartment in which the incident occurred had not been used since four o'clock that morning. The temperature during the previous night had fallen to 20 deg. Fah.

GREAT strides are, according to *South African Engineer*, being made in the sale of electricity in the existing undertakings. The total number of units sold by municipalities during the year dealt with in the returns amounts to 223,604,653 units, as against 170,790,737 for the previous year, the outstanding town being Durban, where the sales have increased from 41,871,922 units to 55,844,166 units. Durban has now taken the lead from Johannesburg in this respect, the number of units sold by the latter town being 54,687,593, as against 44,197,556 for the previous year. A large increase is also shown by Cape Town, the latest figures being 32,881,106 as against 27,873,443 for the previous year. The returns show that these three towns, viz., Durban, Johannesburg and Cape Town, contribute more than half the total units sold by municipalities in South Africa. Pretoria shows an increase of about 3,500,000 units, and in almost every centre there is a substantial increase.

THE quotation below is taken from a recent report of the formal investigation into the failure of a water-tube boiler, which resulted in the death of two men. The explosion was caused by allowing the tubes to become completely blocked by sediment, when one of them, naturally, got overheated and pulled out of the header. "The only engineering feature of interest in this inquiry is the extraordinary extent to which the tube which exploded had contracted in its length. It had contracted 1¼in., leaving a quarter of an inch opening between it and the back header. A quarter of an inch may be accounted for by the distortion of the tube by bending. The tube was also enlarged in diameter, and the metal of the tube increased in thickness at the point of overheating. The cause of the great contraction of the tube in length and the enlargement of the thickness of the metal might be the subject of scientific investigation, but no such investigation was gone into, and rightly so, for the cause of the explosion and the determination of the person or persons to blame is all that we are called upon to decide, and that is abundantly clear."

Miscellanea.

A SULPHURIC acid factory is to be put up in Anhsien, Szechwan, China.

THE Yarra River, Victoria, is to be improved by widening and dredging, at a cost of some £100,000.

A STEEL bridge, 300ft. long, is to be built across the Rivière du Loup, Quebec, at St. George de Beauce.

A CORPORATION has been formed to acquire Anticosti Island and convert the timber there into paper pulp.

IT has been decided to scrap the Diesel engine power plant at Cradock, South Africa, and replace it by steam sets.

A SMALL floating lock, of 500 tons lifting capacity, is being provided in Table Bay Harbour, for dealing with trawlers, whalers and similar craft.

THE Madras Council has voted an estimate amounting to Rs. 25,000, to enable the local government to participate in the British Industries Fair, 1927.

THE plant at Melmoth, Zululand, which has just been opened for extracting tanning material from wattle bark, is said to be the largest of its kind in the world.

THE Chief Secretary of South Australia has stated that the average cost per mile of all bituminous roads in the State was £6285. The cost to date for repairs was £7138, or £149 per mile.

IT is reported from San Domingo that the Haitean Congress, on October 14th, authorised the Government to contract a loan of ten million dollars to be expended on irrigation, canals and other public works.

IT is claimed that the new oil-engined fire-float Beta III., of the London County Council, which was described in THE ENGINEER of February 12th, 1926, created a record in attending the big fire at Wharf-road, Cubitt Town, when, working continuously for 14½ hours, she pumped 1,710,000 gallons of water.

FROM information obtained from the secretary of the Quebec Public Service Commission, the Quebec *Official Gazette* states that from January last to August 15th over 4000 miles of power lines had been authorised by the Commission, as compared with less than 1800 miles in the corresponding eight months last year.

IN the course of his Presidential address to the Scottish Section of the Institute of Metals, Mr. S. E. Fleck said that the only metal of the non-ferrous group in which it could be said that Great Britain was self-supporting was aluminium. For the other metals this country was dependent upon other parts of the world.

FINAL figures relating to the Portland cement industry in 1925, compiled by the American Bureau of Mines, show that the production of Portland cement in 1925—161,658,901 barrels—was the largest quantity manufactured thus far in any year, exceeding that in 1924, the next highest year in production, by 8 per cent.

A SCHEME for supplying Sydney and Canberra with water from the Snowy River has been drawn up by Mr. T. W. Keele. It would involve a pipe line, 220 miles long, and an expenditure of £33,000,000. A fall of 1570ft. would be available for the development of 40,000 horse-power. The dam across the river would be 62ft. high and provide a supply of 150 million gallons a day.

A MESSAGE from Naples states that contracts have been signed for the construction of a port canal which will afford valuable navigation facilities between Naples and the port of Salerno, 33 miles distant by railway. Vessels using the canal will leave from the arrival platform of the Naples-Salerno Autostrada, and the terminus will be near the Pattison Engineering Works on the seaboard at the north extremity of the bay. The canal will have a length of 2½ kiloms., a width of 15½ m., and a depth of 2·50 m. to 2·70 m. The cost is estimated at 51 million lire, including electrically operated loading, unloading and towing apparatus. It is expected that the work, which will be started immediately, will take six years to complete, but part of the canal should be available for traffic within two years.

AN important irrigation enterprise that has recently been completed near Linares, is the Malado Canal scheme, which is entirely the work of Chilean engineers and Chilean labour. From the river bearing the same name the waters are diverted into the Ancón River by means of a canal 24 kiloms. and a tunnel of 4 kiloms. in length. The construction of this portion of the undertaking proved to be most difficult. The canal, which has a width of 4·5 m. and a depth of 3·25 m., is the longest construction of its kind in Chile. An interesting engineering feature is a syphon spillway erected before the entrance to the tunnel. Of the area to be irrigated 70 per cent. is held by various landowners interested in the scheme. The canal, including branches, will have a total length of 70 kiloms. and its waters will irrigate about 27,000 hectares of land. The total cost of the enterprise has exceeded 14,000,000 pesos, say, £350,000.

CONSIDERABLE interest is, says the *Industrial Australian*, being displayed by various public bodies on the border of New South Wales and Victoria concerning the question of additional weirs associated with the Murray water conservation scheme. It is understood that a decision is to be arrived at shortly regarding the site of a weir to serve the Upper and Central Murray Valley. The decision will rest between Yarrawonga and Bungowannah, both places being lower down the river than Albury. Bungowannah was the site originally chosen by the irrigation conference, so that the rich country around Rutherglen, Corowa, Howlong, Berrigan, and Finley might be served. It is now being urged by several of the irrigation leagues that in the event of Yarrawonga being chosen for the purpose there will be little, if any, chance of an additional weir being built at Bungowannah, in which case some of the best land in the valley around Berrigan and Finley will be lost to the scheme. New South Wales has decided not to contribute to the cost of the weir at Yarrawonga, but since both States would be benefited by Bungowannah being chosen as the site, it is believed that both States would contribute to the cost of that site.

COAL-SHIPPING MACHINE AT TOLEDO ON LAKE ERIE

THE WELLMAN-SEAVER-MORGAN COMPANY, CLEVELAND, ENGINEERS

(*For description see page 469*)



FIG. 4—VIEW SHOWING WAGON STANDING IN CRADLE

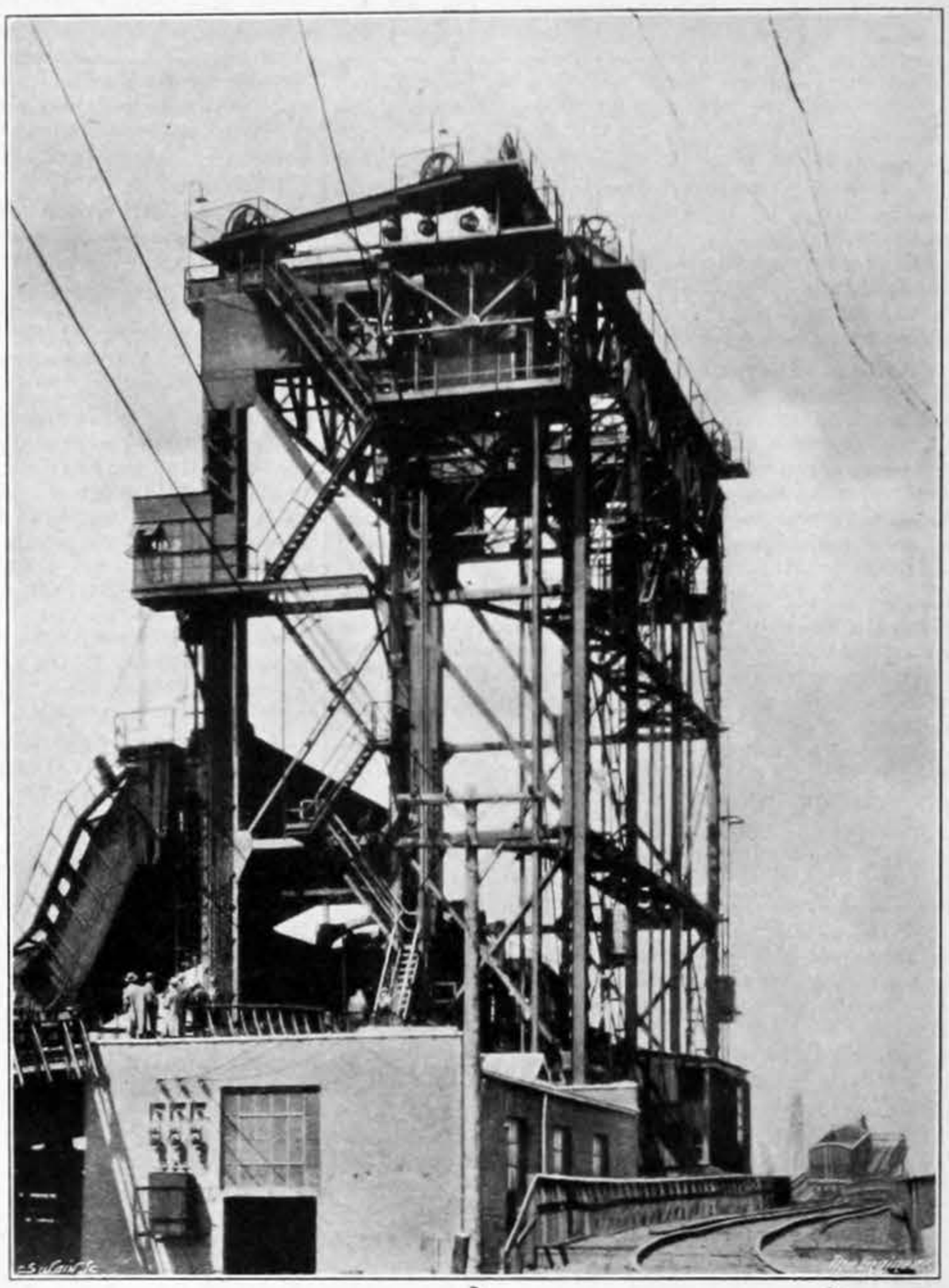


FIG. 5—EMPTY WAGON ON INCLINE OF REVERSING STATION

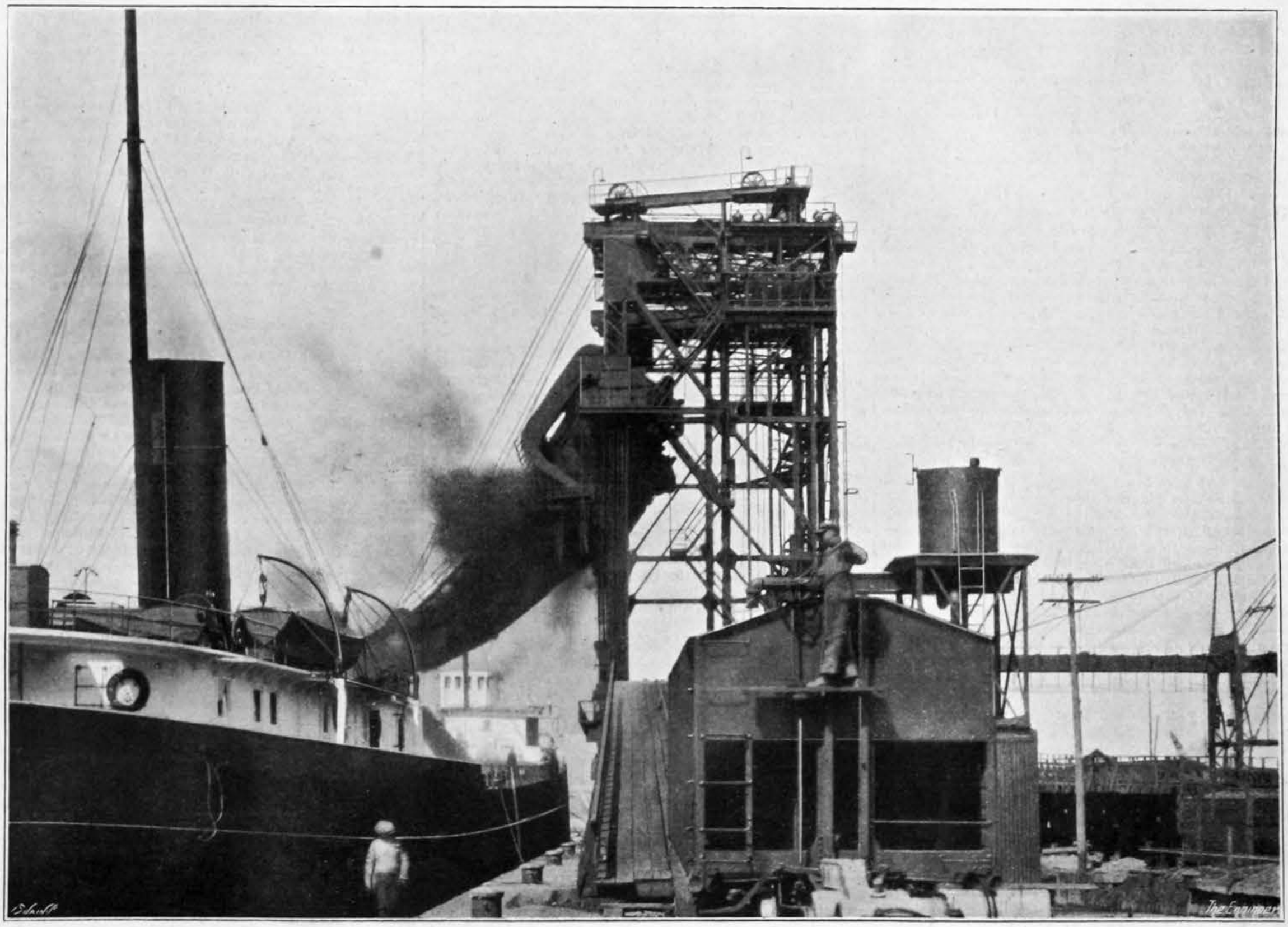


FIG. 6—WAGON ROTATED AND COAL BEING DISCHARGED INTO RECEIVING PAN

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Sixteen-page Supplement—"The Metallurgist."

The Metallurgist

THE OCTOBER NUMBER OF THE MONTHLY METALLURGICAL SUPPLEMENT TO "THE ENGINEER" ACCOMPANIES THIS ISSUE.

THE ENGINEER.

OCTOBER 29, 1926.

British Electrical Engineering.

The position of this country as regards electricity supply and demand, the use of the telephone and the employment of electricity in agriculture, &c., is a matter which has often been discussed, but nothing, so far as we are aware, throws more general light upon the subject than Dr. Eccles' presidential address, delivered before the Institution of Electrical Engineers on Thursday, October 21st, and published in abstract on another page of this issue. While for the most part the addresses of new Presidents deal with specialised subjects, Dr. Eccles made an attempt to speak broadly and in an elementary manner about things that interest the Institution as a whole, and to indicate the directions in which this country lags behind others. Naturally, it was shown, as it has often been shown before, that as regards the annual consumption of electricity per head of population Great Britain stands in a very unfavourable position, which, in Dr. Eccles' opinion, is attributable very largely to our neglect to use the principle of interconnection for cheapening supply. But whilst no one will deny that cheap electricity is desirable, the reason for difference in the use of electricity in different countries often lies deeper than a matter of price. As Mr. W. B. Woodhouse has pointed out, the climate, the habits, and the purchasing power of the people all have their influence, but most important of all is the existence in this country of a cheap and general supply of gas. This important factor is frequently overlooked when comparing the consumption of electricity per head of population in this country with that in other parts of the world.

That a national system of interconnection will rapidly bring the consumption of current up to the high level that some expect remains to be proved, for even if it should materially reduce the price of current, certain difficulties remain. It will not, of course, reduce the cost of wiring houses or of electric cooking apparatus, &c., nor will it alter the fact that the conditions in this country are rather different from those in many others in which the consumption of electricity per person is high. Apart altogether from the fact that here there is a cheap and general supply of gas, it is well to remember that in some countries electric power is often used in large quantities for special purposes. The annual use of electricity per person in California, for instance, has been stated to be 1200 units, which is a consumption far in excess of that in this country; but when it is remembered that in California, where coal is not only dear but in many places unobtainable, electricity is largely used for irrigating the land, it is at once seen that figures alone are apt to prove misleading. As Dr. Eccles admits, industrial power is now sold in the Newcastle district, in Lancashire, the Clyde Valley, and in various other parts at prices about the same as the cheapest power in America, excepting only in the Niagara Falls and the Mississippi Power Company's areas, whilst Mr. W. B. Woodhouse has stated that in Manchester and in many other parts of this country electricity for domestic purposes is cheaper than in Chicago, where the consumption is 1000 units per head of population. That there is plenty of room for improvement in the electricity supply business, and that every effort should be made to secure it, no one will deny, but whether the proposed system of large interconnected power stations will result in a general increased consumption far above that which would be brought about in the ordinary course of events, is quite another matter. The largest of our existing stations are practically as efficient as the greatest of the foreign super-stations, and not a few believe that electricity supply in this country can be improved and developed on the right lines without new restrictive legislation. Just as Dr. Eccles showed that Great Britain is behind other countries in the use of electricity for domestic and industrial purposes, so did he indicate that the British public is slow to appreciate the merits of the telephone. Even the busiest British cities do not install the telephone as freely as Frankfort, Berlin, Sydney, and Melbourne, Paris, and The Hague, and whilst the average American talks 191 times per annum, the average Englishman only talks twenty-three times. There is, of course, ample scope for telephone development in this country, but here again different conditions and the temperament of peoples must be taken into account. Whilst the use of the telephone in Great Britain may be considerably increased, it may never be possible to make it as popular as it is in certain other parts of the world. For business purposes the telephone is now universally employed. The extension of it would be for domestic purposes, in which it may be regarded as a luxury rather than a necessity.

One of the most useful tests of the health of the scientific industries of a country is, in Dr. Eccles' opinion, afforded by the statistics of the Patent Office, and figures were quoted to indicate that we, as a nation, are not performing our due proportion of the higher form of brain work required by our electrical industries. We are not so certain as Dr. Eccles that the prosperity of the Patent Office is a trustworthy indication of national enterprise. Mere numbers of patents without regard to their value is very deceptive. Only by a close analysis of the relative importance of foreign and British specifications can a just estimate be made. The bulk of all "patents" in all countries in the world is trash; relatively few merit protection at all, and only a small percentage make a permanent impression on the progress of industry. The improvement of our manufactures and the founding of new industries, so far as they are based upon invention, is at first sight largely dependent on brain work done abroad. It is, of course, a well-known fact that American and other manufacturers have devoted more attention to research than British manufacturers. On the whole, however, British electrical firms seem to keep pretty well abreast of the times. If British electrical manufacturers have not in the past paid as much attention to research as those of other nations, then failure to do so may be attributable to the fact that several of our largest electrical firms are associated with large American electrical concerns, which have extensive and well-equipped laboratories. Manufacturing improvements, &c., adopted in this country have no doubt often emanated from those sources, but so far as epoch-making inventions are concerned, we do not owe very much to other countries. The thermionic valve—the greatest invention of the last century—originated in this country, whilst the steam turbine, without which heavy electrical engineering could have made relatively little progress, was, of course, a British invention. In spite of all the research and investigation that goes on abroad this country still holds its own in the wireless field. With the first Dominion wireless beam service opened on Monday last, another great step in wireless com-

munication was made by British engineers. By all means let us, from time to time, compare our position in the various branches of the electrical industry with that of other countries, and endeavour to keep pace with foreign firms in the direction of research, but let it be remembered that figures alone are apt to prove misleading and to convey an erroneous impression to the world at large.

The Co-ordination of Experimental Results.

The manner in which one thing depends upon another is a continual source of interest to the engineer. When he has obtained a series of experimental results, he plots them down on squared paper in order to see "what they look like," or, in other words, to get a mental picture of the results which no mere columns of figures can convey. A line drawn fairly through the plotted points gives him a graphic representation of the law according to which the quantities vary and the divagations of the points with respect to the line form a measure of the errors of observation or other disturbing factors. Fortunately, many of the relationships of practical importance to the engineer are of an extremely simple nature, and can be represented graphically by a straight line with substantial accuracy over the working range of very many varying quantites met with in actual work. The relationship, for example, between the quantity of coal burnt per shift in a power-house and the electrical output during the same period can be represented by a straight line, departures from the line indicating abnormal conditions of operation. Similarly the steam used per hour by a turbine can be regarded as a linear function of the output over the range from zero load to the most economical rating of the unit. This last relationship is, of course, exceedingly well known, and so much confidence is placed on it that leading turbine makers base their guarantees upon it. As it is typical of many experimental relationships, we will take it as an example for the discussion of a point often overlooked when dealing with the results of experiments, namely, the relative effect of errors in the two quantities whose relationship is being studied.

To take a simple case, we will suppose that a steam turbine has been tested and found to consume 10·5 lb. of steam per kilowatt-hour at full load, 11·2 lb. at three-quarter load, and 11·4 lb. at half load. These figures are all such as it would be quite possible to obtain under certain conditions, for they are all within 2 per cent. of the actual guarantees of a recent machine. They are, naturally, not in themselves the original data of the test. They are derived from the recorded facts that at a load of 8000 kilowatts the total steam consumption was 84,000 lb. per hour, at a load of 6000 kilowatts it was 67,200 lb. per hour, and at 4000 kilowatts it was 45,600 lb. per hour. If these consumptions are plotted against the corresponding loads it will be found that the figures do not lie on a straight line. The reason is, of course, that they are not perfectly accurate. They are nevertheless all that the engineer has to go upon, and if he wants to represent the general performance of the turbine at all loads, he has to draw on the chart the straight line on which he thinks the points, if accurate, would have lain. For ordinary purposes the position of the line can be located accurately enough by eye, but if it is required to arrive at a result which shall be unimpeachable, the line may be calculated by the "method of least squares." The application of this method to the data we are considering gives for the line the equation $W = 8000 + 9{\cdot}60\,K$, in which W represents the weight of steam consumed per hour and K the hourly output of the alternator in kilowatts. It might be thought that the question is now settled, and the correct position of the line established without room for argument. Calculations, however, are no more reliable than the assumptions on which they are based, and there is in the calculation as exemplified above a certain assumption which is generally overlooked. The data tell us, that at a load of 8000 kilowatts, for example, the steam consumption was 84,000 lb. per hour. We know that this is erroneous to some extent, and we assume, for the purposes of our calculation, that a true statement would be that at a load of 8000 kilowatts the steam consumption was $84{,}000 \pm w$ lb. per hour. This seems the natural thing to do, but there is really no logical justification for it. One set of measurements has just the same chance of being in error as the other. It would be equally rational to assume the steam consumptions to be exact and the outputs erroneous. On this assumption we would take, as our basis of calculation, that at a steam consumption of 84,000 lb. per hour, the load was $8000 \pm k$ kilowatts, and so on. Making the calculation on the supposition that the steam consumptions are exact and the outputs subject to errors of measurement, we find that the line which will best suit the plotted points has the equation $W = 7701 + 9{\cdot}65\,K$. This, as will be seen, is appreciably different from the line previously obtained from the same data. It gives a no-load consumption nearly 4 per cent. less and a rate of increase about ½ per cent. greater than the former line, yet no one can say that it is less correct. The two rival lines cross at a load of 5980 kilowatts; below this load the former line indicates a greater steam consumption, and beyond it a less steam consumption than the latter line. The differences are, in the case we have taken, too small to have any practical importance, but that two different results can be obtained according to the way in which the "method of least squares" is applied is the point we wish to emphasise.

We have taken as our illustration a case of extreme simplicity, in which it was required to find the best relationship between three discordant pairs of data only. In many of the practical problems of the engineer the plotted points which have to be reconciled to a straight line law are many times more numerous and vastly more erratic. If coal consumption per shift is plotted against output per shift for a month, we have, for instance, 90 or 93 points lying, in general, in a band of appreciable width across the chart. By making alternative assumptions, as indicated above, we should again be confronted with two different lines crossing each other at the centre of gravity of the points. The labour, however, of applying the method of least squares to such a case would be altogether too enormous to contemplate, and a sensible man would confine himself to finding the point corresponding to the average output and the average coal consumption, and drawing through that point the line which looked the best whichever way the paper was turned. This would give him the desired line with all the accuracy he could want. The dilemma of having two lines would also be avoided. We have already indicated the reason why it is possible to obtain two different lines, but there still remains the question whether the two lines, if calculated, have any useful significance or not. They are, in fact, known to statisticians, as "lines of regression," a term derived from the biological investigations in which they first became noticeable. What the statisticians were trying to do was to find out a numerical value for the correlation of two quantities, or, in other words, to what extent large values of one variable quantity were associated with large values of another. Their procedure consisted, in effect, of dividing the chart containing the plotted points into a large number of equal squares. A straight line could then be drawn to agree as closely as possible with the centre of gravity of each column of plotted points, and another to agree with the centre of gravity of each horizontal row. These two lines were the "lines of regression," and the measure of their approximation, one to the other, was taken as being the correlation ratio desired. If the lines were at right angles there was no correlation whatever, while if they were coincident the correlation was perfect. The measurement of correlation, in the sense in which the word is used by statisticians, does not come within the scope of the ordinary investigations of the engineer. It is true that he often desires a measure of the divagations of a set of results, but this is by no means the same thing. Lines of regression, as such, have therefore no direct interest for him, but as engineering and statistical science would both be improved by a knowledge of each others methods, it seemed worth while to call attention to a point of contact.

Obituary.

RICHARD St. GEORGE MOORE.

We regret to have to record the death of Mr. Richard St. George Moore, which took place in London on October 20th.

Richard St. George Moore, second son of Mr. Charles Moore, of Birkenhead, was born in 1858. He received his education in London and Germany, and in 1876 commenced a three years' pupilage in the shops of Messrs. Laird Brothers, Birkenhead, which was followed by a further term of one year under Mr. Thomas Barham, Assoc. M. Inst. C.E. Between 1880 and 1885 he was in partnership with Mr. C. G. Clarke, in Hull, when he carried out the construction of the Skegness pier and the sea wall at Bridlington.

In 1885 Mr. Moore began to practice on his own account in Westminster, and subsequently entered into partnership with Mr. F. W. la Trobe Bateman, M. Inst. C.E. In the course of his consulting work he carried out the following, amongst other, works:—1886–90, the design and construction of St. Leonards pier; 1889, design of Brighton Marine Palace and pier, 1720ft. long, and in 1894, the construction of the same; 1892, the West Hampshire waterworks; and 1893, an extension to Ryde pier. He also designed works for the Brighton and Rottingdean Seashore Electric Tramway. He was engineer for the Paris Gigantic Wheel, Gosport drainage, Hankow waterworks, and the Marlborough and Grafton Railway. He was also connected with the Baku Tiflis, Arad, Singapore and Arequipa waterworks. During the war he was a deputy director in the Special Construction Department of the Admiralty. Subsequently, he designed some 800ft. Marconi towers, and was engaged upon waterworks at Gloucester, Mountain Ash, Bideford and Calcutta and Ahmadabad.

Mr. Moore was elected to corporate membership of the Institution of Civil Engineers in 1883, and was a past-President of the Society of Engineers.

Literature.

Outbreaks of Fire: Their Causes and Means of Prevention. By Sidney Gompertz Gamble, Assoc. M. Inst. C.E. London: Charles Griffin and Co., Ltd. Price 30s.

This is an extraordinary book. It is written by an expert in fires and fire fighting, who was for twenty-six years second in command of the London Fire Brigade, and it purports to be a systematic study of fires, their causes and means of prevention. It is that, and more, for it contains an astonishing amount of information of a widely varying character, much of it far outside the area covered by its title, so far outside indeed as to have nothing whatever to do with the subject. For example, what possible connection is there between fires and conversion tables—to pick two from a number of similar tables—giving the multipliers necessary to convert feet per second into knots, or acres into hectares? Or, again, between fires and the distance away that such sounds as the croaking of frogs in a marsh can be heard? Yet such wanderings from the real subject of the book are of frequent occurrence throughout its upwards of 500 pages. In fact, the whole volume irresistibly suggests a scrap book compiled as the result of many years of promiscuous reading by a painstaking student, who made notes as he went, and many times while studying it we have been reminded of Brewer's "Dictionary of Phrase and Fable." The two publications have this in common, at any rate, that their contents are, in general, accurate. Both are alike, too, in the vast amount of labour that must have been expended on their production.

But let us now briefly review its chapters. There is, first of all, an Introduction, which is entitled "Historical Notes on the Fire Service in Great Britain," and then comes Chapter I., which deals with "Air, Water, Fire." Here, the first thing which meets the eye is a list of the astronomical symbols that are used to represent the sun, the moon, and the planets, and a little further on we read:—"All substances consist of one, or a compound of any two or more, of eighty-three elements or simple substances. This number is subject to increase or diminution with the progress of the Science of Chemistry. Oxygen, Hydrogen, Nitrogen, Carbon, Silicon, Aluminium, Magnesium, Calcium, Sodium, Potassium and Iron are the Elements most frequently met with and form 99 per cent. of the Earth's Crust." Whatever, one asks oneself, has all this to do with fires? And, of course, there is only one reply: "Nothing," and the same may be said of a large portion of the chapter. Yet the reader cannot help feeling that, in the author's mind, there *was* some connection between all he has written and the central subject with which he is particularly dealing. He proceeds from discussing the nature of substances to refer to gases, from which he, after several digressions, finally reaches the problem of combustion. Here he is in his element, and much that he says is really germane to the subject and of great interest. His remarks on smoke are worthy of special mention. Smoke, he remarks, deserves far more attention from the point of view of danger to life than it has ever received, as more lives have been lost from suffocation than from actual burning. "Smoke is nearly always worst in the early stages of a fire, and although in the day time it is often the best fire alarm possible, at night it is a serious danger to the sleeping inmates, and hampers the rescue work of the firemen. . . . The construction of a satisfactory smoke and dust respirator for use by firemen under conditions where smoke is so thick as to seriously impede their labours is by no means an easy problem, and of the hundreds of such appliances that have been suggested and made, very few even approach efficiency. Indeed, the lessons of the late War have proved that respirators of any kind are at the most palliatives and the only real remedy is to provide a supply of oxygen."

What is said, too, concerning fire prevention commands respect. With the exception of such fires as are caused by petrol, collodion, and a few other bodies of the same class which burn with such deadly rapidity as almost to defy checking, most fires, remarks the author, have small beginnings and are so easily dealt with in the earlier stages that, unless they are given time to gather force, their extinction is readily compassed, and it is this latter factor which is the most valuable asset in what is known as "fire prevention," but which is really "fire restriction." "We must have fire," he says, "but we must have it under control; we must limit its actions to our requirements, and we can only do this by, as far as possible, removing anything upon which it can feed from contact with it and, above all, preventing it from spreading from the area in which we are utilising it. . . . There is nothing to which the old adage 'Prevention is better than cure' applies more aptly than to fire, and with the object of prevention in view enormous sums have been spent in the erection of what are called with grim homour 'fireproof buildings,' the absolute inutility and absurdity of which title has been fully demonstrated by some of the largest fires of modern times." This disastrous state of things, Mr. Gamble goes on to explain, has been brought about by a complete misconception of what was really required to check the spread of fire and by "a bemuddled confusion of the terms 'fireproof' and 'fire-resisting.' No building material that could be practically employed is 'fireproof,' *i.e.*, has the power of resisting the action of heat without undergoing a physical or chemical change. Granite and sandstone crack and fly under its influence; limestone even at such moderate temperatures as 1470 deg. Fah.—800 deg. Cent.—decomposes and yields lime; bricks fuse and so do iron and steel; and the result is that at the fierce heat engendered by a big warehouse fire, the most refractory materials prove themselves of little resistant value, whilst the methods of construction employed make them an active danger." What will the suppliers of fireproof materials and fireproof structures have to say to these assertions?

Of Chapter II., which deals with the law affecting the practice of fire fighting, we need say nothing. Chapter III. is devoted to a general survey of water supply and a detailed discussion of hydrants, standposts, &c. Chapter IV. is one of the most important of the book. Its title is "Causes of Fires—Dangerous Trades," and its opening sentence is: "It can safely be said that carelessness lies at the root of all so-called 'causes' of fires." "This," comments the author, "may seem a strong statement, but if it be thoroughly and impartially investigated, there is no doubt that it will be found to be correct." Under the single heading of "carelessness" he groups no less than twenty-one possible causes of fires, but says that they are only some of the more prominent. He has arranged them "more or less in the order in which they are most common." We have not space to give the whole list, but we may say that "Matches" come first; "Oil Lamps," "Gas," and "Electricity," fifth, sixth and seventh; "Petrol," eighth; "Rodents," thirteenth; "Lightning," eighteenth; and "Incendiarism," twenty-first. Over seventy pages of the book are taken up with explanations of how fires may occur by reason of carelessness displayed in connection with these various causes, and the remaining four pages of the chapter are filled with lists of dangerous trades and of traders who employ materials which may be considered to be hazardous from the point of view of fire.

After discussing in turn in Chapters V., VI., and VII., "Ship Fires," "Explosives and Explosions," and "Insurance" respectively, the author devotes the next five chapters to "Fire Stations, Land and Floating—Fittings, Bells, Lighting;" "Notification of Fires—Telephones—Fire Alarms—Sprinklers;" "Pumps—Fire Engines, Steam, Motor and Manual;" "Hose;" and "Hand Appliances." All of them contain much useful information, and some of them some interesting historical particulars. They do not, however, call for any special reference, as they do not as far as we can discover contain anything essentially novel. It may be said, however, that the various subjects are for the most part treated in a thoroughly practical manner.

Next follows a chapter—No. XIII.—most of which seems to be entirely remote from the main theme of the book. It is on "Ropes and Knots," and in it are illustrated every conceivable form of knot, and the processes of splicing ropes and cables. Now, it is doubtless most desirable that firemen should know something of ropes—especially wire ropes—and, as a fact, very many of them have an excellent knowledge of the subject, since many of them have been sailors; yet it does not appear, to us at all events, that acquaintance with all the knots illustrated and described by Mr. Gamble is in any way necessary. On the other hand, the four next chapters, which treat of "Physique, Discipline, Clothing, Health, Pay, First Aid, Medals and Rewards"—of firemen—"Getting to a Fire, How to Attack a Fire, Returning from a Fire, Salvage Work;" "Private and Works Fire Brigades;" and "Fire Prevention and Panic in Places of Public Resort," are certainly in place and contain much helpful data and many apposite suggestions. The same may be said of Chapter XVIII., the subject of which is "The Construction of Buildings from a Fireman's Point of View."

Of the remainder of the book nothing much need be said. Chapter XIX. contains various receipts, including several for making articles fireproof, another for cementing rubber to leather, another for a rat poison, and still another for a polish for linoleum, &c. —Why these two latter, one wonders?—as well as various conversion and other tables, among them those mentioned in an earlier part of this review. There is also a long list of "Do Nots"—if you desire to avoid fire. "Some Historical Fires"—a long list running to over twelve pages in small type—forms the subject of the last chapter. It is followed by an appendix, in which very miscellaneous subjects ranging from the composition of "Thermit" to "How to Keep Couplings in Order" are discussed.

On the whole it is a very readable book, but if extraneous matter were left out the bulk of the actual volume might, we believe, be reduced one-half.

Engineering Factory Supplies. By W. J. Hiscox. London: Sir Isaac Pitman and Sons, Ltd. 1926. Price 5s. net.

The purchase, receipt, storage and distribution of factory supplies is a large subject, yet one that demands careful consideration by every manufacturer, and so we trust that the author is unduly pessimistic in making the statement that these matters "in the average factory are regarded as being of minor importance." An adequate supply of the right material at the right time, without involving the retention of unnecessarily large stocks, is so necessary to the well-being of a firm that, when we recollect the numbers of broken promises of delivery solely attributable to failure of supplies, we feel that the claim of Mr. Hiscox that "if adequate precautions are taken, there is no reason why material supplies should fail" deserves careful study, for if his proposals, as enunciated in "Engineering Factory Supplies," tend to the elimination of failures, he has not written in vain. The functions of the buyer and of the storekeeper are described in a systematic way, and a complete organisation of the office is considered. The proposed system is very satisfactorily elucidated by means of forty-nine diagrams, representing the various schedules, cards, &c., suggested in connection with its operation. Not the least useful part of the work is the investigation of the errors that are liable to creep in, with hints as to how they may be detected, and, if not entirely eradicated, at least reduced to a minimum.

Many of the controversial points raised in "Engineering Factory Supplies" could be discussed far more readily if we had some conception of the author's idea of the general organisation of the whole factory, the duties of the different officials, and their relative importance with respect not only to one another, but also to the individual in charge of supplies, who, to our idea, should have a sufficiently high standing to be able to meet the heads of different departments as an equal. If this official has the buyer, the holder, and the distributor under his jurisdiction—the supposition is ours—we should not take exception to the buyer not being an engineer, for presumably he would be answerable to one who was. At the same time, though we may agree that buying is essentially a business proposition, we see no cogent reason why an engineer cannot also be a good business man. While we are informed that the production engineer controls the activity of the buyer in respect of what he is to buy, we infer that other activities are controlled elsewhere, and we read quite incidentally that the storekeeper has the under-manager—whoever he may be—for his chief, but we cannot imagine the buyer reporting to any under-manager. In short, we are left guessing as to the status of the different officials who seem to drift casually into the picture, and this, we feel, is a definite drawback.

Allowing that the functions of good purchasing are common sense, vigilance, discrimination and courtesy, we should be inclined to add that an expert knowledge of the stores themselves is not to be despised, as it will frequently lead to the advantageous exploitation of alternative markets, although keeping strictly within the specification.

Passing on to the store-holding section, and considering the maintenance of stocks on a maximum-minimum basis, we cannot help feeling that it is not policy to treat the minimum as the point at which ordering begins. The minimum should always be in the store; if bad storekeeping or fortuitous circumstances led to the minimum being reached, then withdrawal should only be permitted after the approval of a high official. The most suitable method is to have, in addition, a properly considered "ordering level," each bin card having the three amounts, *i.e.*, maximum, minimum, and ordering level, clearly displayed.

Some of the author's suggestions would lead to a great improvement, and certianly many delays would be obviated if all stores were inspected and ready for issue the day after arrival on the premises. It is, indeed, "a consummation devoutly to be wished," but how often is it practicable except in the simplest cases? We judge that Mr. Hiscox would like to see all stores—raw, work-in-progress, finished parts, spares, tools, expense, &c.—under a unified control, but here, again, we must suspend judgment, so much depending on the "family tree" of the staff of the whole concern, although we are convinced that in many factories there is not enough concentration, or even co-ordination.

The desirability or otherwise of having a mechanic in charge of the tool store is discussed, the author presupposing that if it be decided to use this class of labour, the choice will fail on one who "by reason of age or some disability is not qualified to follow his original occupation." This we feel is fundamentally unsound, and we should select the mechanic on the grounds of his skill and suitability, being convinced that a live man would save both time and money in maintaining tools in a high state of efficiency.

The dearth of good storekeepers is justly deplored, and we warmly endorse the proposal of a definite system of training boys for subsequent positions in the store, the scheme suggested being perfectly practicable.

Altogether, the author is to be congratulated on the way in which he has handled his subject, although, as already indicated, there are several points on which we should like to have seen him more specific.

SHORT NOTICE.

First Course in Wireless. By Robert W. Hutchinson. London: W. B. Clive, University Tutorial Press, Ltd. 1926. Price 3s. 6d.—This little volume appears to be no better and no worse than dozens which have preceded it. It is intended especially for the man who knows little or nothing about electricity, and yet desires to take an intelligent interest in wireless. It begins, therefore, with general principles and passes on by stages to the review of wireless receiving and transmitting systems. We notice that the author repeats the familiar statements about resistance capacity coupling, first, that it is particularly suitable for high wave lengths, and, secondly, that it requires additional high-tension current. Our own experience with very high resistances—ordinary 5 megohm grid leaks—leads us to believe that both these statements require qualification. As a matter of fact, the high-resistance capacity circuit operates admirably on the London wave length with high tension not exceeding 40 volts, and we have not found any circuit more compact, cheaper to build and simpler to operate on a local high-power station than it. Up to 5 or 6 miles from Oxford-street, two valves, one hardly alight, will operate a loud speaker perfectly on a short aerial. It is surprising that the circuit is not more largely used.

SIXTY YEARS AGO.

It is somewhat curious to find that sixty years ago Newton's dynamical principles were being called in question, just as they are to-day, although the reason advanced for doubting their general applicability was not in any way concerned with the theory of relativity. As a consequence of the establishment of the doctrine of the conservation of energy many people had come to the conclusion that Newton's principles were not applicable to machines. This statement seems so remarkable that we may at once say that in our issue of October 26th, 1866, a lengthy article by no less eminent a man than Professor Macquorn Rankine was published with the object of refuting the popular belief. It is difficult at this date to recapture the outlook that led to the misapprehension, but it seems fairly obvious that its cause lay in vagueness of definition and misinterpretation and misapplication of terms. Half the product of the mass of a moving body by the square of its velocity was in those days commonly called the *vis viva* of the body, or its living force by those who preferred an English rendering. Energy as a name for this quantity was in use by a few of the more advanced dynamicists, but even Professor Rankine seems not to have designated it as kinetic energy. Most people spoke of it as a force and seem definitely to have identified it with force as now defined. Hence apparently arose the misconception. It was asserted that Newton's dynamical principles involved a mode of estimating force which was at variance with the properties of the quantity called *vis viva*, and that as a consequence those principles had been superseded by recent discoveries regarding the conservation of energy. Professor Rankine, in our columns, gave a lengthy discussion of the subject, in which he sought to convince the reader that Newton's principles contained nothing inconsistent with recent discoveries and that, indeed, those discoveries depended for their demonstration on the very principles with which they were said to be at variance. He showed that the law expressing the energy of moving bodies was not, as had been asserted, unknown to Newton, and that Newton himself had first discovered it. By extracts from the "Principia" Professor Rankine demonstrated that Newton was fully aware that there was equality between the energy exerted and the work performed, a principle which he described as summing up the whole theory of machines. It took Professor Rankine some considerable time to demonstrate and no doubt required on the part of our readers considerable mental exertion to understand that *vis viva* was not force and that the Newtonian mode of measuring force led, and led rationally, to the velocity squared law for the energy of a moving body. That Newton could have been thought to have been ignorant of the equality between energy possessed and work done is almost incomprehensible to a modern student. Actually he stated it specifically in enunciating the law that action and reaction are equal. In making this statement we are not ourselves, as some may think, guilty of confusing force and energy. By "action" Newton, as the "Principia" shows, meant energy, and by "reaction" work. The practice of interpreting the words as meaning force and reacting force, a practice followed to-day, is, although it results in a valuable and perfectly rational law, a survival of the old confusion between energy and force. It was introduced by Maupertuis in the eighteenth century. The term "principle of least action" as employed to-day seems to preserve the meaning originally intended by Newton to be applied to the word "action."

Wireless Beam Stations.

THE general principle of the beam system of wireless communication was dealt with in a paper read by Mr. Marconi as far back as March, 1899, when it was shown that by means of short waves and reflectors it was possible to project the waves in a beam in one direction only, instead of allowing them to spread all round, and in such a way that they could not affect any receiver which happened to be out of the angle of propagation of the beam. Mr. Marconi demonstrated results obtained by a reflected beam projected across the lecture-room, and showed how a telegraphic receiver could be actuated or a bell rung only when the aperture of the sending reflector was directed towards the receiver. Investigations on these lines were again taken up by Mr. Marconi in Italy early in 1916 with the idea of utilising beams of reflected waves for certain war purposes, and subsequently he was valuably assisted with the work by Mr. C. S. Franklin. The reflectors used in the system were composed of a comparatively small number of wires placed parallel to the antenna and spaced around it on a parabolic curve of which the transmitting or receiving antenna constituted the focal line. Suggestions for using reflectors of this kind were made by Brown in 1901 and by de Forest in 1902, but many essential conditions necessary for efficiency were not apparently realised by these workers at that time. Since 1916 various patents have been taken out by Mr. Marconi and Mr. Franklin, in one of which the latter describes an arrangement in which the antenna and reflector wires are arranged so as to constitute grids parallel to each other, the aerials or antenna being energised simultaneously from the transmitter at a number of feeding points through a special feeding system so as to ensure that the phase of the oscillations in all the wires is the same, and it has been proved by calculation and confirmed by experiments that the directional effect of such an arrangement is a function of its dimensions relative to the wave length employed. We publish on another page an abstract of the James Forrest lecture delivered before the Institution of Civil Engineers on Tuesday last, in which Mr. Marconi again deals with the beam system.

Within recent times a great amount of experimental work has been carried out by Mr. Marconi and Mr. Franklin in connection with this beam system of wireless communication, and it is well known that the arguments in favour of the system eventually led to the original technical policy of Imperial wireless communication being revised, and that the Government entered into a contract with Marconi's Wireless Telegraph Company, Ltd., to build short-wave wireless stations in England to communicate with Canada, South Africa, Australia, and India.

In our last issue we announced that an official certificate received by the Marconi Company from the Engineer-in-Chief of the Post Office stated that the wireless stations constructed at Bodmin and Bridgwater for communication with Canada on the short-wave beam principle had passed their official seven days' test, and that the General Post Office had announced that a high-speed wireless service between Great Britain and Canada through these stations would be opened on Monday, the 25th. It is claimed that a beam wireless station has the following distinct advantages over any other form of telegraph communications for point-to-point communication over similar distances; the capital expenditure involved is considerably less; it is more economical to run and maintain; and it is by far the most speedy method of communication yet devised. The speed of working of the beam system is at present limited only by the mechanical limitations of the transmitting and recording instruments, and when suitable means of recording over land line signals at higher speeds than are at present obtainable have been developed it will be possible to increase correspondingly the overall speed of signalling. The results of tests between England and Canada have shown that the use of beam aerials at both transmitting and receiving stations has resulted in a strength of signal some hundred times that obtainable with non-directional transmitting and receiving aerials at each end, and utilising the same power; and it has enabled the service to be carried on under conditions in which signals obtained by utilising non-directional aerials were hardly appreciable. At the same time the use of beam aerials has resulted in a very large degree of freedom from atmospheric disturbance.

The Bodmin station, which is built upon a strip of land bordering the main Bodmin-Truro road, 4½ miles south-west of the Cornish county town, comprises two transmitting systems, one for communication with Canada and the other for communication with South Africa. The receiving stations are situated near North Petherton, 2½ miles south of Bridgwater, off the main Bridgwater-Taunton road. The masts and aerial system—see Figs. 1 and 2—the design of which is peculiar to the short-wave beam system and is entirely different from the design previously used in commercial wireless stations, are similar at both stations. There are five lattice steel masts for each service, erected in a straight line and aligned so that the great circle bearing on the distant station is at right angles to the line of masts. The beam is therefore projected accurately in the direction of the stations with which communication is being maintained. The masts are 277ft. high with cross arms at the top measuring 90ft. from end to end and giving an additional 10ft. to the height of the mast. The aerial and reflector systems consist of a number of vertical wires, forming, as it were, a wire curtain, suspended from steel cables attached to the cross arms and running along each side of the row of masts. The aerial system is on one side of the masts, facing the distant station, and the reflector system is on the opposite side.

The transmitter—see Fig. 3—is rated at only 20 kilowatts. It is of an entirely new design throughout and is extremely compact. Stability of wave length, which is of the greatest importance in short-wave work is obtained, by exceptional care in the design of the set. The drive, or master oscillator, which is the most important unit for maintaining constancy of wave length, is entirely screened from the rest of the circuits. The transmitter is operated direct from the Central Radio Office at the General Post Office in London. The land line is led into a relay attached to the first panel of the set. By this means the operator in London is in full control of the transmitter, and at the moment he presses his key or feeds his signalling tape into a high-speed telegraph instrument the signals he is sending are being recorded in the telegraph office in Montreal, which is connected in a similar manner to the Canadian wireless receiving station. In the same way the messages put on to the transmitter in the telegraph office in Montreal are instantly recorded at the General Post Office in London, after having traversed the Atlantic and passed through the beam receiving station at Bridgwater. The masts, receiving aerial, and feeder system are duplicates of those at the Bodmin beam transmitting station, except that the feeder tubes at the receiving station are slightly smaller than those at the transmitting station. The receiving masts are erected at right angles to the direction from which the signals are to be received, their exact orientation being:—Canadian line of masts, 158° 13″ W. of true north; South African line of masts, 72° 3′ east of true north. The effect of the reflector wires is not only to screen the aerial from signals coming from behind, but also to reflect back to the aerial energy received from the front of the system. Providing that the incoming signal from the front of the system is of the wave length for which the aerials and reflectors are tuned and spaced, the energy received upon the latter is reflected back on to the aerial exactly in phase with that directly induced. This affords a very considerable increase in the energy received as compared with a broadcast or non-directional aerial. By means of transformers and the special design of the feeder system the energy of all the aerial wires is added and the total energy conveyed to the receivers *viâ* the main feeder tubes, which terminate at what is known as a feeder unit of the receiver.

The Bridgwater receivers—see Fig. 4—are arranged for the reception of signals from Canada on a wave length just over 26 m., which was the wave length used during the

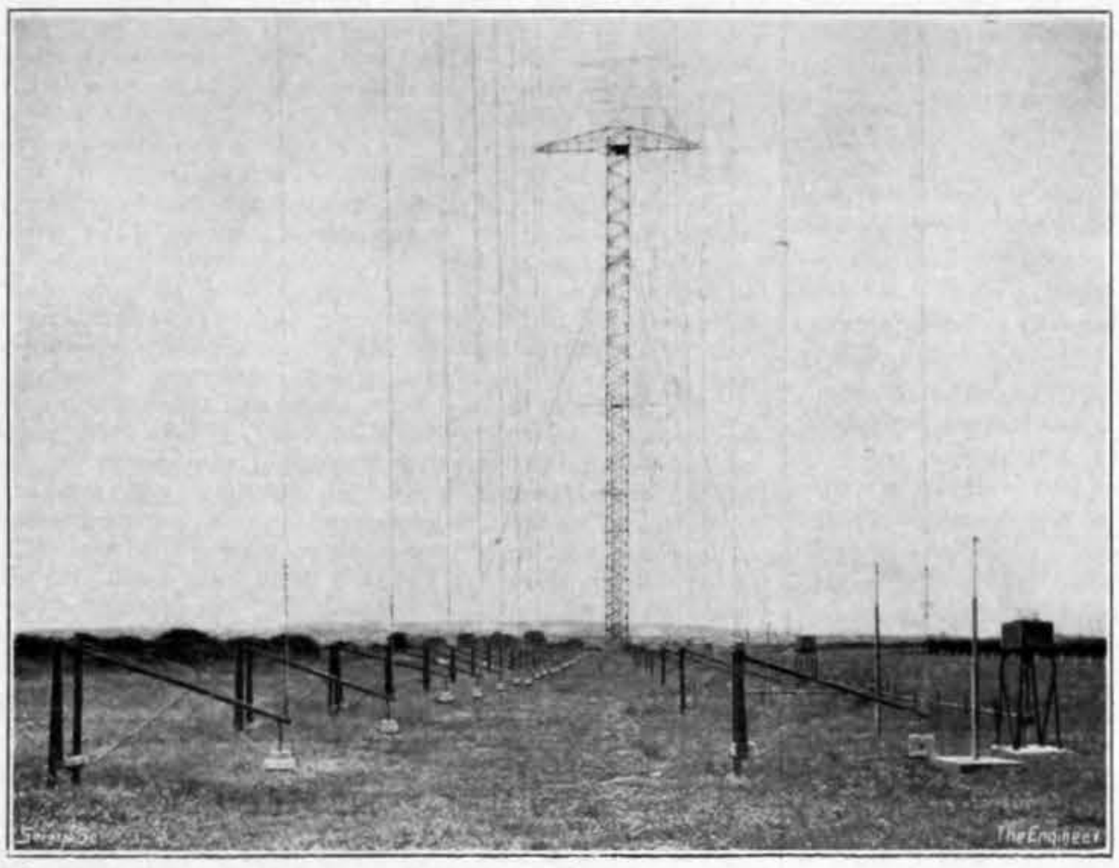


FIG. 1—AERIAL SYSTEM AT BODMIN STATION

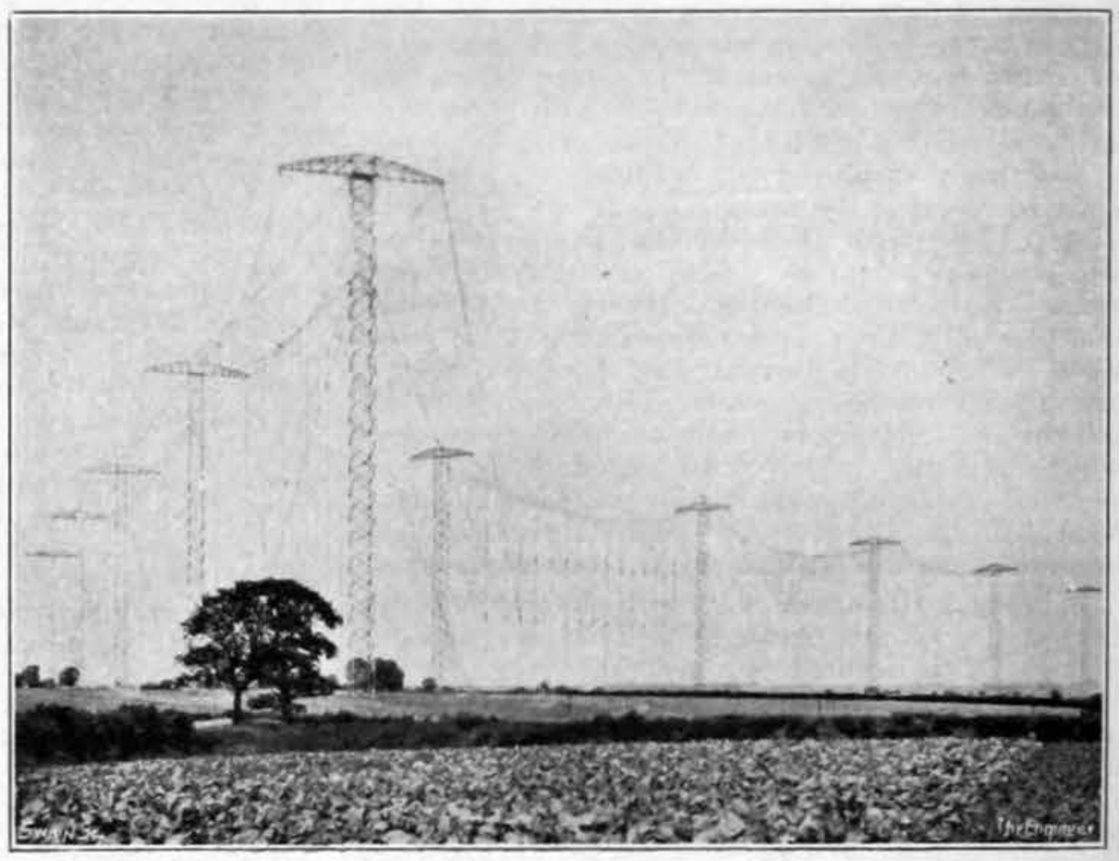


FIG. 2—RECEIVING AERIALS AT BRIDGWATER

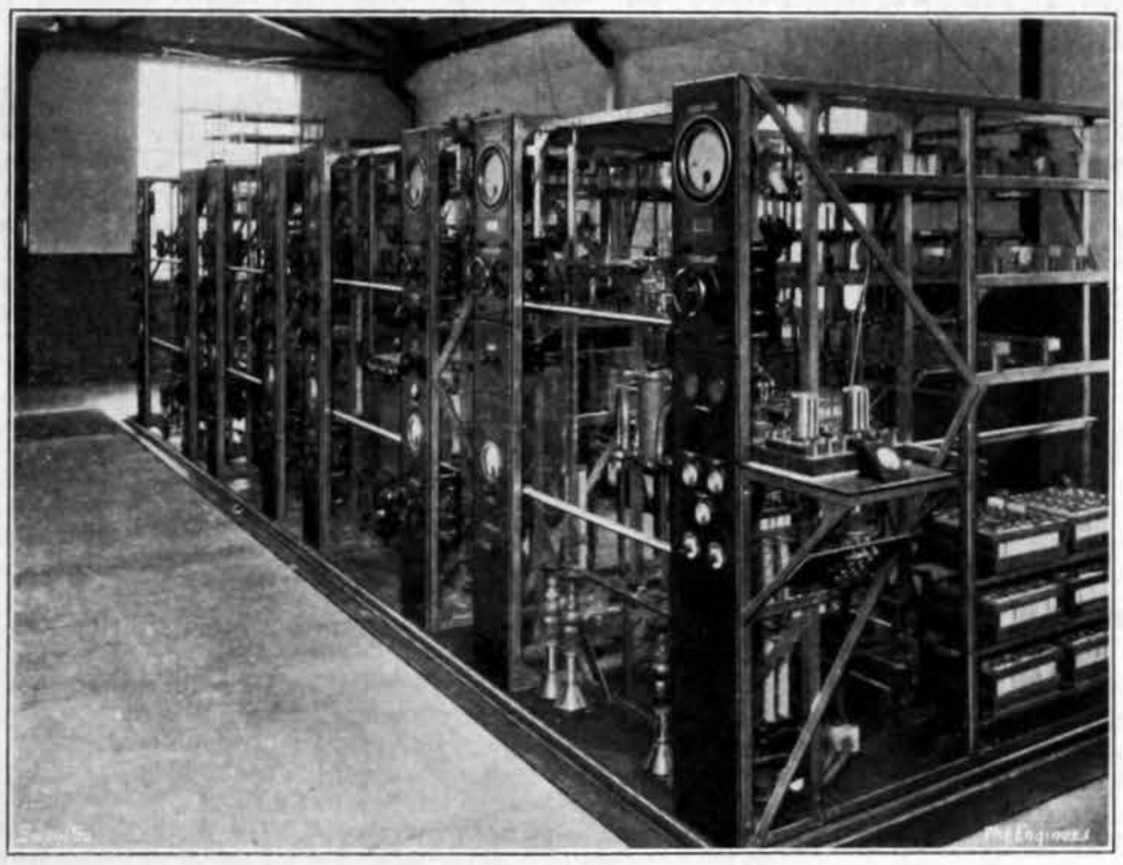


FIG. 3—CANADIAN BEAM TRANSMITTER

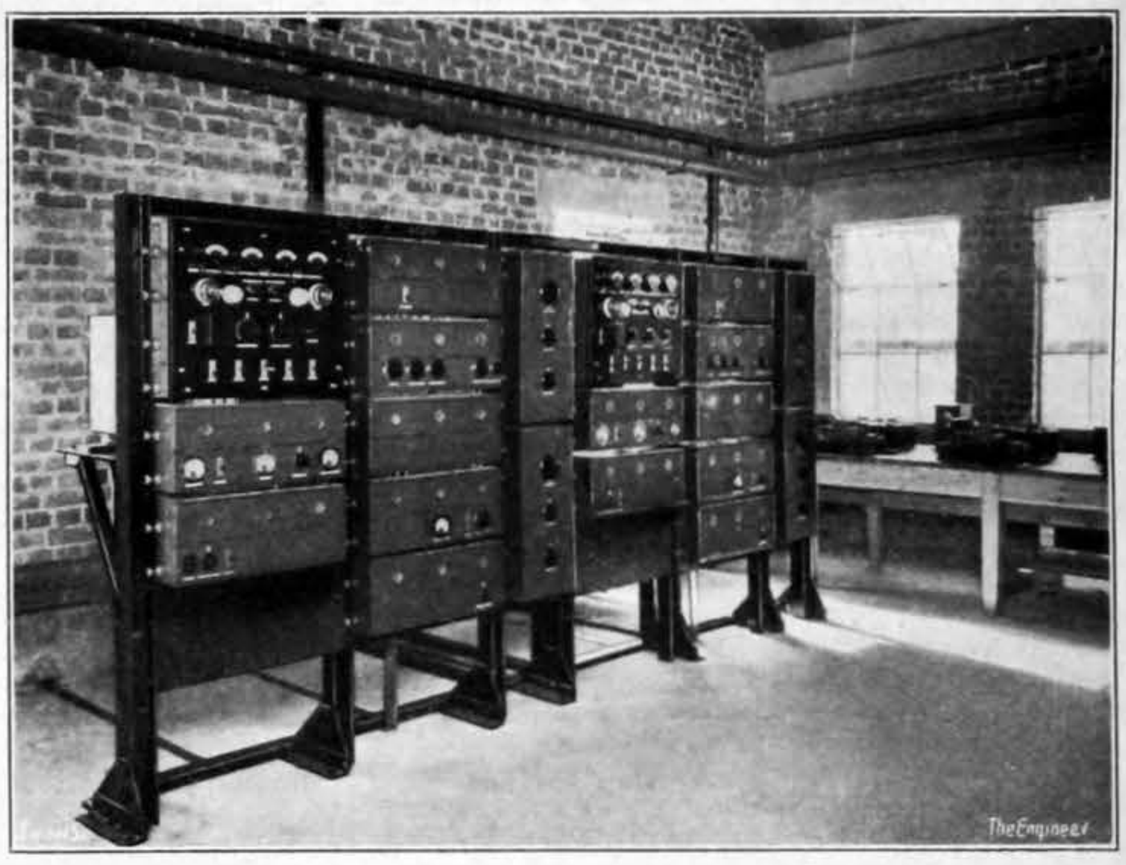


FIG. 4—RECEIVING APPARATUS AT BRIDGWATER

official tests. As an alternative the receivers may receive signals from Canada on a different wave length using the other aerial bay.

There are two Marconi short-wave beam receivers at Bridgwater which are used for reception from two directions, namely, from Canada and from South Africa. In order to avoid interaction between the circuits, which are worked on a common battery system, the frequency of the bands of the two first filter amplifiers and two second filter amplifiers are suitably spaced. Otherwise the receivers are identical.

The Twin-screw Motor Train Ferry Dolores de Urquiza.

In a Seven-day Journal note, published in our issue of August 20th, we referred to the launch of the twin-screw motor train ferry Dolores de Urquiza, which has been built by A. and J. Inglis, Ltd., of Pointhouse, Glasgow, for the Parana River service of the Entre Rios Railways. The ferry, which was completed about the end of September, ran her official trials over the Skelmorlie measured mile in the Firth of Clyde on October 2nd. By the courtesy of her builders we are now able to give some further particulars regarding the ship, her equipment and her propelling machinery, which was supplied by Harland and Wolff, Ltd., of Glasgow.

Hull Particulars.—The illustration given below shows the general appearance of the ship. She is built of steel to Lloyd's 100 A 1 classification, and is designed for the transport of trains across the Parana River between Argentina and the province of Entre Rios, a distance of about 50 miles, which will be covered in close upon four hours. The following are the principal particulars of the hull:—Length overall, 355ft. 6in.; breadth moulded at main deck, 57ft. 6in.; breadth extreme over belting, 59ft. 7in.; depth moulded, 19ft. 9in.; gross tonnage, 2217; designed speed, 11½ knots. There are four sets of rails, which run practically the whole length of the vessel. They are laid to the standard gauge, and are secured to the steel deck by chairs and bolts, heavy buffers being provided at the after end of each pair of rails. To keep the end of the ferry in line with the apron of the loading bridge when loading, four steel sockets are provided at the bow end, which receive the sliding pins of the apron. The hull is stiffly built, and the deck is strengthened with longitudinal trusses and stanchions along its entire length, there being channel section deck beams at each frame. From our illustration it will be seen that the bridge deck is arranged forward of amidships, and is raised high enough to permit the trains to pass beneath it. It is supported by columns of latticed channel construction, with lattice girders beneath them.

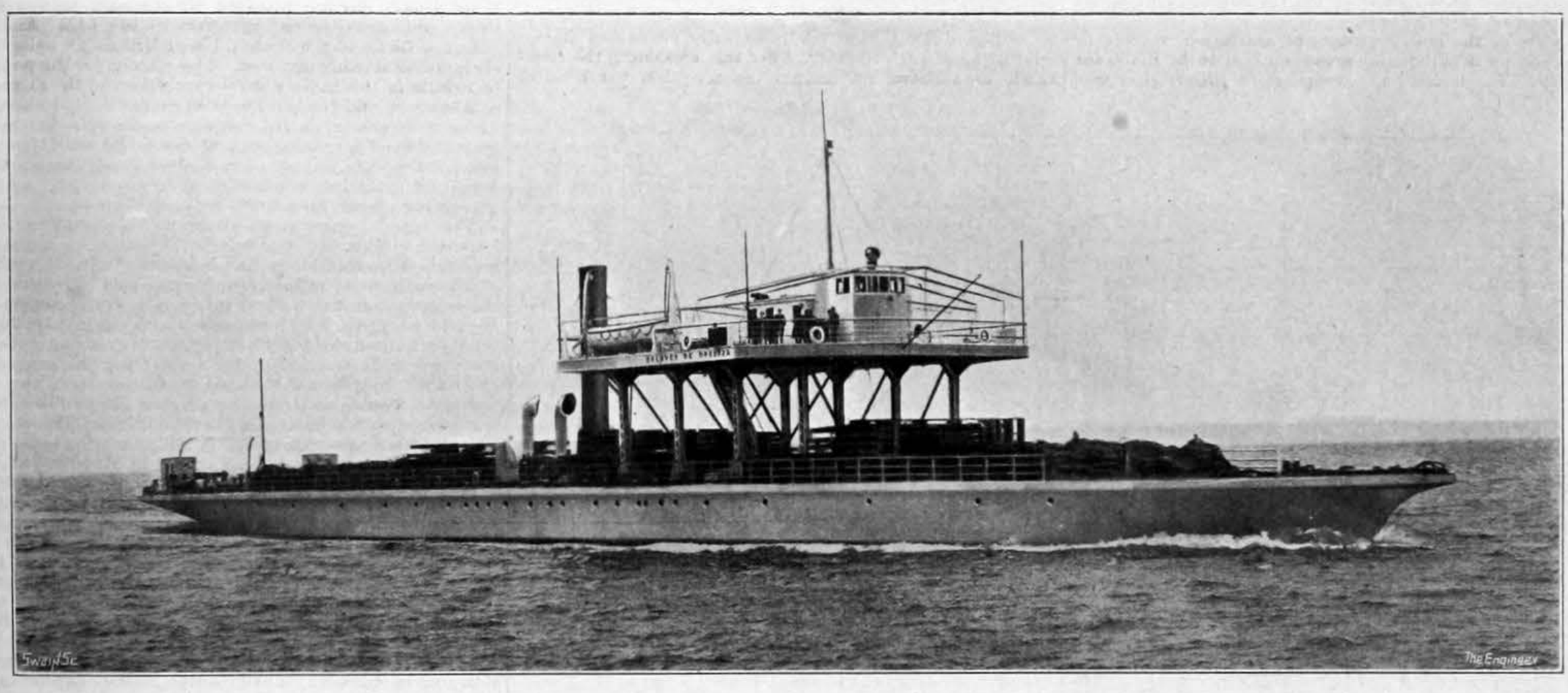
Accommodation.—On the raised bridge deck is a deck-house, containing the captain's rooms, and two rooms for the pilots. In addition, there is a wheel-house built above the surrounding superstructure, with windows designed to give an all-round view. The accommodation for the ship's officers, engineers and crew is on the main deck forward of the engine-room. It includes, besides separate cabins, a large gallery and pantry, an officers' mess-room, and mess places for sailors, greasers and petty officers. Bathroom and wash-house accommodation is also provided.

Deck Auxiliaries and Fittings.—The deck machinery comprises an electrically-driven windlass forward, and an electrically-operated reversing warping capstan aft. Steering gear of the hydraulic-electric type is employed. Fuel oil is carried in two oil-tight bunkers in front of the engine-room below the accommodation deck. These bunkers carry about 100 tons of fuel oil. About 5 tons of lubricating oil are carried in a tank below the floor of the engine-room.

Propelling and Auxiliary Machinery.—The two propelling engines are six-cylinder, four-stroke, single-acting oil engines of the latest Harland-B. and W. trunk piston type. They have a cylinder bore of 400 mm. and a piston stroke of 750 mm., and are each designed to develop over 900 indicated horse-power when running at a normal speed of 200 revolutions per minute. The engines are arranged for supercharging and a motor-driven blower delivers air into the air inlet manifolds. Compared with the firm's crosshead type of marine oil engine, some differences in design may be noted. The cam shaft, which is chain-driven from the crank shaft, is arranged near the top of the cylinders, so that the valves are directly operated and no intermediate push-rods are required. The usual servo-motor reversing gear with hand levers for speed and fuel controls is provided. To enable the engineer on duty to control both the engines, the starting and reversing controls are arranged at the after end of the engines, and in this particular vessel they have been centralised at one starting platform. A three-stage compressor for providing the injection air is fitted to each engine, and is mounted at the forward end, being driven direct from an extension of the main crank shaft. The engines are built for forced lubrication, and the pistons are oil cooled, water cooling being employed for the cylinder casings and covers. The compressed air used for manœuvring is stored in a single steel reservoir at a pressure of 25 atmospheres, or about 370 lb. per square inch. Extra large air compressors have been provided on the two auxiliary engines, so that, in addition to supplying the necessary injection air, manœuvring air can be supplied to the air reservoir, and the use of a separate air compressor thus dispensed with.

The two auxiliary engines referred to are each three-cylinder units, which are coupled direct to 55-kilowatt generating sets supplying current for the lighting of the ship and operation of all auxiliary machinery with the exception of the engine-driven bilge and fuel oil pumps.

Trial Results.—Successful speed and manœuvring trials of the Dolores de Urquiza were run on Saturday, October 2nd, over the measured mile at Skelmorlie. The ferry was loaded with 1400 tons deadweight, and in such a condition the guaranteed speed of 11½ knots was exceeded, a speed of 12¼ knots being attained. A feature of the trial was the comparative quietness and smooth running of the machinery, a matter of first importance in a railway ferry which is designed to carry sleeping coaches. At the trials, Sir Brodie Henderson, of Messrs. Livesey, Son and Henderson, of London, represented the Entre Rios Railways Company, Ltd., while Mr. Turpin was present on behalf of Messrs. Trewent and Proctor, of London, the surveyors of the vessel and her machinery during its construction.



MOTOR TRAIN FERRY DOLORES DE URQUIZA

American Engineering News.

Steel for Machine Tools.

In selecting steel for making tools it is better to purchase by specification than by the trade name or brand, according to Mr. Mudge, metallurgist of the American Western Electric Company. Such a specification should maintain reasonable manufacturing variations of analysis and tolerances; give a working range of physical characteristics; tell the manufacturer what is wanted, and also tell him what in the purchaser's opinion based on experience in his own works will best meet these requirements. A specification of this kind is a direct help to the steel manufacturer, as it enables him to visualise the needs and conditions and to grade his material accordingly. Many large engineering works have adopted specifications for their tool steel, and are getting more satisfactory tools in this way. With some slight modification the smaller works could obtain similar results. In heat treatment, supposing the steel to be good, the most important factor is the personal equation, or the human element. The next most important feature is automatic temperature control. Various forms of gas and electric furnaces have given good results, under the above two conditions, but this particular form does not use oil in the hardening room. Even with good steel, good heat treatment and good design, a careless operator can ruin the best tools, and when a tool is cracked it is not always easy to place the blame.

Steam Engine Supplying Process Steam.

To meet the increasing demand for steam engines delivering their exhaust steam to industrial processes, a vertical uniflow type of engine has been designed in which pressure-actuated valves control the amount of exhaust steam passing to the process main and to the condenser. In this engine, as built with six cylinders, the steam valves are of the unbalanced double-beat type, and are operated by revolving taper cams on a shaft which is shifted longitudinally. The mechanism for regulating the exhaust, known as the "selective exhaust," consists essentially of a piston valve controlling the exhaust of each cylinder. The valves are shifted by means of oil pressure in a double-acting cylinder with a differential piston and a pilot valve which is controlled by the back pressure. If the back-pressure drops the pilot valve will move so as to admit oil under pressure to the lower part of the oil cylinder and to the two clearance valves of the steam cylinder. These valves then change the steam cylinder over from condensing to back-pressure operation. A change of 1 lb. in the back-pressure system will suffice to operate the delicately balanced pilot valve, while the change in oil pressure is from 10 lb. to 60 lb. Of several engines built by the Chuse Engine and Manufacturing Company, of Mattoon, U.S.A., the largest is a 1250 kilovolt-ampère generator unit, having cylinders of 17in. diameter and 19in. stroke, and running at 257 revolutions. A machine of 375 kilovolt-ampères, with cylinders 10in. by 12in., runs at 450 revolutions.

Mechanical Treatment of Sewage.

"Biological treatment of sewage is and must continue to be largely ineffective and unreliable, owing to the impossibility of controlling the performance of vast quantities of bacteria of various kinds *en masse*." That is the opinion put forward with much supporting information by Mr. George A. Johnson, a leading American consulting engineer of wide experience in sewerage works. In his opinion the future development of sewage disposal will be along the lines of mechanical treatment, securing better and more uniform results at no greater expense than by the biological processes now in favour. Three proposed treatments are outlined:—First, screening by self-cleaning rotary screens and then sterilisation, both in continuous operation; second, screening followed by chemical precipitation, with dosing devices, and a coagulation and sedimentation basin with continuous sludge removal, and finally oxidisation and sterilisation by chemical or electrolytic means; thirdly, screening, chemical precipitation, oxidation, and then final sedimentation with a contact period to effect oxidisation and sterilisation. In this last case the sludge removal would be intermittent. For the first method, the screenings would be disposed of by incineration with refuse, or by burial. For the other two methods the screenings would be mixed mechanically with the precipitated sludge and then drained and carried out to sea in hopper barges, or else dried and ground for use as fertiliser or fertiliser base.

Welding Structural Steel Framework.

The use of welding as a substitute for riveting in the construction of steel-frame buildings, roof trusses and similar structural work is attracting considerable attention and experimentation. One of the results of the experimental work is the development of a new type of "plate joint." Thus in the connection of two diagonal members to the bottom boom of a roof truss, the three members are not in contact or directly welded together. The diagonals stop short of the boom member, and their webs are partly cut away, as is part of the web of the boom member, which is of inverted T section. A plate shaped to fit the irregular space thus formed is then inserted, taking the place of the usual gusset, and this plate is welded to the three members, all joints being butt welds. In this way there is a saving in weight of steel as compared with riveted construction. A serious difficulty is the impossibility of knowing how efficiently each weld is made, so that much remains to be done in engineering investigation and proof-testing before there can be confidence in the welding of steel framework for large structures. However, it is considered that recent experiments and tests encourage the belief that this and other difficulties may be overcome eventually. It is pointed out that with the "plate joint" there is about 15 per cent.

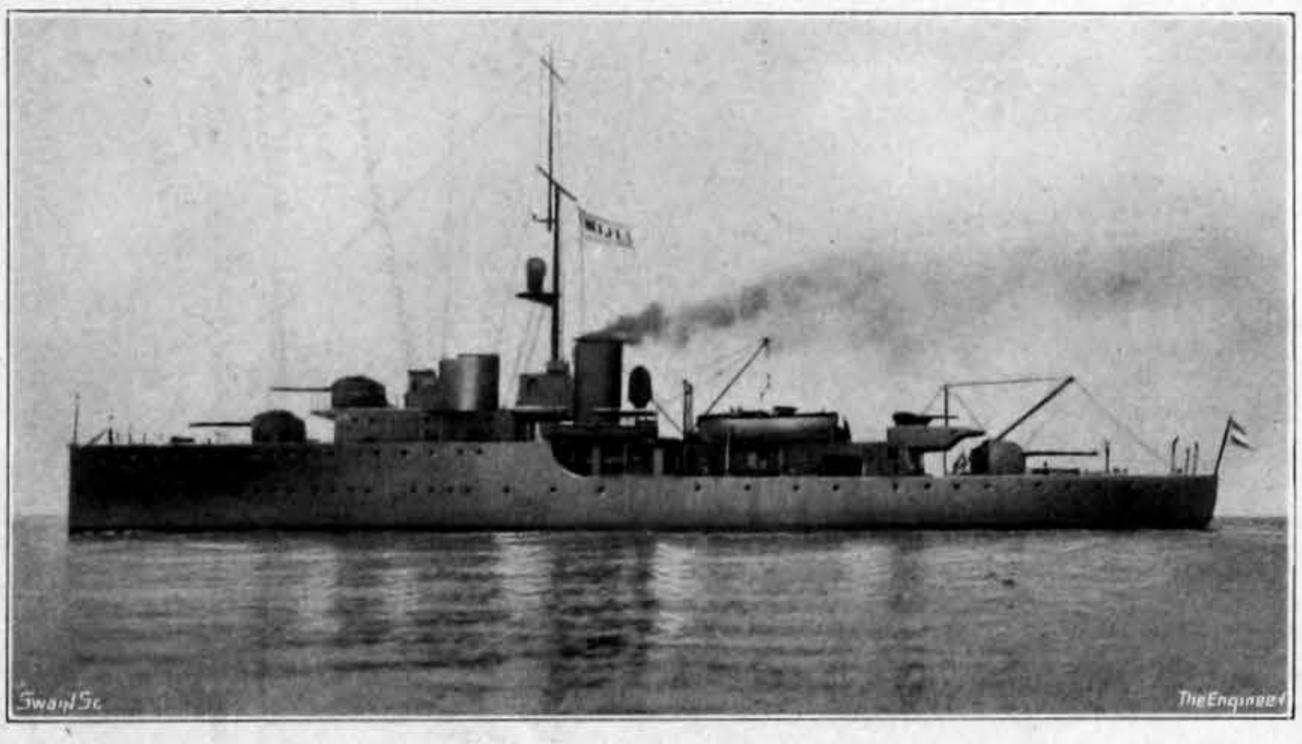
increase in rigidity as compared with a riveted joint. These experiments are being continued with different kinds of rolled shapes and different kinds of structures.

Dutch Gunboats for the East Indies.

The Netherlands naval squadron in the East Indies is about to be reinforced by two gunboats, or sloops, of an interesting type. The Flores and Soemba, as they are named, were built respectively by the Fijenoord and Wilton yards in Rotterdam, both being launched in the summer of 1925. They are intended for patrol service in East Indian waters, and in case of emergency to act as guard boats to the minefields off Surabaya. We are indebted to our contemporary, *Het Schip*, of The Hague, for the following details of these vessels. The specification laid stress on certain essential features, such as (*a*) extensive cruising radius; (*b*) robust and simple propelling machinery; (*c*) shallow draught—not more than 3·60 m.—with a view to river navigation; (*d*) handiness of manœuvring; and (*e*) roomy living quarters, adapted for long cruises in tropical waters. The military characteristics were to be:—(*a*) An armament of three 5·9in. guns and one 3in. gun, which would be sufficiently powerful to deal with torpedo boats, armed trawlers, or other small craft that might attempt to sweep up the defensive minefields; (*b*) moderate protection, viz., a strong steel deck, an armoured conning-tower, and plating over the magazines; (*c*) a very complete system of subdivision. It was recognised that such protection would be of no avail against direct hits, but that is a risk which the gunboats share in common with large cruisers of the so-called "Washington Treaty" class. A sea speed of at least 14 knots being considered necessary, the machinery was designed for an output of 2000 indicated horse-power. The Flores on trial developed 2086 indicated horse-power at 167 revolutions, equivalent to a speed of 14·987 knots.

In view of the heavy armament and other weights to be carried on deck, special provision had to be made for stability. The task of the designers in this respect was rendered more difficult by the stipulation that two of the 5·9in. guns should be mounted forward, the second being superimposed to fire over the first. The principal measurements are: Length overall, 75·6 m.; length on water line, 74 m.; breadth, 11·5 m.; depth of hold, 6·30 m.; draught, 3·60 m.; displacement, 1683 tons. Owing to the moderate speed accepted it was possible to install engines of small dimensions, leaving sufficient headroom for the armour deck, which is also worked over the magazines and steering gear. The oil bunkers are so arranged as to serve the purpose of anti-rolling tanks, and their low position keeps the metacentric height within moderate limits. The scantling is strong, but owing to limitations of space the double bottom could not be extended beyond the machinery spaces, and even there it is not carried up to the turn of the bilges. To minimise the danger of fire, steel decks are worked throughout, and the usual teak planking has been replaced by a non-inflammable material known as Triolin. The propelling plant consists of two triple-expansion engines, each nominally developing 1000 indicated horse-power, taking steam from four Yarrow small-tube oil-burning boilers, fitted with Howden's system of forced draught. The twin propellers are three-bladed, with a diameter of 8ft. 2in. The rudder is of the Flettner type. The new Dutch gunboats are the first vessels of war to be equipped with this pattern of rudder.

The vessels appear to be admirable craft for their purpose, and the designers have succeeded in endowing them with powers of offence and defence well above the average for ships of such limited displacement. The armament is heavy enough to make them formidable antagonists even for a light cruiser, while the protective deck and the armoured conning-tower, which account for 225 tons of the total displacement, would enable them to stand up to the fire of medium-calibre guns without undue risk. The equipment includes paravane sweeps for clearing a path through hostile minefields.



THE DUTCH GUNBOATS "FLORES" AND "SOEMBA"

At a meeting of the Birmingham, Coventry and West Midlands branch of the Institute of British Foundrymen, held on October 9th, it was decided to form a Junior Section of the branch. Membership will be open to moulders, core makers, pattern makers, engineeers, laboratory assistants, students, &c., between the ages of sixteen and twenty-three years. The Lancashire Junior Section now has over 200 members.

Institution of Electrical Engineers.*

In estimating the relative electrical progress of the nations, one of the favourite figures for comparison is the consumption per head of population. By itself this comparison is not sound, but the figures are repeated in Table A, the figures in this table relating to the year 1923.

Table A.—*Annual Consumption of Electricity per Head*, 1923.

	Units.		Units.
Norway	1800	Belgium	250
Canada	910	Germany	230
Switzerland	805	Britain	155
United States	528	Italy	129

From this it is seen that our consumption per head was less than one-half of that of the United States. The output of electricity per head of population in 1925 in nine countries is shown in Table B. Another comparison may be obtained by taking the most fully electrified industrial areas of each country. On this reckoning the Newcastle area shows an annual consumption per head of about 600 units, which is one-third of that for similar zones in America.

Table B.

Country.	Population.	Total output of electricity.	Output per head of population.
	Millions.	Millions of units.	Units.
Canada	8·8	10,490	1,190
Switzerland	3·9	4,170	1,070
United States	105·7	65,801	623
France	39·2	9,700	248
Italy	38·5	7,600	197
Great Britain	42·8	8,125*	190
Germany	62·5	11,521	185
Holland	7·1	896†	126
Denmark	3·3	231†	70
Total	311·8	118,534	380

* Including railway, tramway and non-statutory undertakings. † 1924.

Still another comparison is offered by the average price at which electricity is sold in different countries. Table C gives the figures for 1923 and Table D those for the year 1925. All these tables are very disparaging to this country, but they are somewhat unfair. In the first place, many private industrial generating plants in Great Britain have been ignored. In the second place, the taking of an average conceals the fact that in many instances the cost of electrical power in this country is as low as in the corresponding areas in America or Switzerland. For instance, industrial power is now sold in the Newcastle district, in Lancashire, the Clyde Valley and other places at prices about the same as the cheapest power in America, excepting only the Niagara Falls and the Mississippi Power Company's areas.

Table C.—*Price of Electricity*, 1923.

	Pence per unit sold.
Great Britain	2·07
United States	1·05
Canada	0·72
Switzerland	0·60
Northern Italy	0·46

Table D.—*The Price of Electricity*, 1925.

	Pence.
Great Britain	1·90
United States	1·53
Canada	0·72
Switzerland	0·60
Northern Italy	0·40

A method of comparison which points an important lesson consists in finding for various countries the kilowatt-hours of energy delivered, on the average, by each kilowatt of machinery installed. Taking all the central stations in four countries, we obtain Table E. A more

Table E.—*Units Sold by Central Stations and Units Delivered Annually per Kilowatt Installed.*

	Units sold, 1923. Millions.	Units per kilowatt.
United States	38	2700
Italy	4·9	2640
Switzerland	2·0	2430
Great Britain	3·8	1220

* Abstract of presidential address delivered by Dr. Eccles on Thursday, October 21st.

Table F.—*Units Per Kilowatt Installed for Output of 2000 Million Units per Annum.*

Italy (five companies of Edison Group)	4250
Germany (two companies)	3460
United States (one company)	3430
France (three companies)	2040
Great Britain (seventeen companies)	1730

just comparison is that of Table F, in which, from each of five countries, a number of the largest undertakings sufficient to make up a total annual output of 2000 million units have been taken, and the output per kilowatt of plant tabulated. The figure of 1730 units per kilowatt for Great Britain indicates that we have been getting only 4¾ hours' work per day out of the machinery in a number of our best stations. It is to be noticed that the figure for Germany has risen from 1540 in 1913 to 3460 in 1923. Table G gives the output of electricity of principal undertakings in six countries (1925). The conclusion that we in this country are not getting full value from our installations is confirmed by finding the number of units sold for each pound sterling invested in stations, transmission lines and distribution networks. In 1925 America obtained 35 units per annum, Great Britain 28 units from each pound sterling invested. The reasons for the position of Britain in this matter are the smallness of the machines and stations and the rigid separation of the undertakings. The recent change in the German position is due to the installation of larger equipment combined with thorough interconnection; in some areas special advantages have arisen from the interconnection of hydraulic and thermal generating plants, on a scale not possible here.

Table G.

Country.	Number of companies.	Capacity of generating plant.	Output of electricity.	Output per kilow't of plant installed
			Millions of units.	Units.
Canada	3 companies	1,289,000	5,828	4,500
Italy	Edison group	530,000	1,722	3,250
United States	14 companies	5,595,092	17,064	3,060
Germany	9 companies	1,764,300	4,593	2,600
Great Britain	14 undertak'gs	1,363,800	2,881	2,110
France	14 companies	1,640,000	2,987	1,820
Total		12,182,192	35,075	2,880

The rate of growth of electrical consumption is an important index of progress. In Brtiain the capacity of authorised undertakings has increased from 2½ millions of kilowatts to 4¾ millions during the past six years, and the average annual rate of increase of consumption has been 14 per cent., which compares with Germany's 25 per cent. per annum and Italy's 35 per cent. per annum between the years 1921 and 1925. Sir John Snell, in his address at Oxford, prophesied that within fifteen years our consumption would rise from the present 7000 million units per annum to not less than 21,000 millions. This implies that in fifteen years this country will reach the same state of electrical development as exists in America at this moment. It seems to be thought that the rapid rate of growth in other countries is temporary, and that our smaller but steady increase will catch up.

If our backwardness in electrical development is not directly due to the lack of water power or lack of fuel, what is it due to? It seems that there is a complex of primary causes, economic and political, but the chief electrical cause is our neglect to use the principle of interconnection for cheapening supply.

In Britain only four examples of effective interconnection can be quoted: (1) the North-East Coast area supplied by the Newcastle Electric Supply Company with generating plant totalling 260,000 kilowatts, and an annual output in excess of 800 million units; (2) South-East Lancashire, where the Lancashire Electric Power Company, Manchester, Salford, Bolton and Rochdale Corporations are interconnected with generating plant of almost 400,000 kilowatts and an annual output of 650 million units; (3) the Clyde Valley area, served by the company of the same name, with five stations aggregating, after completion of the two water power plants on the Clyde, 120,000 kilowatts, with an annual output of 250 million units; (4) the North Wales zone, supplied by the North Wales Power Company, the Mersey Power Company, and the Aluminium Corporation, with a total annual production of about 140 million units. Centralisation is taking place in London under the auspices of the London Power Company, which sold 358 million units in 1925. In Dalmarnock, which has a capacity of 131,250 kilowatts, in Barking, Nechells and Barton, Britain possesses power stations of large capacity and a high level of efficiency, and it will probably be found impracticable to erect stations much larger than these in Britain because of cooling water and other difficulties. The effect of interconnection on load factor can be seen from the fact that the Newcastle Electric Supply Company works now at a load factor of 48 per cent., the Clyde Valley Company at 45 per cent., and the Mersey Power Company at over 50 per cent., compared with a national average of 28 per cent.

The figures of the last paragraph serve to show what progress has been made in Britain during the past few years towards the advantages of centralisation and interconnection. The largest of our stations are practically as efficient as the greatest of the foreign super stations—Barton, for instance, has reached 22 per cent. Interconnection has been proved profitable, notably in the Clyde Valley and Lancashire areas, but much remains to be done—the national load factor is still less than one-half that of some other countries, and the area of country adequately served is less than two-thirds of the whole. That this state of affairs should be remedied all will agree, but there is some divergence of view as to whether we need electrify so intensely or so rapidly as the other nations.

Even the busiest British cities do not install the telephone as freely as Frankfort, Berlin, Sydney and Melbourne, Paris and the Hague. Perhaps a better test of telephone utilisation is the number of conversations per head per annum. While the average American talks 191 times per annum, the average Englishman talks only 23 times. Statistics show that we get less service from

each instrument than most other nations, or, if we look at it from the other side, the supply of telephones in this country is leading the demand, which is as it should be for progress.

One of the most useful tests of the health of the scientific industries of a country is afforded by the statistics of its patent office. This test is particularly applicable to the electrical industries, which, more than any other industries, progress by means of research and invention. In fact, in the electrical world, every great new industry has been the result of invention—as witness the telegraph, the dynamo, the telephone, the electric lamp and the steam turbine—and very many of the improvements in the methods of electrical manufacture have been based on research and invention. Statistics have been obtained of the patents granted in the three principal electrical countries and an endeavour has been made to interpret them. First it is to be noticed that, in 1925, about 49,000 patents were granted in America, 16,000 in Germany, and about 15,000 in Great Britain and Northern Ireland. In America 89·2 per cent. were native inventors, in Germany 77 per cent., in Britain 57 per cent. Of the whole number of patents the electrical proportion was 9·8 per cent. in America, 10·3 per cent. in Germany, and 21 per cent. in Britain. The electrical patents form, of course, the section of greatest interest to this Institution. Of the American electrical patents, 13·5 per cent. are of foreign origin; of the German, 26 per cent. are foreign; and of the British electrical patents, 59 per cent. are foreign. This appears to indicate that we, as a nation, are not doing our due proportion of the highest form of the brain work required by our electrical industries. This conclusion is confirmed by other statistics I might have cited regarding the relative smallness in number of the patents held by Englishmen in America and Germany. It is confirmed, also, by a study of various branches of the electrical industry—in many branches the number of Englishmen holding patents in foreign countries is much lower than the number of other foreigners holding patents. The main conclusion is that Englishmen are, at the present epoch, making many fewer electrical inventions than is expected of them.

The figures quoted in the preceding paragraphs show that we, as a nation, are, on the whole, importing more inventions than we originate—in other words, the improvement of our manufactures and the founding of new industries here, so far as they are based upon invention, is dependent largely on brain work done abroad. In addition, we export fewer inventions than the other leading nations do. Thus in this intellectual side of industry we have a big adverse trade balance, for which, doubtless, we pay a correspondingly large annual tribute in money. This is an item which the economists seem to have omitted from their list of invisible imports.

Can any remedy be suggested for the state of things just described? A remedy is indicated on looking at the American and German records of education and research. Necessity is said to be the mother of invention, but research is certainly its father, and technical education a grandparent. Compared with America and Germany, there are too few technical colleges and research laboratories in this country. The huge pre-war leeway in research has not yet been made up, in spite of the splendid post-war efforts of some of our great electrical concerns and our research associations. It seems that we have to choose between two courses; either we must spend money on technical education and research at home or, as an alternative, we must pay other nations to do the necessary brain work for us. This choice cannot be evaded. Inaction is not a loophole. By doing nothing we should merely find that some of our scientific industries would become out of date relative to the leading nations. The instrument industry appears to have recognised the urgency of its own needs and has supported its research association handsomely; if the cable industry and the heavy electrical industry were to organise similarly liberal support for other corresponding research associations, for instance, by a levy on turnover, the adverse trade balance shown by the Patent Office would probably be remedied in due course, and we might again export British inventions.

The remedies indicated in the preceding paragraph are fundamental and will consume a decade or more in application; but we require at this moment immediate remedies for our immediate needs, as disclosed by the above analysis. Of these immediate needs that of cheapening the supply of power to the basic industries of the country is the most pressing. To effect this cheapening we must turn Britain into a single power zone. Failing that, we shall lose pride of place as a manufacturing country. These alternatives are not of our choosing; they are forced upon us by the calculated action of rival manufacturing nations which have seen more quickly than ourselves that electrification is the only way of modernising the whole of industry and who have proceeded feverishly, and sometimes harshly, to execute their schemes. We, as electrical engineers, desire nothing more than to help forward this electrical modernisation of our country in any manner that may be decided upon by the nation generally, and we believe that if electrification is pursued steadily and tactfully it can be accomplished without causing hardship or injustice.

Lloyd's Register Scholarships.

The Institute of Marine Engineers has just issued the following information regarding Lloyd's Register Scholarships, Student Graduate Examinations, and Essay Competitions in 1927:—

Lloyd's Register Scholarships.—Lloyd's Register Scholarships are three in number, one being available each year for three years at £100 per year. They are bestowed by Lloyd's Register of Shipping. Application should be made by intending candidates not later than March 10th, 1927, in order that arrangements may be made for the examination, on the dates announced below. The examination will be held simultaneously in the various centres to suit the residences of candidates. The regulations, with lists of subjects on which questions will be set, are as follows:—(I.) The Scholarship is open for competition to candidates who are British subjects—that is to say, of British parentage in its Imperial sense—graduates, student graduates or associates of the Institute of Marine Engineers, apprentices or junior engineers (not necessarily connected with the Institute), the age limit being from eighteen to twenty-three at the date for entering the University. Preference will be given, in the event of nearly equal marks, to the candidate who acquits himself best at the subsequent oral examination before a special committee. The successful candidate, if not already associated, must join the Institute in the grade for which he is qualified. (II.) The Scholarship is intended to assist marine engineering students, desirous of gaining higher attainments, better to qualify them for the duties of life in their chosen profession. An undertaking must be given by the successful candidate that he will continue his studies for the full period of the term, extending over three years, with a view to the B.Sc. degree. (III.) The examination papers will be set from and based upon the following subjects, and the award will only be given in the event of a candidate showing sufficiently good qualifications.

May 9th, 1927:—(*a*) Arithmetic, including the metric system; algebra to quadratics; (*b*) elements of statics, dynamics, thermodynamics, and hydrostatics; (*c*) geometry, based on Books I., II., III., and IV.; (*d*) general knowledge, English composition. May 10th:—(*e*) Theoretical mechanics, principles and problems; (*f*) foreign language—choice given to the candidate who is required to notify this on his application—elementary construction and translation; (*g*) trigonometry, including logarithms; (*h*) practical engineering and workshop practice.

As the object of the Scholarship is to provide means for young engineers to add to their proficiency as marine engineers, only those are eligible who have served at least two years in a commercial engineering workshop, and until the time of application have been employed at engineering, either ashore, afloat or at college, with the intention of entering upon the business of marine engineering, but not necessarily to remain a sea-going engineer. Subject to the approval of the Council, the successful candidate may choose the university or college most convenient to himself, but he must take all the classes in the recognised curriculum for engineering students at the university or college chosen.

Student Graduates.—Applications to sit at the examinations will be received till March 3rd, 1927. The dates for the examination are:—April 19th: Theoretical mechanics, heat and heat engines; April 20th: machine construction and drawing; applied mechanics; April 21st: mathematics, including geometry; English language, including composition; April 22nd: electrical engineering. Further particulars may be obtained on application to Mr. James Adamson, honorary secretary, the Institute of Marine Engineers, 85–88, The Minories, Tower-hill, London, E. 1.

Manchester Association of Engineers.

In the course of his opening address to the members of the Manchester Association of Engineers on Friday, the 22nd inst., Sir Benjamin Longbottom, M.I.E.E., M.I. Mech. E., made an extended reference to the Electricity (Supply) Bill. He said that the total output of electricity at present from all stations in the country was 7000 million units per annum, and it was estimated that that figure would be trebled in fifteen years, and more than trebled if extensive main line electrification were carried out on the railways. As the output of the Manchester undertaking was some 300 million units per annum, twenty-three such stations could supply the whole of the country's present requirements. The average price per unit obtained in Manchester was 1·122d., as against an average of 1·75d. throughout the country. Hence, if all the stations were as efficient as Manchester the average charge would be reduced nearly 35 per cent., which represented a saving of over £17½ millions on the national consumption. If the generating costs were as low as at the Barton station, the saving would be greater still, for Barton had the lowest fuel consumption per unit of any station in the kingdom.

Sir Benjamin said that this country was on the eve of great developments. Industry was entering on a new phase of reorganisation. The railway companies must very soon decide how they intended to deal with the increasing menace of road transport. The evidence recently submitted by the National Farmers' Union and other bodies to the Railway Rates Tribunal showed that there was a close community of interests between agriculture and rail transport. The frank recognition of that fact should lead to co-operative effort, which would benefit both parties. A joint application to the Central Electricity Board might result in the establishment of high-tension transmission lines along the railways, with convenient sub-stations from which a supply of electricity could be taken both to the railway track and to the adjacent agricultural areas. Light electric railways with motor trucks could be run to recognised collecting centres, and so relieve the road of much of the heavy traffic and expedite delivery of perishable goods. Electric power could then be gradually adopted both on the main lines of railways and for agricultural and dairy farming operations. That would not only be of mutual benefit, but would serve the highest national interests, as the traffic would be handled more economically and expeditiously by electrification, and farmers would have placed in their hands a tool which would enable them to increase the productivity of the soil and make farming a more attractive and prosperous industry. The probable result would be a revival of rural industries and a check to the tendency of our people to concentrate in large and already congested centres.

During the evening several interesting presentations were made. The Constantine Gold Medal awarded by the Council for the best paper read during the last session was presented to Mr. Daniel Adamson, and the Butterworth Medal for the best contribution to the discussions was presented to Mr. F. Walker. The President received a gold and enamel badge of office for present and future Presidents, which has been presented by several past-Presidents of the Association. This badge was designed and made by Messrs. Reid and Sons, Newcastle-upon-Tyne. The body of the jewel is suspended from a figure of Vulcan and the centre of the jewel depicts the old Arms of the City of Manchester, in proper heraldic colours.

Letters to the Editor.

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

DESIGN OF ROAD VEHICLES AND DAMAGE TO ROADS.

Sir,—The last few years have shown a big increase in the capacity and speed of mechanically propelled road vehicles, and local authorities have endeavoured to keep pace with this traffic by the construction of improved road surfaces, at large cost to the community.

Much of this road construction has been of an experimental nature to try out the merits of various types of road-surfacing material in resisting wave formation or corrugation. The vehicle driver, finding a smoother road, generally increases his speed without discomfort to himself, and it is quite a common thing to find vehicles marked 12 M.P.H. travelling at 18 to 25 miles per hour, with a corresponding increase of wear and tear to the road surface.

The question might be asked whether designers of road vehicles are giving attention to the action of the lorry on the road surface. A great deal of development has taken place in internal design, as regards engine and gear-box, but not sufficient attention has been paid to suspension and its various reactions on the vehicle and damage to the road surface. It can be safely stated that the amount of vibration produced in a building at the side of a modern smooth road by a passing vehicle is an indication of the relative capacity of the vehicle to do damage to the road surface; and it is of interest to note that it is not always one of similar carrying capacity, at a greater speed, which produces the most percussive action.

From an observation of over a dozen different types of lorries, all carrying road ballast for road-making, it is clear that where the design is such that the centre of gravity of the load is practically carried over the centre of the back axle—as in Fig. 1—the greater vibration is produced, and this form of construction is least suitable for speed. If, however, the load is more distributed over the wheel system—as with Fig. 2—much steadier running, even at higher speed, is obtained.

For example, one sees vehicles marked as carrying a load on the back axle of 4 tons and 3 tons on the front axle; but a

Fig. 1.

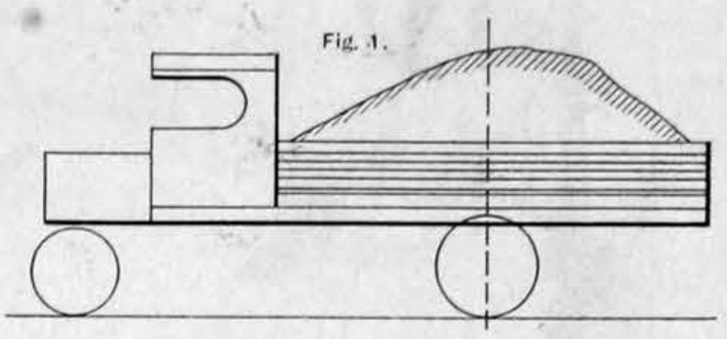
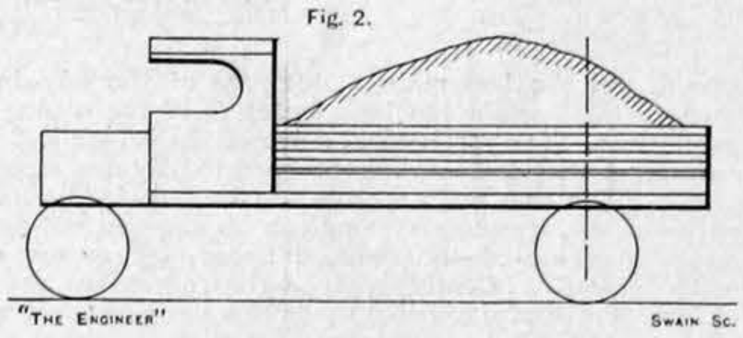


Fig. 2.



weighing test gave 7 tons rear axle and 35 cwt. for the front axle. This vehicle driven at 20 miles per hour caused great vibration even on a relatively smooth road.

Designers appear to attach more importance to convenience of drive or simplicity of tipping device than to smooth quality of running performance; which latter is, after all, of great importance to the purchaser from the point of view of upkeep and repairs to tires. It is the Fig. 1 type which one sees most often with a broken back axle and users have experienced trouble with axle bearings. Furthermore, tires suffer equally with road surface, and it is a common thing to see tires with large pieces broken out pounding the road like a battering ram.

Another cause of percussive action appears to be the double chain drive, in which one chain is pulling against the other, owing to unavoidable variations of pitch which take place after wear, and for which there is no adequate compensation. Not only is the question of road damage of importance, but the constant vibration, sometimes very severe, which is felt in buildings along the roadside, must eventually prove damaging to property, and is certainly an intolerable nuisance in suburban residential districts.

One dreads the thought of increased weight carrying "juggernauts" being allowed to take the road without some definite improvement along the direction of steady, vibration-free running.

The matter might very well be taken up by the Ministry of Transport, and tests instituted whereby a certain type of vehicle would be assigned a fixed maximum speed according to its capacity for steady running, before granting a licence to use the roads.

Speed governors might be insisted upon. By means of legislation suitable types could be encouraged, and graded taxation would soon eliminate the unsuitable vehicle. Further, local authorities should exercise sharp control over the running of badly conditioned lorries, making it an offence to use defective tires or to run at an excess of speed above that for which the licence is issued. In conclusion, it might be stated as a generalisation that there is a large number of badly designed vehicles on the road.

A speed of 12 miles per hour is presumably taken as a basis for maximum efficient running speed; but how many vehicles on a smooth open road keep to 12 miles per hour? From observation over a measured portion of good road, the speed is often 15 to 16 miles per hour for steam lorries and from 18 to as high as 27 miles per hour for petrol-driven lorries. Therefore, either the speed is wrong, or the designer must take into account higher speeds than the 12 miles per hour marked on the vehicle when setting out to produce a type of lorry which will travel with a minimum of road damage and absence of annoying vibration.

October 22nd. An Engineer.

Electric Control Equipment for a Bascule Bridge.

In our issue of April 9th last we gave a description of the Second Narrows Bridge, Vancouver, which, it will be remembered, comprises a bascule span. This span is operated electrically, and in what follows we propose to give a description of the controlling equipment, which was manufactured by Electric Control, Ltd., of 177, Reid-street, Glasgow. The control gear for an electrically operated bridge of this type is always interesting on account of the necessity for interlocking the various operations so as to secure absolutely safe and reliable working. The present example is no exception to the general rule.

The supply is 440-volt, three-phase, 60-cycle alternating current, and the two main motors are of the slip-ring induction type, while the lock motor is of the squirrel-cage pattern. The mechanical drive of the bridge leaf is so arranged that the leaf can be operated by one motor or both. The two main motors are in gear for normal operation, but, if necessary, one can be dropped out and the bridge operated—at reduced speed—by means of one motor only. Contactor type controllers are used, and for the sake of simplicity the bridge engineers decided upon plain step-by-step master controller operation for the main motors and "switch-direct" operation for the lock motor.

Figs. 1 and 2 illustrate one of the main motor controller boards. It will be noticed that accelerating relays and timing elements are not employed. The board carries, (*a*) two double-pole contactors fitted with a mechanical interlock for reversing the stator; (*b*) four double-pole accelerating contactors for cutting out the rotor starting resistance; (*c*) a contactor for two main motor brake circuits; (*d*) a double-pole overload release fitted with a time lag; and (*e*) a system of hand-operated main and control circuit isolating switches. A separate view of one of the contactors is given in Fig. 3.

The board for the lock motor carries two double-pole mechanically interlocked contactors for switching the motor directly across the line in either direction, a double-pole overload release, an emergency brake contactor, an interlocking relay, and main and control circuit isolators.

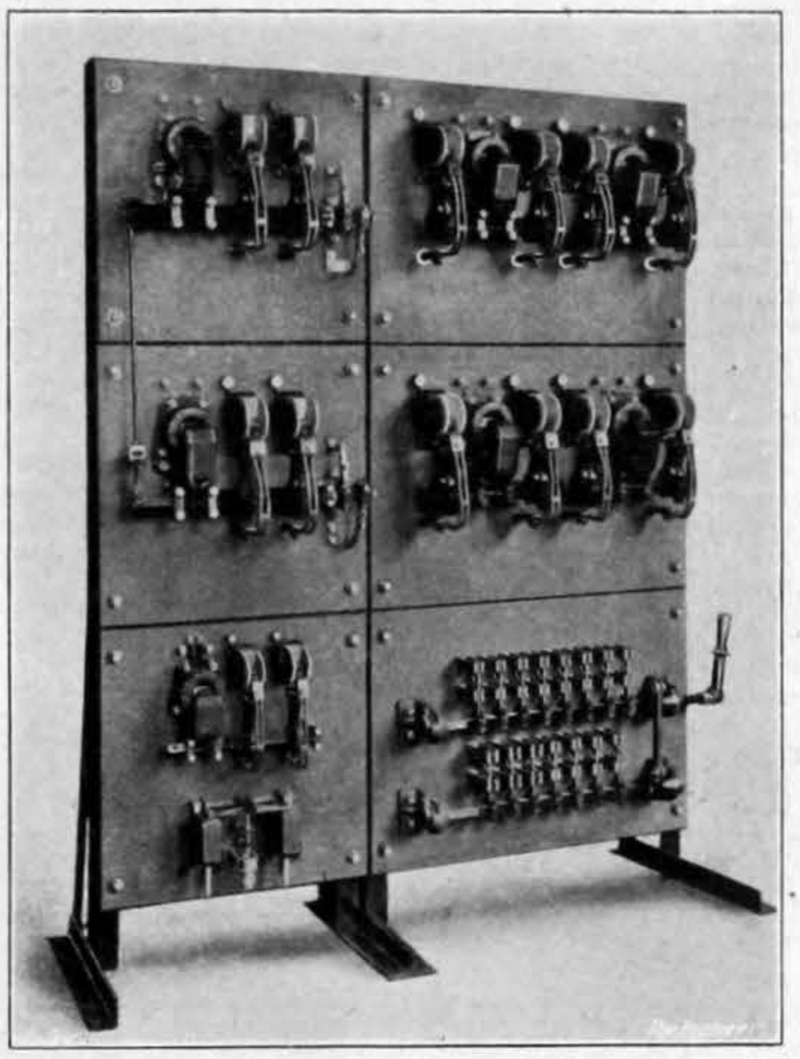
The equipment also includes a main contactor-type circuit breaker panel with distribution switchgear, comprising main switches and fuses for each of the motors and for the control circuit supply, an ammeter and a voltmeter for the main supply, and also a panel to control the lighting circuits about the bridge and those for the signal lamp indicator. This indicator operates in conjunction with the movement of the lifting span to indicate its operation and position during the opening and closing periods. The auxiliary switchgear and accessories include the bridge and lock master controllers, the various limit switches operated from the movement of the bridge, and the slow-speed emergency brake.

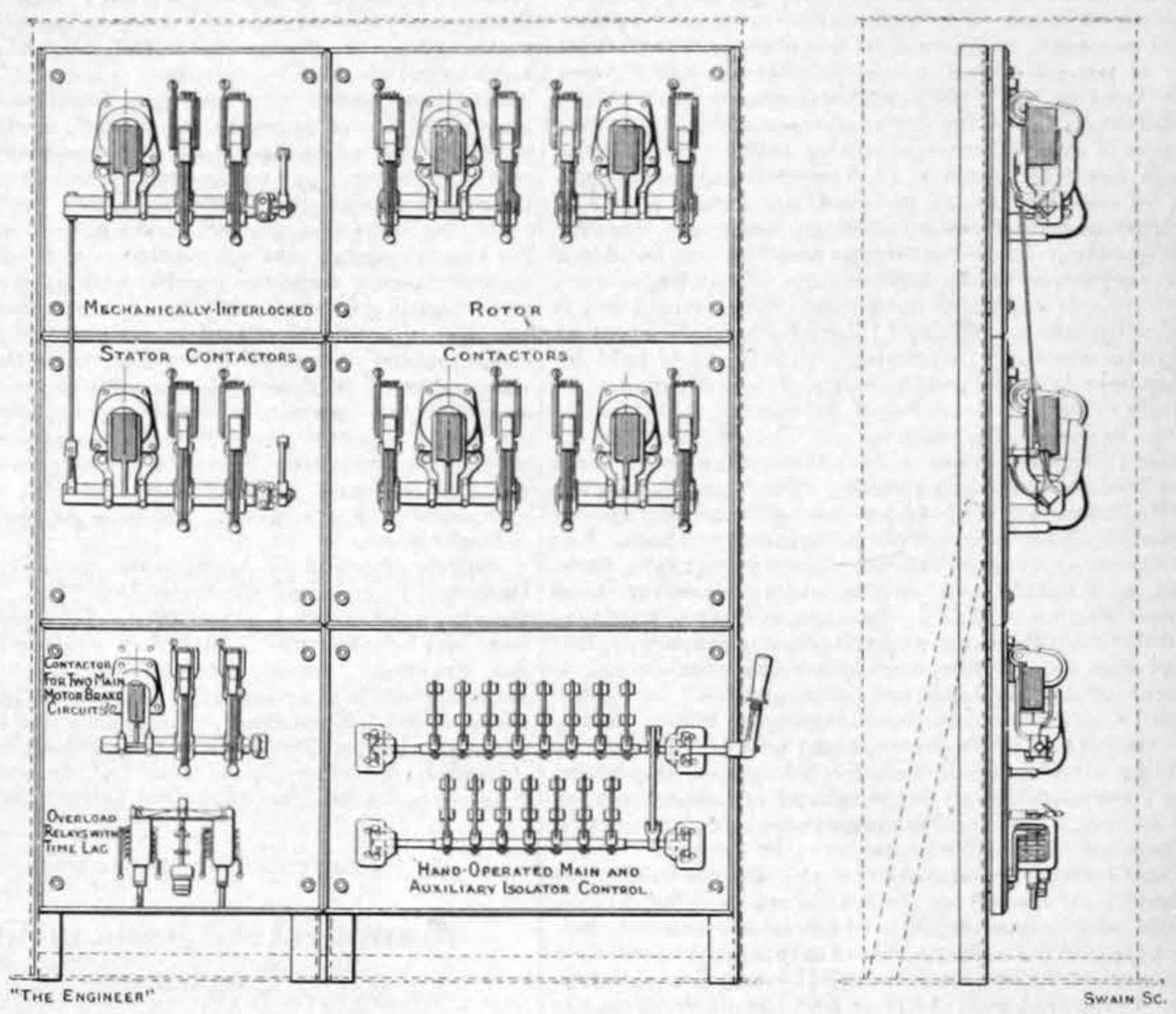
The complete cycle of operations is as follows:—Closing the emergency brake knife switch operates the contactor, which releases the brakes until the knife switch is opened again. This contactor is provided with an auxiliary switch that closes an interlocking relay and sets the whole of the control equipment ready for the first stage in the operations. To unlock the bridge the lock master controller is operated. It closes a contactor and starts the motor by switching it straight across the lines. The lock motor continues to run until stopped by a limit switch operated by the lock bolt, when it is fully withdrawn. As the lock motor is brought to rest another limit switch closes and sets the main motor controller ready for operation. The bridge can then be opened by operating the main master controller, the first position of which starts the motor, with all rotor resistance in circuit. Subsequent operation of this master controller closes the various contactors which cut out the resistance step by step until the motor is brought up to full speed.

When the lifting span is 7 deg. from the fully open position a limit switch opens the contactor circuits and causes the motor to slow down and stop. It is then re-started by operating the slow-speed switch and ultimately stopped by a limit switch in the fully open position. Closing the bridge is performed in the reverse manner, descending slowly at first with the main master controller on the first position "closing," and running up to full speed as the master controller is moved over the successive steps. When the span is 7 deg. from the fully closed position a bridge limit switch brings the motor to rest, after which the operation of closing through the final 7 deg. is accomplished at slow speed by means of the slow-speed closing switch. During the closing operation the lock motor is started automatically through the medium of a limit switch and the lock bolt advanced a pre-arranged distance. When the bridge has reached the fully closed position a plunger switch is operated, which allows the lock to be fully closed by operating the lock master controller, the motor being finally stopped by a limit switch when the bolt is right home.

In cases of emergency hand-operated switches can be used to operate the bridge or lock independently of the interlocks, limit switches or master controllers. There is also a coasting switch which comes into service in opening or closing the bridge and operates to lift the main brakes of the bridge motors.

The overload relays are arranged so as to shut down either main bridge operating motor independently of the other with the object of permitting the bridge to complete the opening or closing operation with one motor should the other motor be tripped owing to overload from any cause. The overload relays are of the hand re-setting type, which require the attendance of the operator when tripped, thus drawing his attention to the existence of overload conditions. Hand-operated, multiple-blade, isolating switches are provided on all the control panels with the object of isolating any motor completely from both main and control circuits by withdrawing the appropriate isolator.





FIGS. 1 AND 2—MAIN MOTOR CONTROLLER BOARD FOR LIFTING SPAN OF LITTLE NARROWS BRIDGE

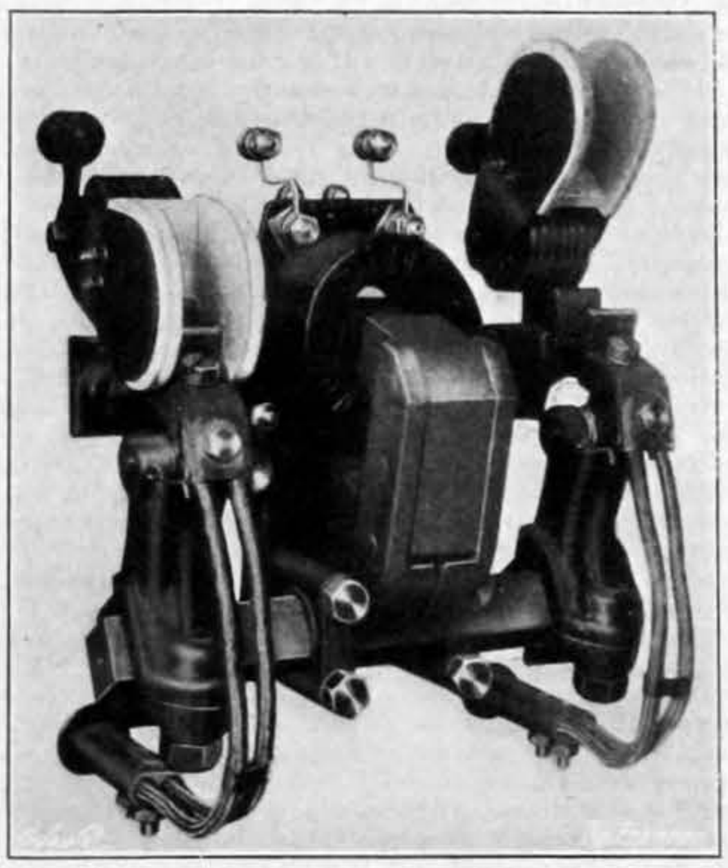


FIG. 3—DOUBLE-POLE CONTACTOR

An oxygen factory has been erected at Fremantle, Western Australia.

South African Engineering Notes.

Industrial Expansion.

According to the last census, that for the twelve months ended June 30th, 1924, the number of factories in the Union was 7112, as compared with 7029 the previous year. Twenty-one new engineering firms were started, forty-one new ventures in vehicle-making were made, and fifty-two building establishments were founded, while a small number of factories were closed. Motor car construction largely accounts for the increase in the vehicle trade. Factories producing articles of food and drink totalled 1868; engineering, 877; vehicles, 858; clothing, 802; and building and contracting numbered 763. There were in the Union 290 printing works, 78 jam factories, 58 tobacco manufacturers, 28 soap and candle works, 26 sugar mills and refineries, 23 tanneries, and 11 wool washeries. The value of the engineering output was £14,449,000, and of building and contracting £8,462,000. The highest "value of output" figures were in the case of food and drink, which accounted for £26,085,000. The amount of fixed capital invested in the Union's productive industries was £51,398,000, of which amount the value of land and buildings accounted for £20,966,000 and machinery plant and tools for £30,432,000. These figures represent an advance of £1,137,000 on the previous year and an increase of 86·5 per cent. since the year 1915.

A Quick Piece of Work.

A firm of Durban engineers, James Brown, Ltd., recently fitted a new mast 40ft. long and weighing 5 tons in the ss. Middlemoor. The vessel arrived at Durban with her mainmast gone, and the firm having been previously informed, had everything ready, and the new mast stepped a few hours after the vessel's arrival.

New Harbour at Walvis Bay.

A new basin and wharf at Walvis Bay, together with the channel leading thereto, was to be opened to shipping on or about October 1st. The new harbour is on that part of the coast of South-West Africa which formerly belonged to Germany, and for which the Union of South Africa is now the mandatory Power. The approach channel is 440ft. wide and at L.W.O.S.T. will be 30ft. deep over the full width. The wharf channel is 2150ft. long, 700ft. wide, and 33ft. deep at L.W.O.S.T. for a distance of 100ft. from the wharf side. The new wharf, which is constructed on concrete piles and beams, is 1500ft. long, providing three berths of 500ft. each. Five 4-ton and one 7-ton electric cranes are to be installed to serve these berths. Two sheds are to be erected on the new wharf. One shed, to be utilised for cargo landed, will be 550ft. by 80ft., and the other, 600ft. by 40ft., will house general cargo for shipment. In addition, five concrete platforms for the purpose of storing and sorting copper ore awaiting shipment are to be provided in the immediate vicinity of the wharf. In view of the very considerable development of the mining resources of South-West Africa which is now taking place and is only at the beginning—an American company with large capital has secured an option for two years over some highly mineralised and extensive areas—Walvis Bay is likely to require further expansion before long. There is even a prospect that it may become the coast terminus for a railway running across Bechuanaland and into Rhodesia.

South African Railways Electrification.

Electric traction over the whole of the Natal main line between Glencoe Junction and Pietermaritzburg is now in regular operation. The tonnage of goods and passenger traffic hauled south of Ladysmith during July totalled 686,821, a daily average—omitting Sundays—of 25,438 tons. The highest tonnage moved on any one day during the month was 27,104. The erection of steel

structures for the overhead work on the Howick branch line was completed during July. At the end of that month 17,000ft. of catenary wire had been placed in position. It was expected to introduce electric workng on or about September 15th. Preliminary work is proceeding on the Capetown suburban area. Of the twenty-six subways to be provided on the Capetown-Simon's Town section, twelve have been completed and opened to the public. Material for electrically equipping the motor coaches to be put into service with the introduction of electric working is arriving in quantities from overseas.

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

The Coal War in the Midlands.

The action of the Staffordshire police authorities in preventing Mr. A. J. Cook, the Miners' Federation secretary, from addressing meetings of miners in this area has focussed attention on the Midlands as the centre of the latest skirmish in the coal war. Though there are many industrialists hereabouts who question the advisability of making a display of force, and preventing the exercise of the normal rights of free speech, they are all more or less agreed that an organisation which describes itself as a "Council of War" must expect to be met by stringent methods. It is questionable even if Mr. Cook had been permitted to speak, whether his words would have had the desired effect. He has visited Cannock Chase before, and he has spoken in the Warwickshire coalfields, yet the return to the pits continues, until at date on the Chase nearly 18,000 men out of a normal total of 25,000 are at work. Moreover, it is felt that the Cannock Chase coalowners, by deciding to give an advance in wages of 10 per cent. on the basis rates, making the present percentage 62½ instead of 52½, made an effective counter. Under the new arrangement the miners know exactly where they stand, as the new percentage is guaranteed up to March 31st next. After that date the percentage is to be not less than 52½ until June 30th. The existing conditions as to subsistence wages, allowance coal and hours will remain. The North Staffordshire Colliery Owners' Association has also posted notices of an increased percentage on the basis rate of wages for men who have resumed work on the eight-hours shift. The Warwickshire owners have increased the percentage addition to basis rates by 10 per cent., while the Leicestershire coalowners have granted a 10 per cent. bonus to all workmen as from October 20th to November 30th, on which date they will again consider the position. It is felt that Midland miners are faring rather well, and that mere persuasion will not induce them to give up the substance for the shadow. From a trade point of view, it is sincerely to be hoped that such will be the case, and that the improved terms will act as an inducement to the remaining men to sign on at the pits.

Raw Iron Production.

The call for pig iron to-day is so great that quite a lot of attention is given to the statement that a Derbyshire concern which possesses collieries and coking plant, contemplates restarting a blast-furnace for the production of foundry iron. With only five furnaces in blast the kingdom over, the relief which an additional furnace would give could not be dismissed as negligible, particularly as at the moment consumers in this district are compelled to buy from northern furnaces and have to contend with considerable transport costs on top of the appreciated value of the iron. Cleveland No. 1 costs over £7 per ton delivered in Birmingham, and No. 3 £6 15s., and there is no definite assurance as to when the iron will be delivered. Durham No. 1 now costs £6 6s. 3d. and No. 3 £3 1s. 3d. delivered in about six to eight weeks. There are practically no offers now of Scotch iron. East Coast hematite was quoted on 'Change in Birmingham to-day £5 11s. 3d. At these prices Midland consumers consider transactions too speculative. They turn to continental sellers. Here, again, they are met by increased costs and scarcity of material. Superior grades are increasingly difficult to procure, while common types are quoted up to £5 2s. 6d. delivered. There is a good opening for any furnace which can be put into operation, but the fuel difficulty is such that no general resumption of activities at the furnaces can be anticipated. In the districts where iron and steel masters look for their main supplies of coke, most of the miners are still out. Blast-furnace owners will not risk restarting plant which may be brought to a standstill before it gets fairly going. Until steady deliveries of fuel can be relied upon the great majority of the furnaces must continue inactive.

Steel.

The steel position is unchanged. There is little native material available, and continental supplies are now difficult to obtain. Operations at some of the Staffordshire re-rolling mills have been interrupted by delay in deliveries of continental semis. Foreign prices have advanced further, angles and small bars being quoted £7 to £7 2s. 6d.; joists, £6 17s. 6d.; and constructional plates, £7 12s. 6d. to £7 17s. 6d. It is impossible now to get orders accepted by foreign steel works for delivery before December, and commonly eight weeks are required. Consumers are naturally anxious to be free of foreign contracts when steel from British mills is again available, but certain urgent requirements must be met, and a number of contracts have been arranged this week.

Finished Iron.

The amount of business passing in the finished iron department is negligible. Special prices rule for the small tonnage of bars which changes hands. None comes on to the open market. Nut and bolt makers perforce continue to draw their supplies of common bars from the Continent.

Galvanised Sheets.

Galvanised sheet prices continue to appreciate. Demand is well ahead of supply, and production costs are higher; hence the appreciation. Most of next month's output is sold, and some mills are unable to undertake more than small commitments before the New Year. Makers find it impossible to take full advantage of the business offering as deliveries of bars from the Continent cannot now be depended upon. The supplies of native bars available are negligible. On 'Change to-day most of the district makers of galvanised corrugated sheets asked £17 5s. to £17 10s. for 24 gauge, and named somewhat distant dates for delivery.

Engineers' Increasing Costs.

Engineering firms, the operations of which depend on castings, still buy the pig iron available, although to its very high cost has to be added the enormous prices of foreign coke. Some German fuel now being delivered into the Midlands costs £3 15s. per ton, but the price is rising rapidly and a recent quotation was £3 14s. at the port or something like £4 5s. delivered Birmingham. Engineers say the costs make profitable production impossible; indeed, that they are carrying on at a loss. But as the alternative is complete stoppage, the expenditure is incurred.

Railway Orders for Midlands.

Some substantial orders have lately been received by Midland railway rolling stock establishments, the latest additions being an order for 120 bogie covered goods wagons for the Sudan Government Railways to the Metropolitan Carriage and Finance Company, Ltd., Saltley, Birmingham. Contracts for twelve high-sided bogie wagons and nine bogie platform wagons for the North-Western (India) State Railways to Stableford and Co., Ltd., Coalville, Leicestershire; and the Gloucester Railway Carriage and Wagon Company, Ltd., respectively. An order for seven first-class bogie dining cars for the Central Argentine Railway to the Midland Railway Carriage and Wagon Company, Ltd., Birmingham.

Cheslyn Hay Pit to be Reopened.

The Nook Pit at Cheslyn Hay, in the Cannock Chase coalfield, which was closed down nearly two years ago because of financial difficulties, is, I learn, to be reopened in the near future by a new company, the Wyrley and Nook Collieries, Ltd. Up-to-date plant is to be installed to deal with an output of 1000 tons of coal per day. The pit-head gear will include a modern steel pit frame. The ironstone mines, which are very valuable, are also, it is stated, to be worked.

Mechanical Pit Bank Arrangements.

During the last six months the surface works of the Cannock and Rugeley Colliery have undergone large changes. The tubs are now all operated by mechanical haulage. Even at the pit top an automatic system for pushing off the tubs from the cage has been installed. When conditions underground again become normal, it is estimated that the output at this colliery will be considerably increased.

Power Electricity to Cost More.

Wolverhampton Electricity Committee has decided that to meet the increased costs of production owing to the cost of coal, a 10 per cent. increase is to be charged to all works for the supply of electrical energy.

Rolling Stock Work Held Up.

Many of the Midland rolling stock establishments, though they have plenty of orders, are curtailing production and suspending labour. Operations have almost ceased in the iron and steel working departments, and this means that the wood-working branches have to slow down, too. It is stated that some of the principal carriage and wagon builders in this area are employing only about 25 per cent. of their full complement of labour. The trouble, of course, is the scarcity of iron and steel. Native billets and bars, angles, channels and the other metals used for the underframes and various components cannot be obtained. Continental material, even if it were available, would not meet the case, since British material is specified in many contracts. Even where it would be permissible to use it, however, it has become increasingly difficult to procure imported iron and steel within a period making it worth while having.

Staffordshire Ironworks to be Demolished.

Established at least a century ago, the Bromley Ironworks, Brierley Hill, which up to three years ago had been operated by Messrs. Roberts and Cooper for nearly forty years, has been acquired by Messrs. John Cashmore, of Great Bridge, for demolition purposes. The works formerly found employment for 200 men, and are within a few hundred yards of the site of the Leys Ironworks, which were demolished about two years ago. The goodwill of the Bromley Ironworks, as well as the rolls and brands, has been secured by Messrs. John Bradley and Co., of Stourbridge, who a year or so back also purchased from Messrs. Roberts and Cooper the Brettell-lane Ironworks, which are being continued as a working unit.

Unemployment.

For some little time there has been a steady decrease in the number of unemployed in the Midlands, and the latest returns show that this favourable state of affairs continues in spite of the devastating effects of the coal war. Over the past week there has been a further decrease of 5766, bringing the unemployed down to 200,599. Of the total, 39,559 are in Birmingham. Coventry has 5552 persons out of work; Bilston, 4057; Cradley Heath, 5259; Dudley, 3579; Stourbridge and Brierley Hill, 4758; West Bromwich, 4264; and Wolverhampton, 6214.

LANCASHIRE.

(From our own Correspondents.)

MANCHESTER.

Power for Textile Mills.

The question of power supplies for textile mills was a prominent feature of the proceedings at the annual conference of the Textile Institute, held at Buxton last week end. Mr. J. A. Robertson, in the course of a paper on "The Centralisation of Electricity Production," said that electricity was already in fairly general industrial use, but there were other industries in which steam had to be raised in any case for process work in which the progress of adopting electricity was relatively slow. This was especially the case in the textile industries. The only limits to the use of electricity, the speaker claimed, had been fixed by commercial considerations. Under the conditions of the proposals contained in the Weir report, electric power, he said, would be so cheap as to remove these commercial drawbacks. The experts had not been over-optimistic in their expectations as to reduced costs and increased consumption. The generating costs were estimated under the scheme at ·31d. per unit. This figure, although much lower than the average cost to-day, was very little below the cost in several modern stations in this country, and having regard to the lower capital charges as the result of Government guarantees, Mr. Robertson thought ·31d. a realisable figure. Mr. W. Howarth, who presided at the conference, said the main reason why progress had not been made with the introduction of electricity in the cotton mills of Lancashire was one of cost. The Lancashire cotton trade, he said, worked on very narrow margins of profits and losses, and it had to be very careful in making any change over from steam to electricity. What appeared to be quite certain in the Electricity Bill was that all the outlying townships and villages and farmhouses would be subsidised at the expense of the country's leading industries. Until they had proper safeguarding clauses inserted in the Bill industries would fight against it and would limit its operations in every possible way.

Foundrymen's Pilgrimage.

Foundrymen of this area were represented at the recent tour of inspection of United States foundries, attended by over a hundred delegates from European countries and organised by the International Committee of Foundrymen, by Mr. E. Longden, foundry superintendent of J. H. Hetherington and Son, Ltd., textile machinery manufacturers, of Manchester, and Mr. W. Jolley, foundry superintendent at the Trafford Park Works of the Metropolitan-Vickers Electrical Manufacturing Company, Ltd. The British delegation has now returned to this country after visiting foundries at New York, Buffalo, Philadelphia, Cleveland, Pittsburg, Detroit, Chicago, and Washington. Its views on American foundry practice, which presumably will form the substance of an official report, will be awaited with a good deal of interest.

Non-ferrous Metals.

During the past week all sections of the non-ferrous metal market have had a weak spell, which, at the time of writing, shows no sign of abating. As might be expected, tin has been the biggest sufferer, current quotations for this metal showing a very substantial reduction compared with those ruling a week ago. Explanations of the fall have been numerous enough, but there is no doubt that the quiet trade demand, especially in the United States recently, coupled with a certain amount of unloading, has been the chief cause. What the future has in store from the point of view of prices is a highly speculative question. It is worth noting, however, that the "bulls" are relying upon a possible favourable development in the statistical position and an improvement in the trade demand when the coal trouble is settled, as the bases of a renewed upward movement. Copper was not affected to any important extent, although standard metal is about £1 a ton lower than it was a week ago. The credit for this relative stability of prices is being given to the United States Copper Export Association, which commenced working a fortnight ago. In the meantime, the demand for copper remains rather quiet. The demand for spelter during the week has been of moderate dimensions, but it has not been of sufficient weight to prevent a fall in values. Buying of lead is on a cautious scale, and, in common with all the other metals, current values represent a fairly sharp decline compared with the beginning of the week.

Iron.

In the iron market here the ruling factor continues to be the marked scarcity of supplies, and except for the usual price advances, there is again little to report. Ironmakers near the seaboards are, of course, better able to stand the cost of importing fuel, although in a good many instances their experience of it has not been a happy one. For makers of common irons situated in the Midlands the use of foreign fuels is not an economic proposition, even at the high prices that offers are now commanding, and I am told that the prospects of renewed supplies this year are becoming more and more shadowy. Some Middlesbrough foundry iron at 137s. 6d. per ton, delivered, and some Scotch at 127s. 6d. to 132s. 6d., also delivered in the Manchester area, are about all that is obtainable of British makes, apart from odd lots that continue to crop up of no particular brand. Offers of continental iron, at about 112s. 6d. per ton, delivered Manchester, are occasionally being made, and American exporters are also said to be feeling their way. Bar iron remains scarce and nominal, so far as prompt supplies are concerned, with no marked disposition on the part of either buyers or sellers to worry about forward commitments. A limited quantity of Midland bar iron at about £14 per ton is reported.

Steel.

The principal features of an otherwise dull steel market have been the continued firmness of continental materials, and the official increase for 5s. per ton in the official prices for British tank plates and joists and sections,

making the minimum quotations for these goods £8 7s. 6d. and £7 12s. 6d. per ton respectively. As a matter of fact, however, makers are inclined to regard this step merely as a formal move, and it would be a difficult matter indeed to find any rolling mill prepared to accept these figures in connection with forward business, or, at the moment, any other figure, for there is very obviously a growing uneasiness in respect of the price of fuel when supplies are available in quantities sufficient to permit a resumption of operations. A fair quantity of continental steel has arrived during the week at Manchester, and the Ship Canal ports, although all of it is in connection with contracts placed several months ago. Delivery dates are too uncertain to permit of free buying at the present time, although a quiet demand is still being met with at higher quotations than those last given. For delivery to buyers' works in the Manchester area, for net cash against shipping documents, sheet bars are about £6 12s. 6d. per ton, billets at £6 5s., wire rods at £7 5s., light plates at £7 10s., Siemens plates at £7 15s., and joists and sections at £6 17s. 6d. There is not much business passing at the moment in galvanised sheets so far as the Indian markets are concerned, and most of the works are still not quoting; what few offers have been made this week have been at about £17 per ton f.o.b. for the usual Bombay or Calcutta specifications.

Scrap.

There is still only a quiet demand for non-ferrous metal scrap, and with the exception of lead, values show little alteration. Scrap lead is easier at £30 10s. per ton, zinc at £25 10s., brass rod turnings at £40, cast aluminium at £75, selected gun-metal scrap at £53, clean light copper at £57, braziery copper at £53, and heavy copper at £62 per ton, for graded qualities, delivered to users' works.

BARROW-IN-FURNESS.

Hematite Rising.

There is a distinct upward tendency in prices for hematite pig iron, and this may be taken as a sure sign that makers are now well fixed for contracts. As a matter of fact, there are some iron producers who hold orders for pig iron which will take them well over six months to discharge. Inquiries are still being received, but most customers are now fixed with orders, and any further contracts placed will be for delivery well forward. The iron ore trade is almost at a standstill, but as soon as the furnaces are in blast again, there will be a period of activity for them. In the steel market there is not the same amount of life, and prices do not show the same tendency to rise as do those of pig iron. The hoop works still keep going on orders which are well held, and the prospects for the future are brightened by the fact that the cotton crop in America is heavy. Coal, coke and briquettes were imported into Barrow last week, and the total tonnage was rather heavy.

SHEFFIELD.

(From our own Correspondent.)

The Heavy Steel Trade.

THERE is little that is new to say about the condition of the heavy steel trades of Sheffield and district. Owing to the coal strike, the melting of open-hearth steel is practically at a standstill, and six months have now elapsed since any considerable quantity of that material was made. A few firms have restarted furnaces in order to provide steel required for urgent orders, but the price of foreign and outcrop coal is too high to enable the large plants generally to be run on anything like economic lines, and so they are still standing. Advantage is being taken of the stoppage, as far as possible, to carry out machnery overhauls, install fresh equipment and various fuel and other economy schemes. The one cheering note that can be struck in the heavy trades relates to the future. Although there now seems no possibility of a resumption on a normal scale this year the ultimate outlook is good. The *Journal* of the Sheffield Chamber of Commerce states that "there seems to be no lack of orders and great activity is anticipated when the miners return to work." The chairman of the United Steel Companies Ltd., at the annual meeting on Monday, said: "During these months of inactivity orders have continued to come in, and when it is again possible to reopen our works with adequate supplies of fuel at reasonable prices, we shall commence operations with a much larger tonnage of work than has been in hand for a long time."

Workmen Reinstated.

It is pleasing to be able to report that Hadfields, Ltd., who suspended some 600 men a month ago, has now reinstated them. At the rolling mills a good deal of light steel is being turned out, but some of them are declining to take work in the heavier classes. In a number of cases orders are being held up on account of the exhaustion of special steel, further supplies of which cannot be made without best British fuel. Some anxiety has been felt in the motor car trade with regard to steel, and the possibility of a stoppage or curtailment of car building, owing to the want of Sheffield supplies, has been mentioned. So far, however, it is not reported that the car builders have felt any inconvenience for want of these supplies. It is true that none of the raw material of which Sheffield self-hardening steel is made has been produced since the coal stoppage, but there were very large stocks of that material in the city in May, which are not yet exhausted, though they are reduced to a very low level, and will not last much longer. With regard to the light and medium industries generally, I may again quote the Chamber of Commerce *Journal*, which states that these branches "have managed to turn out a really wonderful output through the fifth month of the mining stoppage; no really urgent order has been neglected."

A Large Railway Order.

A capital order for railway stock has been booked by Cammell Laird and Co., Ltd., who are to supply 800 25-ton all-steel bogie low-sided wagons to the Central Argentine Railway. Messrs. Cammell's associated firm, the Midland Railway Carriage and Wagon Company, Ltd., Birmingham, has received an order from the same railway for seven first-class bogie dining cars.

A New Coal-selling Organisation.

The amalgamation of colliery interests to a greater or lesser extent is one of the measures most often suggested for the improvement of the coal industry. Yorkshire is able to show more than one example of this class of organisation, the best known being the Doncaster Collieries Association. It is now announced that another is to be formed, to be known as the Rotherham and District Collieries Association, Ltd. The news was made public by the chairman of United Steels at the annual meeting of the company, who described the new body as a joint organisation for the sale of the coal which it produces. The United Steel Companies own the Rother Vale collieries, and their partners in the association will be John Brown and Co., Ltd., and the Dalton Main Collieries, Ltd., who own several large pits in the Rotherham district. The annual output of coal of all the parties will be rather more than 4,000,000 tons. It will be remembered that a hint of this development was given a few months ago by Lord Aberconway, chairman of John Brown and Co., Ltd.

September Steel Production.

The extent to which conditions are still far behind the normal, in the matter of the country's iron and steel production, is shown by the returns for September. The output of pig iron has been falling continuously during the strike, and last month it dropped to 12,500 tons, only five blast-furnaces being at work in the whole of the United Kingdom. On the other hand, there has been some slight increase in steel output, owing to the restarting of a few blast-furnaces in various centres. The production in September was 95,700 tons, or 42,000 tons more than in August, and 60,000 tons more than in July. When it is mentioned, however, that the average monthly production last year was 616,400 tons, the insignificance of the present figures is at once appreciated.

Cutlery and Plate.

A rush of special seasonal trade in the cutlery and plate branches is customary at this period of the year, and such a condition has been noticed during the past few weeks, but it would appear to have spent itself now. At any rate, a marked falling off in orders is reported, and the trades are hardly as active as they were a week or two ago. It is hoped that orders will still come in on a considerable scale, otherwise the present season will prove to be one of the shortest on record. There are not many colonial orders on hand at present, most of those that were received having been executed and dispatched. The home trade for the season may last a little longer if, as is anticipated, shopkeepers in this country give orders for oddments to complete their stocks. On the whole, prices are unsatisfactory. The demand is mainly for cheap lines. At the same time, a fair amount of trade is being done in high-class silver and plated ware; in fact, having regard to the disturbed state of the country, the sales keep up surprisingly well. Some firms are specialising in stainless cutlery of good quality, which can be sold at a cheap rate. Lately, it is reported, a well-known bazaar firm ordered 25,000 dozen stainless knives at a price which enables them to be retailed at 6d. each.

Stainless Cutlery from Abroad.

An exhibition of stainless knives manufactured on the Continent, which has just been held in Sheffield, proved interesting, but not alarming, to local makers. Samples were on view from Germany, France, Sweden, Belgium, and Italy. Compared with the best Sheffield quality, the foreign exhibits were considered, on the whole, poor, while the prices were high. In some cases the blades were badly ground, and the hardening and finish far from good. These remarks do not, however, apply to the Swedish samples, which were excellent in quality but very expensive. It was evident that the application of stainless steel to cutlery purposes is not yet thoroughly understood on the Continent, and that, whatever progress may be made in the future, Sheffield knives are at present pre-eminent.

Leeds Items.

Owing to the increased cost of coal, the electricity department of Leeds Corporation decided in August to increase the price of current by ¼d. per unit for all purposes. The increase came into operation at the beginning of October. It was hoped that it would not be necessary to impose it beyond the end of the present year, but, in view of the continuance of the coal difficulty, the Committee now recommends that it shall be maintained until the end of June next. The General Purposes Committee of the Leeds City Council has decided to proceed with the construction of the ring road from Elland-road to Dewbury-road, at a cost of £51,900. Schemes for the widening of existing roads are also to be carried out. The total cost will be £54,544, and the enterprises will find three days' work per week for 422 men who are at present receiving outdoor relief from the Guardians.

A Hull Bridge Disappointment.

Much disappointment has been caused in Hull by the receipt of a letter from the Director-General of the Roads Department with regard to the proposed new North Bridge. The estimated cost of the bridge is £275,000, and it was hoped that a grant of £63,000 towards this would be received from the Ministry of Transport. The Director-General states, however, that he has no funds available from which a grant could be made, and he does not anticipate that the financial position will alter during the current financial year.

NORTH OF ENGLAND.

(From our own Correspondent.)

Tyne Trade Prospects.

WITH empty berths in nearly every shipyard on the Tyne, it is not surprising that the prospects of a series of contracts which may run to the huge sum of £8,000,000 should arouse intense interest in the district. The news that the Palmer Shipbuilding and Iron Company has secured the contract for the hull and machinery of the new British crusier has been welcomed at Jarrow, which has suffered by the severe and continued depression. There are at present over 5000 unemployed in the town, and many of them will be absorbed in the work represented by the cruiser, which will probably take about three years to complete. The work, however, cannot be commenced until the miners' dispute is settled and supplies of material are available. Messrs. Palmers have their own iron and steel works, of course, and the new cruiser contract which they have obtained will, therefore, mainly benefit Tyneside. Then there is the prospect that about £5,000,000 will be spent in work on Tyneside if the proposed scheme for Empire fast vessels is carried into effect. A third possibility is that the big floating dock for Singapore may, after all, be built on the Tyne, giving another £1,000,000 to be spent on work for the shipyards. Swan, Hunter, and Wigham-Richardson announced on Tuesday that they had received an order for an Ellerman Liner to be built at Wallsend. The vessel will be a high-class cargo boat with single-reduction turbine engines by the Wallsend Slipway and Engineering Company. She will be 455ft. in length, and of about 10,000 tons.

Engineering Works Change Hands.

Negotiations were completed this week as a result of which a new company in Newcastle, with Mr. R. S. Dalgliesh, the well-known Tyneside shipowner, as chairman, has taken over the marine engineering works of Blair and Co., Ltd., Stockton-on-Tees. In the present state of trade there is, of course, not much hope of the works being restarted immediately, but every effort will naturally be made to secure business, not only in marine engineering but in other markets, for supplying which the establishment is suitably equipped. The firm of Blair and Co., Ltd., was originally founded somewhere about 1850, and the works cover an area of 23 acres. In 1920 the controlling interest in the concern was obtained by Mr. J. C. Gould, and the firm became one of an association of shipping and shipbuilding interests, known as the Gould Steamships and Industrials, Ltd. Unfortunately, the change synchronised with the commencement of the serious and extended trade depression of the last five years, and, unable to weather the storm, the affairs of the company were put into the hands of a liquidator during May of the present year.

Cleveland Iron Trade.

The Cleveland pig iron trade presents few new features of moment. The prolongation of the coal stoppage continues to confine transactions to quite trifling parcels, but the belief that material enlargement of fuel output is at hand is responsible for traders showing less inclination to negotiate forward supplies. The opinion prevails, however, that substantial orders would speedily follow movement in the direction of restarting idle plant, but until ample coal and coke supplies are forthcoming and opportunity is afforded of gauging future values, producers cannot be expected to reopen works. Considerable quantities of continental pig iron are now being unloaded in this district. The cargoes arriving have been purchased at fully 30s. per ton below rates ruling for Cleveland pig iron, but foreign iron is becoming less plentiful, and further purchases cannot be made at such comparatively low prices. Consumers needing early delivery of Cleveland pig iron must now pay 120s. per ton for No. 3 quality, and on this basis sales are reported up to the end of December, which seems to indicate that no early drop in prices is expected even if the coal stoppage ends. No. 1 foundry and silicious iron is 125s. per ton; No 4 foundry, 119s.; and No. 4 forge, 118s. 6d. per ton.

Hematite Pig Iron.

Ordinary grades of East Coast hematite pig iron are unobtainable, and there is very little inquiry for this class of iron. Off grades are still, however, being sold in small parcels on the basis of mixed numbers at 88s. 6d. per ton.

Ironmaking Materials.

Business is at a standstill in the foreign ore trade. Best Rubio ore is still nominal at 21s. 6d. per ton c.i.f. Tees. Good British blast-furnace coke is almost unobtainable, but for odd truck lots 50s. per ton and upwards is being paid.

Manufactured Iron and Steel.

The outlook in the manufactured iron and steel trade is regarded as very hopeful in view of the improving prospects in the shipbuilding trade. The North-East Coast shipbuilding yards obtain the bulk of their requirements so far as steel plates, sections, &c., are concerned in the immediate district, and activity at the shipyards is quickly reflected in the order books of iron and steel manufacturers. There are now no fixed prices for manufactured iron and steel. The old minimum prices still stand, but upon them substantial premiums, which vary in different districts, are being paid.

The Coal Trade.

The drift back to the pits in Northumberland and Durham continues on a large scale. There are now over forty collieries working in the two counties, and it is expected that that number will be considerably augmented by the end of the week. At all centres, however, the export trade is still lifeless, as merchants see no prospects of any supplies being available before the middle of November.

No coal export prices are available, as all current production is severely controlled. Pit-head prices are quoted at easier figures, but at every centre variation is substantial, and values vary from 35s. to 45s. per ton, according to local circumstances. There is no special development in the imported coal market. Home requirements are limited to prompt deliveries, as consumers expect a considerable increase in home production during the next week or two, which would have an easing effect on foreign coal values; but, as the position is so indefinite, the larger works, including utility and railways, are not taking any risks, and are keen to secure supplies for definite delivery during the next four or five weeks. Importers can consequently readily clear any definite supplies for next month and can command high prices. Good ordinary American gas coals are quoted at a minimum of 55s. c.i.f. Tyne Dock, while steams, according to grade, range from 52s. 6d. to 60s. per ton c.i.f.

SCOTLAND.

(From our own Correspondent.)

Miners Returning to Work.

DESPITE intensive picketing, the miners are slowly but steadily returning to work in several districts, especially in Lanarkshire, and it is confidently anticipated that the rate of return will be considerably accelerated within a very short period. In some districts the pickets gained a measure of success, but this has been practically wiped out in the areas affected, the men in most cases returning after one day's absence. The numbers returning to work in all districts cannot in any one case be termed substantial, but that the movement is steady is a matter for congratulation. For a considerable period, Lanarkshire was the only district to give any real evidence of the desire to return to work; but now reports from Ayrshire and the Lothians are more encouraging, while Fifeshire is also included. It has been stated that but for the working of outcrop seams, the numbers at work in the mines would have already been greatly augmented. Upwards of 20,000 men are now working in the mines.

Steady Demand for Coal.

While there is not the same rush for coal, owing to the steadily rising prices, a steady demand has been experienced throughout the week. The output of Scottish fuel increases, but is not yet sufficent to make good the contraction in imports due to the scarcity of supplies offered by foreign sellers for prompt shipment. Some qualities are very scarce, and prices are extremely firm. A good turnover is reported in German industrial brown coal briquettes, and importers are arranging for increased supplies to be shipped to East of Scotland ports. Approximate prices are as follows:—Silesian, screened, 80s. to 85s.; unscreened, 80s.; Westphalian, screened and unscreened, 80s., all per ton f.o.t. Glasgow, Grangemouth, Bo'ness or Leith. American unscreened, 80s. per ton, f.o.t. Glasgow. Westphalian foundry coke, 55s. to 57s. 6d. per ton, f.o.t. at Grangemouth or Bo'ness. German industrial brown coal briquettes, 58s. 6d. to 60s. per ton, f.o.t. at Grangemouth, Bo'ness or Leith. Scottish patent fuel, 62s. 6d. per ton, f.o.b. Glasgow, Grangemouth or Bo'ness, and 63s. 6d. at Leith. Scottish screened coal, 80s. to 85s.; triping, 70s. to 75s.; and dross, 52s. 6d., all per ton at truck at pit.

Steel: Sheets Busy.

The scarcity of supplies of steel becomes more acute, and many consumers have great difficulty in carrying on. Only in some instances is foreign material being utilised, as most consumers rely on home products, especially in the case of sections. Bar and hoop mills have a fair outlet and prices are inclined to appreciate. Steel sheets have a steady demand and quotations for early delivery are high. Forward business can occasionally be done at lower rates.

Glasgow and Steel Shortage.

The contractors for the new bridge over the Clyde at Oswald-street, Glasgow, have reported to the Statute Labour Committee their inability to secure adequate supplies of British steel for the completion of the superstructure, as a result of the coal stoppage. The Statute Labour Committee decided to recommend that continental steel supplied by the Steel Company of Scotland should be used for the purpose, as the only alternative is to suspend the construction of the bridge.

Iron.

There is little change in the iron trade. The bar iron works in operation continue to concentrate on the production of steel bars from foreign billets. Bar iron is scarce and firmer in price. There is little or nothing being done in pig iron, as supplies are almost unobtainable, and the prices named for odd lots are very high.

Wages in the Pig Iron Trade.

In view of the fact that the selling price of pig iron during July, August and September last has been certified at £4 1s. 10d. per ton, the wages of the workmen fall to be increased by 4 per cent. on basis rates.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

The Coal Position.

NOTHING has occurred locally to bring about a general resumption of work in the South Wales coalfield. The Executive of the Miners' Federation has had a meeting, but there has been no development in the situation generally, except that more men are at work. The drift back is rather slow, but at the beginning of this week it was officially reported that round about 18,000 men were now engaged at the mines, while there is the prospect that by the end of this week this figure will be exceeded. One satisfactory feature is that in certain areas where there have been demonstrations and disturbances on account of the action of the men returning to the pits, quieter conditions now prevail. Owing to the action of the leaders, there is not quite so much work being done on the outcrops, but still a fair output is being obtained in this district from such sources, all of which is readily absorbed. Supplies of coal are really altogether inadequate to meet local needs, notwithstanding the substantial importations of foreign coals. Unfortunately, those who are engaged in the business of bringing coals to this country are unable to extend their operations, for the reason that coals for prompt loading are quite unobtainable. Foreign countries are finding that they are getting short of supplies for their own use, with the result that restrictions are being put on the quantity to be exported. As things are, steamers which are at American and continental ports are experiencing a great deal of detention, it being quite common to hear of vessels having to wait a week or a fortnight before getting their cargoes. Such delays are causing great difficulty to many purchasers in this country, and in some instances are interfering with big works carrying on operations.

Heavy Charterings.

Returns show that last week over 230 steamers were chartered to load nearly a million and a-half tons of coal for various directions. The heaviest operations were in tonnage to lift coals from the United States to this country. Over 140 steamers were fixed for this purpose, their carrying capacity being nearly a million tons. There is reason to believe that the Government recently bought a considerable quantity of American coal, and tonnage was taken up on a big scale by the firms acting for it, at rates of freight ranging from 25s. to over 40s. per ton. Tonnage was taken up with readiness running into the middle of January next, so that whatever happens on this side American coals will be coming into this country well into next year. So far as this district is concerned, it is understood that within the next six weeks fully 300,000 tons of American coals will be brought to the Bristol Channel. In the face of the unprecedented demand for coals, it is not surprising that prices on every hand are advancing. American run-of-the-mine coals are reported to be quoted at from 8 to 9 dollars per ton f.o.b., while good qualities of continental coals range from 50s. to 60s. per ton f.o.b., but are scarcely obtainable for the next few weeks.

Effect on Works.

The shortage of coals appears to be most in evidence in the Swansea area, where the effect of the coal strike is hitting workers in associated industries very severely. The Elba Steel Works, Gowerton, and the Duffryn Steel and Tin-plate Works, Morriston, have had to close temporarily, while the Bynea Steel Works have had to suspend operations, in addition to which the number of steel smelting furnaces in operation at Grovesend Works, Gorseinon, have been reduced from five to three. At the present time about 40 per cent. of the tin works in South Wales are operating, which means that 17,000 to 18,000 workers are adversely affected. Of course, many employers have been forced in the circumstances to take foreign coals to help them over the shortage, but in many instances these coals have not proved satisfactory for consumption in steel and tin-plate works.

Supplies of Coal and Allocation.

Colliery sales agents have had a meeting to consider the question of the allocation of coal supplies as production in the South Wales coalfield increases. Representatives of the Commercial Committee of the South Wales Coalowners' Association have already had an interview with the Mines Department, and a report on this point having been given and Mr. Finlay Gibson having made a statement on the general position as far as inland requirements are concerned, there was a general discussion on the situation, but no definite decision was reached. The feeling, however, prevailed that rather than have Government control it was preferable that the Emergency Committee now in existence and set up by the Mines Department, or some such Committee, should deal with the allocation of coal supplies when normal conditions are restored. It is expected that representatives of the South Wales coalowners will have another interview with Mines Department officials.

Steelworkers' Wages.

It is announced that the ascertainment under the present sliding scale operating in the West Wales steel industry for the three months ending September 30th last, shows an average selling price per ton of sheet and tin-plate bars, f.o.t. makers' works, of £6 12s. 9¾d., compared with £6 0s. 8¼d. for the previous quarter, which is equivalent to 16¼ per cent. under the sliding scale. This ascertainment will govern wages from November 7th up to and including the first Saturday in February next, and will mean a slight advance in wages on the basis rate to certain grades of workmen. Tin-plate workers will not unfortunately benefit from the improved sliding scale ascertainment, the increase being too small to affect the present position.

Tin-plate Prices.

As the result of the increased cost of production prices of tin-plates are advancing. Plates for prompt shipment are 24s. 6d. basis f.o.b., works port, while for supplies for loading during the first quarter of 1927 the price ranges from 23s. to 23s. 9d.

Traffic Returns.

The statistics issued by the Great Western Railway Company for the ports of Cardiff, Swansea, Barry, Penarth, Newport and Port Talbot, which are under the company's control, show that up to the 3rd of this month 710,970 tons of coal had been imported. The effect of the coal stoppage has been serious on traffic, as from the beginning of this year to October 3rd the total of imports and exports came to only 16,184,983 tons, which compares with 26,465,788 tons for the corresponding period of last year, the decline being therefore no less than 10,280,805 tons. One satisfactory feature is that the import side of trade was fully maintained, chiefly as the result of the heavy coal importations. The total imports this year to October 3rd came to 4,074,866 tons, which, compared with the same period of 1925, marks a gain of 59,114 tons. On the export side, coal and coke exports registered a loss of 9,818,078 tons. Later returns relating to local ports indicate that imports are, on the whole, keeping up very well. Last week a record was established in the importations of petroleum at Swansea, the quantity being over 20 million gallons for the Swansea refineries, which figure compares with 14,417,440 gallons in the previous week.

Siding Rent.

In August last the Great Western Railway Company notified collieries, coal merchants and wagon owners that wagons standing on its system would be charged at the rate of 6d. per wagon per day. This notification caused a good deal of resentment and opposition. Collieries have now received a communication from Mr. Finlay Gibson, the secretary of the Coalowners' Association, to the effect that the Great Western Railway Company has decided not to press the payment on empty wagons standing on its sidings during the mining stoppage, but that the question of charges on loaded wagons and those with pitwood is still in abeyance.

CATALOGUES.

HOPKINSON INDUSTRIAL MOTORS, Willesden-lane, London, W. 3.—October stock list of motors.

STOTHERT AND PITT, Ltd., Bath.—Loose leaf catalogue giving a large selection of all classes of harbour works plant.

WAGNER ELECTRIC SUPPLIES, Limited, 66, Victoria-street, London, S.W. 1.—Stock List No. 22E of motors and starters.

BERNARD HOLLAND AND CO., 17, Victoria-street, London, S.W. 1.—List No. 3 of rotary air compressors for in-bye working in collieries.

O. N. BECK, 11, Queen Victoria-street, London, E.C. 4.—Descriptive pamphlet of the "Perplex" electrically-driven endless chain for cleaning portable boilers.

ADAM HILGER, Ltd., 24, Rochester-place, London, N.W. 1.—A series of booklets E1 on "Spectrographs," L1 on "Measuring Micrometers, &c.," D1 on "Wavelength Spectrometers."

THE CLEWS PETERSEN PISTON RING AND ENGINEERING COMPANY, Ltd., Mill-lane, London, N.W. 6.—Catalogue No. 50, giving the advantages of the "Chipet" piston ring and the sizes kept in stock.

LOCOMOTIVE PUBLISHING COMPANY, Ltd., 3, Amen Corner, E.C. 4.—Loose leaf binder containing the first sections of a complete list of lantern slides and photographs of railway locomotives and works.

VACUUM OIL COMPANY, Ltd., Caxton House, London, S.W. 1.—Nos. 14 and 25 of the Gargoyle Technical Series, entitled "The Lubrication of Laundries" and "Ring and other Bath-lubricated Spindles in Textile Mills."

MIDLAND ELECTRIC MANUFACTURING COMPANY, Ltd., Birmingham.—New sectional list No. 156, dealing with improvements in design and reductions in price of the "Memette" switch and combined switch and fuse.

THE LEA RECORDER COMPANY, Ltd., 28, Deansgate, Manchester.—A binder containing a number of catalogues dealing with "Lea" recorders for measuring boiler feed water, condensed steam, water supplies, sewage, &c., over weirs and V notches.

THE STEEL BAND CONVEYOR AND ENGINEERING COMPANY, Ltd., Barker-street Works, Parade, Birmingham.—Folder giving particulars of the steel band as used for power transmission and illustrating some installations in various classes of factories

NEW ALLDAYS AND ONIONS, Ltd., Great Western Works, Small Heath, Birmingham.—Consolidated catalogue of the firm's products in conjunction with those of Thwaites Brothers, of Bradford, whose business has been purchased by Alldays and Onions, Ltd.

G. AND J. WEIR, Ltd., Cathcart, Glasgow.—The following booklets:—"Monel Metal and its Uses," "The Weir Corrosion Detector," "The Weir Turbo Feed Pump," "Monel Metal Hydro-extractors," and "How to Increase the Capacity of New and Existing Locomotives."

PERSONAL AND BUSINESS ANNOUNCEMENTS.

MR. H. C. D. SCOTT has been appointed chairman of directors of Royles Ltd., Irlam, to succeed the late Mr. O. M. Row, M.I. Mech. E.

RICHARD HILL AND CO., Ltd., of Middlesbrough, ask us to state that they are now represented in the London area by Mr. Arthur Campling, of 3, Victoria-street, Westminster, S.W. 1.

WE are informed that the firm of consulting engineers, St. George-Moore and La Trobe-Bateman, MM. Inst. C.E., is being carried on by the surviving partner, Mr. F. W. La Trobe-Bateman, at No. 5, Victoria-street, Westminster.

THE BRITISH ELECTRICAL AND ALLIED INDUSTRIES RESEARCH ASSOCIATION asks us to announce that on and after October 30th next its offices will be removed from 19, Tothill-street, Westminster, to 36 and 38, Kingsway, London, W.C. 2. Telephone, Holborn 0171.

BOLCKOW, VAUGHAN AND CO., Ltd., ask us to state that Mr. James A. Corder, who has represented the Cargo Fleet Iron Company since 1921, in the London and south-eastern districts, has now joined the staff of their London office in a similar capacity. Mr. Corder will take up his new duties on November 1st.

CONTRACTS.

CAMMELL LAIRD AND CO., Ltd., Nottingham, have received an order from the Central Argentine Railway for eight hundred 25-ton all-steel bogie low-sided wagons, and their associated company, the Midland Railway Carriage and Wagon Company, Ltd., Birmingham, has also received an order from the same railway for seven first-class bogie dining cars.

Current Prices for Metals and Fuels.

IRON ORE.

N.W. Coast—	
Native	18/6 to 21/-
(1) Spanish	18/6 to 21/-
(1) N. African	18/6 to 21/-
N.E. Coast—	
Native	—
Foreign (c.i.f.)	21/6

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
(2) Scotland—		
Hematite	—	—
No. 1 Foundry	‡4 15 0 to 5 0 0	—
No. 3 Foundry	‡4 10 0	—
‡ *For delivery after resumption of work at furnaces.*		
N.E. Coast—		
Hematite Mixed Nos.	4 8 6	4 8 6
No. 1	4 9 0	4 9 0
Cleveland—		
No. 1	6 5 0	6 5 6
Silicious Iron	6 5 0	6 5 6
No. 3 G.M.B.	6 0 0	6 0 6
No. 4 Foundry	5 19 0	5 19 6
No. 4 Forge	5 18 6	5 19 0
Mottled	5 17 6	5 18 0
White	5 17 6	5 18 0
Midlands—		
(3) Staffs.—		
All-mine (Cold Blast)	10 10 0	—
North Staffs. Forge	3 17 6	—
„ „ Foundry	4 7 6	—
(3) Northampton—	*(None offered.)*	
Foundry No. 3	3 5 0 to 3 10 0	
„ Forge	2 16 0 to 2 17 0	
(3) Derbyshire—	*(None offered.)*	
No. 3 Foundry	3 7 6 to 3 15 0	
Forge	3 2 9 to 3 5 0	
(3) Lincolnshire—	*(None offered.)*	
No. 3 Foundry	3 8 0	—
No. 4 Forge	3 5 6	—
Basic	3 6 0	—
(4) N.W. Coast—		
N. Lancs. and Cum.—		
Hematite Mixed Nos.	4 13 0 (*a*)	—
	4 16 0 (*b*)	—
	4 19 6 (*c*)	—

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
Scotland—		
Crown Bars	12 0 0	11 0 0
Best	—	—
N.E. Coast—		
Common Bars	11 5 0	—
Lancs.—		
Crown Bars	12 0 0	—
Second Quality Bars	10 15 0	—
Hoops	14 0 0	—
S. Yorks.—		
Crown Bars	12 10 0	—
Best Bars	13 10 0	—
Hoops	14 10 0	—
Midlands—	*(Prices nominal.)*	
Crown Bars	11 5 0 to 11 10 0	
Marked Bars (Staffs.)	14 0 0	—
Nut and Bolt Bars	10 5 0 to 10 10 0	
Gas Tube Strip	12 10 0	—

STEEL.

	(6) Home. £ s. d.	(7) Export. £ s. d.
(5) Scotland—		
Boiler Plates	11 0 0	—
Ship Plates, ¾in. and up	8 2 6	7 0 0
Sections	7 12 6	6 5 0
Steel Sheets, under 3/16in. to ¼in.	11 10 0 to 12 10 0	
Sheets (Gal. Cor. 24 B.G.)	—	£16 10 0 to 17 10 0

STEEL (*continued*).

N.E. Coast—	Home. £ s. d.	Export. £ s. d.
Ship Plates	8 12 6	—
Angles	8 12 6	—
Boiler Plates	12 0 0	—
Joists	8 0 0	—
Heavy Rails	8 10 0	—
Fish-plates	12 0 0	—
Channels	10 5 0	£9 to £9 5
Hard Billets	8 2 6	—
Soft Billets	7 5 0	—
N.W. Coast—		
Barrow—		
Heavy Rails	8 0 0†	—
Light Rails	8 5 0 to 8 10 0	
Billets	8 0 0 to 11 10 0†	
Manchester—		
Bars (Round)	9 10 0	—
„ (Small Round)	10 0 0	—
Hoops (Baling)	11 0 0	11 0 0
„ (Soft Steel)	10 15 0	10 15 0
Plates	8 5 0 to 8 12 6	
„ (Lancs. Boiler)	11 10 0 to 12 0 0	
Sheffield—		
Siemens Acid Billets	10 0 0	—
Bessemer Billets	11 0 0	—
Hard Basic	8 12 6	—
Intermediate Basic	8 2 6	—
Soft Basic	7 5 0	—
Hoops	12 0 0	—
Soft Wire Rods	9 10 0	—
Midlands—		
Small Rolled Bars	8 15 0	—
Billets and Sheet Bars	—	
Sheets (20 W.G.)	11 10 0 to 12 0 0	
Galv. Sheets, f.o.b. L'pool	17 5 0 to 17 10 0	
Angles	8 12 6 to 8 17 6	
Joists	8 12 6 to 8 17 6	
Tees	9 12 6 to 10 17 6	
Bridge and Tank Plates	—	
Boiler Plates	—	

NON-FERROUS METALS.

Swansea—	
Tin-plates, I.C., 20 by 14	23/- to 24/6
Block Tin (cash)	306 0 0
„ (three months)	301 10 0
Copper (cash)	58 2 6
„ (three months)	59 0 0
Spanish Lead (cash)	30 5 0
„ (three months)	30 3 9
Spelter (cash)	33 16 3
„ (three months)	33 16 3
Manchester—	
Copper, Best Selected Ingots	66 0 0
„ Electrolytic	67 0 0
„ Strong Sheets	92 0 0
„ Tubes (Basis Price)	0 1 1
Brass Tubes (Basis Price)	0 1 0
„ Condenser	0 1 2¼
Lead, English	32 0 0
„ Foreign	30 12 6
Spelter	34 2 6

FERRO ALLOYS.

(All prices now nominal.)

	Per Ton.	Per Unit.
Tungsten Metal Powder	1/9 to 1/10 per lb.	
Ferro Tungsten	1/5 per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£23 0 0	7/6
„ „ 6 p.c. to 8 p.c. „	£22 0 0	7/3
„ „ 8 p.c. to 10 p.c. „	£20 15 0	6/6
„ „ Specially Refined		
„ „ Max. 2 p.c. carbon	£37 0 0	12/6
„ „ „ 1 p.c. „	£43 5 0	15/-
„ „ „ 0·70 p.c. carbon	£54 0 0	17/6
„ „ „ carbon free	1/5d. per lb.	
Metallic Chromium	3/- per lb.	
Ferro Manganese (per ton)	£15 for home, £15 for export	
„ Silicon, 45 p.c. to 50 p.c.	£10 0 0	0 scale 5/- per unit
„ „ 75 p.c.	£15 17 6	scale 6/- per unit
„ Vanadium	14/9 per lb.	
„ Molybdenum	5/3 per lb.	
„ Titanium (carbon free)	0/11½ per lb.	
Nickel (per ton)	£170	
Cobalt	10/- per lb.	
Aluminium (per ton)	£112	

FUELS.

SCOTLAND.

Lanarkshire— (*Prices nominal.*)	Export.
(f.o.b. Glasgow)—Steam	15/9
„ „ Ell	16/6
„ „ Splint	16/6 to 17/-
„ „ Trebles	15/9
„ „ Doubles	14/- to 14/6
„ „ Singles	13/9
Ayrshire—	
(f.o.b. Ports)—Steam	16/9
„ „ Jewel	17/- to 17/6
„ „ Trebles	17/-
Fifeshire—	
(f.o.b. Methil or Burntisland)—Steam	12/6 to 14/9
Screened Navigation	21/-
Trebles	14/- to 15/-
Doubles	14/-
Singles	13/- to 13/6
Lothians—	
(f.o.b. Leith)—Best Steam	14/- to 14/3
Secondary Steam	13/6
Trebles	14/6 to 14/9
Doubles	13/6
Singles	13/6

ENGLAND.

(8) N.W. Coast—	
Steams	*No quotation.*
Household	„ „
Coke	„ „
Northumberland—	
Best Steams	16/-
Second Steams	14/6 to 15/-
Steam Smalls	8/- to 8/6
Unscreened	13/- to 13/6
Household	20/- to 22/-
Durham—	
Best Gas	18/6 to 19/-
Second	15/- to 15/6
Household	20/- to 22/-
Foundry Coke	18/- to 20/-

Sheffield—	Inland. (*Nominal, none on offer.*)
Best Hand-picked Branch	31/- to 34/- —
Barnsley Best Silkstone	28/- to 30/- —
Derbyshire Best Brights	26/- to 28/- —
„ „ House	24/- to 25/- —
„ „ Large Nuts	17/- to 20/- —
„ „ Small	12/6 to 14/- —
Yorkshire Hards	17/- to 19/6 —
Derbyshire Hards	16/- to 19/- —
Rough Slacks	10/- to 12/6 —
Nutty Slacks	7/6 to 9/- —
Smalls	3/6 to 6/- —
Blast-furnace Coke (Inland)*	— —
„ „ (Export)	f.o.b. 16/- to 17/-

(9) SOUTH WALES.

Cardiff— Steam Coals : (*All prices nominal.*)	
Best Smokeless Large	26/- to 27/-
Second „ „	24/6 to 25/6
Best Dry Large	24/- to 25/-
Ordinary Dry Large	21/- to 22/-
Best Black Vein Large	25/6 to 26/-
Western Valley Large	24/6 to 25/-
Best Eastern Valley Large	24/- to 25/-
Ordinary „ „	23/6 to 24/-
Best Steam Smalls	17/- to 18/-
Ordinary „	16/- to 17/-
Washed Nuts	19/- to 26/-
No. 3 Rhondda Large	26/6 to 27/-
„ „ Smalls	18/- to 18/6
No. 2 „ Large	24/- to 25/-
„ „ Through	20/- to 21/-
„ „ Smalls	15/- to 16/-
Foundry Coke (export)	40/- to 50/-
Furnace Coke (export)	25/- to 30/-
Patent Fuel	42/6 to 45/-
Pitwood (ex ship)	32/6 to 35/-
Swansea—	
Anthracite Coals :	
Best Big Vein Large	39/- to 40/-
Seconds	32/6 to 35/-
Red Vein	27/- to 29/-
Machine-made Cobbles	47/6 to 50/-
Nuts	47/6 to 50/-
Beans	42/6 to 44/-
Peas	23/- to 25/-
Breaker Duff	7/6 to 8/-
Rubbly Culm	12/6 to 13/6
Steam Coals :	
Large	22/6 to 24/6
Seconds	20/- to 22/-
Smalls	11/- to 15/-
Cargo Through	16/6 to 17/6

(1) Delivered. (2) Net Makers' works. (3) f.o.t. Makers' works, approximate. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire and Ayreshire.

(6) Home Prices—All delivered Glasgow Station. Boiler Plates 10/- extra delivered England. (7) Export Prices—f.o.b. Glasgow. (8) Except where otherwise indicated, coals are per ton at pit for inland and f.o.b. for export, and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b. * For blast-furnaces only, 17/-, with fluctuations according to analysis; open market 17/6 to 19/- at ovens. † Latest quotations available. (*a*) Delivered Glasgow. (*b*) Delivered Sheffield. (*c*) Delivered Birmingham.

French Engineering Notes.

(*From our Correspondent in Paris.*)

Free Trade Manifesto.

The publication of the international manifesto in favour of freer trade relations in Europe has been somewhat coldly received in this country, where those French experts whose names were appended to the document disavow their connection with it and state that they merely signed the addendum without reference to the manifesto itself. The publicity given to the document has, in fact, embarrassed the French Government, which bases its entire economic policy upon Protection, without which, it is claimed, the country would be unable to carry through its programme of financial reconstruction. The commercial community is almost generally in favour of freer trade relations amongst European countries, but it is helpless in face of a great economic problem, which the official mind believes cannot be solved without the aid of import duties that serve the treble purpose of providing a revenue, protecting new home industries, which cannot exist without them, and of placing in the hands of the Government a means of bargaining for economical advantages with other countries. In the present state of affairs it is hopeless to look for any modification of the existing fiscal policy, except in the direction of a further increase, for the object of all the commercial and industrial agreements now being carried out is to secure for each country a monopoly of its own market. Practically all countries are now producers, and the European production has enormously increased while the purchasing power has fallen considerably, so that the aim of each country is now not so much to secure foreign trade as to keep its own busjness. That is the main object of the Steel Cartel, which seeks to suppress price cutting by keeping down production to within the needs and to enable each country to secure remunerative prices at home. There is indeed a parallel between these continental efforts to secure the home trade and the propaganda in favour of developing trade within the British Empire.

The Steel Union.

The clauses of the Steel Cartel just published confirm the information that has been given in this column from time to time concerning the conditions of the agreement. The Cartel controls the entire production of raw steel in France, Germany, Luxemburg, and Belgium, and as a guarantee a dollar a ton has to be paid to a common fund, while for every ton above the allotted quota the amount to be paid is four dollars. On the other hand, a country which does not produce a quantity of raw steel equivalent to its quota will receive an indemnity of two dollars for every ton falling short of the quota, provided it does not exceed 10 per cent. of the total. The clauses provide so many loopholes for denouncing the Cartel that it cannot be said to have any real permanent character. Its existence depends upon the nature of the commercial treaties that may be carried out in the future, for if any one country should deem itself placed in an unfavourable situation—as, for example, by an increase of German import duties on French steel—that country may withdraw and the Cartel will come to an end. For the existence of the Cartel to be assured it must be taken into account whenever negotiations are carried out for commercial treaties, and it is, of course, practically certain that nothing will be done to imperil its existence so long as the operations of the Cartel are favourable to the interests of steel makers in all the countries concerned. Nevertheless, it is always possible that difficulties may arise, as is the case with the Rail Union, the fate of which seems to be imperilled almost before it has been able to start operations. Not long ago one big French firm objected to the way in which it was deprived of its South American trade, and now it is affirmed that the German rail makers continue to withhold their collective signature from the final contract because they refuse to admit into their quota of foreign trade the quantity of rails they are bound to supply on account of reparation. Another delicate point is that under the Geneva agreement the German railways had to purchase from Poland 30,000 tons of rails, which is, of course, an infraction of the understanding that each party to the agreement should have a monopoly of its own market. Until this matter is cleared up the Germans refuse to sign.

The Improving Franc.

Business is no longer influenced by the fluctuations of the franc to the extent it was until recently, for manufacturers have learnt to their cost that it is disastrous to introduce a speculative element into their affairs, and the main desire of everyone is to eliminate speculation. In many cases that means imposing restrictions which often make it difficult to do business at all, and, if there is generally a more optimistic feeling on account of the improvement in currency values, there is as yet no improvement in trade. There is confidence in the future, but no confidence in the situation of customers, and the monetary stringency is so great that conditions of payment are insisted upon that are not always conducive to the placing of orders. The only really satisfactory features of the situation are the trade returns for the first nine months of the year, showing a notable improvement in the exports; but obviously, as that is due largely to the currency depreciation, it is not altogether a matter for congratulation, and the activity in foreign markets may disappear if the franc should continue to improve. A good deal of this larger foreign trade is also attributed to temporary causes, such as bigger exports to Great Britain during the strike. There is certainly plenty of business to be done in this country as soon as the conditions are favourable, but for the moment the buying is restricted as much as possible, and while the former pessimism was bad for business, the present increasing optimism is scarcely more conducive to industrial activity, since no one knows what is going to happen and no one is inclined to take risks. Consequently, matters are likely to remain as they are now until the situation assumes a more solid and permanent character. Underlying all this is the complete absence of credits and the want of money for industrial undertakings of any kind, and credits must be restored before there can be any improvement in business.

British Patent Specifications.

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

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

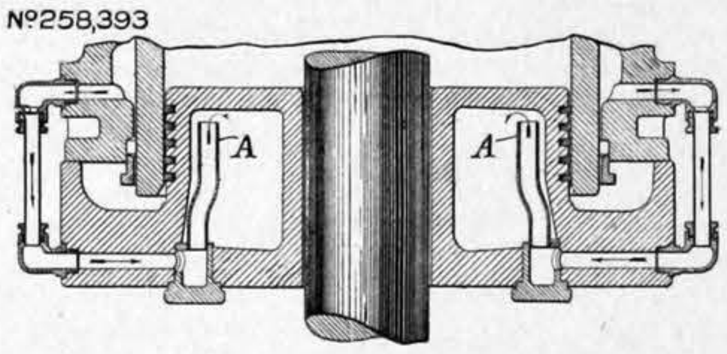
Copies of Specifications may be obtained at the Patent Office, Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

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

INTERNAL COMBUSTION ENGINES.

258,393. July 30th, 1925.—Cooling Cylinder Covers, Richardsons, Westgarth and Co., Ltd., and W. S. Burn, Hartlepool Engine Works, Durham.

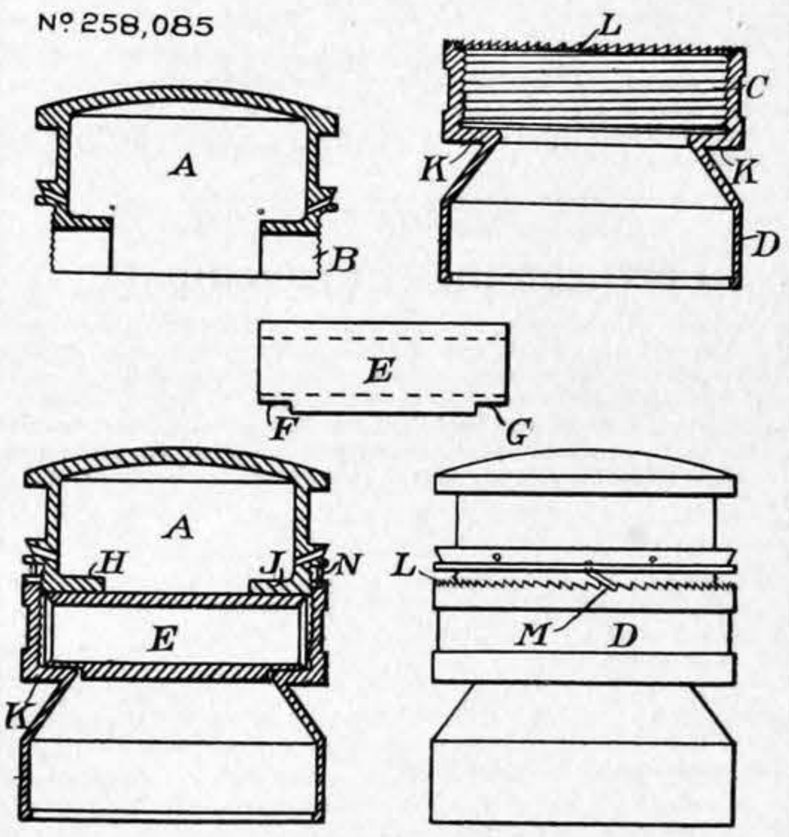
In this specification it is explained that one of the difficulties with engines of the vertical double-acting type is to get the cooling water in contact with the underside of the inner wall



of the lower cylinder cover on account of the formation of a layer of air between the water and the underside of the wall. This trouble, can, according to the inventors, be overcome by directing the cooling water as a series of jets from the internal pipes A A, while the overflow pipe is kept at such a height that there is a tendency for the water to circulate through the upper part of the cover jacket.—*September 23rd*, 1926.

258,085. September 15th, 1925.—Improved Piston Bodies, David Skinner, of 3, Rosebery-terrace, Kirkcaldy.

The piston body, which is preferably of steel, consists of two parts, the top or head A, having an externally screwed extension B, which engages with an internally screwed portion C, on the lower part or skirt D, of the piston body. The gudgeon pin E is of the fixed type, has a flat part F and G respectively formed on each end, and extended bearings H and J are formed in the head A, to receive the rounded portions of the ends of the gudgeon pin, whilst the flat portions F and G rest on and are supported by a flange or shoulder K in the skirt D, when the latter is connected to the head A. The inner end of each flat part F and G on the gudgeon pin E terminates in a shoulder adapted to bear against

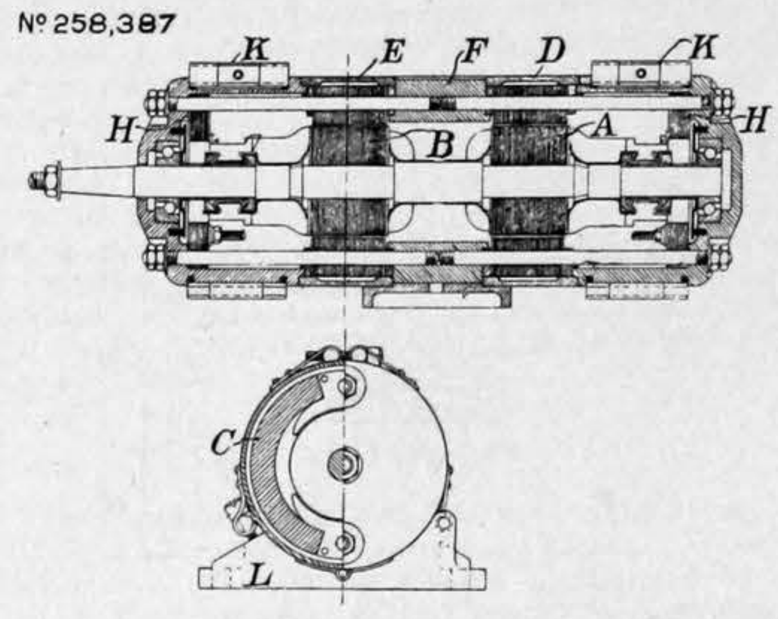


the sides of the flange K in the skirt of the piston, thus rigidly holding the gudgeon pin E in its acting position and eliminating all risk of oscillation and end-on movement. To assist in retaining the head A and skirt D of the piston body in their acting position, a circular rack L is formed on the top of the skirt, and pawls M and N on the head A are adapted to engage with the rack, thus effectively locking the parts A and D. With this form of construction the parts can be readily assembled, and distortion of the piston due to driving home the gudgeon pin is avoided. Moreover, at the same time, the gudgeon pin is effectively retained in its acting position against end-on movement by the shoulder formed on the inner end of each flat portion F and G, and all risk of the gudgeon pin contacting with the walls of the cylinder is eliminated.—*September 16th*, 1926.

DYNAMOS AND MOTORS.

258,387. July 21st, 1925.—Improvements in and relating to Dynamo-electric Machines, The British Thomson-Houston Company, Ltd., of Crown House, Aldwych, London, W.C. 2; Arthur Primrose Young, of "Borrowell," Borrowell-lane, Kenilworth; Joseph Hutt, of 62, Earlsdon-avenue South, Coventry; Ernest George Parrott, of Prescott House Kenilworth; and William Eric Gough, of 61, Craven-road, Rugby.

This invention relates to dynamo-electric machines of the permanent magnet type, and has for its object to provide an improved construction of such machine whereby both high-tension and low-tension output may be obtained simultaneously. A and B represent respectively the high-tension and low-tension armatures which are mounted tandem fashion on a common spindle. Commutators are mounted at the outer ends of the armatures. Bi-polar field piece constructions for the high-tension and low-tension units are built up of laminations riveted between end plates and the permanent magnets C are formed of annular segments of cobalt steel. The field piece constructions and the mangets are enclosed in sleeves D E, which are separated by a distance piece F. The brush gear is mounted on a base H contained within the end plates, which are provided with hinged covers K to render the brushes readily accessible. The machine is mounted on a cradle L and is readily detachable by taking out a set screw. The spindle may be driven by means

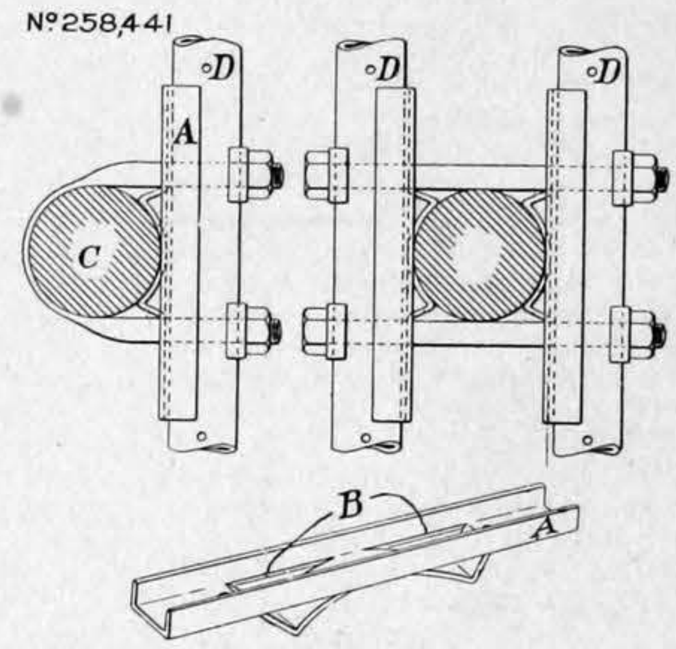


of a windmill, pulley and belt or by direct coupling. Such an arrangement gives a machine which is of simple and light construction and is totally enclosed so as to render it dust and damp proof.—*September 23rd*, 1926.

TELEGRAPHS AND TELEPHONES.

258,441. November 6th, 1925.—Improvements in or relating to the Mounting of Insulator Arms upon Telegraph and Telephone Poles, Percy Charles Barton, of Granville Ironworks, Granville-street, Birmingham.

The method of mounting insulator arms upon telegraph and telephone poles in accordance with this invention is fairly clear from the accompanying illustrations. A channel or angle

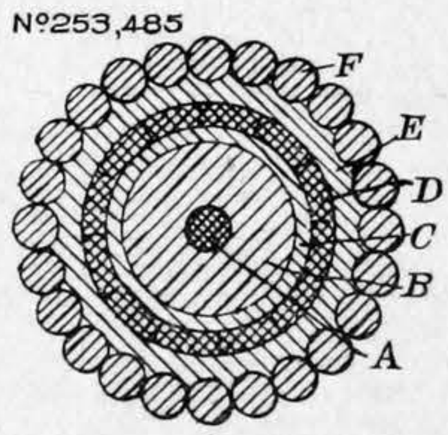


member A is slit as at B. The strip of metal between the pair of longitudinal slits is then forced outwards by pressing, and the strips are shaped to constitute a socket for the side of the pole C. Two methods of using this form of straight metallic device are shown in the upper illustrations, where D are insulator arms, which may consist of metallic tubes. There are four other illustrations.—*September 23rd*, 1926.

TRANSMISSION OF POWER.

253,485. April 10th, 1926.—Improved Single-core Cable, Felten and Guilleaume Carlswerk Actiengesellschaft, of Köln-Mülheim, Germany.

It has been known for some time that the resistance of single-core cables is increased, owing to the fact that in the case of high frequencies the electric lines of the return current are crowded towards the conductor, and the object of this invention is to reduce this trouble. As a result of recent investigations, the



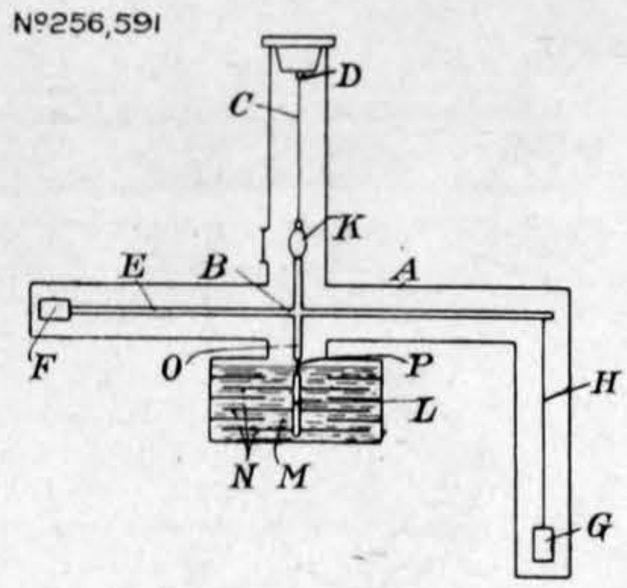
purpose in view can be attained by first of all placing a layer of jute around the gutta-percha cores, and thereupon the return copper conductor, and then a second layer of jute and the sheathing. This form of construction is illustrated in cross section. A is the inner conductor, B the gutta-percha or other insulation, C the first layer of jute, D the return conductor consisting of one or more copper bands, E the second layer of jute, and F the sheathing. A modification is also described.—*September 16th*, 1926.

MEASURING AND TESTING INSTRUMENTS.

256,591. July 14th, 1926.—Improvements in the Damping of Measuring Instruments, Dr. Johann Koenigsberger, of 47, Gunterstalstrasse, Freiburg, Germany.

An example of the damping device constructed in accordance with this invention and employed in connection with a torsion balance instrument is illustrated. A casing A contains the moving element B of the torsion balance suspended on a long wire C secured at D. The balance consists of a horizontal beam E, with weights F and G, the latter being suspended by a thread H. A mirror is supported at K. The casing L is filled with damping liquid M employed to damp the oscillation of the moving element. Several discs N secured on a vertical spindle are

arranged in this casing and constitute the damping device proper, which is suspended from the lower part O of the suspended moving element by a wire P. The wire is extremely

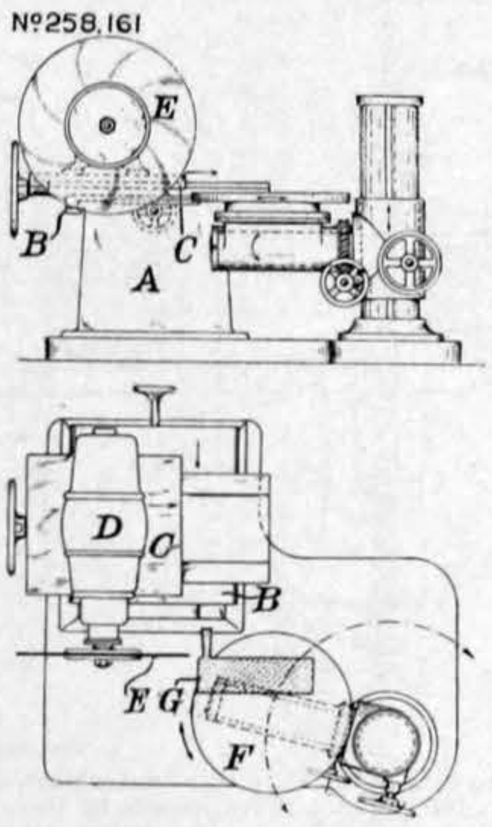


thin and short, and passes as nearly as possible through the centre of the surface of the damping liquid.—*September 23rd*, 1926.

MACHINE TOOLS AND SHOP APPLIANCES.

258,161. February 18th, 1926.—Improvements in or relating to High-speed Friction Saws, Mars-Werke A.-G., of Sigmundstrasse 40, Nurnberg-Doos, Germany.

On a table A a cross slide B C is mounted, and it can be adjusted relatively to the table A by hand wheel setting spindles. The cross slide forms a support for an electric motor D, on the shaft of which a cutting disc E is mounted. By a corresponding adjustment of the cross slide, the disc can be brought to the

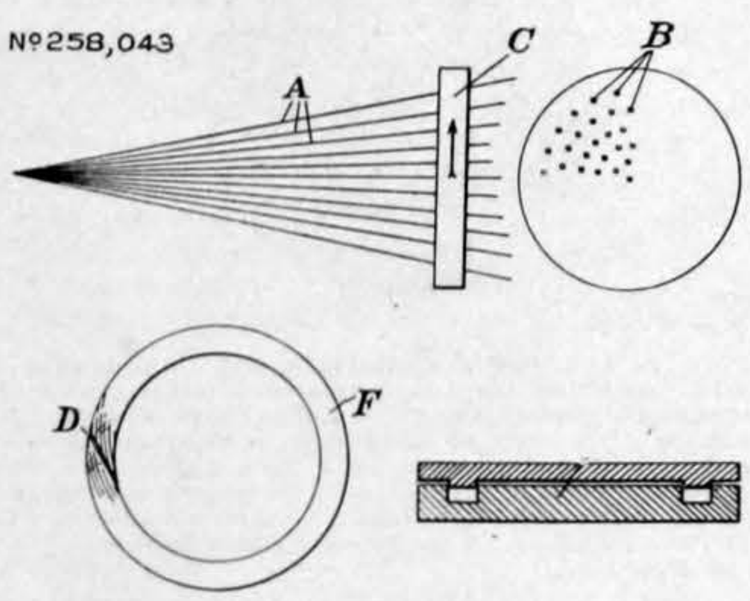


required cutting plane relatively to the work, and then moved towards the latter There is also a second table F, which can be adjusted and turned in every direction, and which, in the construction illustrated, forms the support plate for the work G. This setting table is supported by an upright column by means of a jib or arm, which is mounted on a cylindrical sleeve on the upright, so that it is vertically adjustable by gearing, and can also be turned or rotated about the column.—*September 16th*, 1926.

MISCELLANEOUS.

258,043. July 17th, 1925.—Improvements relating to the Manufacture of Friction Linings for Brakes, Clutches and the like, Herbert Frood and Ferodo, Ltd., both of Sovereign Mills, Chapel-en-le-Frith, Derby.

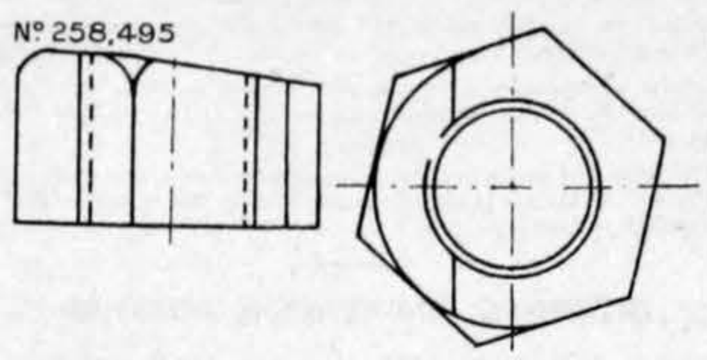
Asbestos yarns A are formed into a rope by being threaded through holes B in a disc C, which is rotated in the ordinary manner. A suitable length of the rope is cut off, the cut ends being at an angle, as shown at D, so that when the length is



shaped into ring form, as shown at F, the ends will lie together and produce a scarf joint of the same outside dimensions as the body of the rope. The rope which has been impregnated, either in the manufacturing stage or after the process described is completed, with synthetic resin or phenol formaldehyde condensation product, is placed in a mould, as shown in the right-hand drawing, and subjected to heat and pressure, whereby the resin is rendered insoluble and a flattened ring of the required dimensions is produced.—*September 16th*, 1926.

258,495. March 24th, 1926.—A Lock Nut, A. Kindström, 3, Tegnérlunden, Stockholm, Sweden.

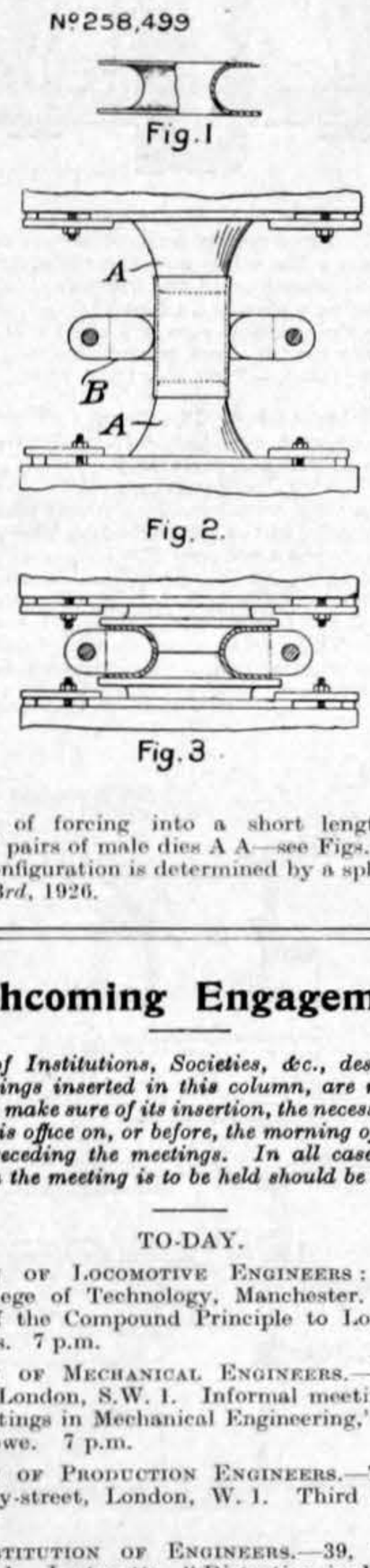
This lock nut is of the type in which the locking action is dependent on a binding tendency on the stock of the bolt, and the principal claim in the specification is worded as follows:—"A lock nut comprising two nuts, having contacting surfaces inclined to the axis of the bolt, wherein the inclined surface on each nut extends over a part only of the nut face, the remainder of the nut face remaining in a plane at right angles to the bolt



axis, the said inclined surface extending from one edge of the nut face to a point beyond the centre of the nut and being inclined to the bolt axis at an angle not exceeding the angle of pitch of the thread." The illustration needs no explanation.—*September 23rd*, 1926.

258,499. April 1st, 1926.—Making Expansion Banjo Pipes, D. Harvie and D. Harvie, Dalmarnock Bridge, Rutherglen, Glasgow.

The claim in this specification is essentially for a process of making an expansion ring for piping, as shown in Fig. 1,



by a process of forcing into a short length of seamless piping a set of pairs of male dies A A—see Figs. 2 and 3—while the exterior configuration is determined by a split female die B.—*September 23rd*, 1926.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Wednesday of the week preceding the meetings. In all cases the TIME and PLACE at which the meeting is to be held should be clearly stated.

TO-DAY.

Institution of Locomotive Engineers: Manchester Centre.—College of Technology, Manchester. Paper, "The Application of the Compound Principle to Locomotives," by Mr. E. M. Gass. 7 p.m.

Institution of Mechanical Engineers.—Storey's Gate, Westminster, London, S.W. 1. Informal meeting. Discussion on "Steel Castings in Mechanical Engineering," introduced by Mr. Robert Lowe. 7 p.m.

Institution of Production Engineers.—The Engineers' Club, Coventry-street, London, W. 1. Third annual dinner. 7.30 p.m.

Junior Institution of Engineers.—39, Victoria-street, London, S.W. 1. Lecturette, "Distortion in Wireless Reception," by Mr. A. V. Ballhatchet. 7.30 p.m.

North-East Coast Institution of Engineers and Shipbuilders.—Newcastle-upon-Tyne. Annual general meeting. "How should an Engineer be Trained?" by Sir Theodore Morison. 6 p.m.

Society of Technical Engineers.—Queen's Hotel, Birmingham. Address on "The Engineers Bill," by Mr. R. Hazleton. 7.30 p.m.

SATURDAY, OCTOBER 30TH.

Finsbury Technical College: Old Students' Association.—The Engineers' Club, Coventry-street, London, W. 1. Fifteenth Annual Dinner.

Institute of Metals: North-East Coast Local Section.—Neville Hall, Newcastle-upon-Tyne. Joint meeting with the Institute of British Foundrymen. 6.15 p.m.

Institution of Municipal and County Engineers.—South Midland District Meeting at Aylesbury. 10 a.m.

SATURDAY, OCTOBER 30TH, TO FRIDAY, NOVEMBER 5TH.

Brewers' Exhibition.—Royal Agricultural Hall, Islington, London, N. 1.

MONDAY, NOVEMBER 1ST.

Bradford Engineering Society.—Technical College, Great Horton-road, Bradford. "The Choice of Steels for General Engineering Purposes," by Mr. A. P. Hague. 7.30 p.m.

Institution of Automobile Engineers: Western Centre.—Merchant Venturers' Technical College, Bristol. Paper, "The Effect of Reduced Intake-Air Pressure and of Hydrogen on the Performance of the Slow-speed Solid Injection Engine," by Mr. G. F. Mucklow. 6.45 p.m.

Royal Institution of Great Britain.—21, Albemarle-street, London, W. 1. General meeting. 5 p.m.

Society of Engineers.—Geological Society's Rooms, Burlington House, Piccadilly, London, W. 1. Paper, "Some Products of a Small Machine Shop," by Miss A. Ashberry. 5.30 p.m.

TUESDAY, NOVEMBER 2ND.

Institute of Metals: North-East Coast Local Section.—Armstrong College, Newcastle-upon-Tyne. "Light Alloys," by Dr. L. Aitchison. 7.30 p.m.

Royal Institution of Great Britain.—21, Albemarle-street, London, W. 1. "The Acoustics of Public Buildings," by Dr. G. W. C. Kaye. 5.15 p.m.

Royal Society of Arts: Dominions and Colonies Section.—John-street, Adelphi, London W.C. 2. "The Importance of Rubber in Economic and Social Progress," by Sir Stanley Bois. 4.30 p.m.

Institution of Civil Engineers.—Great George-street, Westminster, London, S.W. 1. Presidential address by Mr. F. Palmer. 6 p.m.

WEDNESDAY, NOVEMBER 3RD.

Institution of Electrical Engineers.—Savoy-place, Victoria Embankment, London, W.C. 2. Wireless Section meeting. Opening address by the Chairman, Professor C. L. Fortescue. 6 p.m.

Manchester Metallurgical Society.—The Engineers' Club, Manchester. Paper, "Recent Advances in Electro Deposition," by Mr. A. E. Ollard. 7 p.m.

THURSDAY, NOVEMBER 4TH.

Institute of Metals: London Local Section.—Royal School of Mines, South Kensington, London, S.W. 7. "The Structure and Properties of the Aluminium-silicon Alloys," by Dr. A. G. C. Gwyer. 8 p.m.

Institution of Automobile Engineers.—Royal Society of Arts, John-street, Adelphi, London, W.C. 2. Joint meeting with the Royal Aeronautical Society. Paper, "The Effect of Reduced Intake Air Pressure and of Hydrogen on the Performance of the Slow-speed Solid-injection Engine," by Mr. G. F. Mucklow. 7 p.m.

Institution of Civil Engineers: Birmingham and District Association.—Chamber of Commerce, New-street, Birmingham. Address by the chairman, Mr. H. H. Humphries. 6 p.m.

Institution of Mechanical Engineers: North-West Section.—The Engineers' Club, Manchester. Paper, "The Value of Increased Steam Pressure for Power Generation," by Mr. H. L. Guy. 7 p.m.

Institution of Structural Engineers.—10, Upper Belgrave-street, London, S.W. 1. Paper, "Some Aspects of Structural Vibration," by Mr. W. Pollard Digby. 8 p.m.

FRIDAY, NOVEMBER 5TH.

Institution of Fuel Economy Engineers.—Royal Society of Arts, John-street, Adelphi, London, W.C. 2. Lecture, "Pulverised Fuel Firing for Steam Boilers," by Mr. R. Jackson. 6 p.m.

Institution of Mechanical Engineers.—Storey's-gate, Westminster, London, S.W. 1. Thomas Hawksley Lecture, "Elasticity and Plasticity," by Professor E. G. Coker. 6 p.m.

Junior Institution of Engineers.—39, Victoria-street, London, S.W. 1. Lecturette, "Steel Castings and their Relation to Mechanical Engineering," by Mr. R. Lowe. 7.30 p.m.

SATURDAY, NOVEMBER 6TH.

Institute of British Foundrymen: Birmingham, Coventry and West Midlands Branch.—The Engineers' Club, 13, Waterloo-street, Birmingham. "Labour Conditions in American Foundries," by Mr. J. T. Kay. 6.30 p.m.

Institute of British Foundrymen: Lancashire Branch.—College of Technology, Manchester. Paper, "The Manufacture and Properties of Blackheart Malleable Castings," by Mr. A. E. Peace. 4 p.m.

MONDAY, NOVEMBER 8TH.

Institute of Metals: Scottish Local Section.—Institution of Engineers and Shipbuilders in Scotland, 39, Elmbank-crescent, Glasgow. Discussion on "Die Casting." 7.30 p.m.

Institution of Automobile Engineers: Birmingham Centre.—Chamber of Commerce, New-street, Birmingham. Paper, "Lubricating Oils," by Mr. J. E. Southcombe. 7 p.m.

TUESDAY, NOVEMBER 9TH.

Institution of Electrical Engineers: Scottish Centre.—Room 149, Royal Technical College, Glasgow. Opening address by the Chairman, Mr. W. L. Winning. 7.30 p.m.

FRIDAY, NOVEMBER 12TH.

Institute of Metals: Sheffield Local Section.—Applied Science Department of the University, St. George's-square, Sheffield. "Ingots and Ingot Making," by Mr. H. Brearley. 7.30 p.m.

Institute of Metals: Swansea Local Section.—Metallurgical Department, University College, Singleton Park, Swansea. "Zinc Smelting and Recovery of its By-products," by Mr. J. H. Wells. 7.15 p.m.

Institution of Mechanical Engineers.—Storey's-gate, Westminster, London, S.W. 1. Informal discussion, "Estimating," introduced by Mr. L. J. T. Wheatley. 7 p.m.

Junior Institution of Engineers.—39, Victoria-street, London, S.W. 1. Annual general meeting. 7.30 p.m.

Popular Talk in Aid of King Edward's Hospital Fund for London.—Fyvie Hall, Polytechnic, Regent-street, London, W. 1. "Liquid Air," by Mr. W. E. Garner. 5 p.m.

Railway Club.—25, Tothill-street, Westminster, London, S.W. 1. Paper, "Light Signalling," by Mr. W. J. Thorrowgood. 7.30 p.m.

SATURDAY, NOVEMBER 13TH.

Institution of Civil Engineers: Birmingham and District Association.—Visit to South Staffordshire Waterworks at Lichfield and Dudley. 11 a.m.

WEDNESDAY, NOVEMBER 17TH.

Institution of Electrical Engineers: South Midland Centre.—The University, Edmund-street, Birmingham. Wireless Section meeting. Address by Professor C. L. Fortescue. 7 p.m.

Lantern Slides.—Automatic and Electric Furnaces, Ltd., of 173–175, Farringdon-road, London, E.C. 1, asks us to announce that it has available for the use of engineering societies and other technical associations a complete series of lantern slides illustrating electric furnaces for hardening, tempering, carburising, annealing, ferrous and non-ferrous metals, glass, &c., together with component parts of such furnaces, automatic temperature controls, and wiring diagrams, connected with various forms of circuits. Full descriptions of these slides in the form of a lecture can be supplied if required.