A Seven-Day Journal

Railwaymen's Pay.

As a token of goodwill between the railway companies and the representatives of the three railway unions, the railways agreed on Friday, August 10th, to cancel, as from October 1st, one-half of the 2½ per cent. deduction made in April, 1931, in the pay of men receiving less than 40s. per week, and, further, to cancel as from January 1st next, the other one-half of the 2½ per cent. reduction. Those men who received over 40s. per week had their pay reduced, in April, 1931, by 5 per cent. One-quarter of that is to be restored as from October 1st and another quarter from January 1st, and thereafter those men will be subject to a deduction of 2½ per cent. The maximum deduction is then to be 6s. per week, or £15 a year. It is estimated that the concession will cost the companies £1,100,000 a year. What, to our mind, makes this agreement very much more satisfactory is that it has been arrived at despite the fact that no conciliation machinery is now in existence. The discussions as to the restoration of Central and National Wages Boards or the setting up of their equivalent are still proceeding, and the latest information thereon is to the effect that a further meeting is to be held on Monday next, August 20th.

The Empress of Britain's New Record.

The 42,348 gross ton Canadian Pacific passenger liner "Empress of Britain," which was built and engined by John Brown and Co., Ltd., at Clydebank, was commissioned in May, 1931. She has successfully completed three world cruises and is now engaged on her fourth Atlantic season. During the eastbound passage of her forty-sixth voyage just ended she made the crossing between Father Point and Cherbourg in the record time of 4 days 6 hours 58 minutes, which corresponds to an average speed of 25·08 knots. In addition to this notable performance, it is interesting to observe that the high standard of technical efficiency registered during her official trials is being well maintained, her daily consumption of oil fuel on the voyage in question being 377 tons for all purposes, or 0·57 lb. per S.H.P. per hour. The steam conditions under which the geared turbine propelling machinery operates are 400 lb. working pressure, 730 deg. Fah. total temperature, and vacuum 29in. In addition to having made the Atlantic crossing between Quebec and Cherbourg in the shortest time yet recorded, this vessel retains the distinction of being the most economical large passenger liner afloat.

A French Railway Disaster.

The disaster to the express train from Geneva to Vintimille when entering the Avignon Station at half-past four on Sunday morning provides another example of the difficulties that have recently prevented inquiries in France from revealing the exact causes of accidents. The train was composed of eight coaches, a postal van, and a luggage van, and when crossing points about 300 m. from the Avignon Station the coaches left the rails and ploughed over the ballast until entering the station, when the locomotive turned over on to the platform, the postal van swung round against a goods train, and the only wooden coach, of an old type ahead of the steel coaches, was completely smashed. Four out of the five passengers killed were removed from that coach. A guard waiting to relieve the one on the train was killed in the station. About thirty passengers were injured, some of them seriously. The question arises whether the driver had kept within the speed limit of 12 miles an hour when crossing the points. He affirms that he did, and there can be no proof to the contrary because the recording slip of the Flamant instrument was destroyed by a fire that started when the locomotive turned over. Nevertheless, some passengers declare that the train was travelling quickly, and the fact remains that it ran an appreciable distance after the coaches had left the rails.

Progress in Tin Research.

The first general report of the International Tin Research and Development Council, of Manfield House, 378, Strand, London, W.C.2, which was published at the end of last week, should be of interest to a wide circle of engineers. The Council, we may recall, was formed in 1929 for the purpose of acquiring and disseminating scientific and technical knowledge relating to tin, its alloys and chemical compounds, and their processes of manufacture and their industrial applications. It is composed of delegates appointed by the Governments of the principal tin-producing countries of the world and is responsible for an extensive programme of research, which has been set up and is now being carried out in Government, university, and industrial laboratories in this country, on the Continent, and in America. The various sections of the report deal with the tin-plate industry and with the preparation and uses of tin and tin alloys, and the work which has been done by the Council in these particular fields of development. Among the new uses of tin mention is made of the Féry-Carbonne dry tin accumulator, which is lighter than a lead accumulator of equal capacity and has tin and lead peroxide electrodes immersed in dilute sulphuric acid, which is absorbed in an acid-resisting porous ceramic filling, thereby making in effect a dry cell. The report describes the wide service of the Council in supplying technical information to manufacturers and scientific investigators in many countries, and the Bureau of Technical Information, which has been established for this purpose and for the publication of the results of research and development. The Council has also set up at the Hague an office for the collation of statistics which it publishes as a monthly bulletin. An office in New York has been established and an advisory committee formed for the purpose of maintaining contact with the consumers of tin and its products in America.

The American Steel Industry.

Some highly interesting figures concerning the steel industry in the United States were received this week. They were published by the American Iron and Steel Institute and serve to illuminate the operation in practice of the National Recovery Act. So far as the object of that Act was to increase employment the figures imply that it has been outstandingly successful. In June of this year the number of people at work in the steel industry amounted to 455,966. This total is 35 per cent. more than the number similarly employed in June 1933 and is the highest monthly figure recorded during the past four years. One of the prescribed means of bringing about the increase of employment was the reduction of the number of hours per week worked by those engaged in the industry. This means has been resorted to, the average weekly hours worked per person having been reduced from 39·4 in June 1933 to 35·7 in June 1934 or by 9·4 per cent. Turning to the financial side we find that the total wages paid within the industry rose from 24,441,054 dollars in June last year to 40,630,314 dollars in June this year or by 66 per cent. The average earnings per hour increased from 47·3 cents to 63·9 cents or by 35 per cent. The Government has therefore secured the increase of employment which it desired. The workers have been benefited by a decrease in hours and an increase of wages. On the employers' side, we find that the operating rate in June 1933 was 45·37 per cent. of capacity. In June this year it was 52·68 per cent. Thus for an increase of 66 per cent. in the wages bill the employers have secured an increased output of 16 per cent. The Institute's figures do not include a comparison of the prices realised for the industry's products. On investigation, however, we find that quotations in the United States for plates, shapes, and bars, black sheets, billets and sheet bars advanced during the period by from 12 to 20 per cent.

Lloyd's Register Rules.

We have received from Lloyd's Register of Shipping, of 71, Fenchurch-street, London, E.C.3, particulars of the recent additions and amendments made to the Society's Rules for the construction and classification of steel ships. They include new additions to the sections relating to oil fuel, hull strengthening, geared turbines and boilers, steam reciprocating engines combined with exhaust steam turbines, and heavy-oil engines. The main part of the new rules, however, relates to electric propelling machinery and deals with the general requirements of such installations with regard to turbine and oil engine-driven generators, electric propulsion motors, and the necessary control gear and switchboards both for direct current and alternating current working. Other sections of the rules deal with circuit protection devices and the arrangements for bridge or deck control. Questions of the design, manufacture and testing of conductors and cables, secondary batteries, and the spares to be carried are all covered by the rules. In an appendix, tables are given showing the dimensions and sizes for galvanised steel armoured wires, rubber and lead-sheathed cables, and multicored cable with either paper or cambric insulation for 600 and 3300 volts.

The Late Sir James Carmichael.

Engineers, both in Great Britain and the Colonies, will learn with deep regret of the death of Lieut.-Colonel Sir James Carmichael, R.E. (Retired), which occurred in London on Sunday, August 12th. Sir James, who was only sixty-six years of age at the time of his death, was one of the Crown Agents for the Colonies, and for many years was the head of the Engineering Department of that branch of Government service. He received his early education at Clifton College, and passed to the Royal Military Academy, obtaining in 1887 a Commission in the Royal Engineers. His services in India and at the War Office, in which he obtained rapid promotion, gave him a wide experience, both with engineering works and administration problems, which qualified him for the post of Head of the Engineering and Works Department of the Crown Agents, to which he was appointed in 1904. During the war Sir James was assistant to Major-General Sir Percy Girouard on the Armaments Output Committee at the War Office, and was later transferred to the Ministry of Munitions as personal assistant to the Director of Materials in the department responsible for the provision of steel and other metals for all purposes. After serving for a time as Assistant Director in the Department of Munitions Supply, he was transferred to the Iron and Steel Department, then presided over by Mr. (afterwards Sir) John Hunter, and was responsible for the formation of the High Speed Steel Committee. At the end of the war Sir James Carmichael returned to the Crown Agents, with whom he continued to serve as Head of the Engineering Department, and later as Chief Engineer, until in 1921 he was appointed to be one of the Crown Agents. He finally retired in 1932. He was a member of the Institution of Civil Engineers, a member of the Smeatonian Society, and a Chevalier of the Legion of Honour.

A Fast Cross-Channel Motor Ship.

The Belgian State Marine Department's new cross-Channel motor ship "Prince Baudouin" completed on Monday last her maiden voyage on the Ostend-Dover service, when the contract speed of 23·5 knots was considerably exceeded. She was ordered in 1931 from the Société Anonyme John Cockerill, and was built at the firm's shipyard at Hoboken, her engines being constructed at the Seraing works. She is designed for first and second-class passengers, and has a length of 370ft., with a measurement of about 3300 gross tons. She is an open-shelter-deck vessel, and new features of design include a streamlined form of superstructure and a shortened funnel, with low masts in order to reduce wind resistance. The propelling machinery comprises a twin-screw arrangement of Cockerill-Sulzer oil engines, with a total maximum designed output of 17,000 S.H.P., and a service output of 15,000 S.H.P. They are twelve-cylinder units, with cylinders having a bore of 580 mm., or nearly 22⅞in., and a stroke of 840 mm., or 33 1/16in. The auxiliary engines, which were supplied by Sulzer Brothers, of Winterthur, are eight-cylinder units operating on the four-stroke principle. A feature of the engine-room design is the special seating for the engines, which is welded on to the double bottom of the ship. On her arrival at Dover on Monday last, the "Prince Baudouin" was greeted by a large party, representing the Southern Railway Company, the Dover Harbour Authorities, and other railway and shipping interests.

Development of Civil Aviation.

The London Chamber of Commerce has, on the recommendation of its Aviation Committee, submitted through the Air Ministry its views on the development of civil aviation, and in a memorandum submitted for the consideration of his Majesty's Government the following suggestions are put forward, together with a strong plea for the formulation of a properly co-ordinated plan on a national scale. It is proposed that the ground equipment and traffic control of British air routes should be vested in a statutory body on which the Air Ministry, the General Post Office, aircraft operators, insurance and commercial interests, among others, should be represented. This body, it is stated further, should be independent of all other organisations, and should stand in much the same relation to aviation as Trinity House does to shipping. The suggestion is put forward that the finances necessary for equipping and maintaining the air routes with wireless, lighting, meteorological, and traffic control services should be provided by the Government and administered by this body, which should also arrange for the collection of dues as in the case of merchant shipping. It is also proposed that this body should be appointed without delay to plan, in consultation with the appropriate authorities, the principal air routes and aerodromes in this country, having regard to present and future needs. It is further submitted that the duties of such a body should include consideration of matters affecting Imperial air routes.

Launch of H.M.S. Galatea.

On Thursday, August 9th, the light cruiser H.M.S. "Galatea" was launched at the Greenock Yard of Scott's Shipbuilding and Engineering Company, Ltd., the naming ceremony being performed by Lady Alice Shaw-Stewart. The new ship has a designed displacement of 5200 tons, a length of 480ft., a beam of 51ft., and a mean draught of 13ft. 10in. She carries a full complement of 8in. and 4in. guns, 21in. torpedo tubes, and a seaplane catapult. In the hull structure electric welding has been largely employed instead of the usual riveting. There are four sets of single reduction geared turbines of the Parsons reaction type with an output of 64,000 S.H.P. and a propeller speed of 350 r.p.m. The turbines drive independent propellers, and cruising turbines are provided. The gears are of Parsons latest "All Addendum" type. There are four Yarrow type water-tube boilers designed for burning oil fuel under the closed stokehold system with forced draught, which supply steam at 350 lb. per square inch to the main engines and the auxiliary machinery. The auxiliary equipment includes two turbo-electric generator sets and two oil engine-driven generating sets, which supply the necessary power for all motor-driven auxiliaries and the ship's services designed to take electric power.

Cherbourg Harbour Works.

No. II.

(*Continued from page 131, August 10th*).

DREDGING.

THE area between the east face of the first deep-water quay and the west face of the second deep-water quay, now being constructed, was dredged down to rock level, varying between levels —14·0 m. at the outer end of the berths and —10·0 m. at the inner or shoreward end. This work was proceeded with after the caissons in the first deep-water quay had been sunk to their full depth. A typical section of the strata on the line of the quay wall is shown in Fig. 14. The clear space between the two quays is

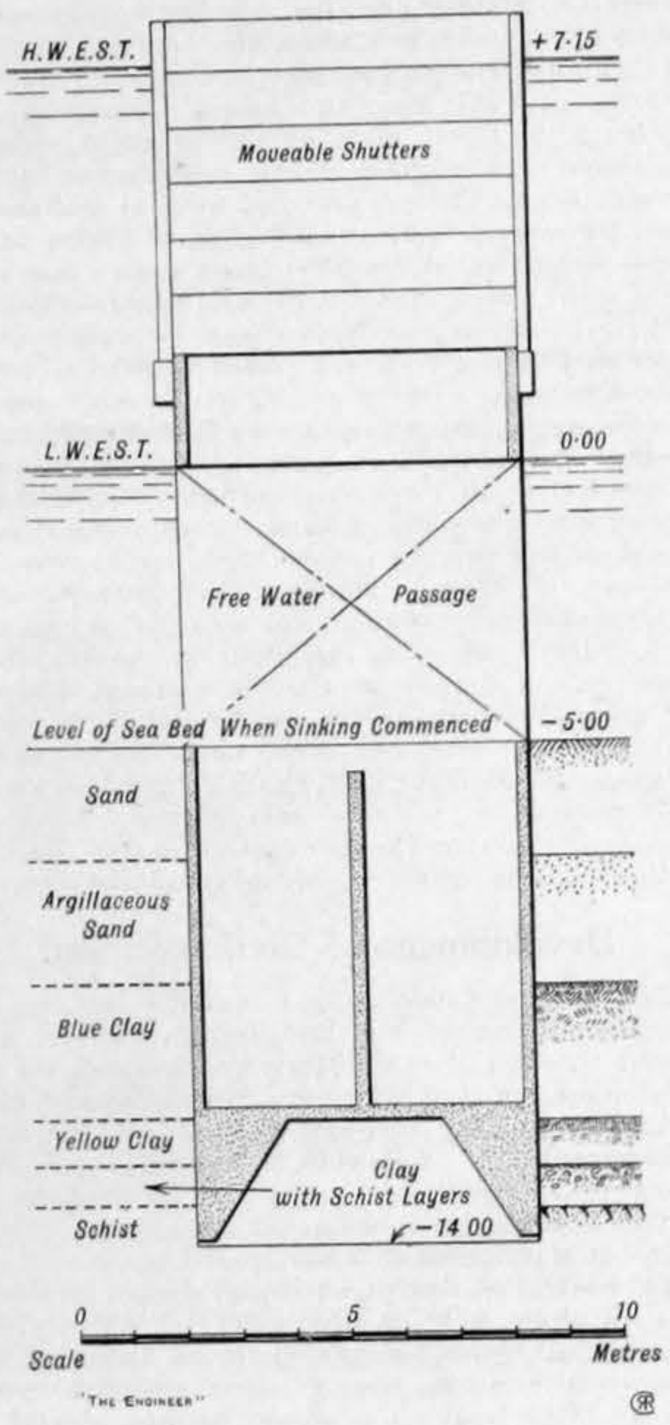


FIG. 14—STRATA ON LINE OF QUAY WALL

230 m. The approach to the deep-water berths in the inner harbour, including the passage between the Homet and Flamands jetties, has also been dredged to —11·0, the dredging in the Petite Rade being of a width sufficient to provide a turning area of 800 m. diameter. All the dredging in connection with the construction of the two moles and in the access channel, as well as the reclamation work, is being carried out by L'Enterprise des Travaux Publics de L'Ouest of Nantes.

GARE MARITIME.

The new gare maritime has been erected on the mole which we have already described. It includes :

(*a*) A main building, 280 m. long by 42 m. wide, adjoining the quay, with a campanile about 70 m. in height and a landing gallery over 500 m. long.

(*b*) A railway station, 240 m. long and 40 m. wide, with a single span roof covering the railway tracks and passenger platforms.

(*c*) A hall about 240 m. long and 15 m. wide, between the main building and the railway station, covering an approach road for motor traffic.

The three buildings adjoin, as shown in Figs. 15 and 16. The main building has two floors extending over its entire area, with additional floors constructed in bays on either side. The first floor is connected with the motor traffic hall and the railway station by wide gangways with access staircases to all the platforms.

Monsieur René Levavasseur, the architect of the gare maritime, when he was called upon to design the building, was faced by conditions which are peculiar to the port of Cherbourg, which is essentially a port of call for Transatlantic liners and not a home port. In this respect its trade differs from that of either Southampton or Liverpool. It was necessary that all the accommodation to be provided should be specially designed for the very rapid handling of passenger traffic in order that the detention of a liner in port should be reduced to the minimum possible time, and that passengers should be transferred to or from railway trains with a minimum of delay. The gare maritime, as constructed, makes provision for the separation of heavy baggage, mails, goods, and motor cars from all classes of passengers and their light luggage. The former are confined to the ground floor of the building—that is, to quay level—whereas the whole of the passenger traffic is carried on at the level of the first floor of the building.

The deep-water quay provides berths which will accommodate at the same time two Transatlantic liners of the largest size. The embarkation of passengers in or their landing from two such vessels can be carried on simultaneously, thanks to the covered-in landing gallery on the east face of the gare maritime, which has a usable length of over 500 m.

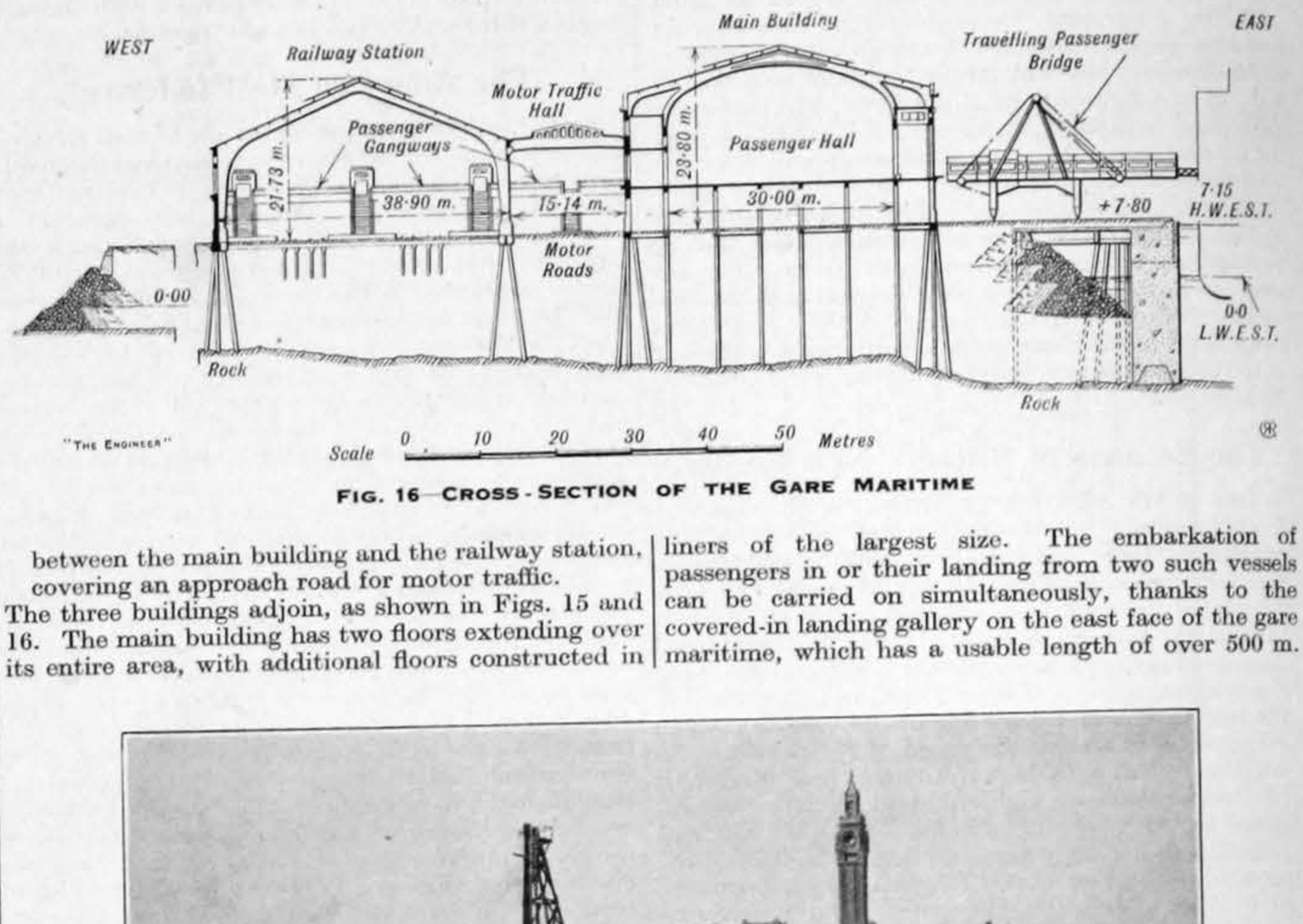


FIG. 16—CROSS-SECTION OF THE GARE MARITIME

FIG. 17—ERECTION OF SUPERSTRUCTURE OF QUAY WALL

Passengers embark or disembark at the level of the first floor of the gare maritime, the connection between the vessel and the gallery being provided by means of nine traversing passenger bridges travelling on rails and spanning the open quay space, 31 m. in width, between the main building and the ship berths (see Fig. 24 and page 162). Each of these bridges comprises an enclosed corridor, 4 m. wide, divided into two equal parts by a longitudinal railing. One half of the gangway is for passengers and the second half for passengers' baggage, other than that intended

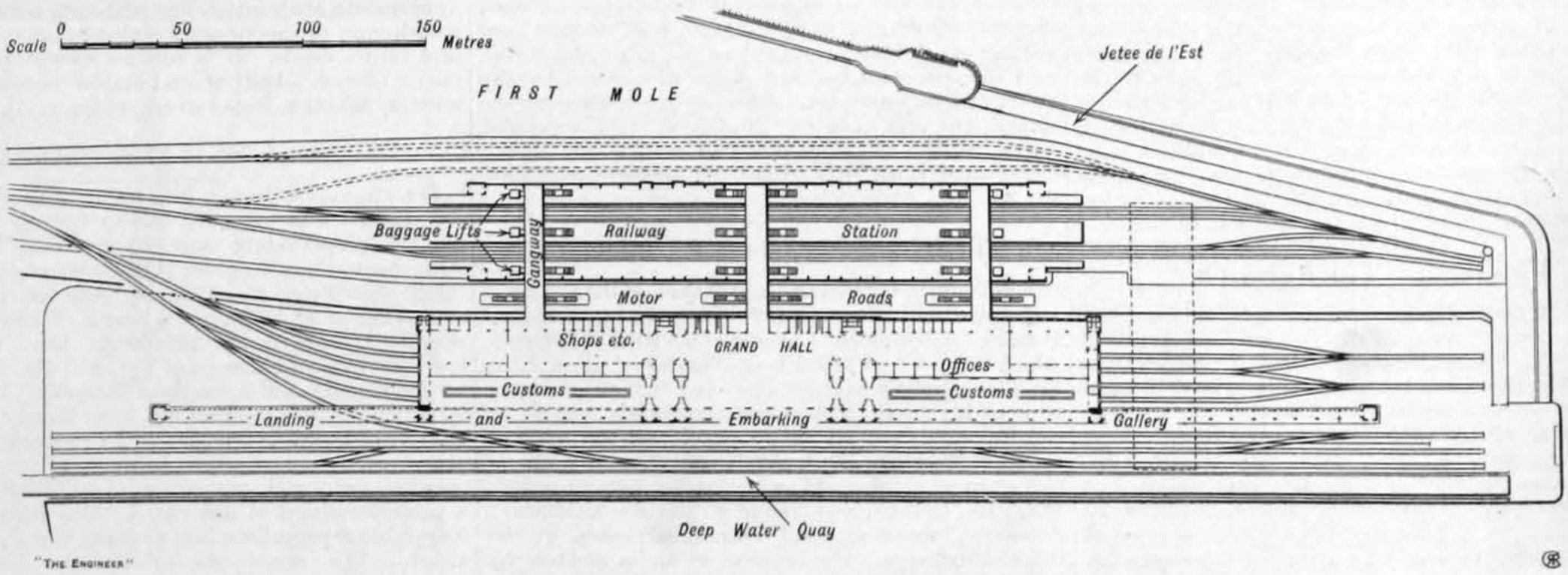
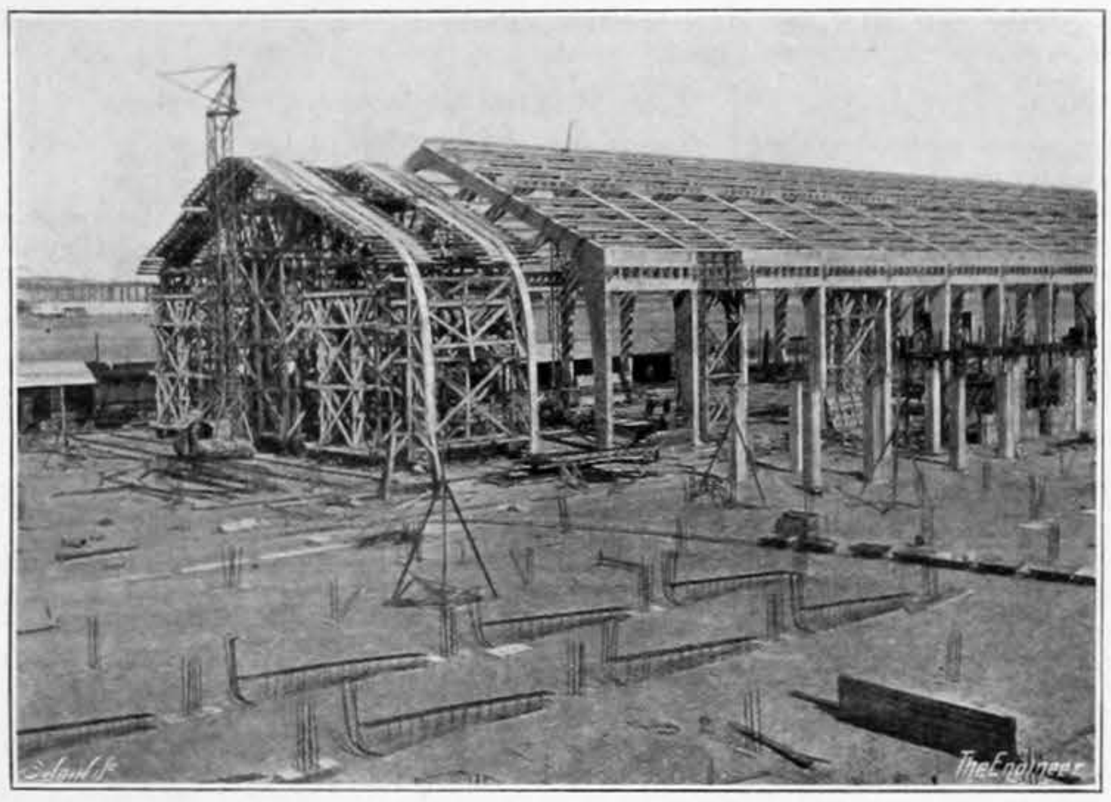
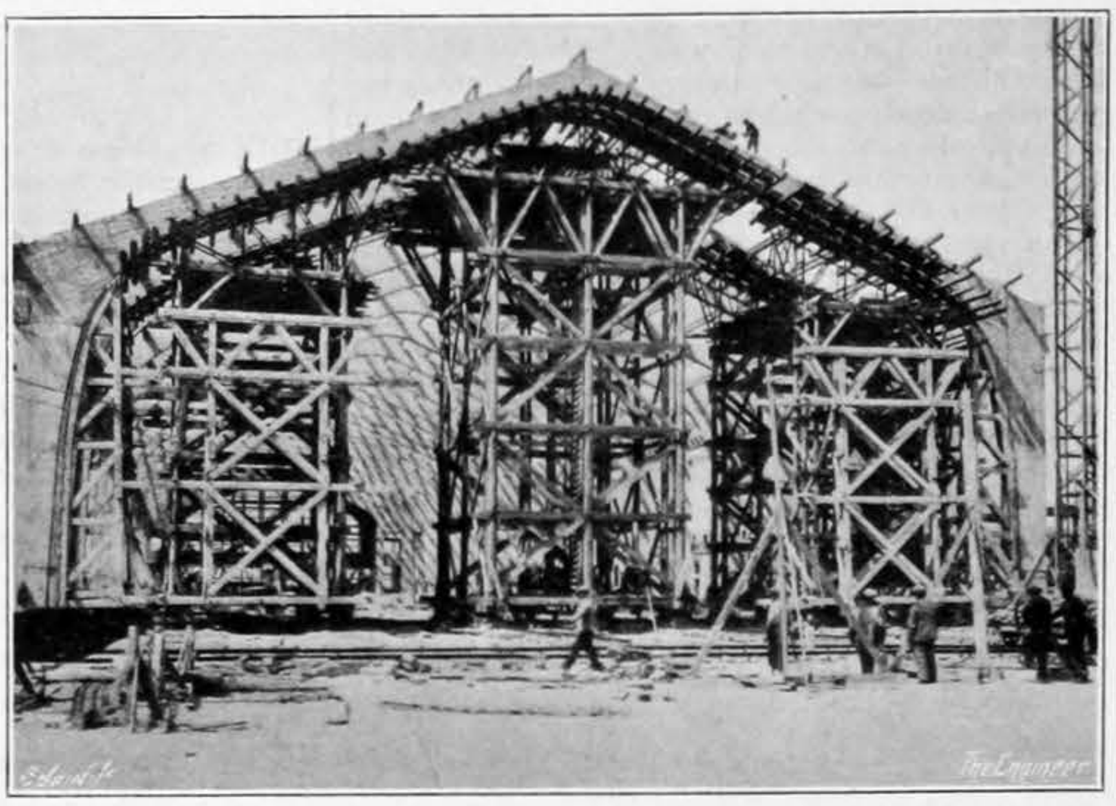


FIG. 15—GENERAL PLAN OF DEEP WATER QUAY NO. 1 AND THE GARE MARITIME

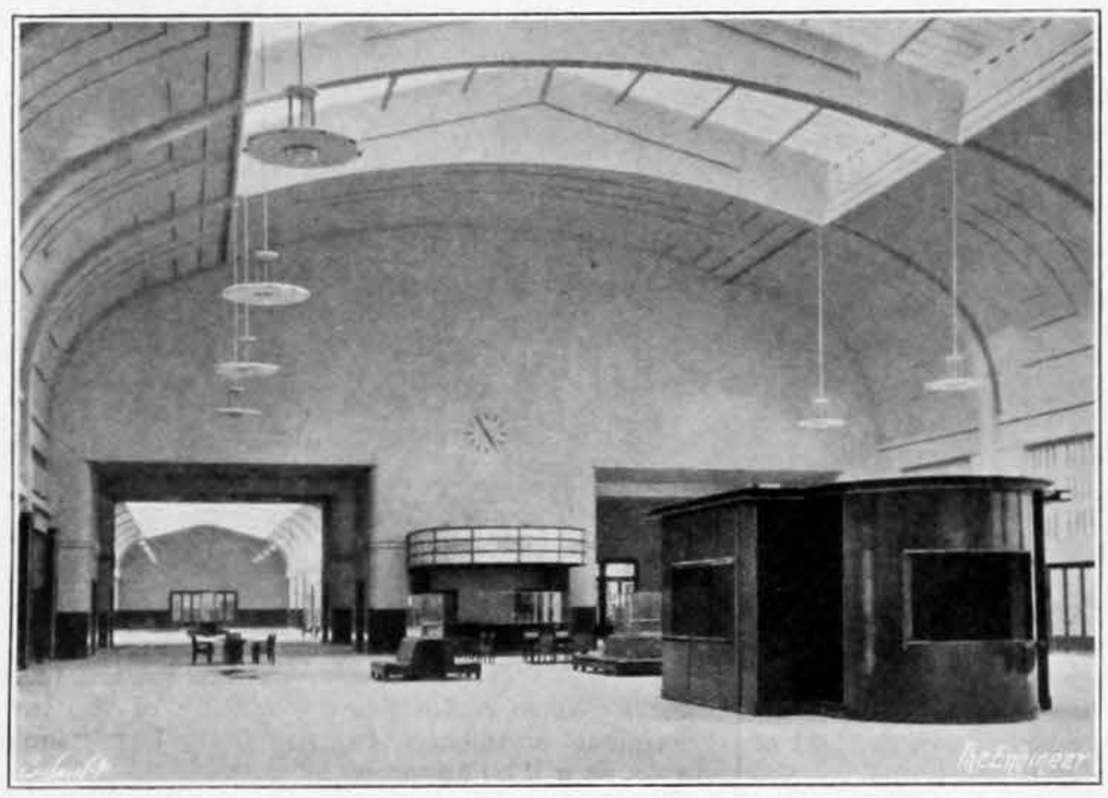
for the ship's hold, and for baggage porters and staff. The baggage is transported over the bridge by an electric belt conveyor with a telescopic extension projecting to a maximum of 9 m. beyond the face of the quay. The conveyor is seen in the cross section of the travelling bridge (Fig. 24). The outer part of the bridge corridor is hinged and can be raised out of the way of the quayside travelling portal cranes, if it should be necessary to traverse one of the latter past a movable bridge, as shown in a view on p. 162. The outer section of the bridge can also be raised and lowered as required to accommodate it to the level of within a few minutes of the vessel being made fast to the quay. Each class of passengers can be disembarked in close proximity to the appropriate Customs examination hall. The travelling portal cranes, which run on lines of rails placed between those supporting the passenger bridges and the edge of the quay, deal with heavy baggage and mails in containers. Special provision is also made for loading and unloading motor cars with a minimum of delay.





FIGS. 18 AND 19—TRAVELLING SCAFFOLDING AND SHUTTERING FOR THE GARE MARITIME

The main building provides, at the level of the first floor, a Grand Hall, 56 m. long, extending the entire width of the building, 42 m., and known as the *Salle des pas Perdus*. It is flanked by two pavilions surmounted by small towers, which serve as water tanks, and by the campanile rising to a height of about 70 m. above quay level. At each end of the *Salle des pas Perdus* are passenger halls containing two distinct sets of Customs examination offices, passport, post and telegraph offices, medical services, lavatories, general offices, buffets, restaurants, offices of the steamship companies, waiting rooms, and numerous shops and similar accessory conveniences for travellers. On this floor are also provided suites of rooms for the reception of distinguished travellers, and on the floors above it rest rooms for passengers.



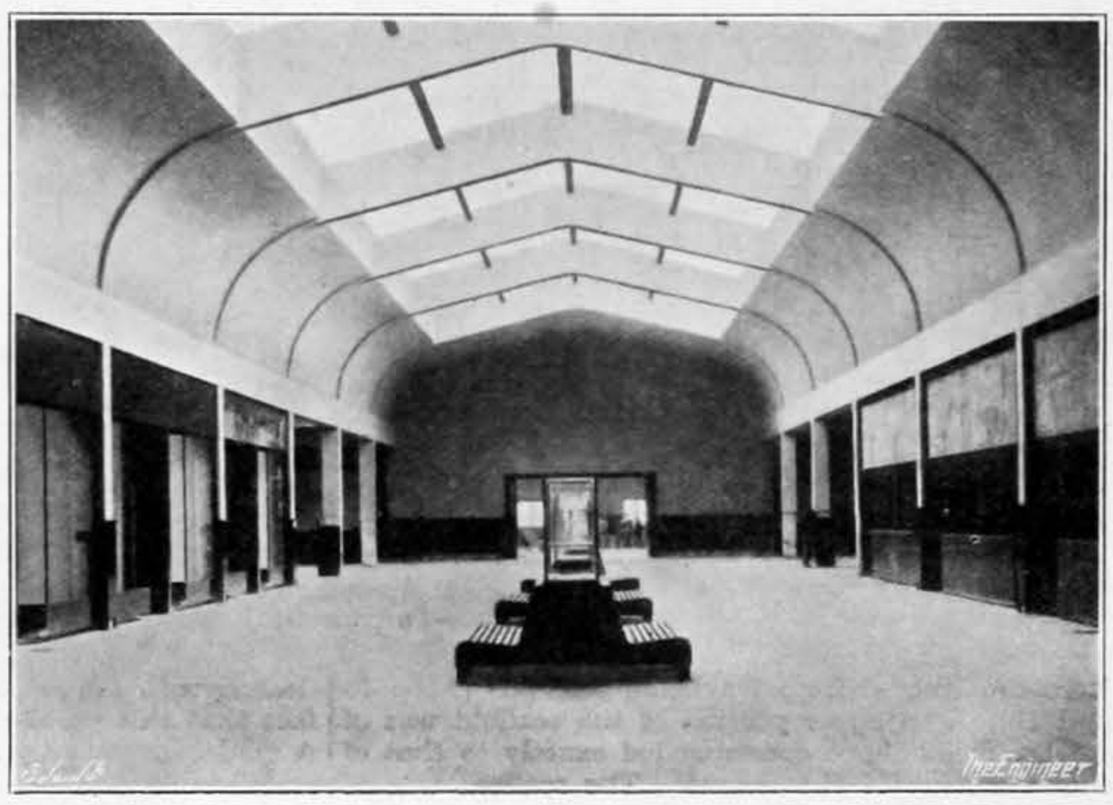


FIG. 20—SALLE DES PAS PERDUS

FIG. 21—PASSENGER HALL

The ground floor at quay level is, as we have said, reserved for heavy baggage and mails and for other goods in transit to or from the railway station at the back of the gare maritime. At this level there are numerous offices and stores, and accommodation for the mail service, medical and quarantine departments, harbourmaster's department, police offices, baggage depositories and fire appliances, as well as storage space rented by the shipping companies which will make use of the deep-water quay. The plant for

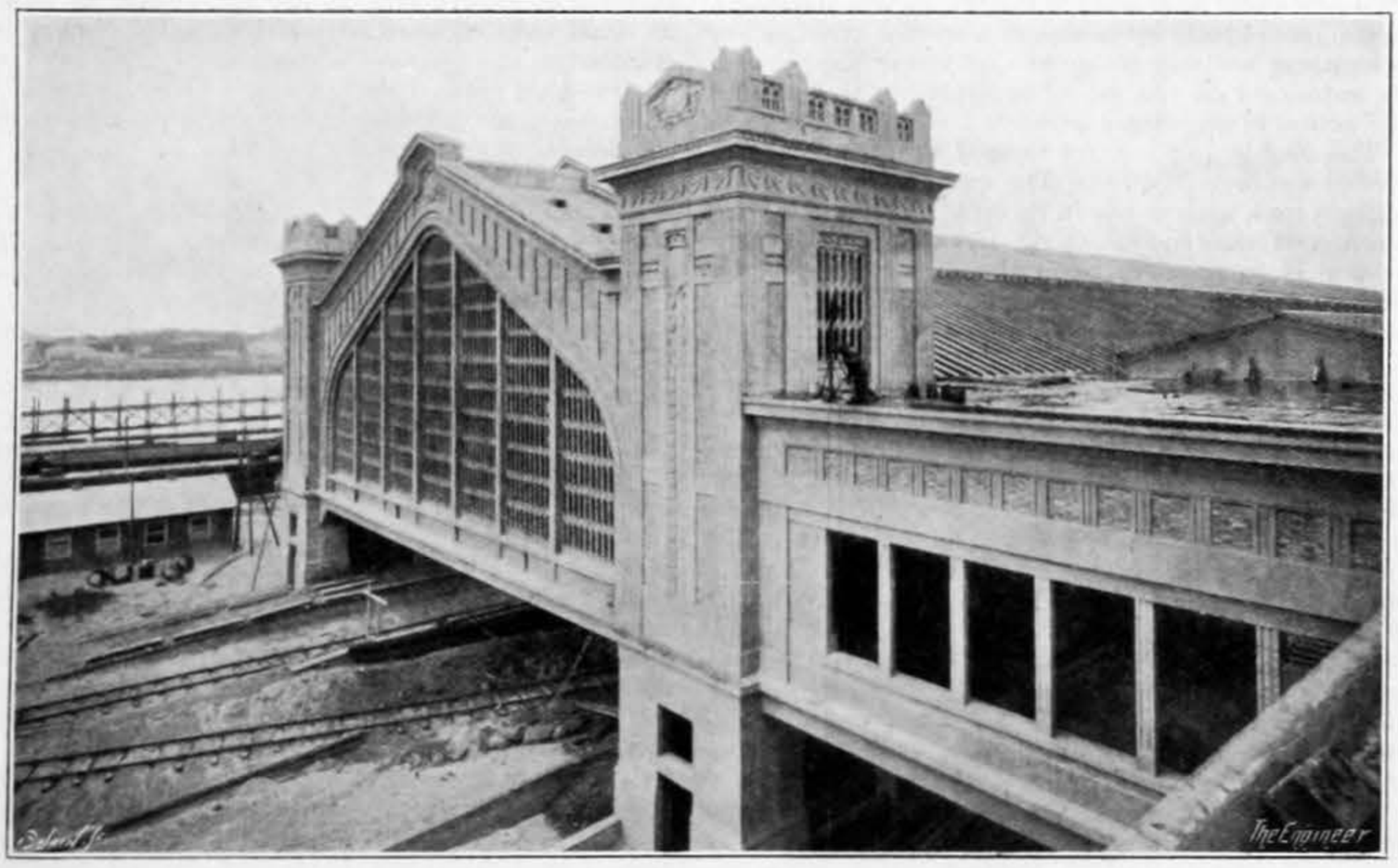


FIG. 22—SOUTH END OF GARE MARITIME BUILDING

FIG. 23—PORTAL CRANE

of the ship's gangway within the limits shown on the drawing (Fig. 24).

This very liberal provision of passenger bridges allows of any gangway door of a liner being made use

central heating and electric services is also housed in the main building at quay level. All the transit of passengers' baggage, both on the first floor and at quay level, is carried on by means of electric runabout trolleys, except where conveyor belts are used.

Between the main building and the railway station proper is a double roadway for motor traffic completely covered in and 15 m. wide. Motor cars can discharge or take up their passengers close to numerous stairways, which ascend to the first floor of the main building. Behind the motor roads is the railway station, the tracks being parallel to the main building. There are three platforms serving four lines of railway track. The railway station is equipped with electric hoists for the conveyance of passengers' baggage to the first floor level.

The buildings of the gare maritime are constructed, mainly of reinforced concrete, on the sand-filled area between the rubble mounds already described. It was therefore necessary to provide a piled foundation, the piles being driven down to rock level by water jets. All the piles, 923 in number, are of reinforced concrete, 0·32 m. by 0·37 m. in section and about 20 m. in length. Some of the piles are driven on a batter.

The reinforced concrete frames which form the main supports of the roof and walls of the buildings were constructed from travelling scaffolds (Figs. 18 and 19). The upper portion of the scaffold was of steel, and its shape corresponded exactly to that of the underside of the frames. The scaffold was of sufficient width to cover one pair of frames simultaneously. The panels of shuttering, as well as the reinforcement, were lifted on to the scaffold by cranes, which were afterwards used for placing the concrete. The complete construction of two frames, wind bracing girders, and purlins occupied about three weeks. Rapid-hardening Portland cement was used in the construction of the frames and the shuttering was stripped after five or six days. The railway station hall is spanned by reinforced concrete trussed frames rising to a height of 20 m. above rail level. These spans are calculated as arches with double articulation. The architectural facing of the buildings is carried out in granite and pink coloured artificial stone.

Our description of the buildings should not close without a mention of the interior decoration. Generally, the decorative treatment of the large halls is simple, and sets off the fine proportions of the reinforced concrete arch ribs in the *Salle des pas Perdus*. It is intended to fill the panels in the gable ends of this hall with mural decoration, probably in fresco. The reception rooms, offices, shops, and the American bar are decorated in the modern manner. Views of the gare maritime, showing its exterior appearance, are reproduced on page 162.

On the quay fronting the main hall there are three railway tracks, as well as the tracks carrying the travelling landing bridges and the portal cranes. All the railway tracks are connected with the main line to Paris, and it is expected that the time of transit between Paris and the Cherbourg gare maritime will in future be reduced to under 4½ hours. On July 30th, when the President of the Republic performed the opening ceremony at the gare maritime, the new "Bugatti" train actually made the journey from Paris to Cherbourg in under 3½ hours. This train is hauled by an internal combustion locomotive.

(To be continued.)

The authorities at Heston air port have decided to install direction-finding apparatus, similar to that in use at Croydon.

Ship Stabilisation by Activated Tanks.

AN EXPERIMENTAL INVESTIGATION.

By NICHOLAS MINORSKY, Ph.D.

Introduction.

THE problem of stabilising ships against rolling has recently attracted a greater degree of interest than before, and has resulted in certain practical applications of which the gyroscopic stabilising equipment installed on board the "Conte di Savoia" undoubtedly occupies the first place. Somewhat less spectacular, but by no means less interesting, is the work conducted, mainly in Germany, on the so-called activated tank system in which the displacement of the ballast is controlled by a local source of power—*e.g.*, compressed air from a turbo-blower—instead of being brought about solely by the ship's angular motion as in the "passive" tank system identified with the name of Dr. Frahm.

A considerable amount of information is available concerning the theory and performance of Frahm tanks. There is, however, practically none dealing with the active tank method, in view of the fact that this problem is a comparatively new one. A model investigation of the active tank method of stabilisation has recently been carried out by the author at the Moore School of Electrical Engineering of the University of Pennsylvania, U.S.A., and in what follows a brief account is given of this work. The experiments were conducted on a pendulum model arranged to operate in accordance with Froude's theory of resisted rolling among waves. It is well known that the differential equation of Froude's theory introduces certain assumptions as to the regularity of the seaway acting on the ship. This particular limitation of the theory was eliminated in the model tests by means of a special arrangement permitting entirely irregular disturbing moments to be impressed on the model imitating in this manner the action of an erratic seaway.

The problem of control formed the principal subject of the investigation. The main drawback in the passive tank system lies in its erratic behaviour when a confused sea is encountered. If, therefore, the active system is to improve upon the performance of the passive system, the improvement must concern the ability of the controlling equipment to perform satisfactorily when the moments impressed on the ship vary in an erratic manner.

The model experiments were carried out in accordance with the law of similitude, thereby permitting the direct application of the results to a full-scale ship. Certain limitations of Froude's theory are inevitably embodied in the model data, which for this reason must be corrected if their extension to the ship's behaviour is desired with a great accuracy. It must be noted, however, that Froude's theory of resisted rolling among waves in its original form is found to be in fairly good agreement with observations of rolling made on normal ships, in spite of all the assumptions and limitations associated with the theory.

According to Froude, the differential equation of resisted rolling among waves is

$$I\frac{d^2\theta}{dt^2}+k_1\frac{d\theta}{dt}+k_2\left(\frac{d\theta}{dt}\right)^2+W h \theta = \varepsilon W h \Theta \operatorname{Sin}\frac{2\pi}{T}t \quad . \quad . \quad . \quad . \quad (1)$$

where θ is the angle of rolling.

Θ is the maximum angle of the effective wave slope.

W is the displacement of the ship.

h is the metacentric height of the ship.

T is the period of the waves.

k_1, k_2 are the coefficients of natural resistance to rolling arising from the action of the bilge keels, skin friction, &c.

I is the moment of inertia of the ship about its longitudinal axis through its centre of gravity.

ε is an empirical coefficient commonly assumed to be unity.

Description of the Model.

The model, Fig. 1, embodies a pendulum about 1900 lb. in weight, having a period of 4 sec. and an equivalent length, *i.e.*, distance between the centre of gravity and the axis, of 1¼in. These particular figures are not altogether arbitrary, but are related to each other so as to make the application of the law of dynamical similitude to the model particularly simple, as will be apparent later.

The terms with k_1 and k_2 in equation (1) characterise the natural damping caused by the bilge keels, skin friction, &c. To obtain similar conditions in the model tests a tank A, filled with oil, was placed under the pendulum, to the lower end of which was attached a paddle of variable cross section. During the oscillation of the pendulum, the motion of the paddle through the oil in the tank introduced frictional terms leading to the extinction of the oscillation. The position of the paddle on the pendulum, as well as its cross section, were adjusted so as to obtain substantially the same decrements—$\Delta\theta$—as those observed on normal ships fitted with bilge keels. It is known that the decrement is related to Froude's coefficients of extinction a and b by the equation

$$-\Delta\theta = a\theta + b\theta^2,$$

where θ is the amplitude of rolling. A relationship also exists between a and k_1 on the one hand, and b and k_2 on the other hand.[1]

In the author's case the coefficient a was about 0·06 and b was less than 0·01. A typical curve of extinction of oscillations is shown in Fig. 4.

An action equivalent to that of the moment of buoyancy $W h \theta$ as well as to that of the effective wave slope $W h \Theta \sin \frac{2\pi}{T} t$ was introduced by springs B B attached to the ends of a lever C, capable of being rocked on both sides of its horizontal position through an angle proportional to the maximum angle Θ of the effective wave slope of Froude's theory. The rocking motion impressed on the lever C was transmitted from a rod D—Fig. 2—connected to a Stephenson link E. By displacing the sliding block of the link it was possible to change both the magnitude and direction of Θ. The rod and link were actuated by an electric motor F. By changing the speed and direction of rotation of the motor and also the value of Θ by means of the link very irregular erratic disturbances could be impressed on the pendulum to imitate the action of a confused sea when the apparent period, the slope, the shape, and the phase of the waves

[1] E. L. Attwood, "Theoretical Naval Architecture," 1916, page 358.

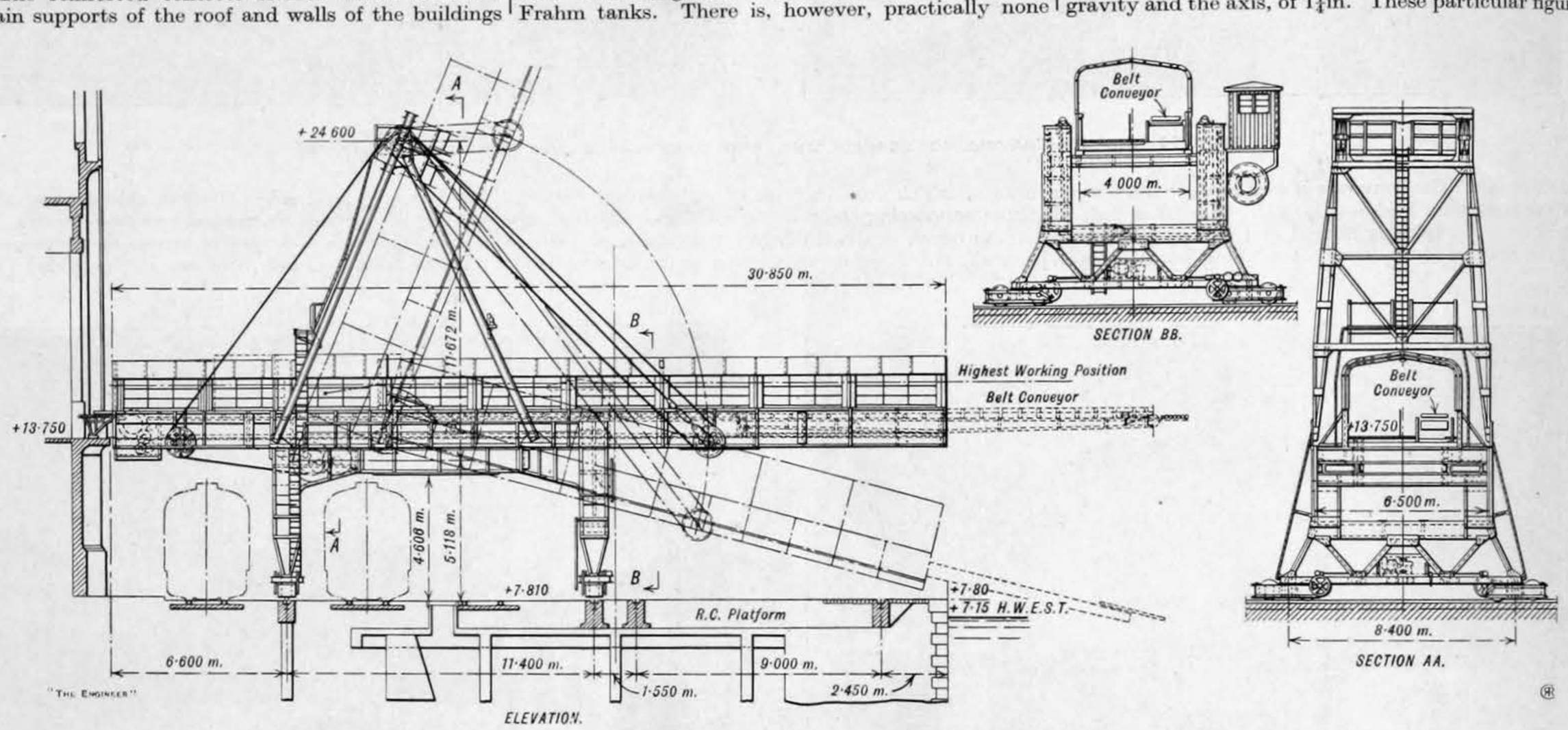


FIG. 24—TRAVERSING PASSENGER GANGWAY AND CONVEYOR FOR LIGHT BAGGAGE

encountered by the ship change erratically from wave to wave.

STABILISING SYSTEM.

Power Plant.—The anti-rolling stabilisation of the model was produced by means of a pair of tanks G G connected by a tubular channel H. The activation of the ballast was derived from an impeller pump

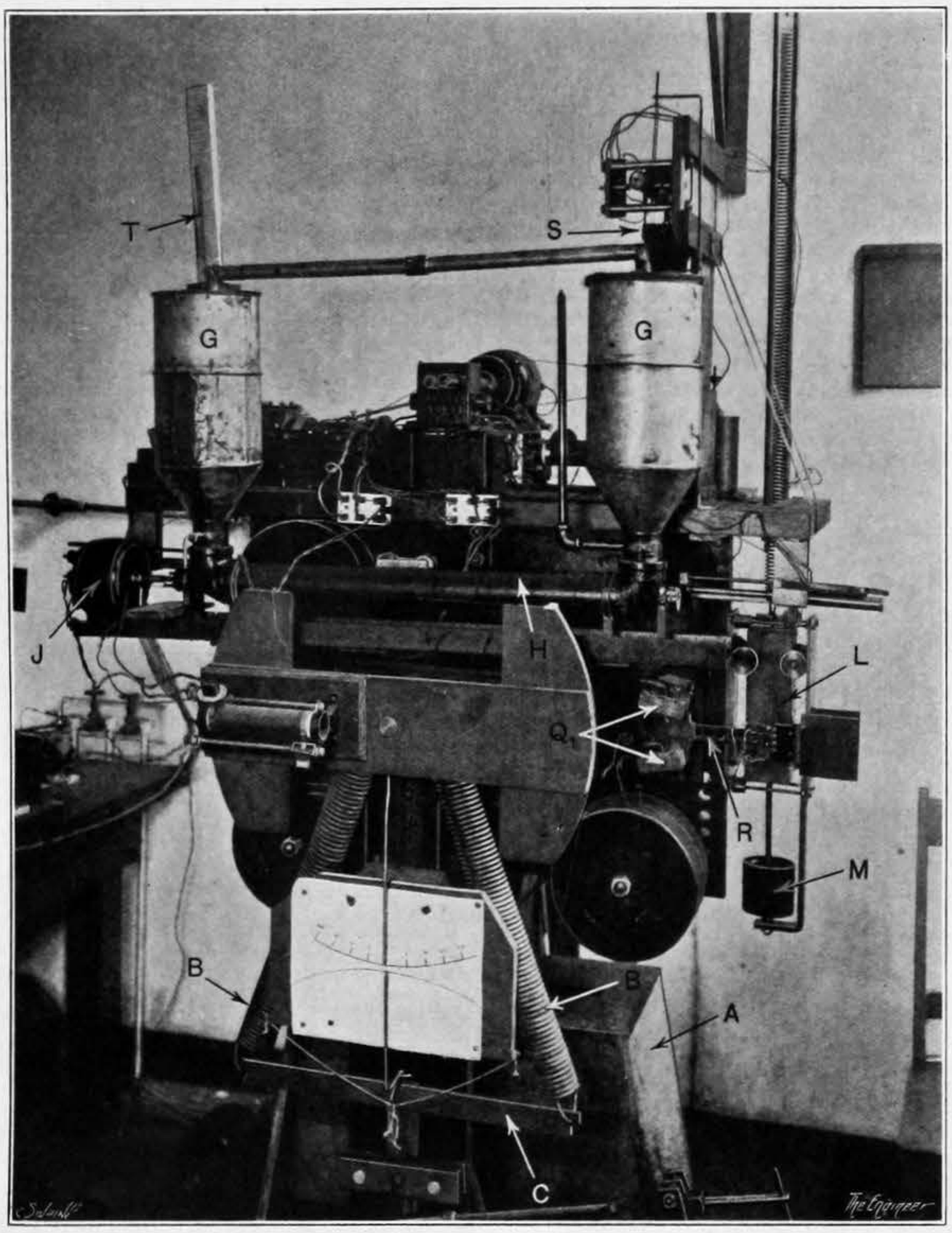


FIG. 1—EXPERIMENTAL ACTIVATED TANK APPARATUS

placed coaxially with the channel in its middle (see also Fig. 3 in this connection). An electric motor J drove the impeller shaft. The armature of this motor was directly connected to that of a generator K. The reversion of the direction of rotation of the impeller shaft was obtained by reversing the field of the generator. The impeller pump consisted of a small four-bladed screw about 3¼in. in diameter. Plane vanes arranged on both sides of the screw in the channel were found to increase materially the hydraulic efficiency of the pump by eliminating rotational motion of the ballast in the channel.

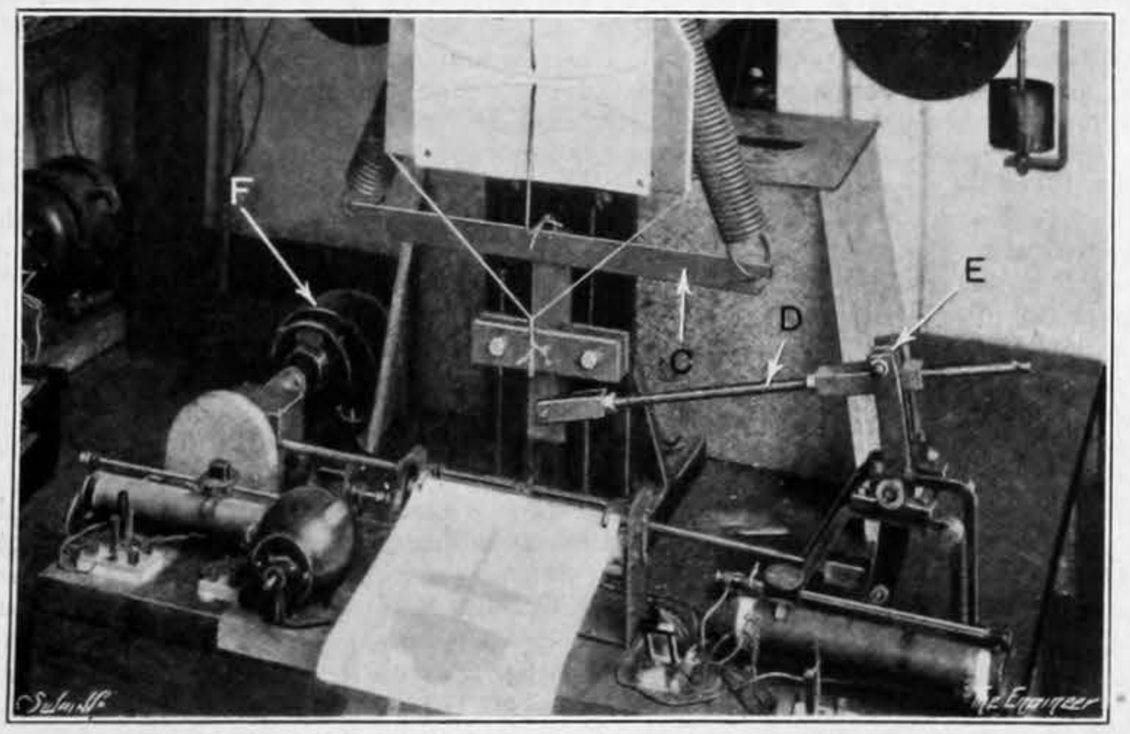


FIG. 2—ROCKING MOTION GEAR

Stabilising Control: Theoretical Considerations.—The primary purpose of any stabilising equipment is to set up a moment substantially equal and opposite to the external moment of the waves. The correct control of the stabilising plant must therefore exhibit three fundamental features, namely, (*a*) continuity of action, (*b*) rapidity, (*c*) correct phase. The first two requirements are almost obvious. The action of the waves on the ship varies continuously with time. Hence the reaction of the stabiliser must also be continuous to enable it to follow the continuous disturbance. The second requirement (*b*) implies that the cause (action of the waves) and the effect (reaction of the stabiliser) should relate to the same instant, which, in combination with condition (*a*), is equivalent to the condition that the stabiliser should deal with the instantaneous values of the disturbing impulses as they arise. These two fundamental conditions (*a*) and (*b*) were satisfied in the model by adopting a thermionic valve system as the connecting link between the instruments described below and the field of the generator controlling the actuation of the ballast through the Ward-Leonard unit J K. The action of a thermionic valve is a continuous one, and on account of the high ohmic resistance when such valves are inserted in an inductive circuit, the time constant of the circuit is greatly reduced, so that it transmits controlling actions with great rapidity.

The last condition (*c*) is less obvious. Actually any term added to equation (1) and capable of producing damping decrements in addition to those which exist by virtue of the terms with the coefficients k_1 and k_2 answers the purpose; the problem thus appears to be somewhat indefinite. The simplest solution, however, is obtained if the damping is associated with the term $\frac{d\theta}{dt}$. The stabilising moment must in this case be of the form $K_s \frac{d\theta}{dt}$ and its insertion in Froude's equation gives a term $(k_1+K_s)\frac{d\theta}{dt}$, where k_1 is the natural damping due to the bilge keels, &c. and K_s the damping due to the stabiliser.

This condition therefore requires that the stabilising moment and hence the instantaneous excess of water w in one of the tanks should be varied so as to be instantaneously proportional to $\frac{d\theta}{dt}$, namely,

$$w=-a\frac{d\theta}{dt} \quad . \quad . \quad . \quad . \quad . \quad (2)$$

Differentiating equation (2) we have

$$\frac{dw}{dt}=-a\frac{d^2\theta}{dt^2} \quad . \quad . \quad . \quad . \quad . \quad (3)$$

From the standpoint of the final result, that is, production of a stabilising moment in phase with $\frac{d\theta}{dt}$, both equations are equivalent, since by integrating (3) we obtain (2). From the practical standpoint, however, there is a certain difference between the two methods of control arising from the fact that, generally speaking, disturbances acting on the ship are never regular. It is easy to see that in the case of irregular disturbing actions the curve of angular acceleration as a function of time precedes that of angular velocity, since the latter builds up as a time integral of the former. From this point of view, control in accordance with equation (3) is preferable to that given by equation (2), although for regular disturbances—of a pure trochoidal type, for example—there is no difference between the two methods.

Assuming control in accordance with equation (3), we see at once how such a control should be produced. The right-hand side contains $\frac{d^2\theta}{dt^2}$ and therefore on its primary side the control must be derived from an instrument responsive to angular acceleration, *i.e.*, an accelerometer. On the secondary side, connected with the motion of the ballast, the control must be related to $\frac{dw}{dt}$ or to the velocity of flow of the ballast between the tanks.

Stabilising Control: Description of System.—The accelerometer used in these experiments was made to respond to linear, and not to angular, accelerations.[2] The instrument is seen on the right of Fig. 1, and is constituted by a block of iron L, 25 lb. in weight, suspended on a long spring and guided by anti-friction rollers. The free period of the block was made considerably shorter than the period of angular motion of the model. An oil dashpot M was found to be of great help in obtaining dead beat indications. The limit of sensitivity of the accelerometer thus constituted was about 0·0125 radians/sec.². This figure corresponds to an angular acceleration of a harmonic motion having an amplitude of about 0·6 deg. and 4 sec. period. If the angular acceleration is below this limit the control system associated with the accelerometer remains idle. It is apparent that an instrument of this kind designed for a ship could be made considerably more sensitive by using a heavier weight and also by virtue of the much longer

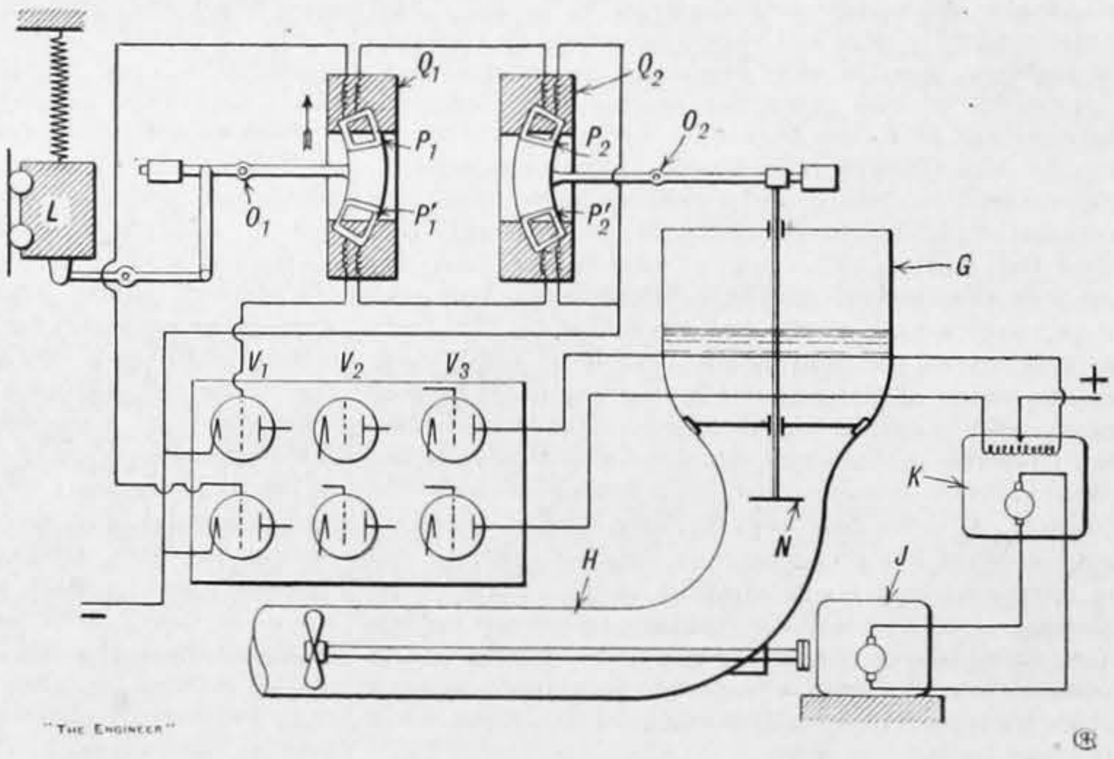


FIG. 3—STABILISING CONTROL EQUIPMENT

[2] In the experimental equipment this arrangement was possible because of the lack of pitching and heaving. On board a ship it is necessary either to use an angular-acceleration responsive instrument (*e.g.*, a heavy fly-wheel supported at its centre of gravity) or to employ two—port and starboard—linear-acceleration responsive instruments of the type used in this investigation. The effect of pitching and heaving in such a case can easily be eliminated in a differential connection of electrical circuits, so as to render the system responsive solely to rolling.

lever arm of angular motion which would be available.

To obtain a secondary control responsive to the velocity of flow in the connecting channel, a ¾in. disc, N, Fig. 3, was placed in the channel at right angles to the lines of flow near the point where the channel enters the right-hand tank. This disc is mechanically connected by a rod to the control member described below. Centralising springs and a dashpot are provided for this rod on top of the right tank G—see Fig. 1.

The electrical circuits associated with the accelerometer and the disc are shown in Fig. 3, in which L is the accelerometer and N the disc of the secondary control. Connected to L and N through amplifying levers are two arc-shaped members pivotally mounted about centres O_1 and O_2, and each having a pair of flat coils $P_1 P_1^1$ and $P_2 P_2^1$. Each coil has about 300 turns of fine wire. The coils are arranged to move in the air gaps of two alternating-current electromagnets Q_1 and Q_2, shown diagrammatically by projection of their pole faces and excited by 500-cycle current. It is apparent that for a deviation of the coils connected to L in the direction of the arrow, the flux linkages and hence the voltage induced in P_1 is increased, and that in P_1^1 decreased. The coil circuit is connected to the grid control of a thermionic amplifier[3] in a "push-pull" connection. The coils $P_2 P_2^1$ of the secondary control connected to the disc N are inserted in series with the same grid circuit; their action, however, is in opposition to that of the coils P_1 and P_1^1. The amplifier system was formed by two stages of voltage amplification V_1 and V_2, and a third stage V_3 of power valves arranged to function as rectifiers. For the sake of clarity the intermediate connections of the amplifier circuits are omitted. The currents from the plates of the power valves V_3 pass through the differential field of the generator K.

Movement of the accelerometer unbalances the electrical equilibrium of the push-pull circuit, and starts the motor. The flow of the ballast past the disc N moves the coils $P_2 P_2^1$, and gradually decreases the primary action of the accelerometer control until the velocity of the flow adjusts itself to the instantaneous value of the angular acceleration. The continuity and rapidity of the action of the valves are such that the secondary system is able to follow the primary very closely, so that the fundamental equation (3) is continuously fulfilled. The accelerometer control lever can be seen at R in Fig. 1, and the corresponding electromagnet at Q_1. The corresponding elements of the secondary follow-up control are situated above the right tank at S. Observations on the variation of level in the tanks were made against a scale by means of a rod T connected to a float in the left-hand tank.

Experimental Data.

A series of records was taken for different conditions of performance. The recording chart and its connection to the pendulum can be seen in Fig. 2.

Fig. 4 gives the curves of extinction of free oscillations, corresponding to the still-water performance of the ship. Curve 1 was taken with the tanks closed. The decrements of subsequent oscillations in this case correspond to the coefficients a and b of Froude's theory. Curve 2 shows the extinction of amplitudes when the tanks are opened. The damping effect is increased by the passive performance of the tanks. Curve 3 was taken with the tanks open and the stabilising control started substantially at the same time. In view of the initial transient state corresponding to the speeding up of the motor, the stabilising action appears only at the second swing, and the approach to the equilibrium position is dead beat.

Fig. 5 illustrates steady quenching on a regular seaway. Curve 1 represents synchronous rolling with the tanks out of action. Curve 2 illustrates the action with the tanks open—*i.e.*, passive performance. Curve 3 shows the action with the stabiliser in operation.

In Fig. 6 the curves 1, 2, and 4 are the same as curves 1, 2, 3, in Fig. 5. Curve 3 shows the performance when the amount of transferred ballast was lowered by inserting a resistance in series with the armature of the motor. The amount of water ballast in this case was not sufficient to cope with the effective wave slope. Such a performance can be conveniently designated as the performance outside the roll-quenching limit, whereas the performance corresponding to curve 4 may be designated that inside the roll-quenching limit. In the latter case the amplitude of the residual rolling is determined by the degree of accuracy of the controlling instruments and circuits. In the former case the amplitude is determined by the amount of transferred ballast.

Fig. 7 illustrates roll quenching under conditions characterised by various relationships between the intensities of the primary and the secondary controls; it corresponds, therefore, to variable values of the coefficient a in equation (3). In the regions a to d the coefficient a was increased (in the order $a \longrightarrow b \longrightarrow c \longrightarrow d$), while from e to h it was decreased. This coefficient a of equation (3) measures the amount of transferred ballast, and hence the magnitude of the stabilising moment for a given angular velocity of rolling. Offhand, one may expect that the greater a the closer the stabilisation should be. This is really what happens when one passes from the region a to the region b in Fig. 7. For still more intense degrees of control (regions c and d) the amplitudes, however, are increased and not decreased and the residual rolling becomes irregular, although the disturbing moment was regular and constant throughout the test. A closer analysis of the records provides an explanation of this phenomenon. When the intensity of the control becomes too great, for a short time—*e.g.*, one-quarter of the period of rolling, which in this case is one second—the disturbance is wiped out almost completely. This fact is evidenced by the appearance of flat spots in the rolling curve. These flat spots can be noticed in the region c of the record; in d and e the curve F shows their locus. Each time such a spot develops the value of the angular acceleration falls below the limit of sensitivity of the accelerometer (which was 0·0125 rads/sec.^{2} in the author's case) and the control system becomes temporarily idle. About one-quarter of the rolling period later the amount of accumulated ballast finds itself instantaneously on the wrong side of the ship relatively to the phase of the disturbing moment at that instant and the disturbing acceleration develops anew under the joint action of the wave slope and of the ballast. Immediately after the stabiliser again enters vigorously into action and again a flat spot develops. We have thus a series of sustained transients reproducing themselves periodically. In this way the stabiliser momentarily drops out of step with the disturbance and a fraction of the period later it masters the rolling again. The over-regulation of the stabilising control therefore leads to rather complicated dynamical phenomena impairing the efficiency of the stabiliser. These phenomena are closely connected with the free period of the tank system, as is evidenced by the fact that the position of the flat spots relatively to the period is not constant, but varies with each roll, indicating the existence of a second frequency—that of the tank system. As a conclusion we may say that the increase of the intensity of the control is not sufficient by itself to reduce the amplitudes of residual rolling. Such reduction can be accomplished only if simultaneously the sensitivity of the accelerometer is increased.

Fig. 8 shows the performance of the stabiliser when quenching erratic disturbances. In the region a the phase of the wave slope was several times reversed by 180 deg., imitating the complicated action of a confused sea when two patterns of waves from different directions may, as is well known, give rise to such abrupt phase changes. In the region b the periodicity of the waves was changed erratically between ±50 per cent. about the average period of 4 seconds. In the region c variations in the period were combined with variations in the magnitude of the effective wave slope. The residual amplitude of rolling, it will be seen, is pretty much the same in all three cases, indicating that the roll quenching efficiency of the stabiliser is fairly constant under practically all conditions. This result is undoubtedly to be ascribed to the fact that the stabilising action was arranged to follow the disturbance continuously and without any appreciable time lag.

A controlling system arranged according to equation (2) gave in the earlier stages of experimentation a considerably lower roll-quenching efficiency than that shown in Fig. 8 with the control based on equation (3), although for steady quenching both systems gave practically the same results.

In Fig. 9 records analogous to those of Figs. 5 and 8, but with oil as ballast, are given. It will be noted that the passive performance (region $a\,b$) is very poor, a fact attributable to the viscosity of the liquid. The active performance is practically the same as with water. The load on the impeller shaft was, however, from 2·5 to 1·75 times greater than with water ballast, depending upon the temperature of the oil.

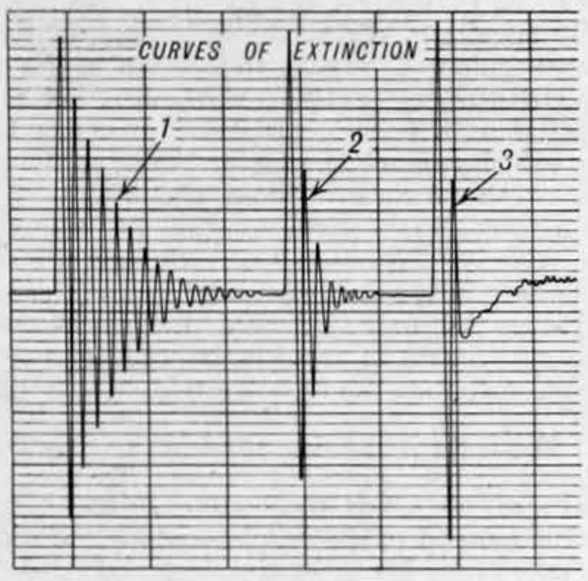


FIG. 4

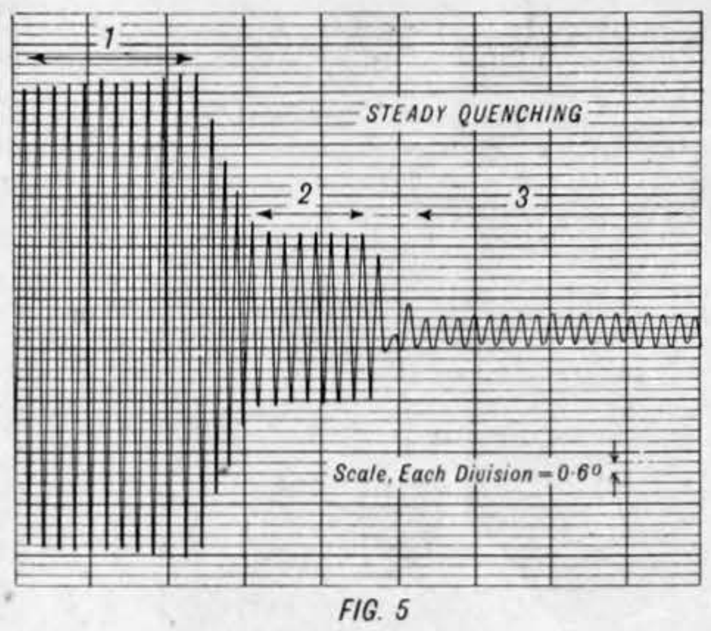


FIG. 5

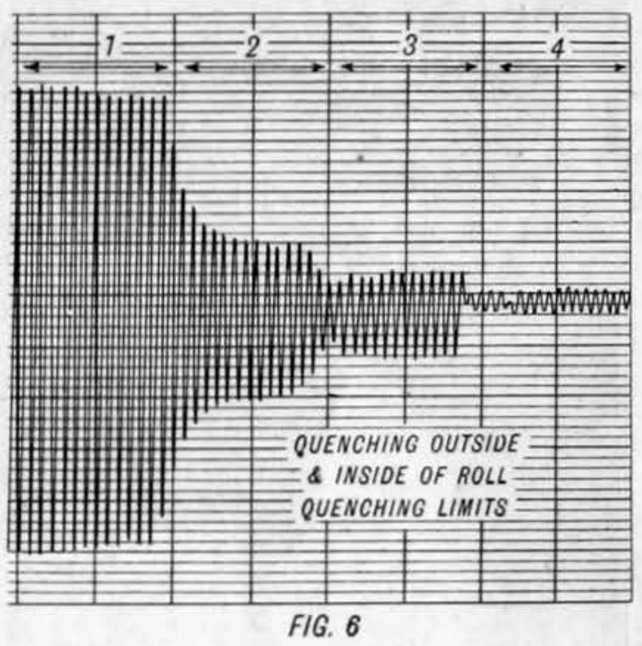


FIG. 6

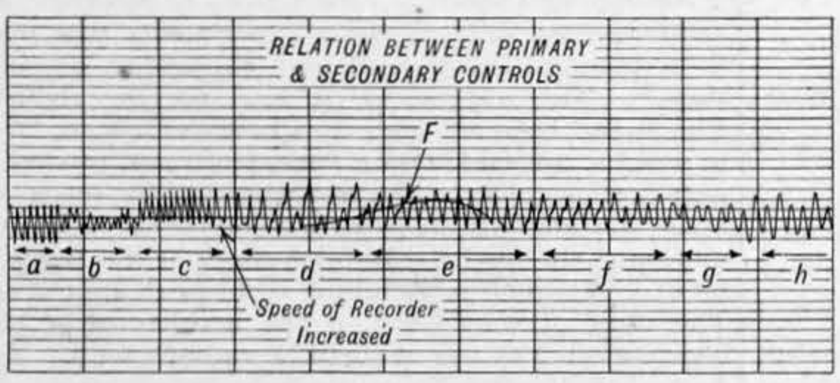


FIG. 7

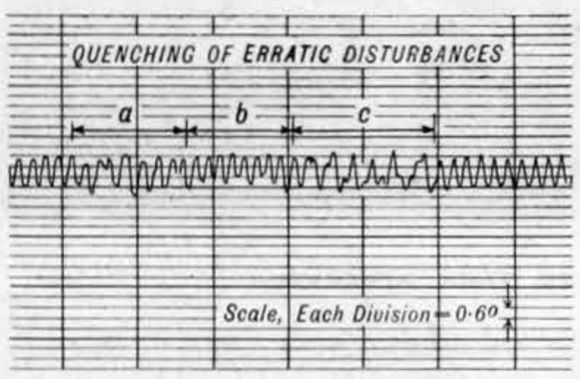


FIG. 8

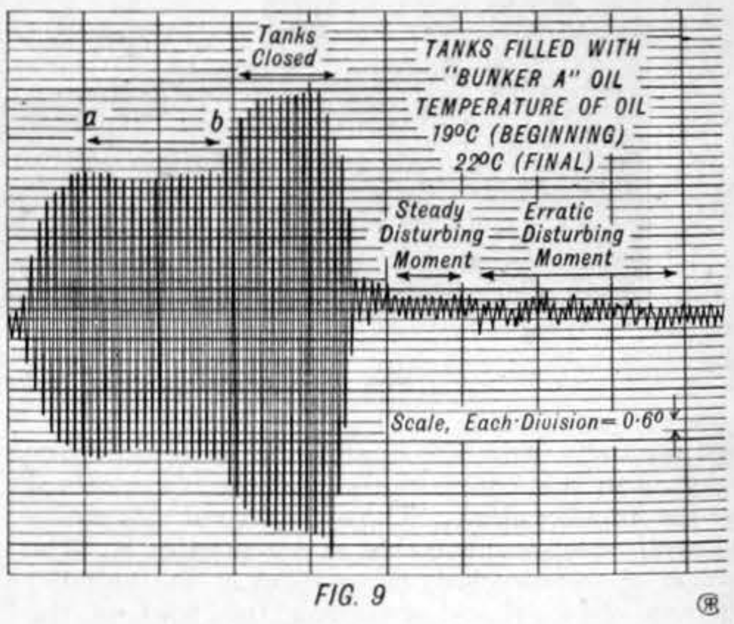


FIG. 9

"THE ENGINEER"

FIGS. 4-9—TYPICAL RECORDS OBTAINED FROM THE EXPERIMENTAL APPARATUS

Application of the Law of Similitude to Model Data.

A series of measurements obtained from the model is given in the following table. As previously mentioned, these model data have been adjusted so as to permit the roll quenching characteristics of a ship equivalent to the model—or simply "equivalent ship"—to be obtained by a straight application of the law of dynamical similitude. The data for such an equivalent ship are given in the last column of the

[3] For large powers instead of the three-electrode valves used in these tests grid controlled rectifiers of the thyratron type can be very advantageously employed.

table. The intermediate column gives the coefficients of similitude for the different quantities ; the model data must be multiplied by these coefficients in order to obtain the data for the corresponding ship.

Most of the data for the model were measured with a degree of accuracy of 2–3 per cent. or less (weights, lengths, time). Measurements of the stabilising moments were made with smaller accuracy on account of the difficulty of marking the level in the tanks during the performance ; probable errors in this case are presumably less than 7–8 per cent. of the quantity measured. The model data given in the table are the averages of a dozen measurements. The metacentric height was determined by the inclination method ; the probable error in this case is of the order of 5 per cent. The ratio of linear similitude is assumed to be $s = 25 : 1$.

	Model data.	Ratio of similitude.	Equivalent ship.
1. Available beam	$B' = 29 \cdot 5$in.	$S = 25$	$B = 61 \cdot 5$ft.
2. Cross-sectional area of tank	$A' = 37$ sq. in.	$S^2 = 625$	$A = 160$ sq. ft.
3. Cross-sectional area of channel	$a' = 3 \cdot 5$ sq. in.	S^2	$a = 15 \cdot 2$ sq. ft.
4. Displacement	$W' = 1900$ lb.	$S^3 = 15,625$	$W = 13,250$ tons
5. Metacentric height :			
Tanks closed	$h' = 1 \cdot 25$in.	S	$h = 31 \cdot 2$in.
Tanks open	$h' = 1 \cdot 08$in.	S	$h = 28$in.
6. Maximum disturbing moment	$M' = 56$in.-lb.	$S^4 = 390,625$	$M = 1 \cdot 82 \times 10^6$ ft.-lb.
7. Maximum effective wave slope	$\Theta = 1 \cdot 6°$	—	$\Theta = 1 \cdot 6°$
8. Maximum stabilising moment :			
Passive performance	$S'p = 22$ in.-lb.	S^4	$S_p = 7 \cdot 15 \times 10^5$ ft.-lb.
Active performance	$S'_a = 49$ in.-lb.	S^4	$S_a = 1 \cdot 59 \times 10^6$ ft.-lb.
9. Period of one double oscillation	$T' = 3 \cdot 9$ sec.	$S^{1/2} = 5$	$T = 19 \cdot 5$ sec.
10. Amount of transferred ballast :			
Passive performance	$w'p = 1 \cdot 49$ lb.	S^3	$w_p = 10 \cdot 35$ tons
Active performance	$w'_a = 3 \cdot 33$ lb.	S^3	$w_a = 23 \cdot 2$ tons

An inspection of the characteristics of the " equivalent ship " shows that for $W = 13,250$ tons the available beam[4] of $61 \cdot 5$ft. is somewhat too great. Furthermore, $\Theta = 1 \cdot 6°$ is too small for actual sea conditions. We will assume in the following $\Theta = 4 \cdot °0$, which covers a reasonably wide range of fairly rough weather conditions, excluding, however, heavy Atlantic gales. Assuming $B = 55$ft., $T = 16$ sec., $\Theta = 4°$, and keeping the same h, the amount of transferred ballast in active performance w_a would be increased in the ratio $\frac{61 \cdot 5}{55} \times \frac{4 \cdot 0}{1 \cdot 6}$ and will therefore be about 65 tons ; that is, about $\frac{1}{2}$ per cent. of the ship's displacement. It is therefore necessary to displace about 65 tons of ballast between the tanks in accordance with equation (3) on a ship having $W = 13,250$ tons and $h = 27$in. in order to stabilise it against the action of a synchronous wave slope $\Theta = 4°$ to the degree of roll quenching indicated on the above records.[5] It is possible, on the other hand, to calculate w_a directly from the equation $W h \Theta = w_a \frac{B}{2}$, whence $w_a = 75$ tons.

It is seen that the ratio of the calculated and observed values for w_a is practically the same as the ratio of S_a to M given in the table. This ratio approaches unity for a gradually increasing intensity of control. It is to be noted, however, that with the intensity of stabilising action adopted in these experiments the amplitudes of synchronous rolling were reduced from nearly 30 deg. down to less than 3 deg. From the practical standpoint such a degree of stabilisation is presumably more than sufficient.

[4] The expression " available beam " designates the distance between the centres of gravity of the tanks.

[5] One might think that by passing from $\Theta = 1 \cdot 6°$ to $\Theta = 4 \cdot 0°$ the non-quenched amplitudes would increase proportionately. It must be noted, however, that this increase is always less than in proportion because of the coefficient b in Froude's equation for synchronism $\frac{\pi}{2} \Theta = a\ \theta + b\ \theta^2$ causing departures from linearity for the increasing amplitudes θ of rolling.

Induced Air Scavenge for Two-Stroke Engines.

By P. W. PETTER.

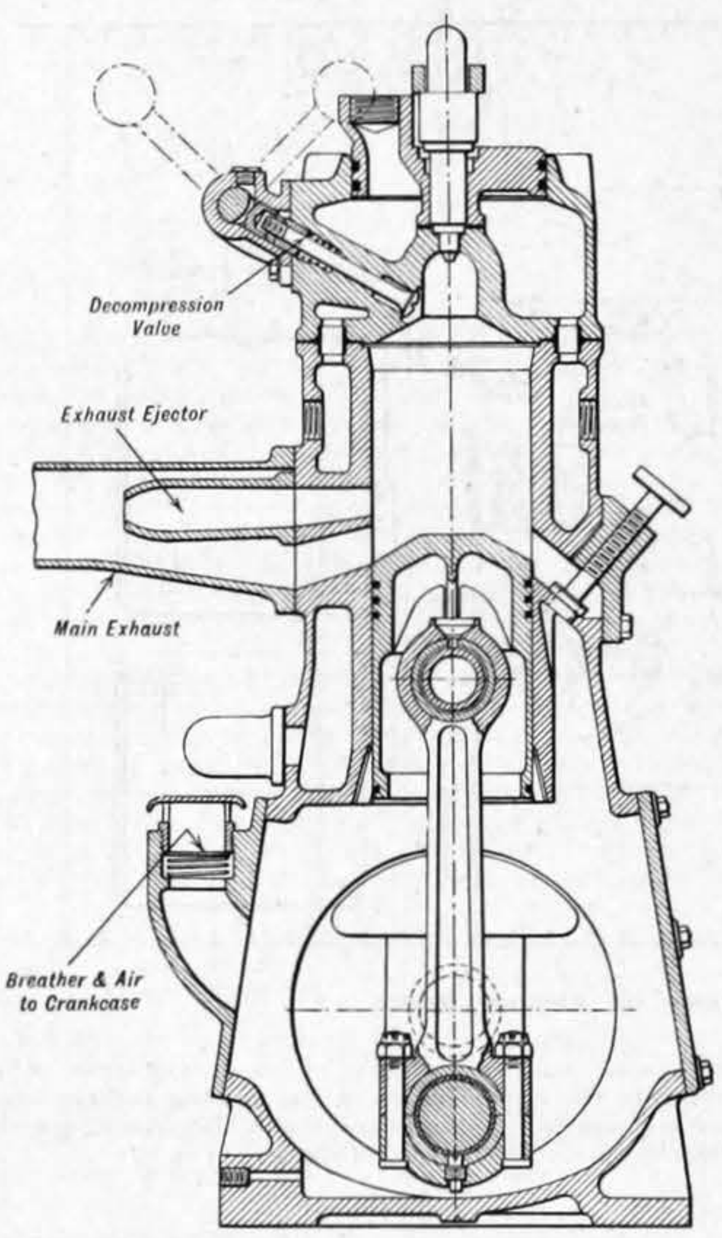
IN view of the great interest which is now being taken, both in this country and on the Continent, in the development of induced air scavenge systems for two-stroke oil engines, we have pleasure in publishing from the pen of Mr. P. W. Petter a short account of experimental work recently carried out at Westland Works, Yeovil, on this special subject.

The possibility of utilising the inductive effect of the exhaust gases as they pass from the cylinder in internal combustion engines, particularly those operating on the two-stroke cycle, has received the consideration of research engineers for many years past, and many patents have been granted for devices intended to assure this end. The principal advantage to be obtained by a solution of this problem would be the elimination of the means at present necessary for the refilling of the cylinder with a supply of fresh air, either by what is known as crank case scavenging or some form of independent blower.

About the year 1918 an engine was built in the United States by the Weiss Engine Company, which had, in addition to the normal scavenging ports connected to the crank case, a series of air ports connected directly to atmosphere, and the constructors claimed that the momentum of the escaping gases produced a partial vacuum in the cylinder which drew scavenging air through the supplementary ports open to atmosphere, and augmented the normal quantity of air supplied by crank case compression.

In recent years the energy in the exhaust gases has been utilised to compress the air charge for supercharging internal combustion engines, and experiments with the Rateau and Buchi exhaust-turbo blowers have shown that there is ample energy available for the purpose. These are, however, mechanical devices, and are used solely for the purpose of converting the pressure energy in the exhaust gases into pressure energy in the air charge.

The first Petter experiments with an engine operating with induced air were made in 1922. One of the firm's standard two-stroke cycle surface-ignition engines was fitted with a short length of pipe on the exhaust side for an experiment quite distinct from those now under consideration, when the surprising result was found that the engine would run, feebly it was true, with the crank case cover removed, although, strange to say, the exhaust was discharged through the air ports and the fresh air came through the exhaust pipe. After considering this unexpected phenomenon, the following conclusion as to what was happening was reached.

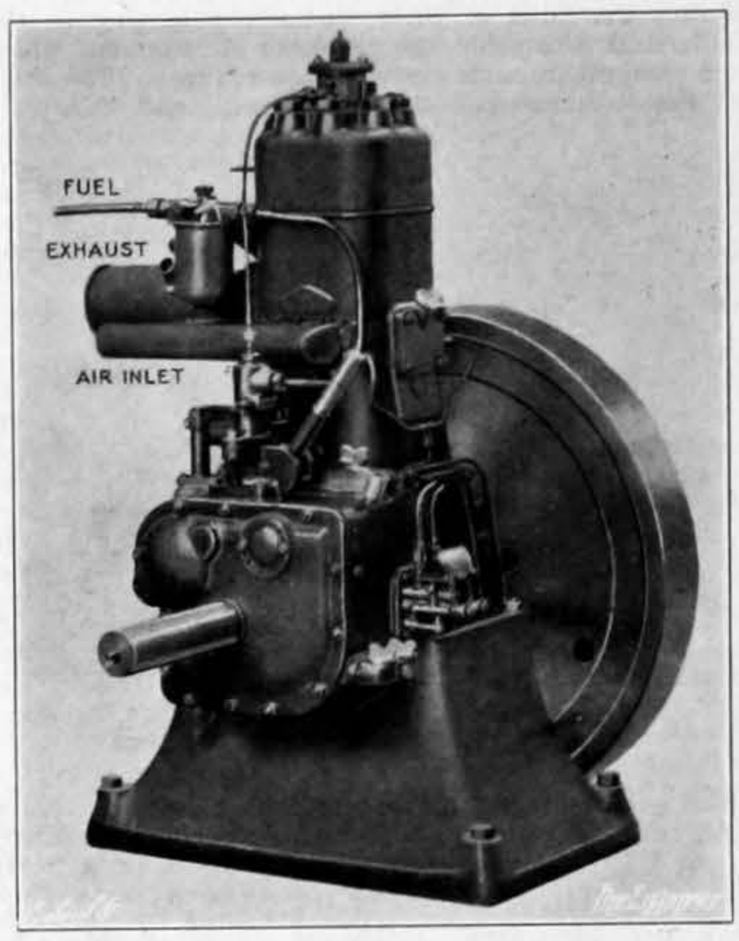


EXPERIMENTAL ENGINE WITH INDUCED AIR SCAVENGE

The engine was running with a very feeble explosion. When the exhaust port which had a lead over the air ports was uncovered, the exhaust gases passed from the cylinder into the exhaust pipe " cushioning " the air therein and setting up a certain amount of return pressure. As the piston in its descent uncovered the air inlet ports, the slightly compressed air in the exhaust pipe returned in the reverse direction to the cylinder, so expelling the exhaust gases and partially charging the cylinder with fresh air.

A continuation of the experiment with the various modifications that suggested themselves, did not, however, lead to results that would justify development from a commercial point of view, and eventually research work on this particular engine was discontinued. Last year, however, a new series of experiments was begun, from which some remarkable practical results have been obtained.

In the first instance experiments were made with a two-stroke cycle engine having a bore of 4½in. and a stroke of 6¼in., the engine having a closed cylinder with the exhaust and air ports placed circumferentially around the cylinder at the lower end of the piston travel, as shown in the accompanying vertical section. From the plan it will be noted that there are two air ports on each side directing the air to the back wall of the cylinder away from the exhaust port, and a central port opposite to the exhaust port. The central port was found to be of no advantage, and is now utilised only for admitting air from the crank case, as described later on, to facilitate starting.

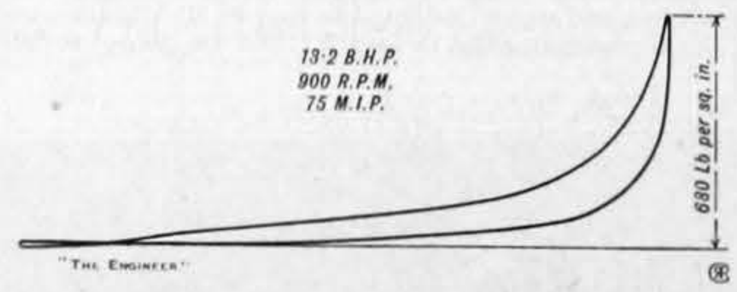


EXPERIMENTAL ENGINE

The exhaust port is divided horizontally into two sections. The upper section receives the exhaust gases from the cylinder first. These gases are led through an exhaust pipe of relatively small diameter and discharge the gases at high velocity through an ejector nozzle in the centre of a larger pipe, which communicates with the lower section of the exhaust ports. The injection action set up by the rush of the exhaust gases from the cylinder at high pressure when the upper section of the exhaust port is uncovered, and the impulse of these gases, create a partial vacuum in the cylinder which is then filled with fresh air through the air ports which are directly open to atmosphere.

The extent of the vacuum so created is largely dependent upon the force of the explosion, and this is particularly interesting because in effect it leads to an increase in the volume of air admitted to the cylinder as the power demand upon the engine increases. Satisfactory running of this engine has been obtained up to a working load equivalent to 60 lb. B.M.E.P. The engine was, however, difficult to start because the volume of air admitted to the cylinder after a weak explosion is small. To overcome this difficulty, a hand-controlled valve was provided for starting, which, when opened, admits air from the crank case in the normal manner of a crank case compression engine. This simple device has entirely removed the starting difficulty. As soon as the engine has run up to speed, the valve is closed and thereafter air is admitted by induction only. A general view of the engine is reproduced herewith, together with a typical indicator diagram.

The experiment is now being continued with an engine having a straight-through scavenge. In this form the engine is constructed with the air inlet ports circumferentially at the base of the cylinder and with a mechanically operated exhaust valve in the cylinder head. The results being obtained with this engine are generally better than those obtained with the engine having the closed type of cylinder. Alternatively, straight-through scavenge can be secured in an engine with opposed pistons working with three cranks and connecting-rods per cylinder, as in the well-known Doxford type, or in an engine having two cylinders and two pistons working together with the air inlet in one cylinder and the exhaust in the other, with a common combustion head, as in the Trojan engine.



TYPICAL INDICATOR DIAGRAM

The exhaust system in an engine of this type is an important consideration and a proper proportioning of the exhaust pipes is necessary in order to secure the best result. It is possible that further experiment will enable a simplification of the exhaust system which would improve the engine from the point of view of general application, but the results already obtained are sufficient to justify the belief that they point the way to the possibility of improvements of great value in the development of the two-stroke cycle internal combustion engine. Application has been made for patents in connection with the various devices described in this note. The experimental engine can be seen running at Yeovil by anyone sufficiently interested to make a visit for the purpose.

Geared Drive on the Motor Ships "Manoeran" and "Madoera."

ONE of the most important conversion programmes carried out last year was that for re-engining and altering the hulls of three steamers belonging to the Netherland Steamship Company, of Amsterdam, which were changed from steamers to motor vessels. The ships are the "Manoeran," the "Madoera," and "Mapia,"

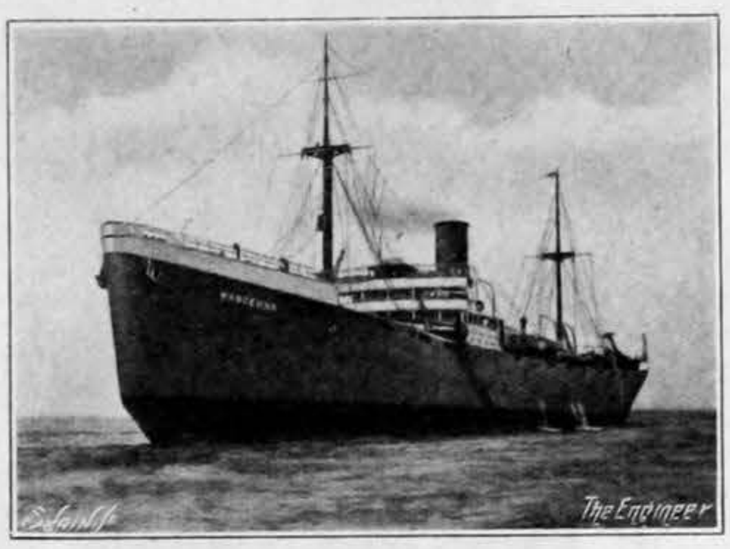


FIG. 1—M.S. "MANOERAN" AT SEA

which were built in 1921 and 1922 at Alloa and Sunderland, and were equipped with steam propelling machinery by Sir W. G. Armstrong, Whitworth and Co., (Engineers), Ltd. The owners decided last year to re-engine the ships with twin-screw oil engine machinery. The first two of the three ships above named have now been in commission for some time, and we are indebted to Ing. A. H. Ysselmuiden, of Amsterdam, and the Demag A.G., of Duisburg, for the following description of their propelling machinery and geared drive.

Propelling Machinery.

The "Manoeran" and "Madoera" are both ships of 14,000 tons deadweight carrying capacity. By installing oil engines, raising the total engine output from 4200 to 6500 S.H.P., and by appropriately refashioning the shape of the hulls, it has been possible to improve the speed of the ships from 12 to 15 knots.

Fig. 1 is a view of the "Manoeran" taken on the high seas, and the drawing reproduced in Fig. 2 shows the general lay-out of the machinery installation. Each of the two engines has a designed output of 3350 S.H.P. at 225 r.p.m., and seven cylinders with a bore of 560 mm., or 22 1/16 in., and a stroke of 840 mm., or 33 1/16 in. The two units are coupled to the propeller shaft through double-helical gearing designed to reduce the engine speed of 225 r.p.m. to 86 r.p.m. at the propeller shaft. The engines drive the gear pinions through Bibby couplings, but solid couplings are used on the propeller shaft. In Fig. 3 we reproduce a view of the machinery of the "Madoera" under test at the Werkspoor works, while in Fig. 4 one of the gears is shown on the test bed during the "running-in" process.

Design of Gearing.

In designing the gearing, the Demag A.G. was called upon to meet the following three fundamental conditions:

All-round adaptation to the existing accommodation.

Safety under all circumstances, both as to risk of damage and possibility of breakdown.

Steady and quiet working free from vibration under all load conditions.

In what follows we propose to describe the manner in which these conditions were complied with and to deal with some of the more interesting points in the construction of the gears and their housings.

The oil engines and their auxiliary machinery took the place of three of the five steam boilers and the reciprocating steam engines, and the distance between the two pinion shafts of the gear casing was fixed at 3160 mm., or 10ft. 4 7/16 in.—see Fig. 4. In the fore and aft direction there was, however, plenty of room available, while vertically the centre height of the gearing and the gear-case bed was designed to follow closely the existing foundations in the double bottom of the hull.

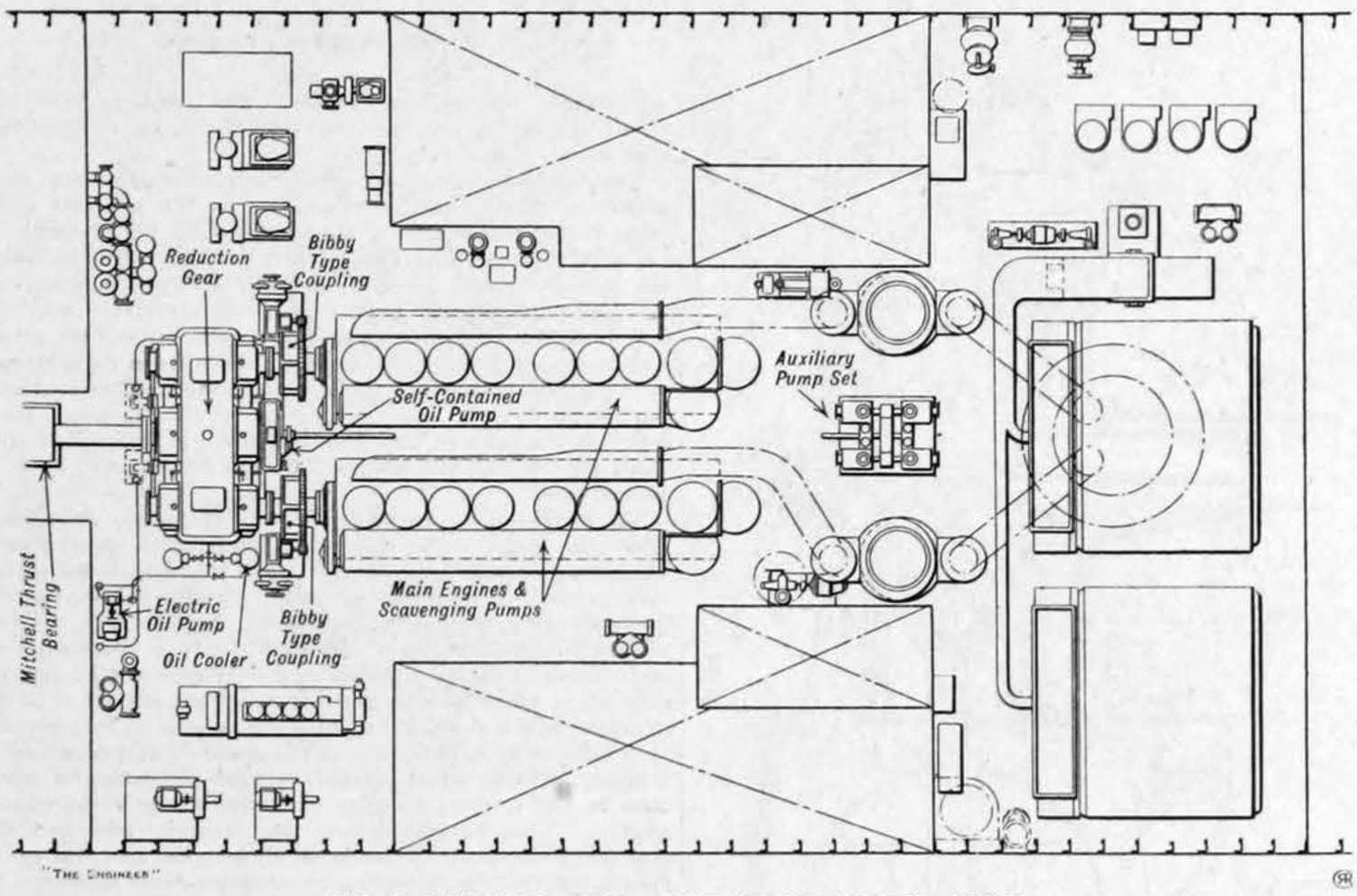


FIG. 2—GENERAL ARRANGEMENT OF ENGINE ROOM

specially shaped flared grooves, in which they rest, are fundamental to the principle of the coupling, and afford a means of positively altering the elastic length of the coupling when resonance occurs. In the couplings we are describing the grid springs take the form of four superimposed layers, each layer being divided into six segments. Under normal working conditions, two spring layers are ample to warrant absolutely satisfactory transmission, more than twenty times the normal torque being actually required to break the springs. The coupling therefore possesses a large factor of safety.

The elasticity of the coupling can be varied within wide limits by inserting either two, three, or four layers of springs, and Fig. 5 shows the torque displacement diagram of the coupling with these different spring layers. The Bibby coupling has the further advantage of providing much latitude in the matter of misalignment of the shafts connected by it. On the operating side the design of the coupling is such that it can run over long periods with a single filling of grease, while the springs are easily accessible after the coupling shell has been removed, so that either of the two engines can be quickly disconnected from the gear system by taking out the coupling springs.

In order to eliminate as far as possible torsional oscillations, the free ends of both engine crank shafts were

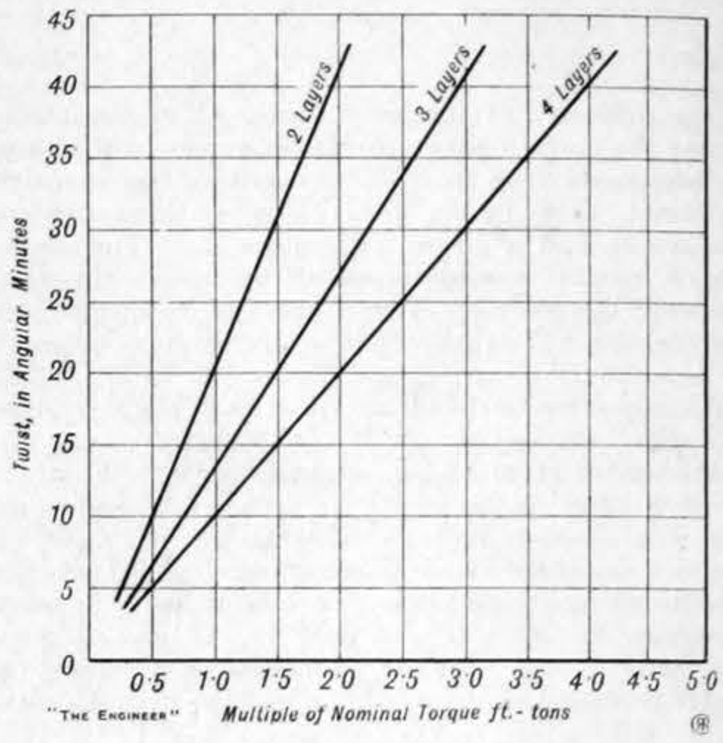


FIG. 5—TORQUE DISPLACEMENT DIAGRAM

equipped with Sandner hydrostatic oscillation dampers, which were supplied by Lohman und Stolterfoht A.G., of Witten in the Ruhr.

Apart from the special couplings and dampers we have referred to above, particular care was taken in the calculations for and the design of the gearing, the choice of materials, and the liberal dimensioning of all important parts where called for.

Gear Wheels and Gear Casing.

The rotating parts of the gearing comprise the two pinion shafts and the large gear wheels. Double helical gearing is employed, the pinions having two faces, each 400 mm., or 15 3/4 in. wide, with a gap of 140 mm., or 5 1/2 in., between them. The pinions and the wheel shaft were made from annealed open-hearth steel, with a tensile strength at delivery of from 51 to 57 kilos. per square millimetre, or 32·4 to 36·2 tons per square inch, and with an elongation of 28 to 34 per cent. For the shrouds, which were shrunk on to the pinion shafts, and on to the cast iron body of the main wheel, a special silicon-manganese steel was employed. Although it is quite usual to use solid pinions, it was decided in this case in view of the large size of pinion shafts to employ shrouded pinions. The shrouds or tires were tempered to give a yield point of from 54 to 59 kilos. per square millimetre, or 34·2 to 37·4 tons per square inch, and tensile strengths of 76 to 84 kilos. per square millimetre, or 48·2 to 53·3 tons per square inch, while the elongation varied between 20 and 28 per

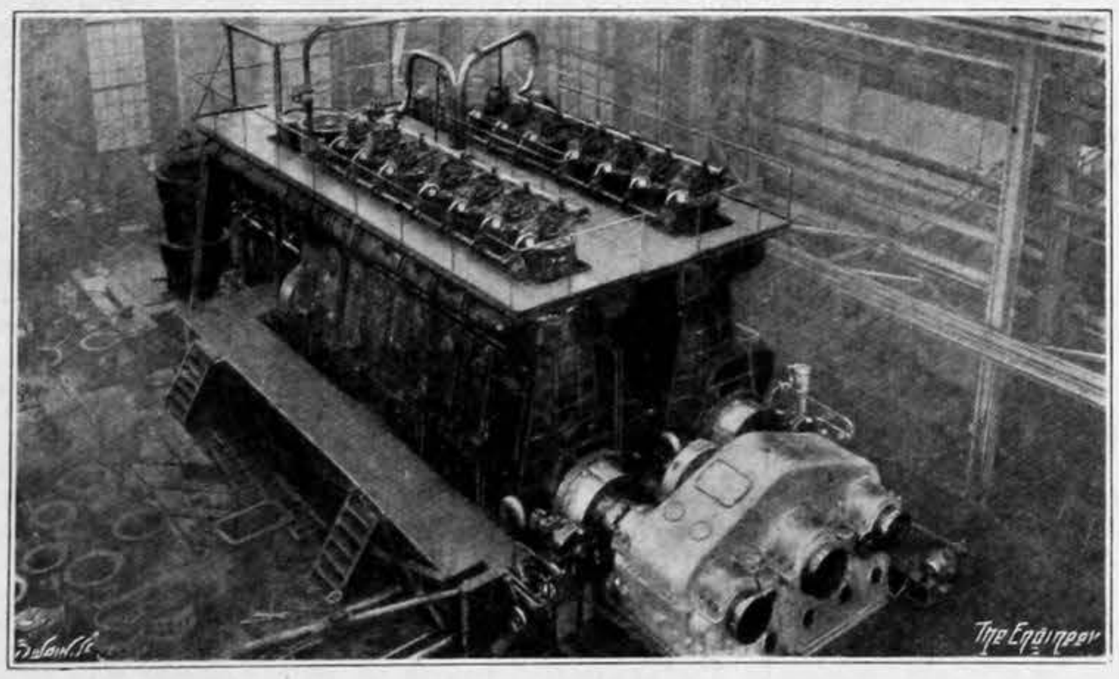


FIG. 3—ENGINES AND GEAR DRIVE UNDER TEST

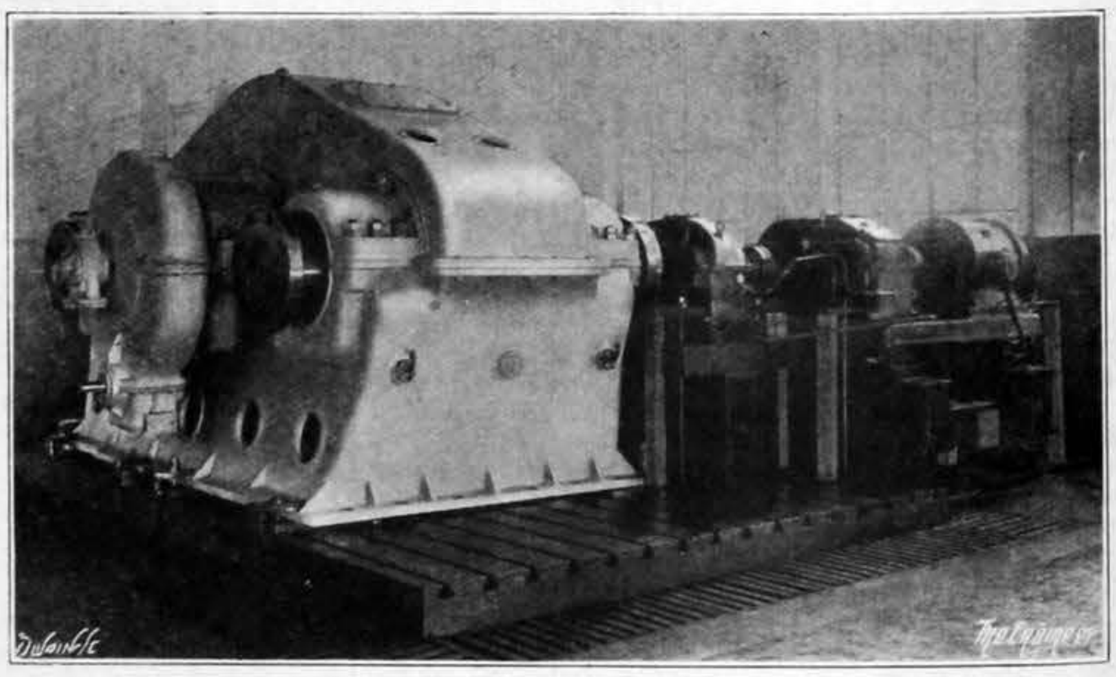


FIG. 4—RUNNING IN GEAR DRIVE ON TEST BED

The Bibby Couplings.

As shown in Fig. 6, the special Bibby couplings are of a modified design in order to allow the elastic length of the coupling to be altered in a ratio of 2 : 1. They are attached between the ends of the engine crank shafts and the gear pinions. It may be recalled that the actual power-transmitting element of the coupling is a grid-like spring, which is divided into segments, and which is made from high grade chrome-vanadium steel. These shock-damping, elastic, flexible springs, in conjunction with the cent. The impact value was tested by the small Mesnager method, and this notch test showed surprising toughness. Values of 6 m. kilos. per square centimetre were obtained, with figures even beyond 8 m. kilos. per square centimetre for the shrouds of the large wheels. When well annealed, the shrouds for the large wheels showed a tensile strength and yield point but little below those for the tempered pinion shrouds. The fatigue test strength of the steel used was particularly favourable, it being guaranteed at 40 kilos. per square millimetre, or 25·4 tons per square

inch, for the pinion shrouds and 34 kilos. per square millimetre, or 21·6 tons per square inch, for the wheel shrouds.

As our drawing indicates, both the pinion shafts and wheel shaft are forged solid with their coupling flanges. They were bored out hollow to facilitate the examination of the material. When exposed to normal running torque the torsional stress cannot be more than 82 kilos. per square centimetre in the case of the pinion shafts or 304 kilos. per square centimetre for the wheel shaft, figures which again provide a large margin of safety. Hertz's equations were made use of in calculating the tooth flanks, which in their extended form take in all factors of the problem, the physical properties of the material, the speed, pressure at the pitch line, width of tooth, its obliqueness, the radii of curvature of the pinion and wheel flanks, and the angle and period of contact. By keeping the crushing stress as low as possible and as far away as possible from the yield point and the tensile strength of the material, it was sought to provide ample protection against possible tooth wear. As to the possibility of tooth fracture, this was rendered remote by the choice of materials, the use of a relatively coarse pitch of 12 metric module, with an obliquity of about 36 deg. In the design of the gears, the bearings and the construction of the gear case the Demag Company was able to draw upon its very wide experience in the construction of gears for heavy rolling mills, special gears for oil engine and turbine drives, and other power plant work. Attention may be drawn to the large size of the bearings—see Fig. 6—which are equal in length to the bearing diameters. The pinion bearings were cast in special steel, but cast iron shells are employed for the bearings of the large wheel. In all cases a white metal alloy without lead, composed of 80 per cent. tin, 10 per cent. antimony, and 10 per cent. copper, was used to line the bearing shells. Special care was taken to provide for a good oil film by suitable oil ways. All the bearings, it may be noted, are parallel without collars or axial abutment faces. The gear case itself is stiffened by webs and its base and cover are both of cast iron with loose bearing caps. The lubrication follows accepted gear case principles. There are four oil sprayer heads, each of which can be removed separately for cleaning, while the gear is in operation. Two independent oil pumps, one electrically driven by a 4·5-kW motor and the other directly driven from the large wheel shaft, are provided. The direct-driven pump is designed to operate in either direction of rotation. As long as the main gear is working the two oil pumps are in constant service. Each of them has a designed output of about 200 litres or about 40 gallons per minute. In the extremely remote event of one pump failing, the other will deliver sufficient oil to keep the gearing fully lubricated. The oil coolers are arranged on the delivery side of the oil circuit. Each cooler has sufficient surface to cool all the oil in circulation. Sea water is used for cooling purposes and copper-tin alloy tubes are used, with naval bronze castings. Each cooler has an oil filter of the plate type mounted directly above it, with provision for cleaning while in operation. These coolers were supplied by Neidig and Co. A standard arrangement of thermometers and pressure gauges is provided, and there are drain pipes leading from the gear case to the two separate oil tanks from which the pumps draw their supplies.

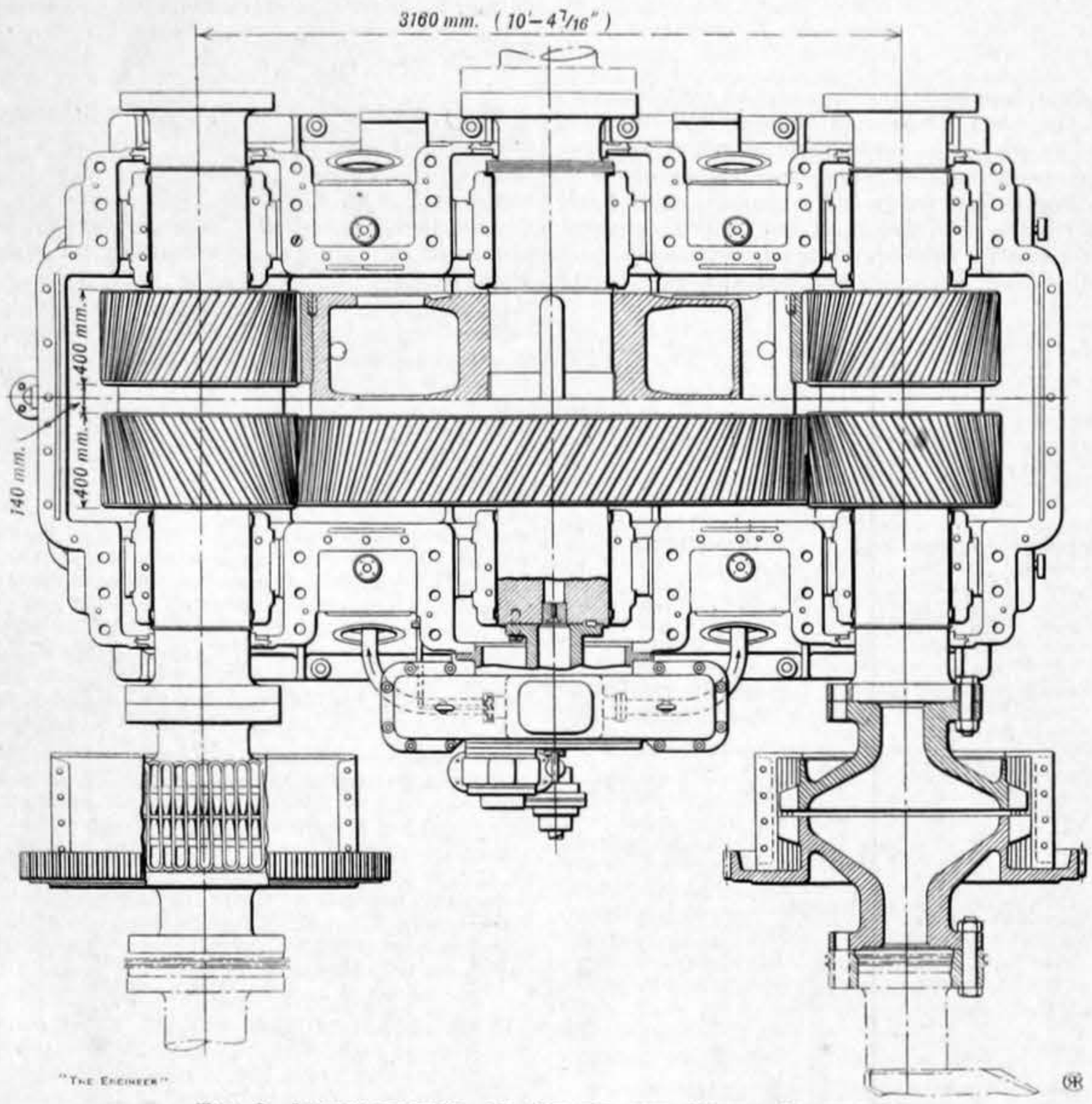


FIG. 6—ARRANGEMENT OF GEARS AND BIBBY COUPLINGS

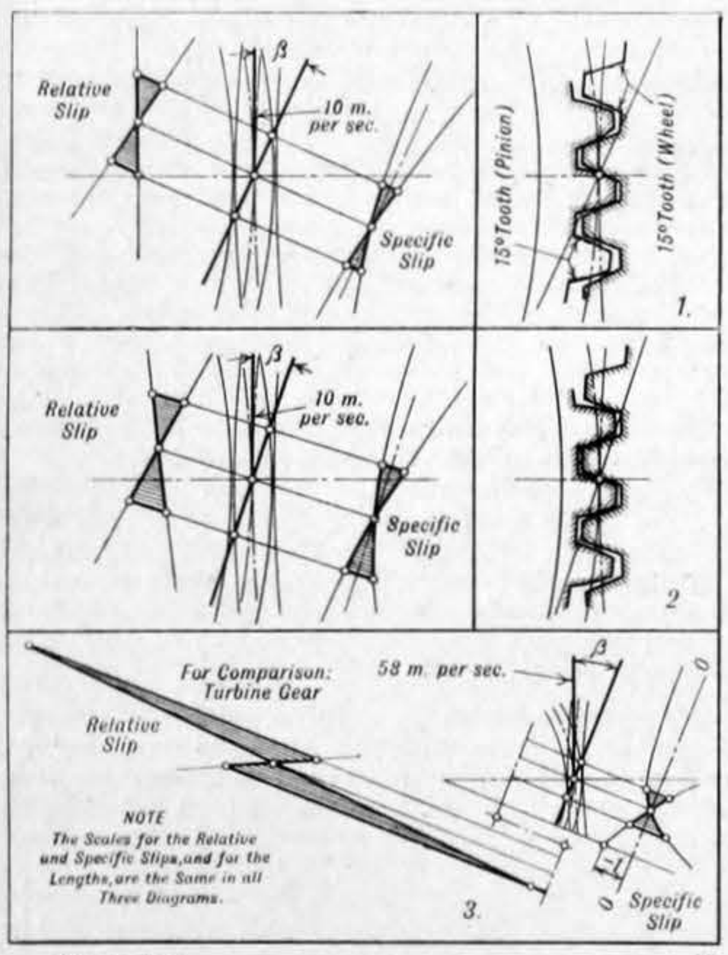


FIG. 7—GEAR SLIP DIAGRAMS

(1) NEDERLAND GEAR.

Executed as follows ;—

Pressure angle of normal pitch ..	20 deg.
Numbers of teeth	59/155
Standard modulus	12
Obliqueness of teeth	35° 39′ 9″
Face modulus	14·768
β = pressure angle of face pitch ..	24° 7′ 44″
V = tooth speed at pitch circle ..	10·25 m.p. sec.

Low specific slip.
Thick tooth roots on pinion and wheel.

(2) NEDERLAND GEAR.

For comparison ;—

Pressure angle of normal pitch ..	15 deg.
Numbers of teeth	59/155
Standard modulus	12
Obliqueness of teeth	35° 39′ 9″
Face modulus	14·768
β = pressure angle of face pitch ..	18° 15′ 1″
V = tooth speed at pitch circle ..	10·25 m.p. sec.

Specific slip almost twice that of (1).

(3) TURBINE GEAR.

Executed as follows ,—

Pressure angle of normal pitch ..	20 deg.
Numbers of teeth	31/201
Standard modulus	5
Obliqueness of teeth	25° 1′ 29″
Face modulus	5·518
β = pressure angle of face pitch ..	21° 53′
V = tooth speed at pitch circle ..	58·25 m.p. sec.

Specific slip about 2½ times that of the Nederland gear No. 1.

NOTE.—The scales for the relative and specific slips and for the lengths are the same in all three diagrams.

ACCURACY OF GEAR CUTTING.

To ensure quietness of running under all conditions of load, care was taken to give sufficient stiffness to the bearings to ensure unchanging alignment, while the tooth form was specially selected for the work. In their earlier practice the Demag Company used pressure angles of 14·5 deg. and 15 deg., but for many years past a standard 20 deg. pressure angle has been adopted by the firm.

The slip diagrams reproduced in Fig. 7 were got out in order to ascertain the respective merits of the two types of gearing with different pressure angles Nos. 1 and 2, and they are compared with a turbine gear No. 3. From these diagrams it will be seen that with a pressure angle of 20 deg. much less slip is obtained—nearly half that of the 15 deg. gear—while again the larger pressure angle produces a thicker tooth root. Apart from the improved meshing conditions thereby obtained—at least seven teeth of either half wheel always are in mesh—the comparatively large angle of tooth obliquity, nearly 36 deg., was decided upon mainly on account of the fact that oblique teeth are always a guarantee of requisite pressure being obtained in the oil film between the tooth flanks.

The gears were cut on special gear-cutting machines recently supplied by the Schiess-Defries Company for large work. The pitch error diagrams reproduced in Fig. 8 give some interesting information as to the accuracy of the helices of the "Madoera" gear wheel. The two diagrams to the right and left respectively refer to the left-hand and right-hand helix of the wheel. One diagram with the smaller amplitude records the pitch errors one by one from tooth to tooth, while the other larger amplitude diagram is the so-called "total error diagram," which is obtained by plotting continuously the deviations of the errors found by measuring, from a given mean previously computed, by adding up the individual pitches ascertained by measurement and then dividing that sum by the number of teeth. The results obtained may be regarded as excellent in themselves and they are, we are informed, far better than the guarantee of accuracy given when accepting the order, namely, that the pitch error should not exceed roughly 1/100,000 of the diameter of the large wheel and the total error not more than 1/10,000 the diameter of the large wheel.

SHOP TRIALS AND PERFORMANCE AT SEA.

The machining of all the parts was carried through to the programme previously arranged, and the trial assembly and test run were duly carried out, both gears being run in both ahead and astern at slow speeds and low loads over several weeks. This running-in process yielded, we are informed, very good wearing impressions on the tooth flanks, which bore testimony to the accuracy employed in the cutting of the gears. Referring to Fig. 4, which shows the gear arranged for running-in, attention may be drawn to the small gear wheel enclosed in a casing at the forward end of the large wheel shaft. This gear wheel is employed to drive a set of auxiliary pumps. It is a single helical drive, and a Bibby coupling was interposed between the gear and the pump shaft which runs at 700 r.p.m. All parts of the gear drive we have described were constructed and completed to the requirements of and under the inspection of Lloyd's Register of Shipping. During the tests the no-load power demand of the gearing was determined as 34 H.P., and by computing the full-load loss an efficiency of 99·2 per cent. was arrived at, which, even allowing for the 6 H.P. taken by the electrically driven lubricating oil pump, gives a total efficiency of over 99·1 per cent., an excellent figure. The first set of gearing to be completed was that for the m.s. "Madoera," and, as shown in Fig. 3, it was put on trial on the test bed at the Werkspoor Works, Amsterdam, where a full-load trial was carried out by means of a water brake. This trial was so satisfactory to all concerned that it was decided to install the second set of gearing in the "Manoeran" without further trials. No further work was required to be done on either set of gears when they were installed in the ships, and they ran quietly and efficiently from the moment of starting up. The two ships were commissioned shortly before the end of last year, the "Manoeran" entering service on October 31st, 1933, and the "Madoera" on December 10th, 1933, since which time they have continued to operate satisfactorily on the company's regular services from Amsterdam to the Dutch East Indies.

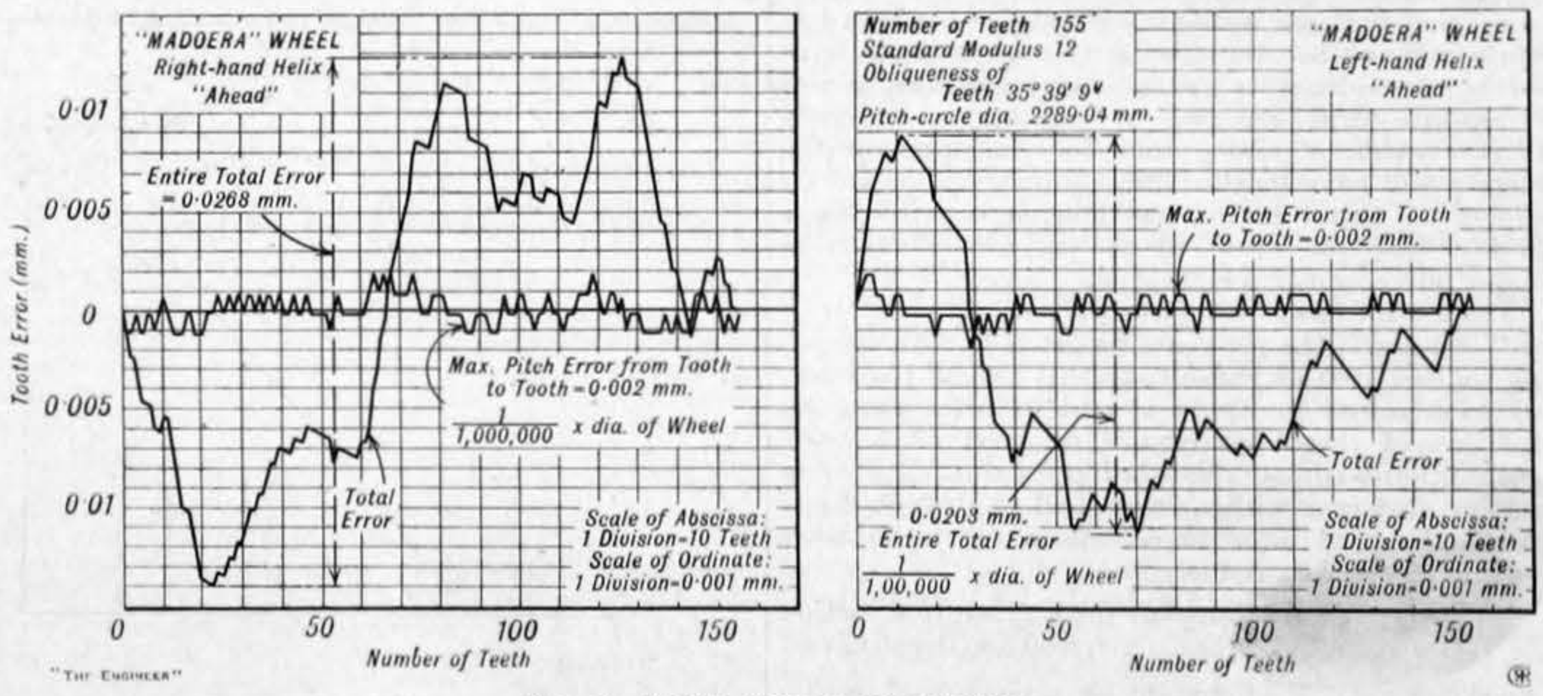


FIG. 8—PITCH ERROR DIAGRAMS

Durability of Twist Drills Machining Cast Iron.

By G. VARLEY.

WHEREAS there exists a very considerable literature on the effect of speed, feed, and depth of cut on the durability of various grades of cutting materials used as lathe tools, more especially in relation to the cutting of steels, the relevant literature on cutting cast iron of varying degrees of hardness is much less, and for twist drills is almost non-existent.

The author puts forward the following brief note on this subject, partly because he has not been able to find any published data on this matter, and partly in the hope that he may obtain support or otherwise for his findings. Even to the most casual observer it is apparent that very large variations in peripheral speed and feed are utilised, not only as between one works and another, but even at the one machine, with a general tendency to run at such conditions as will necessitate drill grinding at infrequent intervals. It is evident, *a priori*, that the hardness of the casting will have marked effect on the life of a drill, and of all materials machined in engineering shops to-day, cast iron shows by far the widest variation under one nominal specification.

The author has collected works data for twist drills of "standard" 18 per cent. tungsten H.S.S., operating on cast iron of various (tested) Brinell hardness, all as itemised in Table I, and in attempting an analysis of these figures has adopted as a basic assumption a similar relationship for durabilty when cutting cast iron with a twist drill to that obtained by Taylor and later investigators for lathe tools cutting steels, &c., namely :—

$V^x T$ = Constant for a given tool section at a given feed and depth of cut.

(Feed per cut) $^{\frac{1}{2}}V$ = Constant for a given tool section at a given tool life.

Combining these relationships :—

$$V^x \,.\, \text{Feed}^{\frac{x}{2}} T = \text{constant} \quad . \quad . \quad . \quad . \quad (1)$$

For a twist drill running at V feet per minute peripheral speed and C cuts per inch feed, drilling N holes through 1in. thickness of metal between grinds,

$$\text{R.p.m.} = \frac{12\,V}{\pi\, d}$$

$$\text{Penetration inches per min.} = \frac{12\,V}{\pi\, d\, C}$$

$$\text{Life T in minutes} = \frac{N\,\pi\, d\, C}{12\,V}$$

The effect of tool section on tool life at the same cutting conditions will be peculiar to a twist drill in that it is a tool of proportions varying exactly as the diameter, whereas the seat of failure is not the whole or even an appreciable portion of the cutting edge, but only the most stressed point, namely, the wing corner. The period in cutting life at which regrinding is necessary is also somewhat vague at usual workshop speeds and feeds, but is usually made fairly apparent by the "squeak" of the drill in cutting, and this occurrence appears to be related to an area of wear at the wing of the drill so proportioned to the drill diameter as to necessitate a reduction of drill length by regrinding that is proportional to drill diameter.

The extent of wear of the cutting edge and the proportions of the cutting edge thus are related independently of drill size, and it is concluded that tool section in this case does not enter as a variable into the life equation.

Substituting in (1)

$$\frac{V^x}{C^{\frac{x}{2}}} \quad \frac{N\,\pi\, d\, C}{12\,V} = \text{constant.}$$

or

$$V^{x-1}\, N\, d = K\, C^{\frac{x}{2}-1} \quad . \quad . \quad . \quad (2)$$

where V, N, *d*, and C are, as already stated, and K will probably be controlled by the hardness of the material drilled.

To check the results of Table I, the entries applying to cast iron of a Brinell hardness of 190 have been extracted as in Table II, and logarithmic plotting applied.

For from (2)

$$\log.\left(\frac{V}{C\,N\,d}\right) = x \log.\left(\frac{V}{\sqrt{C}}\right) - \log. K.$$

These values have been calculated in Table II, columns 6 and 7, and are plotted in Fig. 1, and show a fairly close approximation to a straight line, for which the values of X and log. K are :—

$$X = 6$$

log. K = 6·854, and equation (2) becomes :—

$$\frac{V^5 N\, d}{C^2} = K \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

The value of log. K has been calculated for all the observations of Table I, column 8, and these values are plotted against log. Brinell hardness number in Fig. 2. From this diagram a series of "smoothed" values of K for equation (3) have been obtained at varying Brinell hardness numbers, as given in Table III.

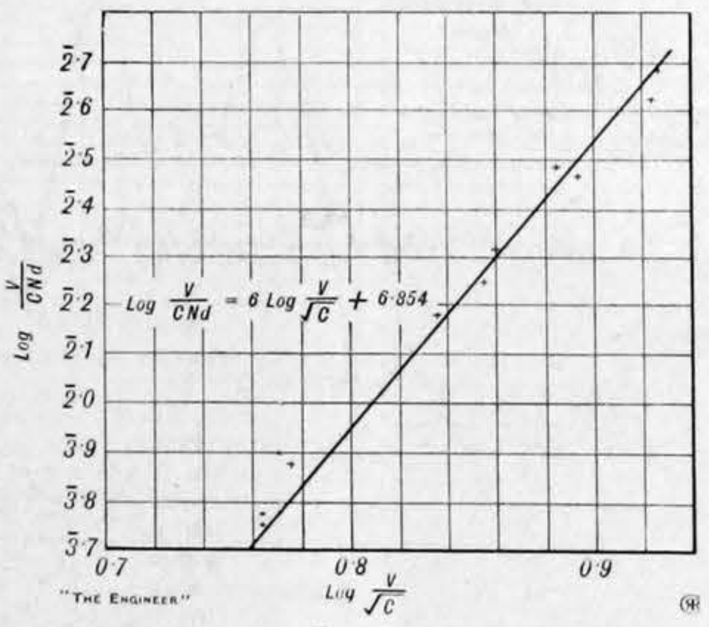


FIG. 1

The line of Fig. 2 and the values in Table III may be represented by the empirical relationship

$$\frac{V^5 N d}{C^2} = K = \left(\frac{456\cdot6}{\text{Brinell No.}}\right)^{18} \quad . \quad . \quad . \quad . \quad (4)$$

If the modern super-high-speed drills containing cobalt are used, a considerable increase in life per grind is obtained compared with the preceding results. In Table IV the author has collected some results for these drills, and if the values of log. K in column 8 of this table are compared with those of Table I, an average of approximately 3·4 times the life is obtained at the same speed and feed in the same material compared with "standard" high-speed drills.

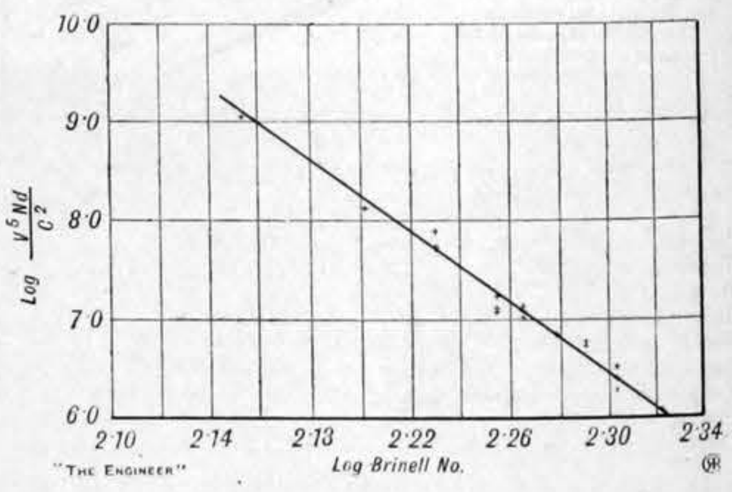


FIG. 2

It will be observed that in the preceding notes there is no specific mention that the observations related to dry drilling, the implication being that normal workshop practice was followed. Examination of twist drills after use on the harder irons now customary at present-day speeds and feeds shows that overheating of the cutting edge, and particularly the corner of the drill, is the most prolific cause of drill failure, and at once suggests the use of a coolant for drilling cast iron. Table V gives some observations on drill life using soluble oil in water cutting compound, from which it will be found that drill life at the same conditions is increased approximately 5½ times by the use of this cooling medium.

TABLE I.—*Life of Twist Drills when Drilling Cast Iron.*

	Drill dia. *d*. Inches.	R.p.m.	Feed in cuts per inch, C.	Depth of holes. Inches.	No. drilled per grind.	N = No. of holes through 1in.	Brinell hardness of cast iron.	Log $\frac{V^5 N d}{C^2}$
1	19/32	355	58	3¼	24	78	190	6·8480
2	1 3/8	125	60	1⅞	50	94	190	6·8205
3	1 3/8	125	60	4¼	22	99	190	6·8430
4	11/16	355	58	1¼	30	37½	190	6·9115
5	1 5/16	168	47	2⅜	8	19	190	6·8778
6	2	100	58	6	5	30	190	6·8458
7	1½	125	47	9¾	4	39	190	6·8775
8	15/16	342	120	1½	16	24	190	6·8577
9	1½	218	120	2	8	16	190	6·8843
10	21/64	515	47	2½	10	25	200	6·4534
11	5/16	820	60	2	5	10	210	6·0715
12	13/16	325	47	1½	4	6	200	6·5424
13	1⅛	198	71	1⅝	54	88	180	7·1215
14	2	127	42·3	3	5	15	180	7·2400
15	2	127	46	3	9	27	175	7·5203
16	2	95	23	3	5	15	170	7·7138
17	1	315	37	2½	10	25	170	7·8425
18	5, boring cutter	40	77	18	1	18	190	6·7763
19	1½	168	47	1½	10	15	185	7·1045
20	15/16	435	67	3	4½	13½	175	7·5915
21	1 3/8	190	58	2	20	40	175	7·4855
22	17/32	258	47	3	17	51	185	7·0687
23	29/64	205	29	4	8	32	180	7·1034
24	21/32	218	29	2½	8	20	195	6·7160
25	1½	131	29	2½ 2	2 2	9	195	6·7620
26	21/64	218	29	4½	2	9	200	6·3692
27	17/32	443	29	1¾	54	94½	143	9·0241
28	17/32	296	29	1¾	54	94½	160	8·1486
29	1 3/16	277	120	3¼	8	26	185	7·0068
30	41/64	557	38	1 3/8	72	99	143	8·8814
31	33/64	277	37	½	8	4	195	6·6855

TABLE II.—*Drilling Cast Iron of* 190 *Brinell Hardness.*

	Drill dia. *d*. Inches.	R.p.m.	V. Feed per min.	C. Cuts per inch.	N. through 1in.	Log $\frac{V}{\sqrt{C\,N\,d.}}$	Log $\frac{V}{\sqrt{C.}}$	Log K = log $\frac{V^5 N\, d}{C^2}$.
1	19/32	355	55·2	58	78	2·3126	0·8601	6·8480
2	1 3/8	125	45·0	60	94	3·7635	0·7640	6·8205
3	1 3/8	125	45·0	60	99	3·7410	0·7640	6·8430
4	11/16	355	63·9	58	37½	2·6307	0·9237	6·9115
5	1 5/16	168	57·7	47	19	2·6923	0·9252	6·8778
6	2	100	52·35	58	30	2·1774	0·8372	6·8458
7	1½	125	49·1	47	39	2·2516	0·8548	6·8775
8	15/16	342	83·9	120	24	2·4925	0·8843	6·8577
9	1½	218	85·6	120	16	2·4731	0·8930	6·8843
10	5	40	52·4	77	18	3·8782	0·7758	6·7763

TABLE III.

Brinell No. of cast iron.	$K = \frac{V^5 N\, d}{C^2}$	Brinell No. of cast iron.	$K = \frac{V^5 N\, d}{C^2}$
210	$1\cdot18 \times 10^6$	175	$31\cdot5 \times 10^6$
205	$1\cdot82 \times 10^6$	170	$53\cdot1 \times 10^6$
200	$2\cdot85 \times 10^6$	165	$90\cdot7 \times 10^6$
195	$4\cdot49 \times 10^6$	160	158×10^6
190	$7\cdot15 \times 10^6$	155	280×10^6
185	$11\cdot6 \times 10^6$	150	504×10^6
180	$18\cdot9 \times 10^6$		

TABLE IV.—*Durability of Super High-speed Drills.*

Drill dia. *d*, Inches.	R.p.m.	Feed C in cuts per inch.	Depth of holes. Inches.	Number drilled per grind.	N = No. of holes through 1in.	Brinell hardness.	Log $\frac{V^5 N\, d}{C^2}$.
47/64	342	29	4	16	64	180	7·8362
15/16	277	29	3	16	48	177	7·8898
15/16	342	37	2¼	4	9	190	7·4093
15/16	557	38	3	40	120	143	9·5700
61/64	277	29	3½	16	56	175	8·0000
61/64	342	37	3	8	24	180	7·8779
61/64	342	37	3	4	12	185	7·5769
61/64	439	37	3	1	3	185	7·5173
61/64	218	29	4½	8	36	195	7·2455
1 29/64	218	29	3½	8	28	180	7·7826
1 3/16	218	37	2½	16	40	183	7·6959
1¼	218	37	2½	3	7½	195	7·1021

TABLE V.—*Drilling Cast Iron with Standard High-speed Drills and Soluble Oil Coolant.*

47/64	1040	38	3	19	57	143	9·9662
47/64	342	37	4	40	160	180	8·0226
1⅛	168	47	11¼ 9½	4 2	64	183	7·9428
47/64	440	38	3	8	24	185	7·7230
31/32	218	37	4½	24	108	187	7·5968
31/32	277	37	4½	8	36	187	7·6397
31/32	277	37	4½	5	22½	195	7·4356

Railway and Road Matters.

Sixteen of the 6000-volt A.C. electric motor vehicles, which were used in the electrical services on the former Brighton system, have been converted into goods brake vans, with a verandah at each end, and a brake compartment in the centre. They are carried on two four-wheeled bogies, and have a tare weight of 28 tons.

The annual official document known as the Railway Returns for the year 1933 has now been issued, price 6s. It contains particulars of the capital, traffic receipts, working expenses, operating results, and statistical tables of the equipment and maintenance of the companies' property and of the business done by all the railways in Great Britain.

The gear, with the unpleasant but apt name of "The dead man's handle," provided in electrically operated train motors for automatically cutting off the current should the motorman's hold of the control handle be released, did its duty recently. A train from Rickmansworth to Baker-street came to an unexpected stop near Neasden, and on the conductor going to the motor compartment he found that the motorman had collapsed.

An interesting point came to light in some proceedings recently before the London Passenger Transport Arbitration Tribunal. The London Passenger Transport Board had refused, on grounds of little public interest, to take over the garage of a certain omnibus company. The latter took the case to the Tribunal, where it was rejected. Going thence to the Court of Appeal, the decision was again against the omnibus company. On the question being raised as to the costs of the appeal it was found that the Tribunal had no power to make any order; consequently each party would have to pay its own costs.

Just before Parliament was adjourned the Postmaster-General was asked whether on giving the air mail contracts to Railway Air Services, he took into consideration similar services which could be rendered by private air line companies, and whether he asked them to tender. Sir Kingsley Wood said, in reply, that the inland air services which had been placed at his disposal by Railway Air Services were purely experimental. Members might rest assured that before final arrangements were made due regard would be taken of any available air service which would be suitable for Post Office requirements.

Having regard to the fact that the Manchester Ship Canal Company is officially recognised as a railway company—being in possession of 42¾ route miles of railway, 74 locomotives, and 2177 wagons—it may be recorded in this column that Mr. F. A. Eyre retires from the position of general manager on October 1st, and will be succeeded by Mr. H. M. Gibson, the chief superintendent. In the near future, it is officially announced, Mr. Leslie Roberts is intended to be the general manager; meanwhile he resigns his membership of the Mersey Dock and Harbour Board on October 1st to go to the Ship Canal as deputy general manager.

A passenger was recently fined at Bow-street police court for opening a carriage door before the train had stopped. The case was more serious than these words convey, as the open door struck a woman standing on the platform and so injured her that she had to be taken to hsopital. Arising out of this irregularity, it may be said that in 1933 four passengers were killed and 145 injured through falling between the train and platform when alighting from trains and seven were killed and 1113 injured from falling on to platforms, ballast, &c., when alighting from trains. Whilst in some of these cases the passenger may have fallen from a train at rest, such instances must be very few.

Since the note herein on July 27th concerning the extension of the electrification of the Southern Railway to Sevenoaks, that company has issued some figures as to the results that have followed the opening of the electrical services as far as St. Mary Cray on May 1st. During that month 27,879 passenger journeys were made over this section, compared with 16,058 in May, 1933, an increase of over 73 per cent. From 1924 to 1934, prior to the electrification of this extension, passenger traffic for the same period had increased by only about 4000. The St. Mary Cray extension is the first portion of the electrification scheme to Sevenoaks, the whole of which, it is anticipated, will be in operation on January 1st, 1935.

Some correspondence in *The Times* that originated from an inquiry as to why the term "amber" was used for "the commonplace yellow" employed for the warning indication in street signals, leads us to observe that there has been no such refinement on the railway, as there the "warning" or "caution" aspect in signals always has been referred to as "yellow." The Ministry of Transport Departmental Committee in 1921 on Light Signals spoke of red, yellow, and green aspects. The Ministry of Transport requirements for new railways in the 1925 and the current—1928—editions, speak of yellow-coloured arms for distant signals, yellow for the front light of distant signals, and red or yellow for shunting signals. The same terms are also used in the railway companies' standard rule book.

During the last dozen or fifteen years we have had occasion to refer to the future of the viaduct over the river Solway, which has been closed because of the need of repairs since September 1st, 1921. Its future is now, however, decided, as the London, Midland and Scottish Company has placed a contract for its demolition with the firm of W. H. Arnott Young and Company, of Glasgow. Dismantling has been begun. The viaduct, which is 1940 yards in length and the longest railway bridge in this country, except the Forth Bridge, is part of the Solway Junction Railway, which was sanctioned on June 30th, 1864, to build a line from Kirtlebridge on the Caledonian Railway to Kirkbride on the Maryport and Carlisle, with a junction with the Glasgow and South-Western at Annan. In the great frost of January, 1881, the viaduct was damaged by some of the piers being swept away by ice flows, and it was not until May 1st, 1884, that traffic over it was resumed. Under the Railways Act, 1921, the Solway Junction Railway was incorporated in the L.M.S.

Notes and Memoranda.

A new bronze containing nickel has been developed by the International Nickel Company. It is a copper-nickel-tin bronze, containing approximately 8 per cent. nickel. It is described as responsive to heat treatment and, remaining tough, it develops an elastic limit of some 50,000 lb. per square inch. There has also been perfected a bearing metal consisting of cadmium, hardened by the addition of about 2 per cent. nickel.

A recent issue of the *Schweizerische Bauzeitung* gives some particulars of trials on tramcars having rubber buffers in the wheels. It is stated that such wheels effect a material reduction in noise and jolting, and especially in the whistling and scraping noise which occurs when trams are passing round curves. Rubber-inserted wheels have now been used for a distance of over 40,000 miles, and it is asserted that they are effecting a reduction in tram rail wear and will permit of tramcars of lighter construction.

One of the tallest trees in the world is the Canadian Douglas fir, lumber from which is now being exported in heavy volume from Vancouver to the United Kingdom. According to a pamphlet recently issued by the Dominion Forest Service, the total stand of Douglas fir is now estimated at 573,090 million foot board measure, of which 35,695 million feet is accessible under existing transportation conditions. About 70 per cent. is situated on Vancouver Island and the adjacent mainland. The Douglas fir grows to a great size, sometimes exceeding 10ft. in diameter and 250ft. in height. One of the tallest Douglas firs on record had a height of 380ft. Trees 15ft. in diameter have been found, and a single tree has been cut which scaled 6000ft. board measure.

At a recent meeting of the Chemical, Metallurgical and Mining Society, Mr. Paul F. Hirschfelder gave an interesting paper on "A New Proposal for Conditioning Air in Hot Mines where Workings and Broken Rock Require Moistening," in which he suggested the use of an aqueous solution of magnesium chloride as a substitute for water in all parts of a mine, *i.e.*, the downcast shafts, drives and working, and even in the drilling machines. By means of his proposal he said the ventilating air could be delivered at the bottom of the downcast with 50 per cent. humidity under all conditions, although the woodwork in the shaft might have to be kept wet as a protection against fire. He claimed that by this method it would be possible to maintain 40 per cent. air humidity at the 10,000ft. level.

According to the report of the New South Wales Department of Public Works for the year ending June 30th, 1933, the total cost, including the bridge proper, the approach spans, roadway approaches, railway alterations, resumptions, &c., of the Sydney Harbour Bridge had amounted to £10,057,170 7s. 9d. Of this amount, £1,339,027 11s. 3d. was for resumptions, £1,414,401 9s. 2d. for interest during construction, £2,065,429 for approaches, and for the bridge proper (excluding wages variations, &c.) £4,238,839 15s. 6d. Allowing for adjustment of outstanding claims, the completed cost of this work should not exceed £10,190,000. As the land tax collected, plus accumulated interest thereon, amounts to approximately £1,690,000, the capital sum on which future interest has to be provided should not exceed £8,500,000.

The basic limit imposed upon the power of ordinary microscopes is determined by the wave length of the light employed. If the bacteria or other object examined is smaller than about 0·0005 mm., it cannot be investigated by visible light. This limitation is overcome by the electron microscope which, according to an extract in the *Electrical Review*, has been so perfected that it is now applicable to biological and medical purposes, as well as to the examination of the surfaces of metals. Electron emissions from a heated filament are focused by condenser plates or electro-magnets, and the object is impregnated with metal to provide a framework capable of withstanding the heating effect of the electron stream. It is claimed that the results already secured represent the first step towards a further insight into the smallest forms of life.

A large factory has been opened for the production of ionised oils by a new process, according to the *Chemical Trade Journal*, which says that lower costs of production and improved quality of British textile products are among the results expected to follow. Ionised oils, it is stated, readily mix with water, and have remarkable emulsifying and detergent properties. Before the invention of the new process no method existed of ionising pure olive oil, which is used universally for processing in the textile trade. The new method can be commercially applied to almost any oil, including ground nut, soya bean, cod, palm kernel, or even mutton tallow. Oils so treated are non-oxidising and have extraordinary bleaching and softening powers. In the course of the research work it was discovered that these oils could be used to treat coir, sisal, hemp, jute, flax, and many other vegetable fibres which, under existing methods, required months of slow extraction or very expensive mechanical appliances.

The authors of an article in the *Indian Concrete Journal* report on results of tests made with standard Portland cement briquettes immersed in two grades of molasses, light and dark. Some sets of briquettes were immersed in molasses at the ages of one, seven, and twenty-eight days; others were given protective coatings at the age of seven days, and then immersed in light molasses. The specimens immersed in molasses at early ages and subsequently broken had the appearance of having been frozen, the surfaces being soft and honey-combed. Cracks also were found as deep as the molasses had penetrated. Twenty-eight-day specimens were not greatly affected by the molasses. Light, refined molasses had greater effect upon the briquettes than the dark molasses. Protective coverings on briquettes used in the tests were effective in preventing the destructive effects of the molasses for a few months. After one year of exposure, only one of the three protective coverings used in the tests remained effective. Sodium silicate covered specimens showed an improvement over the untreated specimens of the same age.

Miscellanea.

The Blackwall Tunnel is being closed on August 18th for four days for the installation of traffic control signals.

The Cunard-White Star liner "Albertic" has been sold to Japanese ship breakers for about £34,000, delivered on the Clyde, where she has been laid up since November, 1930.

This month the Swedish train ferry service between Trelleborg and Sassnitz—Sweden's principal link with the European Continent—completes its twenty-fifth year of service.

During the first seven months of this year 3265 ships passed through the Suez Canal, compared with 3047 in 1933. Receipts totalled 498,670,000f., an increase of 16,610,000f.

It was announced at a meeting of the British Medical Association that the National Physical Laboratory has decided to institute an investigation into mechanical and electrical aids to hearing.

The sixteenth annual *Model Engineer* exhibition of engineering and marine models, tools, and light machinery will be held at the Royal Horticultural Hall, Westminster, from September 6th to 15th.

The city authorities of Istambul, Turkey, are preparing plans for the construction of a tunnel under the Bosphorus to link Europe and Asia. The tunnel would be constructed between Arnoutkenny and Vanikenny.

It was originally intended that the Honore Mercier bridge over the St. Lawrence should not be opened until next spring, but progress with its construction has been so rapid that it is already in service. It was built by the Dominion Bridge Company, and is 2918ft. long in twelve spans.

A new motor lifeboat of the light Liverpool type, 35ft. 6in. long by 10ft. broad, specially designed for stations where the lifeboat has to be launched off a carriage or the open beach, has been stationed at Cromer. It has a speed of just over 7 knots and can travel 115 miles without refueling.

A great increase was shown in the output of Canadian central electric stations for June when the production amounted to 1,708,291,000 kilowatt-hours, as against 45,697,000 kilowatt-hours for the corresponding month last year. Exports to United States amounted to 113,648,000 kilowatt-hours.

The United States Bureau of the Census announces that, according to a preliminary tabulation of data collected in the Biennial Census of Manufactures taken in 1934, the value of machine tools made in the United States in 1933 amounted to 22,857,875 dollars, a decrease of 58·5 per cent. as compared with 55,109,887 reported for 1931.

The total number of unemployed workers in June, 1934, in the U.S.A., was 7,934,000, according to an estimate of the National Industrial Conference Board. This is an increase of 89,000, or 1·1 per cent., from May, 1934, and a decline of 5,269,000, or 39·9 per cent., from the total in March, 1933, when unemployment was at its highest point.

According to Colonel C. H. Bressey, the chief technical officer to the Ministry of Transport, the length of unclassified roads in Great Britain is some 134,118 miles, including a large proportion of almost unimproved roads. Expenditure other than loan charges on the maintenance, repair, and minor improvements of highways and bridges in Great Britain for the year 1931 to 1932 amounted to £34,764,000.

Orders have just been placed by the Pennsylvania Railroad, for twenty-eight electric passenger locomotives, at a cost of more than 6,000,000 dollars. They will comprise part of the fleet of 101 new electric locomotives the railway will use in inaugurating through electric service between New York and Washington next year. The new engines have a cab, in which the engineman's control position is placed in the centre instead of at the ends.

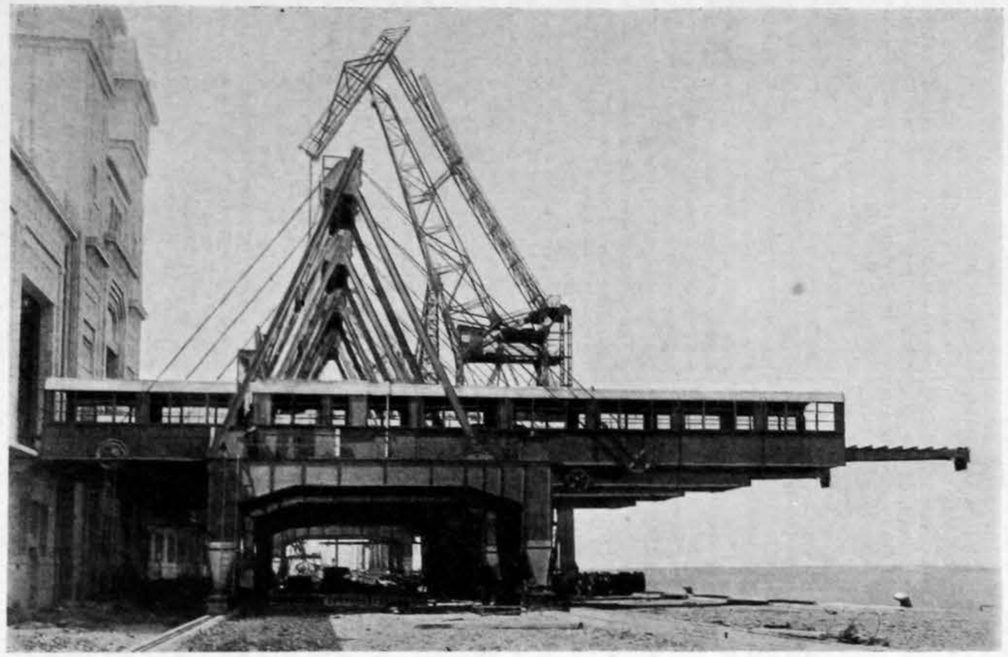
The firing of the fog gun at two-minute intervals in foggy weather at Dover has been superseded by a diaphone fog signal giving a blast of two seconds' duration every ten seconds from the lighthouse. A bell giving one stroke every seven and a-half seconds will be sounded from the western end of the southern mole or breakwater, and the small diaphone on the breakwater, which gives a three seconds' blast every ten seconds, will continue in operation.

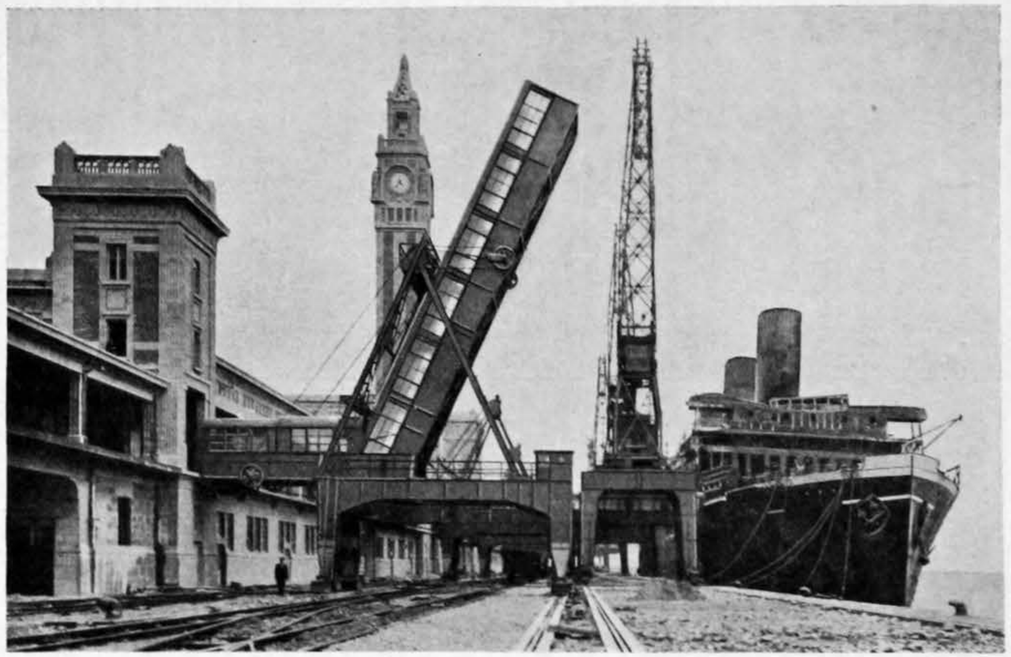
For the current year the programme of the Bureau of Public Roads, National Economic Council of China, provides for the construction of about 3100 miles of main roads by various provinces which receive funds from the Bureau for this purpose. In addition, it will undertake the direct construction of about 2500 miles of main highways in the North-Western Provinces. The Bureau was established in 1932, and during the past two years about 2500 miles have been built with its financial aid and under its supervision.

At a meeting of the Institute of Marine Engineers, which was held on Thursday, August 2nd, a Guild of Benevolence was established, which will take the form of a national movement to help marine engineers and their dependents in times of distress. The Guild is the outcome of the "Titanic" relief scheme for marine engineers' dependents, and is based on the organisation now conducted by the Liverpool Marine Engineers' Guild. The various interests will now be co-ordinated into one substantial central fund, which will be administered under the guidance of the Institute of Marine Engineers. The President of the Institute, Mr. John H. Silley, announced that Lord Weir had promised £6000 and the P. and O. group £2500, while £1000 had been received from Lord Inverforth and a similar sum from Lord Essendon on behalf of the Furness-Withy group. Mr. Silley said that, while he frankly admitted that the scheme was being launched at possibly the most difficult time in the history of British shipping, it was particularly gratifying to him to know that shipowners were showing great practical sympathy with the efforts of the Institute to assist brother engineers who happened to be in distress.

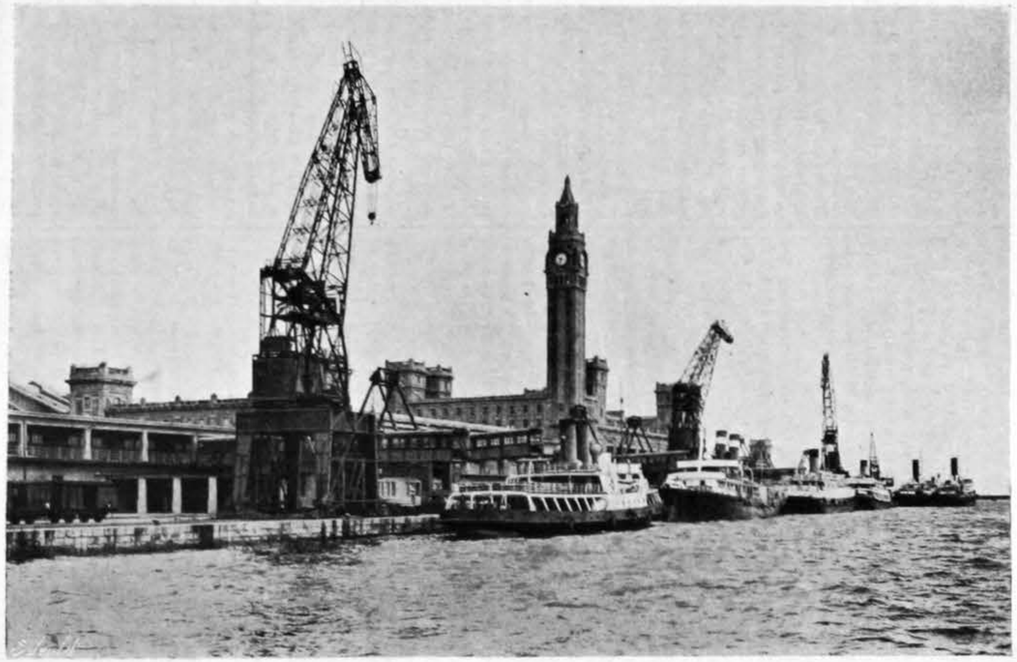
CHERBOURG HARBOUR—THE DEEP WATER QUAY AND GARE MARITIME

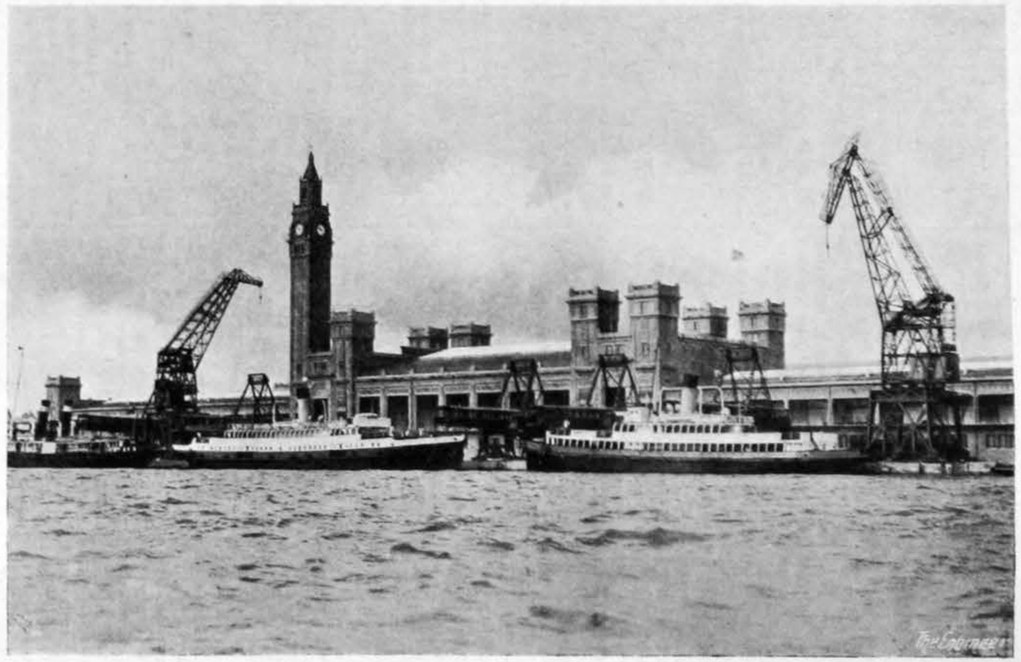
(*For description see page 152.*)





ABOVE:—TRAVERSING PASSENGER GANGWAYS
BELOW:—THE QUAY AND STATION BUILDING





ABOVE:—PASSENGER GANGWAY IN RAISED POSITION
BELOW:—THE QUAY AND STATION BUILDING

The Engineer

AUGUST 17, 1934.

VOL. CLVIII. No. 4101

Contents.

NOTICES TO READERS.

**** If any Subscriber abroad should receive* THE ENGINEER *in an imperfect or mutilated condition, he will oblige by giving prompt information of the fact to the Publisher, with the name of the Agent through whom the paper is obtained. Such inconvenience, if suffered, can be remedied by obtaining the paper direct from this office.*

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A SHORTAGE OF SKILLED LABOUR.

DURING the past week much prominence has been given in the daily Press to some remarks regarding a shortage of skilled labour in the shipbuilding industry which Mr. R. L. Scott made at the launch of H.M.S. "Galatea" at Greenock on August 9th. Mr. Scott described the shortage of skilled workmen as being very serious and stated that if a sudden demand for an increased output of merchant or naval ships arose the craftsmen required to build them would not be available. This situation, paradoxical as it may seem in connection with an industry which heads the list as regards unemployment, has, it seems, arisen from two causes. The older skilled workers, disheartened by prolonged periods of idleness, have, in many instances, sought employment in other forms of activity or have emigrated. Simultaneously the lean years through which the shipbuilding industry has been struggling have witnessed a diminution in the number of apprentices entering the skilled trades. Very naturally youths who in normal times would have found their way into the shipyards have shown a preference for callings requiring a less prolonged period of training and promising a greater steadiness of employment than the shipbuilding trades. For ten years, a period covering two generations of apprentices, these two processes have been going on side by side, the one resulting in an accelerated rate of removal of skilled men and the other in a diminution in the rate of their replacement. Others besides Mr. Scott have called attention to the position. Mr. Henry Robb speaking at Leith, also on August 9th, dwelt not only on the shortage of skilled craftsmen but with the shortage which has simultaneously manifested itself in the ranks of students of naval architecture from whom the future technical executive staffs will be drawn. In 1922, he said, there were 372 students on the roll of the Institution of Naval Architects. Last year there were only 80. In the Scottish universities and colleges there were 200 students of naval architecture in 1922 while last year there were only 65. Mr. Walter Runciman recently stressed the same point and used it effectively as an argument when urging British shipowners to scrap older tonnage and to replace it by new vessels. Our shipping industry, he argued, cannot prosper without a prosperous shipbuilding industry behind it and prosperity in the yards is dependent upon an adequate supply of skilled craftsmen.

To what extent, we must naturally ask, is this serious situation in the first place peculiar to this country and secondly peculiar to the shipbuilding industry? That Great Britain is not alone in experiencing a shortage of skilled labour is certain. It would appear to exist with equal severity in the United States. According to a recent statement by Mr. R. E. W. Harrison, Chief of the Machinery and Agricultural Implements Division of the Department of Commerce the shortage of skilled labour in the United States is in certain branches of industry already serious. He says that when business recently improved to an extent making it possible to run some plants up to 50 per cent. of their capacity one of the biggest problems which had to be faced by the managements was to find sufficient skilled labour to man the machines and operate the processes. The supply normally provided by immigration had been interrupted by national policy while that originating in apprenticeship had been restricted by a general failure on the part of manufacturers to institute sound apprenticeship schemes during the preceding period of prosperity. Mr. Harrison's remarks apply not to one but to several leading industries in his country. Similar evidence of a present or prospective shortage of skilled labour has come recently from the Continent and particularly from France. For the time being the supply of craftsmen is sufficient to meet the needs of French industry working, as it is at present, on a low level but well-founded fears are felt that a deficiency would at once become manifest if only a small increase of activity were demanded. In this country it is perhaps only natural that the shortage of skilled labour should have become publicly prominent in connection with the shipbuilding industry. Shipbuilding is not only one of our staple industries; it is a calling which does not lend itself readily to mass production methods and which employs a high ratio of skilled to unskilled labour. Further it has suffered from lack of work in recent years more acutely perhaps than any other branch of the engineering and allied industries. These facts have united to make prominent the growing dearth of craftsmen available for shipyard work. The problem is, however, certainly not peculiar to the shipbuilding industry although circumstances have given it chief prominence in connection with it. The same factors which have led to a shortage of skilled labour in the shipyards have been at work in most other branches of engineering. The intensity of their incidence may have varied from branch to branch. Here and there local circumstances or the courageous adherence to apprenticeship schemes established in times of prosperity may have eased the situation to the point of complete relief from all fears for the future. Elsewhere the conditions which have brought about the present situation in the shipyards have been reinforced by the natural effect produced by the extensive resort to methods of mass production. Mass production lowers the necessity for the employment of skilled labour but in the long run and taken over the nation it must reduce the volume of skilled labour available to industry as a whole.

It is extremely difficult to suggest any practicable solution of the problem but it is certain that if decisive steps are not soon taken to solve it its effects will become unpleasantly grave. Skilled workers cannot be trained in a day or a month. If a sudden and sufficient influx of apprentices to our shipyards and engineering establishments took place to-day the deficiency in the supply of skilled labour would not be made good until at least five years had elapsed. Who knows to what extent the next five years will witness a demand for the skill which will be lacking? It is evident that there ought to be a phase difference between the number of apprentices in training and the state of prosperity prevailing at the same time. At present the regulations of the trades unions limit the number of apprentices in proportion to the number of tradesmen employed. The employers, for the most part, augment the effect of this restriction by an understandable disinclination to engage new apprentices during times of bad trade. Hence it comes about that under present conditions the number of apprentices in training at any one time is, broadly speaking, directly proportional to the prevailing state of prosperity. The two factors ought not to be in step but out of phase by a time interval equal to the period required to convert a youth into a skilled workman. The training of apprentices ought not to be regarded by the employers either as something in the nature of an expensive moral obligation or as a source of cheap labour but as a long-term investment. The full realisation of that fact is essential to the solution of the problem now presented to us by the growing dearth of skilled labour. Whatever solution may be found for it we feel assured that it will not be arrived at by local or sectional efforts but that it will be reached by the united action of associated industries throughout the country possibly with substantial assistance from the Government. In one respect we cannot help regretting that the shortage of skilled labour has been united with an alleged shortage of students in training for executive positions. There may be a dearth of students of naval architecture but there are no signs of any shortage of students preparing for the civil, mechanical, and electrical engineering professions. It would be most undesirable if the mistaken impression received wide publicity that the current or prospective demand for young professionally trained engineers is or will be in excess of the supply. The executive ranks are to-day overcrowded and so far as we can see are likely to remain so for some years to come.

Ship Stabilisation by Activated Tanks.

THE most courageous experiment so far made in the field of automatic ship stabilisation undoubtedly is, and for some time will undoubtedly remain, the triple gyroscopic equipment installed in the Italian liner "Conte di Savoia." Rumour has not been idle concerning that equipment but most of it, we are assured, is unfounded. The performance of the stabilisers, it appears, has been and continues to be satisfactory. More we cannot say, for the owners and the Italian Government have pursued a policy of secrecy on the subject, justifiably, no doubt, from their point of view but regrettably from the purely technical and scientific standpoint. Many engineers, naval architects and shipowners would like to receive authoritative answers to numerous questions concerning the cost, upkeep, running expenses, efficiency and other features of the equipment. Full particulars of its design and construction were published in our issues of January 15th and 22nd 1932 but complete official silence has been preserved regarding its behaviour and value in practical operation. Turning to alternative methods of ship stabilisation we find that the activated anti-rolling tank system is to-day commanding considerable attention. In one form or another the activated tank system has now been fitted and tried under practical conditions in at least three ships, the German gunnery training vessel "Bremse," the Hamburg-Amerika liner "Cordillera," and the "Königen Luise" belonging to the same company. In our issue of June 29th Dr. Rellstab described the Siemens-Halske type of activated tank equipment. In this week's issue will be found an account of the important experiments on the subject conducted in America by Dr. Minorsky. To these names we may add that of Dr. Frahm who, in conjunction with Messrs. Blohm and Voss, is also working in the same field.

The activated tank system is a development of the passive system, introduced into practice by Dr. Frahm in 1910 on the Hamburg-Amerika liners "Ypiranga" and "Corcovado" and subsequently applied to well over a million tons of shipping, including the "Bremen" and "Europa." In view of its extensive adoption it might be thought that the passive system had established a reputation for completely satisfactory operation under all conditions and that its employment represented a definite addition to the comfort and economy of a ship. In actual fact however these points have never been publicly proved beyond a shadow of doubt. Under certain conditions passive tanks can, and certainly do, exercise a beneficial effect on the rolling characteristics of a ship. It is beyond dispute, for instance, that a ship fitted with them will, when heeled in still water and released, come to rest again much more quickly than she would do without them. Again, taking the somewhat more arduous conditions of a ship at sea exposed to the action of a uniform and regular train of waves, we need feel no doubt about the ability of passive tanks to modify the rolling motion. Only rarely however, do the waves encountered at sea constitute a uniform and regular train. Their common condition is that of a "confused sea" consisting of two or more trains superimposed on one another, the constituent trains being similar neither in height, length, period nor direction. In such a sea a ship is not exposed to

a rhythmic series of heeling moments following some specific pattern which can be analysed. In extreme cases a heeling moment to port may be followed by another in the same direction without the intervention of a heeling moment to starboard. The water in the tanks, set into oscillation by the rolling of the ship, tends to continue in oscillation in its own period. That period is determined primarily by the design of the tanks. It is controllable subsequently, to a certain extent, by those in charge of the ship but in no way is the period of oscillation, and still less the phase, controlled automatically by the motion of the vessel. It is not, therefore, difficult to postulate possible, even probable, sea conditions under which the tank water, oscillating more or less rhythmically, would fail to preserve the correct period and phase required to counteract the irregular heeling moments applied by the waves. It is even possible to visualise practical conditions under which the tank water would exert on the ship, temporarily, not a stabilising, but a de-stabilising moment. The root of the problem thus presented clearly lies in the passive nature of the oscillation acquired by the tank water, that is to say in the lack of automatic adaptability of the period and phase of the tank water in accordance with the erratic requirements of an irregular seaway. The object of the activated tank system is to overcome this lack of adaptability by changing the free oscillation of the water column into a forced oscillation of a period and phase which are varied automatically to suit the instantaneous external sea conditions. In the method favoured in Germany the forcing agency is air pressure which is applied to or withdrawn from the surface of the water in the tanks. In Dr. Minorsky's method a reversible pump is inserted in the water connection between the two tanks. Obviously very much, if not everything, depends upon the speed of response and the certainty of action of the apparatus employed to control automatically the admission of air pressure to the tanks or the speed and direction of rotation of the water pump. In the Siemens-Halske system the air-controlling valves are operated, through relays, by a gyroscopic instrument which detects incipient rolling of the ship. The Minorsky method dispenses with a gyroscopic piloting device and makes use of a double control based on the angular or linear transverse acceleration of the hull and on the instantaneous velocity of flow of the water in the trunk connecting the tanks.

The activated tank system may be criticised on the ground that it does not possess the simple, non-mechanical character of the passive system and that it is dependent almost, if not quite, as much as the gyroscopic system upon the ship's power supply and the correct functioning of special machinery and instruments. Whatever may be the precise method of applying the system, there is required an arrangement of blowers, water pumps or other machinery for imparting forced motion to the water and instrumental and relay equipment for detecting the effect of the waves and operating the controlling gear in accordance with the indications received. An actual inspection of the equipment on the liner "Cordillera" left us with the general impression that, while in some of its instrumental details the arrangement exhibits a certain amount of complexity and delicacy, in its main elements it is of a robust and straightforward nature and is capable of being made and installed at a reasonable cost and without occupying a great amount of valuable space. In addition to the prime fact that the new method is designed to overcome a very serious defect in the action of the old, it has two important features which must be taken into consideration in any endeavour to assess its absolute and comparative merits. There are occasions, in some cases numerous and prolonged, when the passive tank system can be relied upon to exercise its anti-rolling function in a satisfactory manner. On such occasions by shutting down the blowers or the pumps the active system can be made passive and the stabilisation of the ship thereby effected without the expenditure of power or dependence upon the functioning of mechanical equipment. When required the system can be activated almost at a moment's notice. In this connection the active tank system, it may be noted, contrasts very favourably with the gyroscopic system the stabilising effect of which disappears if the power supply is interrupted. Secondly the active system possesses a characteristic completely absent in the passive system. The blowers or pumps can be run to maintain an excess of water in one or other of the tanks, either a constant excess or what may be called a running excess. If for instance the ship develops a list to one side, as for example by the flooding of a compartment or the crowding of the passengers to port or starboard, the tank water may be distributed unequally to counteract the list. If again the ship encounters a heavy sea combined with a wind blowing on one quarter the tanks may be run with an inequality of amplitude in the motion of the water with the object of counteracting the heeling effect of the wind and of stabilising the ship in the vertical position. In this respect the active system reproduces a valuable characteristic of the gyroscopic system. Summing up we may therefore say that the active system, regarded purely from the technical point of view, possesses features of considerable scientific interest. A demonstration of its success in action —not merely under selected sea conditions but over a prolonged period of sea voyaging—has, however, still to be given. Only when the results of such a test have been made freely available will shipowners be in a position to consider the crucial question of the economic value likely to accompany its commercial adoption.

Literature.

Portland Cement. By A. C. Davis, M.I. Mech. E., &c. London: Concrete Publications, Ltd. 1934. 30s. net.

Any work on cement from the pen of Mr. Davis, who is the works managing director of the Associated Portland Cement Company, is likely to contain much of interest and value. An earlier work by the same author—"One Hundred Years of Portland Cement"—is well known as a history of the development of the cement industry. In the present volume of over 400 pages Mr. Davis deals more particularly with all phases of cement manufacture. In a preliminary chapter he sketches the history of Portland cement, but in much less detail than in his earlier work. This interesting historical sketch is, however, quite adequate to the purpose. The most valuable part of the present volume will be found in the chapters devoted to raw materials and manufacturing processes. These are full of interesting and useful information and represent about two-thirds of the contents of the volume. The remaining chapters, devoted to the chemistry of cement, methods of testing, and notes on the use of Portland cement, are sufficiently comprehensive for the ordinary engineering reader. Research workers and chemists will not need to turn to Mr. Davis' volume for information on the subjects of their special studies.

Portland cement is by far the most important cement for constructional purposes, and the author emphasises, we think rightly, the pre-eminent part taken by British industry in its development. "Aspdin," he says, "originated a British industry which has never flagged, and England has ever since taken the lead in the important developments in cement manufacture. These improvements have been copied throughout the world, but England can still claim to produce Portland cement of a quality unsurpassed by any other country. . . . At the present time much valuable knowledge exists and, except in a few minor points, such as the adjustment of the setting time (which can, however, be approximately controlled), the manufacture is performed with precision and the product is of uniform and excellent quality, in spite of the fact that the chemistry, both of the formation of Portland cement from its raw materials and of the changes which it undergoes on setting, is still incomplete." Mr. Davis further points out that "during the last decade important developments have taken place in the character of Portland cements produced in England, and these have been copied abroad." This statement is, perhaps less than fair to those research workers in America and on the Continent of Europe, who have done so much in recent years to improve cement manufacture and to their efforts towards the production of cements suitable for specialised classes of work.

On the subject of cements for special purposes Mr. Davis has little to say. We should have liked to know more of his views on this important subject. Something is being done in this country, even if only on a limited scale, to meet the special needs of cement users in the construction of marine works and in mass construction on a large scale as in some dams. Mr. Davis does make a brief reference to low-heat cement in the following words: "While the strength and rate of hardening have been increased by the manufacturer, the volume changes occurring in set Portland cement concrete remain to some extent in the control of the user. More rapid hardening may be accompanied by an increase in the evolution of heat, which is advantageous in cold weather, but may lead in big masses of concrete to internal temperatures liable to cause shrinkage movements on ultimate cooling unless maturing conditions are controlled with knowledge and care. In the latter case cements with a low evolution of heat are finding favour." Of course, the author may quite reasonably make reply to the foregoing criticism by pointing out that his work is primarily a description of manufacturing processes, a subject which has, we believe, not hitherto been dealt with so adequately as in the present work. The author deals fully with this part of the subject from the selection and winning of the raw materials to methods of packing and dispatching cement, and this section is full of excellent illustrations, including line diagrams, of processes and machinery.

The chapter headed "Cement Sampling and Testing" is brief and there may be readers who will regret that Mr. Davis has not written something about the recent work of the Building Research Station at Watford and Continental research chemists on methods of testing. But this chapter does contain a very valuable section on causes of concrete failures. Why this useful and practical summary of expert knowledge should be embedded in a chapter on testing is not clear.

The chemistry, mineralogy, and composition of Portland cement are dealt with in six chapters in quite sufficient detail for those who are not specialists in the chemistry of cement, and these are followed by two useful sections on tensile, compression, and transverse tests of cement and concrete. These, together with parts of other chapters, form separate continuations of the author's general remarks on testing. We gather that Mr. Davis is doubtful of the value of transverse tests. "Investigations have been made from time to time to determine whether this test is useful as a laboratory check upon the quality of cements, but it has yet to be shown conclusively that the test offers advantages over the tensile strength test." Brief reference is made to the "Code of Practice" for reinforced concrete issued by the Department of Scientific and Industrial Research early in the present year, and, in the concluding chapter, Mr. Davis summarises the fruits of his long experience in a series of notes and rules for the use of cement for concrete work so as to obtain the best results in practice.

Gas Engineers' Handbook. Compiled by the Pacific Gas Association (Gas Engineers' Handbook Committee). Revised by the American Gas Association. London and New York: McGraw-Hill Book Company, Inc. 1017 pp. Price 42s. net.

To appraise a handbook is to start with a disadvantage. A handbook only becomes useful when it is used continuously and when its contents are so well known that they become like old friends, "to help thee in thy need." A good handbook is perhaps the most difficult of all books to compile, for everything contained in it must be accurate, there must be no verbose discussions, but plain statements of acknowledged fact only, and, above all, it must be complete. A text-book may omit certain phases of the subject, it may be stronger on some than on others, and so long as a technical book yields a reasonable amount of information the purchaser generally considers his money to be not ill-spent. Not so the handbook, and the difficulty is the greater because the type of information that one man may require will not be that which will suit the needs of another. It is, therefore, an outstanding merit of this book that it has been compiled by a committee of American gas engineers belonging to many different companies with differing needs, and that it has been enlarged and revised by a technical committee appointed by the American Gas Association. It may not unreasonably be considered as representing the practice and needs of the whole gas industry of America. Insularity is rapidly disappearing, so that we in this country feel an especial interest in comparing American practice with our own.

The inherently scientific character of the work is one of the first things to be noted. The pages devoted to heat transfer, for example, contain many formulæ for conduction and convection under diverse circumstances, including elaborate methods of solving film conductance and radiation problems, and a discussion upon rates of absorption and heat transfer between gases and liquids in such apparatus as towers, scrubbers, cooling ponds and sprays. There is also an unusual treatment of problems in which heat transmission is variable with time. When compared with English handbooks the impression is left that the American gas engineer is far better equipped for getting down to first principles in solving his problems than is his British counterpart. The extensive use of the equations of physical chemistry in certain sections of the book, such as those dealing with equilibrium constants and reaction velocities, provides further evidence of the scientific outlook of the American gas engineer.

The book is commendable for the nice balance which is maintained between the bare presentation of facts and formulæ and the more extended explanations and

notes which render the formulæ useable, even by those not fully acquainted with the particular phase of the subject under discussion. One may in this connection refer to the 50-page description of the reactions and working of producers and blue water gas sets, to the short (30-page) but highly informative section on coal carbonisation, and to the elaborate treatise—no other word is sufficient—upon gas analysis. Some sections of the book are not applicable to British practice; we do not, for example, need to know how to reform natural gas, and we are not greatly interested in oil gas; but these portions are sufficiently small to be neglected without influencing one's decision upon the book as a whole as one eminently suited to the needs of all those, whether gas engineers or coke oven operators or designers, who are interested in scientific coal carbonisation.

The book is divided into eight sections:—Mathematical and conversion tables and graphs; properties of air, gases, steam, and water; properties of substances and engineering materials; fuels and combustion; production of gas (producer gas, B.W.G., C.W.G., coal gas, and purification of gas); testing and measurement; transmission and distribution; utilisation of gas, including information upon industrial applications. Particular reference may be made to the last section from the point of view of the general engineer who will be interested in the information given upon the use of gas for metal melting, heat treatment, baking, steam generation, and gas engines, and upon the recovery of waste heat.

Civil Engineering Handbook. Edited by L. C. Urquhart. New York and London: McGraw-Hill Book Company, Inc. 30s. net.

This "handbook," for which Professor Urquhart, of Cornell, is responsible as general editor, is a new work of nearly 900 pages and differs materially from the pocket books and handbooks in common use in America and in this country, such as Molesworth, Kempe, and Trautwine. In the present work there are few of those tables of data and dimensions which form such a large—and useful—part of the ordinary pocket book. The book is the work of ten authors, all of them holding engineering professorships in universities of the United States from Yale to California, and each being responsible for the presentation of a separate subject of civil engineering practice. These are Surveying, Railway and Highway Engineering, Mechanics of Materials, Hydraulics, Stresses in Framed Structures (by the general editor), Steel Design, Concrete, Foundations, Sewerage and Sewage Disposal, and Water Supply and Purification. The editor in a short preface says that one aim of the handbook is to present "the fundamentals of the various sub-divisions of civil engineering." It is also, he says, intended that many of the sections may be used as text-books in undergraduate courses. All the individual contributions are, as might be expected, essentially American in treatment. The references to authorities, specialist technical works and examples of construction are mainly American, although European publications in German and English are occasionally mentioned.

A cursory examination of the contents gives the impression that some of the sections, if not all, are in the main concise abstracts or abridgements of one or more specialised works. The section on "Foundations," by Professor C. C. Williams, of the Iowa State University, for instance, seems to be a *résumé* in 80 pages of three well-known American works, all of which we have reviewed in these pages when they were published. These are the standard works on foundations by Fowler and by Jacoby and Davis, and the author's own book on masonry structures and foundations. The information now given by Professor Williams does not appear to have been brought up to date and revised, so as to include references to recent construction and developments in design. We expect that undergraduate students in America, who may be required to study "Foundations" as a special subject, would be told to read "Fowler" or some parts of it, while the more experienced engineer would certainly not be content with the present abstract if he had occasion to supplement his own professional knowledge and experience by reference to technical literature. Some of the data given in this section might have been expressed with more clarity. It is not clear whether the weights given in the table on page 681 represent lb. per lineal or square foot; and on page 675, an example of the cost of concrete piles is given per *lineal* foot, but there is no indication of the size of the pile; a similar criticism applies to the figures in the table on page 674.

The section on "Concrete" by Professor S. C. Hollister seems to us to be a comprehensive account of the principles of concrete construction as practised in the United States and to be up to date and suited to the requirements of students. Professor Babbitt's "Water Supply" also is a useful outline of present-day American practice. Mr. H. W. King, of the University of Michigan, in 90 pages, attempts a summary of the principles of hydraulics which is up to date, but for comprehensiveness cannot be compared with Unwin's classic *résumé* of the subject which occupied about the same amount of space in the old eleventh edition of the "Encyclopædia Britannica" (1910). We note that Professor King heads his short bibliography of authorities with a reference to the American edition of Professor A. H. Gibson's "Hydraulics." This is one of the very few references to standard text-books by British authors which appear in the handbook. "Surveying," by Professor R. E. Davis, and "Railway and Highway Engineering," by Professor J. B. Babcock, of the Massachusetts Institute, are based exclusively on American practice. Professor Urquhart's contribution on "Stresses in Framed Structures," and that which follows it on "Steel Design," by Professor C. T. Bishop, of Yale, are good summaries, but the latter devotes to the now very important subject of welded structures little more than a page of text.

The handbook, for reasons which we have sufficiently indicated, is likely to be of little use to British students, and its value to engineers in the office and in the field is limited. It can neither take the place of the existing comprehensive pocket and other reference books, nor does it relieve the practising engineer of the necessity to refer to separate works on his special subject.

The Hardness of Metals and its Measurement. By Hugh O'Neill, D.Sc., M.Met. London: Chapman and Hall. 25s.

Dr. O'Neill has made himself master of the subject of hardness testing and no one is more qualified than he to write a book on the subject. Despite its complexity, he has succeeded in writing an exceedingly good treatise. The development of hardness testing has practically all taken place during the present century, but during that time an immense amount of information on the subject has been published. Indeed, Dr. O'Neill has drawn on no less than four hundred and ten sources of reference for the compilation of his book. As a book of reference, therefore, it fills a gap which will be appreciated alike by investigators, students, and works staffs.

The book begins with an introductory essay on "Hardness," which is mainly of academic interest. The first chapter deals with features of some of the static indentation tests, and is of first importance as regards the interpretation of such tests. Chapter II deals with the static ball test, and is devoted mainly to a critical study of the Brinell hardness and similar indentation tests. The various types of machines available for hardness testing are given in Chapter III. Chapter IV deals with hardness and its relation to deformation and strain hardening, whilst Chapter V deals with the crystallinity of metals and its bearing upon hardness. Chapter VI discusses hardness tests on metals and alloys as affected by heat treatment, whilst Chapter VII continues this subject into the domain of tests on soft metals and hot metals. Chapter VIII discusses the preparation of samples and the method of carrying out the tests, and points out where errors may arise and discusses methods of preventing them. Chapter IX deals with forms of hardness other than indentation hardness, namely, abrasion, machinability, and cutting hardness. It will therefore be understood that Dr. O'Neill has dealt with his subject from all the necessary angles, and that there is in this book matter to interest not only the practical man and the engineer, but also to the physicist and others who wish to go fully into the significance of the various hardness tests and their relation with other physical and mechanical properties of the materials.

There is little to criticise in the book. The general arrangement is good, although perhaps the matter of Chapter VIII might have been given next to Chapter III, to which it is closely related. There is occasionally some little looseness in the mathematical expressions; for example, on page 57 there is the following statement:—

$$\text{Sin}\ \frac{\varphi}{2}=\frac{d}{D}=30^\circ=0\cdot5,\ \text{then}\ d=\frac{D}{2}$$

The practice of putting the root index outside the radical sign (*e.g.*, $3\sqrt{\ }$ instead of $\sqrt[3]{\ }$) occasionally leads to confusion in mathematical expressions (*e.g.*, formula 6 on page 28). Indentation forms of hardness, although they are governed by a complexity of factors, are relatively simple when compared with the other types of hardness dealt with in Chapter IX, and it is perhaps a pity that that chapter was not made more extensive than it is. It would have been of advantage had file testing machines been discussed in an adequate manner. As regards abrasion testing, one factor not dealt with by Dr. O'Neill is the heat generated by friction as affecting the surface properties of the material. The high abrasion resistance of Nitralloy is probably due as much to this factor as to its extreme hardness, and the wear resistance of manganese steel may also be due to the fact that on heating the soft austenite changes over to the hard martensitic form.

Dr. O'Neill is to be thoroughly congratulated upon the production of a very valuable treatise on his subject.

The World's Metal Production and Consumption.

The movements in the production and consumption of non-ferrous metals last year are set forth in the customary annual report of the Metall Gesellschaft of Frankfort-on-Main, which states that 1933 brought about the long-desired halt in the downward course which has proceeded since the record year of 1929. The upward trend in the consumption last year is mentioned as having continued in the first half of the present year, and has led to a not inconsiderable diminution in the stocks of copper, zinc, tin, and lead, although, in the case of the last-named metal, the stocks in May, 1934, were higher than in 1933. The increase in the consumption and the reduction in the stocks afforded the possibility of a substantial augmentation of production at the mines, works, and refineries as compared with 1932. The accompanying statistics are extracted from the report:—

World's Production in Thousands of Metric Tons.

	1933.	1932.	1929.
Lead	1148·8	1148·5	1742·2
Copper	1049·7	929·0	1894·7
Zinc	986·5	781·5	1457·3
Tin	100·1	106·0	195·0
Aluminium	141·5	153·5	276·8

World's Consumption in Thousands of Metric Tons.

	1933.	1932.	1929.
Lead	1207·2	1093·3	1699·9
Copper	1068·0	902·2	1761·9
Zinc	1006·0	827·5	1439·8
Tin	144·8	114·7	183·8
Aluminium	162·0	141·3	276·0

It will be seen that an exception to the increase of production took place last year in aluminium and tin, the output of which, despite the growing consumption, further declined, and it only joined the rising movement in the other metals in the current year. Notwithstanding the improvement last year, both production and consumption on the whole remained very far below the maximum level which was reached in 1929. The diminution in 1933 as compared with 1929 was 49 per cent. in aluminium and tin, 45 per cent. in copper, 34 per cent. in lead, and 32 per cent. in zinc. During the past few years it has been chiefly the United States and South and Central America which have been compelled to reduce the production of metals far beyond the average level. Thus, as contrasted with 1929, the output in these countries, excluding Canada, only amounted to 33 per cent. in copper, 38 per cent. in aluminium, 42 per cent. in lead, and 52 per cent. in zinc.

On the other hand, it has been possible in the same period for the British Empire, the European Continent, and Russia, with the Far East in general, to maintain the production of metals above the degree of the world average, and in part even considerably to increase the output over 1929, especially of copper in Canada and Rhodesia, where large new deposits of copper ores have been opened up and worked. In Europe the copper works in Yugo-Slavia, Sweden, and Belgium have also maintained the level attained in 1929. The tin works in Europe have increased their output over 1929, mostly in Holland, where ores from the Dutch East Indies are smelted to a larger extent than formerly; and also in Belgium, where tin ores from the Congo are being treated. Besides the Chinese out-turn of tin, the production figures for Russia for aluminium, lead, copper, and zinc in part show quite substantial advances over 1929.

It is noted that a considerable displacement has taken place in the countries from which European consumers have been supplied with metals in the past five years. While, for instance, in 1929, no less than 84 per cent. of the European imports of copper were obtained from the United States and Chile, and only 16 per cent. from British oversea regions—mostly Canada and South Africa—and from the Belgian Congo, in 1933 the share of the United States and Chile in the deliveries to Europe only amounted to 47 per cent., as Canada, Rhodesia, and the Congo increased their participation to 53 per cent. In absolute figures, the copper imports into Europe from the United States and Chile declined from 518,000 tons in 1929, to 209,000 tons in 1933, while in the same period the European imports from the British possessions and the Congo rose from 98,000 tons to 235,000 tons. A similar state of affairs exists in regard to the European imports of lead. The percentage share of the United States and Mexico in the supply of lead to Europe fell from 39 per cent. in 1929 to 22 per cent. in 1933, whereas the share of Canada, Australia, and British India grew in the same period from 57 per cent. to 75 per cent. The same development occurred in the European imports of zinc, the United States and Mexico having lost ground to the advantage of Canada, Australia, and Rhodesia.

Under existing conditions producers in countries with a depreciated currency are said to regard present prices as being sufficient and remunerative, and are not endeavouring to raise them, so as to be able to maintain equilibrium between production and consumption. On the other hand countries with a stable currency find present prices quite inadequate. This displacement in the price conditions between the individual groups of producers operates as a specially disturbing factor on the private economic measures for the regulation of the metal markets within the framework of the international syndicates, and it is because the various producers express different views concerning the necessary level of prices that it is difficult to bring about uniform action in the regulation of the output. Under the circumstances the impression is gained that a recovery in the metal markets will only take place when the present currency chaos has been overcome, and stable currency conditions have been re-established.

Noise.

By A. H. DAVIS, D.Sc.

No. I.

I. Characteristics of Noise.

TO appreciate points arising in the assessment of noise one must recall that sound has its origin in vibration, and that the sound waves sent into the air by a vibrating body consist of alternations of condensation and rarefaction, which travel outwards, just as ripples travel outwards from a periodically disturbed water surface.

The sound enters the ear as successions of minute changes in pressure corresponding to these condensations and rarefactions, and gives rise to the sensation of hearing. The character of the sensation depends upon the frequency, amplitude and wave form of the incident waves. Other things being the same, the frequency, *i.e.*, the number of alternations which reach the ear per second, determines the pitch of the sound. The amplitude of the wave, *i.e.*, the degree of condensation in sound waves corresponding to wave height in ripples, determines loudness, and wave form determines quality. Wave form relates to the manner in which the pressure in a sound wave rises and falls with time. When aerial waves consist of a regular succession of vibrations the sensation is that of a tone, but an irregular non-repeating disturbance results in what is technically known

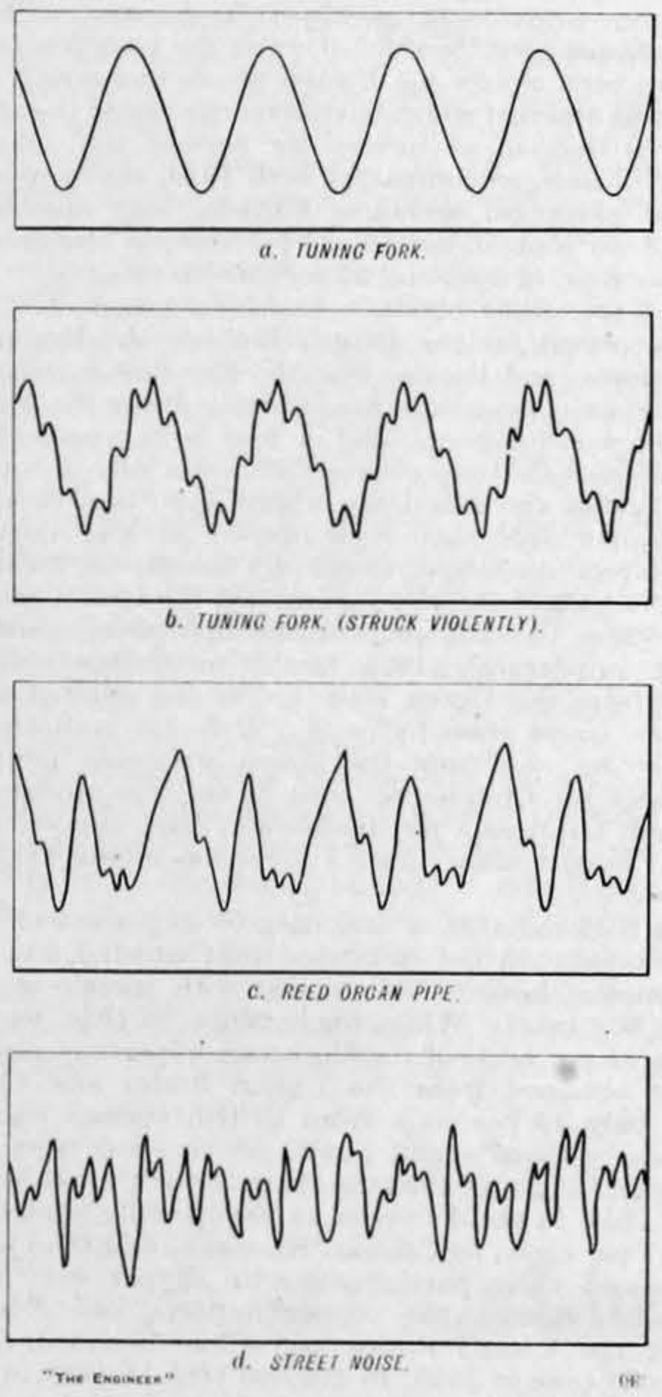


FIG. 1—CHARACTERISTIC SOUND CURVES

as "noise." The simple pendular motion of the prong of a tuning fork in free vibration gives rise to a wave form represented in Fig. 1 *a*, which is the characteristic "sine wave" associated with pure tones. In Fig. 1 *b*, relating to the compound vibrations of a violently struck fork, the more leisurely fundamental vibration is accompanied by subsidiary fluctuations of higher frequency as evidenced by the wavelets present. Fig. 1 *c* is an oscillograph record obtained at the National Physical Laboratory for the note of a conical reed organ pipe. Fig. 1 *d* shows a part of an oscillograph of a street noise. It will be observed that the wave form is irregular and does not repeat accurately. The sound was, in fact, a noise in the physical sense.

Loudness.—Before a pure tone can give rise to the sensation of hearing, the aerial vibrations entering the ear must attain a certain minimum amplitude, which depends upon the pitch of the note concerned. If the amplitude is further increased, the loudness increases until the sensation of feeling or tickling occurs in the ear, and, soon afterwards, pain. In Fig. 2 the top and bottom curves, due to Fletcher and Wegel, show respectively, over the range of normal hearing, average values for the upper and lower limits of audible sound expressed in terms of the oscillatory pressures set up in the air by the sound.

Between the upper and lower limits the human ear can distinguish some 120 graduations of loudness at a frequency of 512 cycles per second, if a second or two elapses between successive sounds. For ordinary loudness levels (intensities exceeding 10^4 times the minimum audible) they are approximately equally spaced upon a logarithmic scale of intensity. Consequently, the loudness level in just perceptible steps above threshold is closely related to the logarithm of the intensity of the exciting sound, and a logarithmic unit is adopted. Following a lead by the Bell Telephone Laboratories, this is usually called a "decibel."

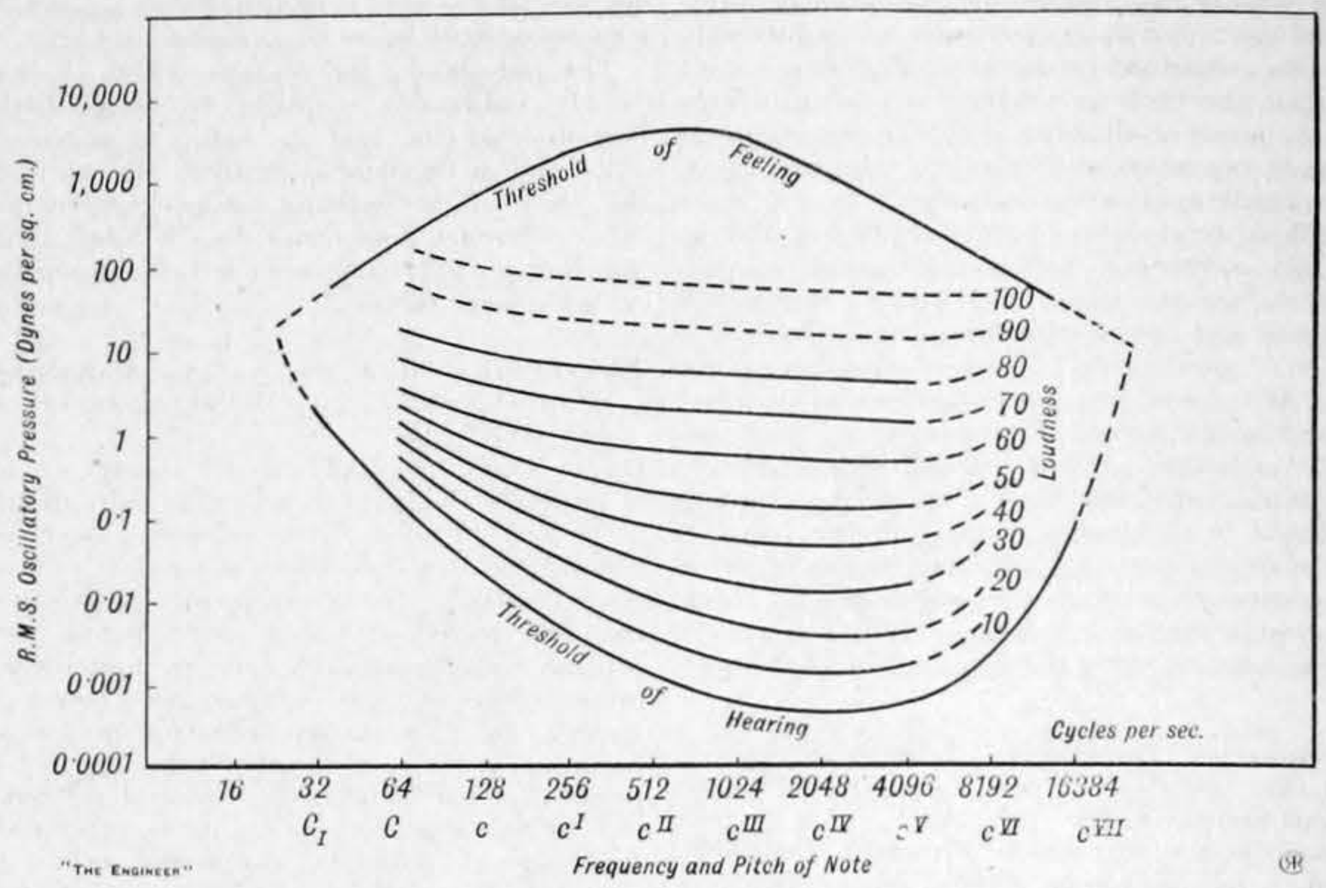


FIG. 2—UPPER AND LOWER LIMITS OF AUDIBILITY

If I and I_o are two different values of the sound energy, the difference in energy level L expressed in decibels is given by :

$$L = 10 \log_{10} (I/I_o).$$

This gives for notes of medium pitch, 120 logarithmically spaced gradations over the range of hearing from threshold to pain.

FIG. 3—ACOUSTIC PRESSURE METER

So far we have considered loudness relations only for the same pitch. The intermediate curves of Fig. 2, however, connect the intensities of sound of different frequencies which were found by Kingsbury to be equally loud to the ear. For sounds above about 700 cycles per second it appears that if two notes are equally loud, they remain equally loud when the amplitudes of both are increased in the same ratio. The closer spacing of the curves at low frequencies indicates that low notes require less increase of amplitude to raise their level of loudness than notes of medium pitch.

From the curves of Fig. 2, it is clear that the loudness of any pure note may be expressed as a number by stating the intensity, in decibels above threshold, of an equally loud note of chosen standard frequency, say, 1000 cycles per second. The actual pitch chosen as standard does not appear to be vital, but it is clearly a convenience to choose the pitch in the region, above about 500 cycles per second, where a decibel has approximately a constant loudness effect.

The loudness of a pure note on such a scale can clearly be inferred from the curves when its pitch and physical intensity are known. There appears, however, to be no accepted method of deducing the loudness of a complex sound from a knowledge of its constituents, although it is true that complicated relations have been proposed.

Consequently, the only method of expressing the loudness of a complex note or of a noise would appear to be the direct experimental comparison with a note of standard pitch and controllable intensity.

It is to be noted that in expressing loudness of a sound, no mention is made of its own intensity, but the intensity of a comparison note of equal loudness is given in decibels above threshold. When a sound has a loudness equal to that of a standard audiometer note at a level of *n* decibels above threshold, it will be said to have a loudness of "*n*" phon.[1]

Masking.—Experimental data giving the masking effect of a sound or noise upon notes of various pitches, that is the extent to which one sound drowns or interferes with the audibility of another, may be used as a measure of the interfering effect of the sound, for it shows the reduction of the capacity of the ear in the presence of the sound.

It has been found that in general a sound is most easily masked by a note of approximately the same pitch, but that where a difference in pitch exists, a moderately pure tone more easily masks a tone of higher pitch than one of lower. Since an appreciable level of sound is necessary before a low note will mask a higher one, it is clear that masking values are not very useful for assessing the loudness of comparatively quiet sounds.

II. Physical Measurement of Sound and Noise.

Measurements by Means of Microphone Equipment.—The measurement of sound with physical apparatus is in itself an interesting subject. Various methods have been adopted, from which it is possible to deduce the amplitudes of vibration of the air particles in the sound wave, or the degree of variation of air density or pressure associated with the alterations of compression and rarefaction. It must suffice to say here that, when calibrated, an electrical microphone is a valuable instrument if it is of high quality. For this purpose resonances—which are common in commercial

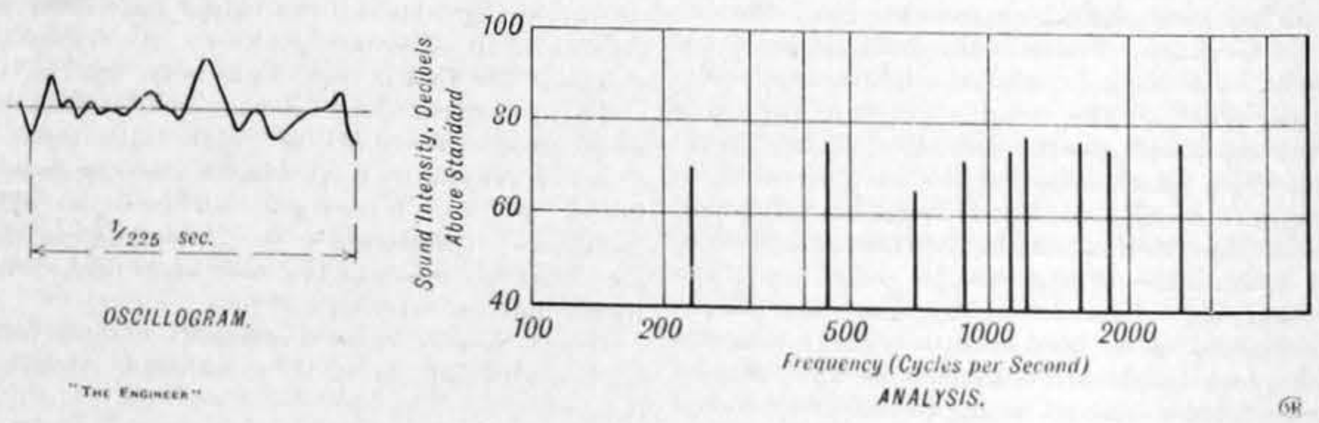


FIG. 4—ANALYSIS OF A MOTOR HORN NOTE

[1] A phon is the German equivalent of the decibel. In this article "decibel" is employed in connection with intensity measurements, "phon" for expressing loudness. If one term—say, decibel—is used for both purposes, confusion arises from the fact that when a low-pitched note is increased in intensity by *m* decibels, its loudness on the scale of a 1000-cycle audiometer increases by more than *m* decibels.

telephones—must be avoided within the range of acoustic frequencies.

In measuring sound with a microphone-amplifier system it is possible—

(1) To make an estimate of the average sound pressures measured by a microphone with auxiliary amplifiers.

(2) To ascertain the wave form of the noise by taking an oscillograph record of the variations of acoustical pressure.

(3) To analyse the noise and thus determine either (*a*) the intensity and frequency of its components—a procedure of special value in identifying the sources of machine noises by correlating constituents with, say, the frequency of meshing of teeth on gear wheels—or (*b*) the distribution of energy in various frequency bands.

Simulating the Response of the Ear.—In view, however, of the different sensitivities of the ear at various frequencies, the results of physical measurements cannot be interpreted as loudness to the ear, except perhaps in the case of the analyses. For closer estimates of the aural importance of a noise an equipment may be incorporated in the amplifier of any of the above types of apparatus, so that it has an ear-like frequency response curve. It is impracticable to arrange an equipment to do this for all loudness levels, but it is comparatively simple by suitable choice of the inter-valve coupling units when the approximate loudness level is known. The curves of Fig. 2 show aural equal loudness curves, and it is possible to arrange an amplifier and valve voltmeter to give equal deflections for sounds of different pitch as defined by one of these curves. A convenient curve for moderate sounds is that corresponding to a loudness level of, say, 40 db. above threshold (see Free, *Jour.* Acous. Soc. Am., July, 1930). For fairly loud sounds the 80 db. curve is useful. It should be noted, however, that the 80 db. curve is practically flat, so that for moderately loud sounds it is fairly satisfactory to employ an equipment with a uniform response curve. It is also satisfactory as a rule if very high or very low tones are not involved. It should be realised, however, that an instrument adjusted to have an ear-like characteristic at one or two levels has definite limitations. Particularly, it should be noted that a small change in the intensity of a note of very low frequency is equivalent in loudness to a considerably greater change in the intensity of notes of medium pitch (*c.f.* Fig. 2), a fact of which an instrument adjusted for only one or two loudness levels takes but little cognisance. The instrument is therefore unlikely to give very reliable estimates of overall loudness where low-pitched notes and medium-pitched notes occur together. It has a distinct usefulness, but its limitations must be recognised.

Physical Noise Meters.—Various meters have been made for the measurement and analysis of noise. In a convenient portable microphone and amplifier unit designed by the writer (Fig. 3), for general acoustical work, which will measure the overall acoustical pressures, dials are provided for altering the sensitivity of the instrument in decibel steps over the range of 110 decibels. By plugging into the amplifier circuit one or two tunable electrical circuits or filter circuits, the instrument will measure the intensity of components, or the energy level in selected frequency bands. Where greater selectivity is desired the apparatus may be used in connection with an auxiliary input stage, for analysis by Grützmacher's method. An output plug allows a cathode ray oscillograph to be connected to the output of the amplifier when required.

Fig. 4 is an analysis of a motor horn note as obtained at the National Physical Laboratory with the instrument in conjunction with a single tuning unit. It is shown in association with an oscillogram obtained by connecting the output of the amplifier to a cathode ray oscillograph. The oscillogram was drawn from an average of several superimposed curves. This horn had components which did not fit in a harmonic series and was rich in powerful high-frequency notes. The author's observations indicated that both these factors tend to produce strident notes, a point which was subsequently confirmed by independent experiments published in America.

Simple switches throw into circuit (*a*) a network giving to the apparatus a response curve corresponding to that of the human ear at a level of moderate noise (say 40 db. above threshold), and (*b*) a network correcting a resonance in the microphone used with the equipment. It is also possible to substitute for the microphone an instrument on the lines of a gramophone pick-up. When the pick-up is held in contact with the parts of a machine or the walls of a building, vibrations may be detected and relative measurements and analyses made—a procedure which assists in elucidating the actual areas responsible for the emission of sound.

(To be continued.)

German exports of electrical machines fell from 27,302 metric tons in 1932 to 13,133 in 1933, the values being RM. 72 millions and 35 millions respectively. Foreign sales of other electrical products decreased from 64,245 metric tons to 54,055. Electrical products exported to Great Britain were 2217 metric tons in 1933, compared with 2939 in 1932.

A Fatigue Testing Machine for Wire.

In our issue of May 26th 1933 we briefly described and illustrated a fatigue testing machine for wire exhibited at the Royal Society's Conversazione. This machine, the invention of Professor B. P. Haigh and Mr. T. S. Robertson of the Royal Naval College, Greenwich, was, at that date, in an early stage of its development. It has since been re-designed and improved in its details and in the form illustrated and described below is now being manufactured by Bruntons Ltd., Musselburgh, Scotland. Although the machine is described specifically as being intended for tests on wire it is not, it is claimed, of interest solely to manufacturers and users of wire. It can be employed for conducting tests on any material which is capable of being forged, rolled or cast in the form of a rod and subsequently of being turned, ground, extruded or drawn into a wire. Its simple and comparatively inexpensive nature, combined with its high speed of working, therefore render it available for a general study of fatigue phenomena and the manner in which surface finish, heat treatment, immersion in different liquids and so forth affect the fatigue strength of metals. Doubtlessly, however, the fact that the specimens are in the form of wires must be taken into account when the results obtained from the machine are compared with those given by other fatigue testing machines employing more robust forms of test specimen or when they are to be employed as a basis for the design of parts of other than wire formation.

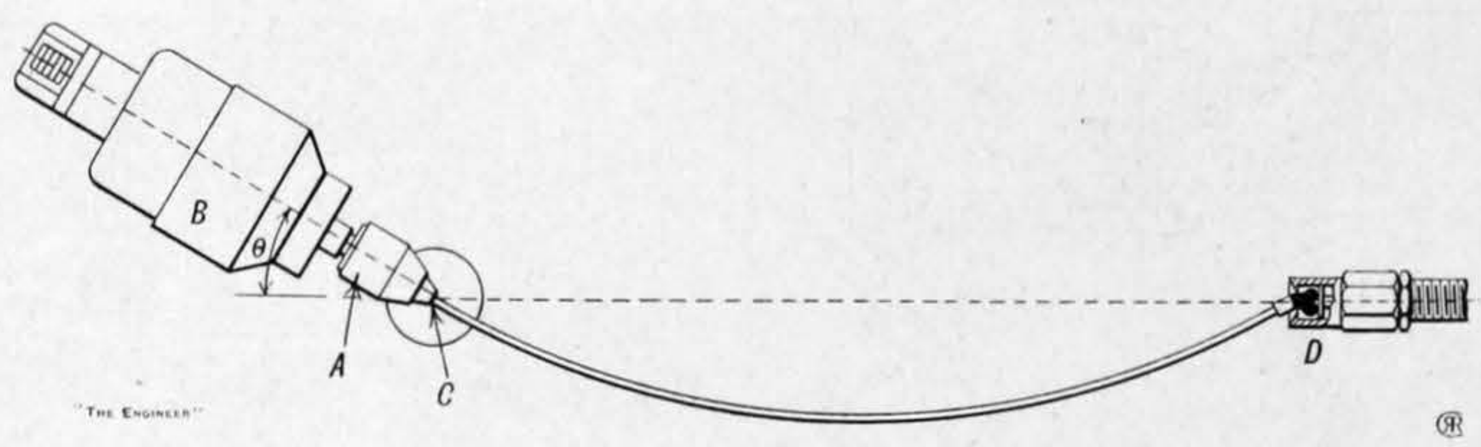


FIG. 1—PRINCIPLE OF ACTION OF THE HAIGH-ROBERTSON MACHINE

At first sight it would appear to be no more difficult to test a wire specimen under fatigue conditions than an ordinary specimen provided the range of stress is from zero to a positive, or tensile, maximum and is never allowed to pass into the compression zone. Even, however, with this somewhat severe restriction the fatigue testing of wire is not easy to accomplish satisfactorily for almost invariably the wire fractures at or close to the grips. In such cases doubt must always exist as to the extent to which the fatigue strength indicated by the test has been influenced by the local concentration of stress applied to the specimen by the gripping devices. The ordinary method of overcoming this difficulty, namely the employment of a specimen with enlarged ends is not available in the case of wire for while the body of the specimen might be turned or otherwise reduced to the diameter of a wire, the metal would not have the surface finish and other qualities characteristic of a true wire produced by drawing through a die.

In our issue of April 27th this year an account will be found of some experimental equipment for the fatigue testing of hard drawn steel wire devised by Messrs. Dowling, Dixon and Hogan. The general scheme of the testing arrangements consisted of supporting the wire specimen as a "free free" bar in a magnetic field and causing it to vibrate by passing through it a pulsating electric current of resonant frequency. In this method of testing the specimen is subjected to bending stresses and does not rotate. The maximum stresses occur at the opposite ends of one diameter of the cross section and are alternately tensile and compressive. In the machine devised by Professor Haigh and Mr. Robertson the wire specimen rotates under load and every point round the periphery of the specimen is in turn subjected to the full range of stress.

The principle of action of the Haigh-Robertson machine is indicated in Fig. 1. One end of the wire is held in a chuck A driven by a small motor B, the chuck and motor being arranged to swivel about a vertical axis at C. The other end of the wire is supported within a ball-thrust bearing D. When this bearing is advanced, parallel with itself, towards the chuck the wire flexes as indicated, the flexing taking place entirely in the horizontal plane and resulting in the chuck and motor swivelling about the axis C through an angle 0. The specimen in this way assumes the condition of an end-loaded strut and from Euler's theory it follows that the bending stress at its mid point is directly proportional to the angle θ through which the chuck and motor move under the action of the end thrust. The actual bending stress at the mid point is given by

$$f = \tfrac{1}{2}\,\pi\,0\,E\,d/L^{2}$$

where E is Young's modulus for the material and *d* and L are the diameter and length of the wire.

When the motor is started the wire does not whirl about the straight-line axis C D but rotates about its own curved axis after the manner of a flexible shaft. At ordinary speeds of the motor the wire may make about 20 million turns per 24 hours while for small gauge wires the speed may be raised to 28 million turns per day. With each turn every point on the circumference of the wire passes through a stress cycle ranging from a maximum tension to a maximum compression. The greatest range of stress occurs at the mid point in the length of the specimen, the range diminishing towards zero at either end. The wire therefore is in a condition which ensures that it will fracture at the mid point or remote from the region of the local stress applied by the gripping arrangement.

In addition to the bending stress the wire is subjected to a compressive stress by the end thrust

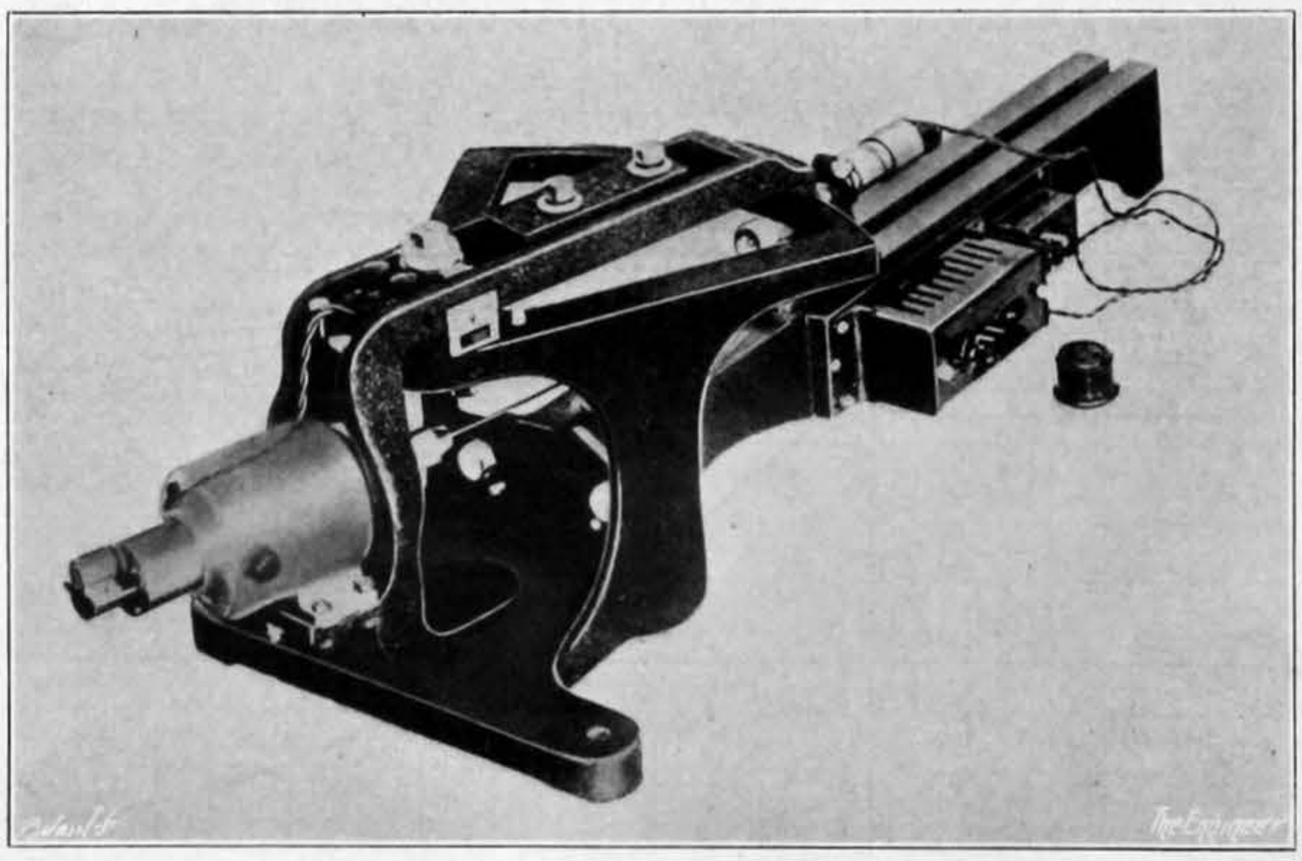


FIG. 2—THE HAIGH-ROBERTSON FATIGUE TESTING MACHINE FOR WIRE

but for moderate angles of flexure this compressive stress is very small relatively to the bending stress and may be neglected so far as its effect on the fatigue strength of the material is concerned. To allow for the fact that Euler's formula becomes increasingly erroneous as the angle θ increases, a correcting coefficient can be applied to the formula connecting the stress and the angle of deflection θ. This coefficient varies from unity when θ is zero up to 1·0058 when θ is 30°.

A general view of the machine is reproduced in Fig. 2 while in Fig. 3 details of its design are given. The base plate E is arranged after the manner of a lathe bed the sliding "tailstock" F carrying the ball thrust-bearing which supports the non-driven end of the specimen. The adjustment of the tailstock is sufficient to permit specimens ranging in length from 3½in. to 30in. to be tested. The thrust bearing is illustrated separately in Fig. 5. Over the end of the wire there is fitted a tapered sleeve within the mouth of which there is placed a 5 mm. steel ball. This ball bears against a group of three other balls of the same size, the thrust from which is taken by a hardened steel disc. These three balls run within a hardened steel race within which, when the specimen breaks, they are retained by a cap. The disc against which they bear has a slight amount of longitudinal freedom and moves forward slightly, when the specimen breaks, under the action of a spring plunger. This small motion is sufficient to open a switch actuated by the plunger which switch breaks the motor circuit and stops the counter provided to indicate the number of stress cycles supported by the specimen up to the point of fracture. The tailstock is clamped to the bed in a position to suit the length of the specimen. The flexing and loading of the wire is effected by turning a knurled head on the tailstock.

The "headstock" end of the bed is fitted with a casting G Fig. 3 which carries bearings on which swings the frame H supporting the chuck and its motor. The frame H is formed with an arm provided at its end with a vernier J which is used to read the angle θ against a scale K on the casting G. The connections between the swinging frame and the casting are arranged to eliminate friction as far as possible from the swivelling motion. Two radial ball bearings serve to determine the direction of the axis but the weight of the frame is supported by a spring-loaded sapphire bearing above the upper ball bearing. This sapphire bearing is illustrated in Fig. 6. It is adjusted until the vernier J swings just clear of the scale K. A balance weight L Fig. 3 is provided on the arm of the swinging frame and is adjusted to counteract the weight of the motor &c. and thereby relieve the radial ball bearings of any side thrust. Current to the motor is supplied through two spring connections lying about the sapphire bearing. These connections are coupled to a "follow-up" arm mounted loosely on the casting G. This arm is adjusted by hand to a position indicated by a pointer and when it is in this position the two spring connections apply no torque to the swivelling frame.

Minor details of the machine include a drip feed lubricator for the thrust bearing incorporated in the motor drive and a guide or guard to restrict the whirling of the specimen after it breaks.

In Fig. 4 the results of six series of tests on steel wire carried out on the machine are plotted logarithmically. All the samples were taken from the same coil. Three series of samples were tested in the "as-drawn" condition and three after the samples had been galvanised. The three series of each group were tested in air, in London tap water and in salt water respectively. The wire was 0·099in. in diameter and in the "as-drawn" condition had an ultimate tensile strength of 86·5 tons per square inch and in the galvanised condition 81·3 tons per square inch. Altogether the diagram covers tests on thirty-nine wires which failed or remained unbroken after anything from one-quarter of a million to one hundred million stress cycles. The diagram represents all told about 440 million stress cycles or the equivalent of some twenty-two days' continuous running of the machine at its normal speed. The longest test —100,000,000 stress cycles—was completed within a week a figure which compares very favourably with the six or seven weeks required for a similar test on other machines running at 1500 revolutions per minute. The curves themselves are of much interest. Two curves are given for the tests on galvanised wire in air because the plotted points exhibit a certain amount of "scattering." Whichever of these curves is taken, however, it will be seen that galvanising lowers the fatigue strength of wire by a small amount when the tests are conducted in air. On the other hand it raises the fatigue strength very definitely when the wires are tested either in tap water or salt water. The diagram also shows that a ten-million cycle test is sufficient to establish the fatigue limit of "as-drawn" and galvanised wire in air and that much longer tests are required in both cases if the wires are immersed in water. It will also be observed that the test results for galvanised wire in water are only slightly affected by a change from fresh to salt water whereas in the case of "as-drawn" wires the effect of the change is very marked, salt water lowering the fatigue strength much more than fresh water. All these results are in accordance with corrosion fatigue tests carried out by other workers using other forms of testing equipment. In particular they reproduce the main conclusion reached in 1916 in the course of an investigation of fatigue in the wire ropes used, during the War, for towing Paravanes for the protection of shipping against mines. Details of that investigation were given in a paper presented by Professor Haigh in 1929 before the Institution of Chemical Engineers, in which Chemical Action in relation to Fatigue was dealt with generally. It is interesting to note that the 1916 investigation not only revealed the principal features of what is now generally recognised as "corrosion-fatigue" but led to the important conclusion that the difficulties which it caused could be effectively eliminated by galvanising the wire. It is highly interesting to observe that corrosion fatigue phenomena, as well as other important surface effects, can be investigated with the simple equipment described in this article.

Up to the present, one of the principal difficulties experienced in carrying out research in fatigue has been the expense incurred in producing turned and polished pieces suitable for testing. The use of wire overcomes this difficulty as the test pieces can be simply cut off and immediately inserted in the machine. The Haigh-Robertson machine should therefore greatly facilitate fatigue research in general as well as the practical testing of wire. The machine is suitable for lecture table demonstrations. It runs almost silently on any stout support, and pieces can be broken in the course of a very few minutes to reveal all the characteristics of the brittle fracture of fatigue.

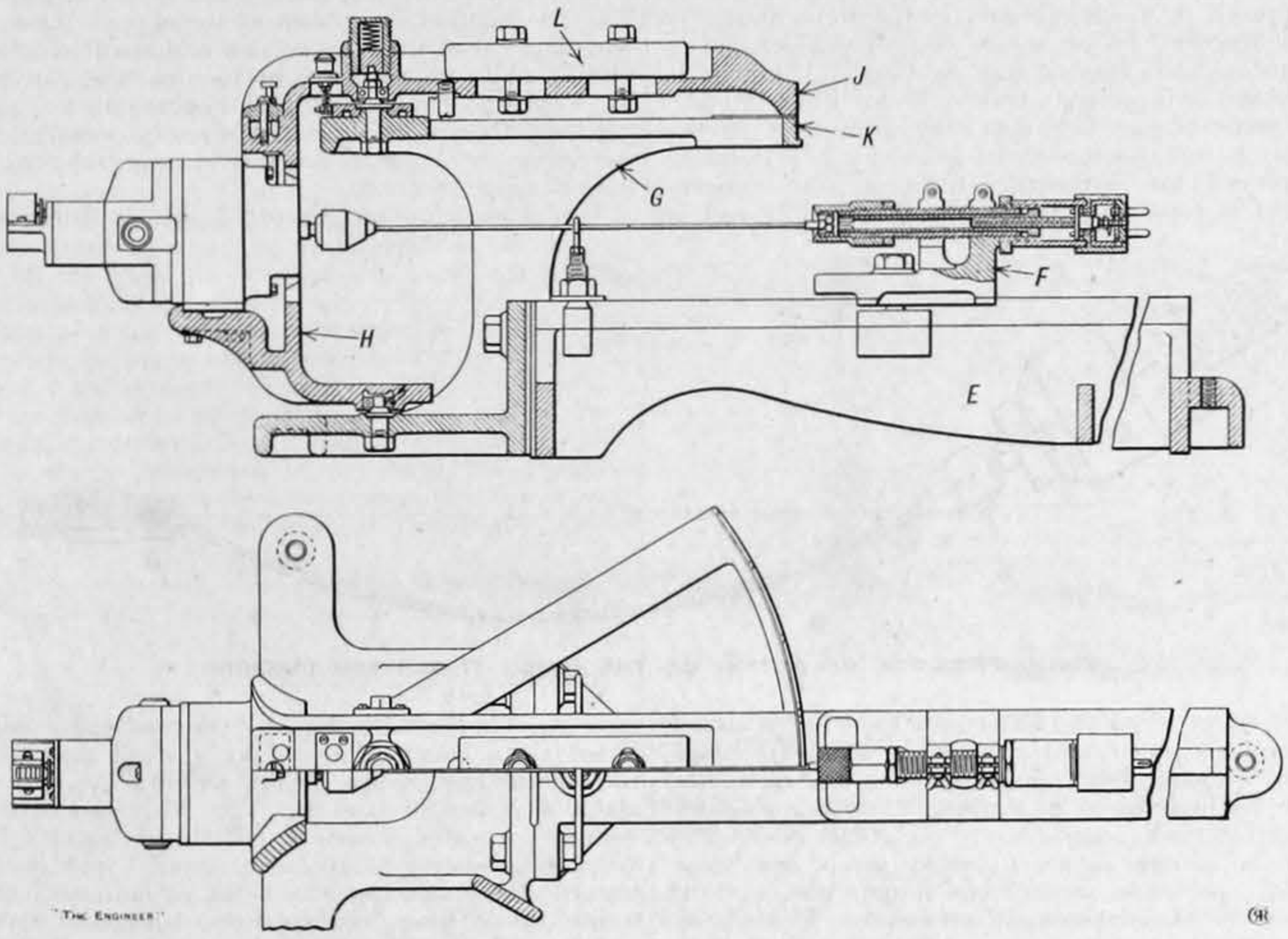
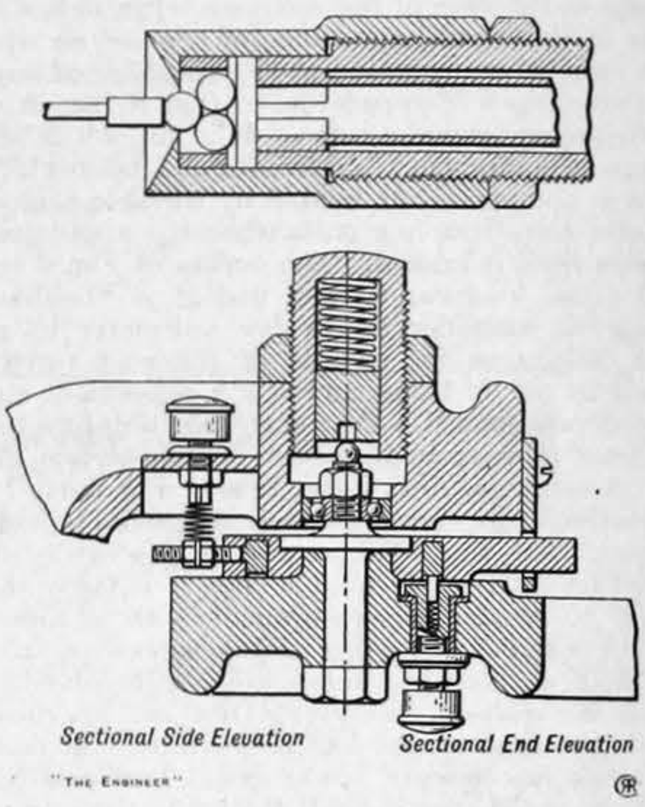


FIG. 3—GENERAL ARRANGEMENT OF THE TESTING MACHINE



FIGS. 5 AND 6—THRUST BEARING AND SAPPHIRE SUPPORT

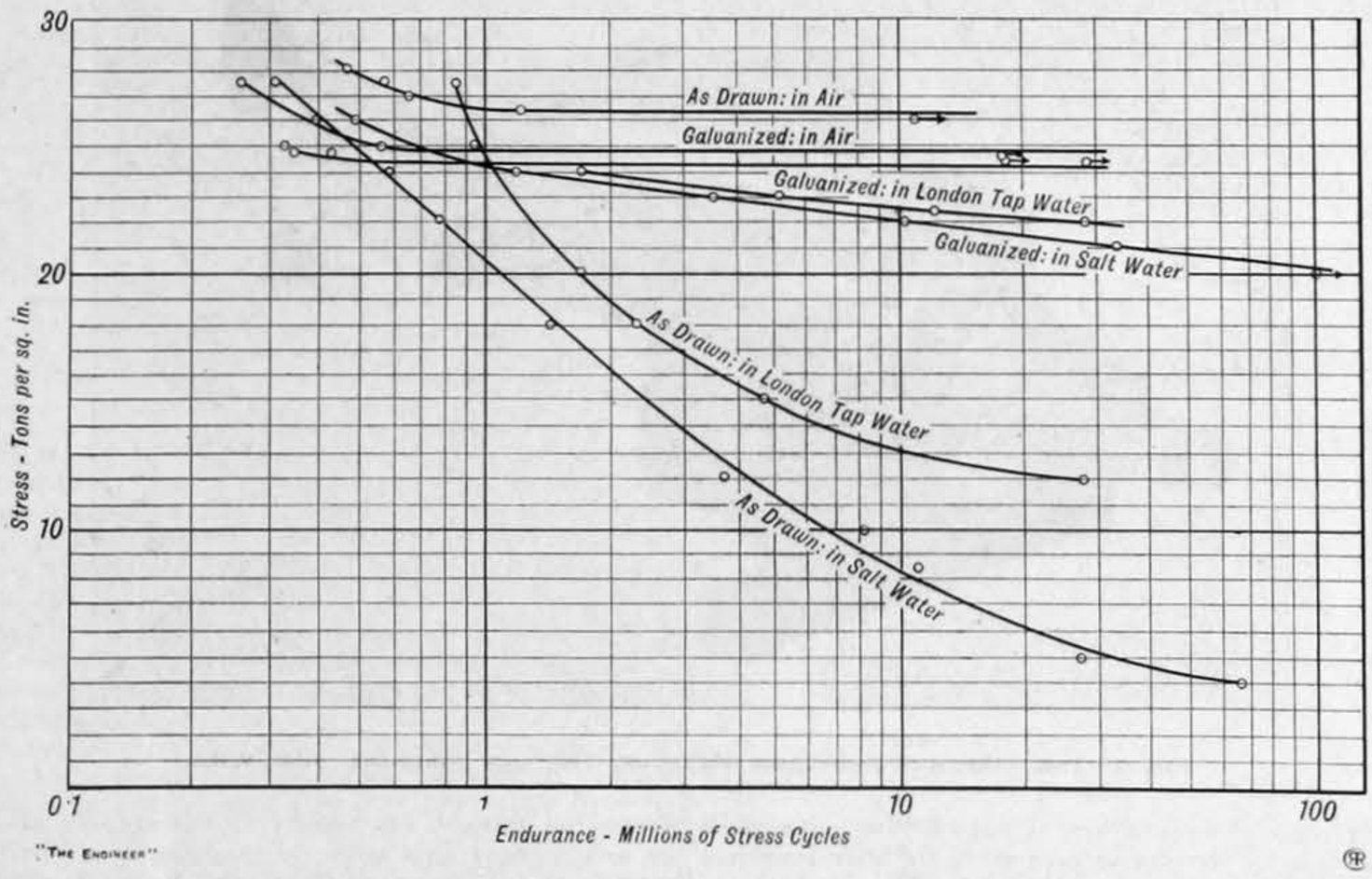


FIG. 4 RESULTS OF TESTS ON STEEL WIRE IN AIR AND WATER

L.M.S. 4-6-0 Mixed Traffic Engines.

INCLUDED in the 1934 building programme of the L.M. and S. Railway are seventy two-cylinder 4-6-0 superheated mixed traffic engines, fifty of which will be built by the Vulcan Foundry and twenty at the railway company's works, Crewe. These engines have been designed to meet the requirements for a general utility engine. Their general appearance and principal dimensions are shown in the accompanying engraving and diagram.

The boiler is of the Belpaire pattern, with a taper barrel, and with a view to reducing the weight 2 per cent. nickel steel plates have been used. The working pressure is 225 lb. per square inch. A superheater is fitted, and the main regulator has been incorporated in the superheater header in the smoke-box.

A steam manifold—with a main shut-off valve—is

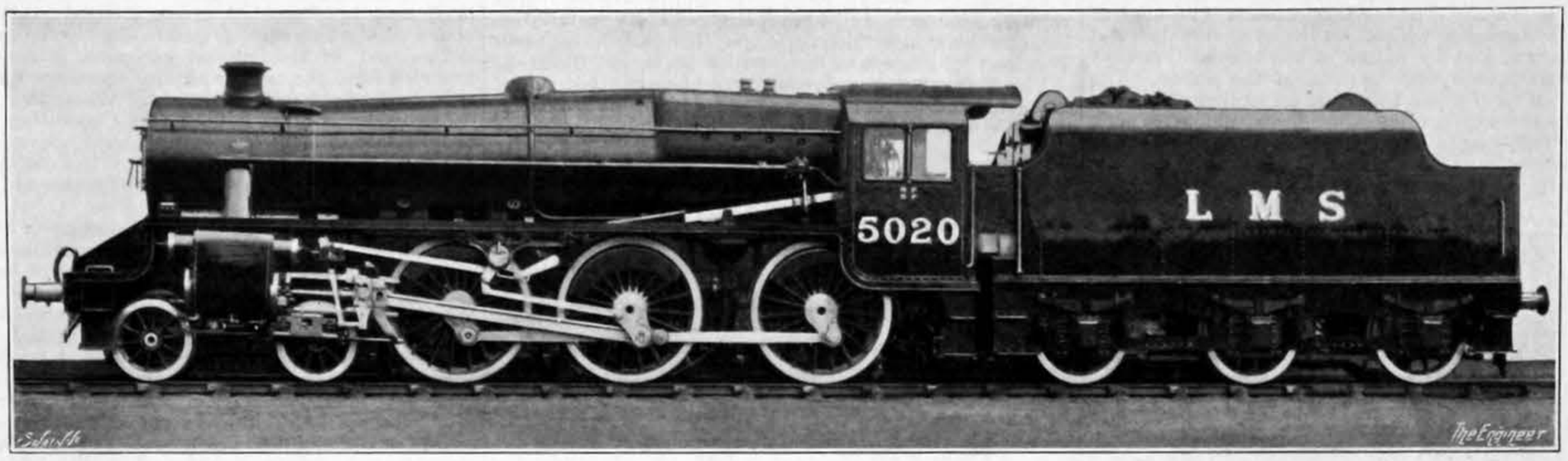
provided on the top of the fire-box door plate in the cab, and on this manifold are attached the valves for the ejector and steam brake, the injectors, carriage warming, whistle, pressure gauge, and sight feed lubricator to the regulator. The feed water is supplied through top feed valves mounted on the second boiler barrel ring and provided with water distributing trays. Two pop type safety valves, 2½in. diameter, are fitted at the crown of the fire-box. The firedoor is of a standard sliding pattern with a screen to prevent glare from the fire. An exhaust steam injector with 10 mm. cones is fitted on the right-hand or fireman's side, and on the other side a live steam injector with 10 mm. cones is provided.

The two cylinders are carried outside the frames and are 18½in. diameter by 28in. stroke. Walschaerts motion is fitted, the valve travel being 6½in. The piston valves, cylinders, piston-rod packing, and valve spindle bushes are provided with mechanical lubrication, the oil to each piston valve head being steam atomised. The coupling and connecting-rods and motion work are, in accordance with the latest practice, of high-tensile manganese-molybdenum steel, the connecting-rods being of a fluted section and the coupling rods of a rectangular section.

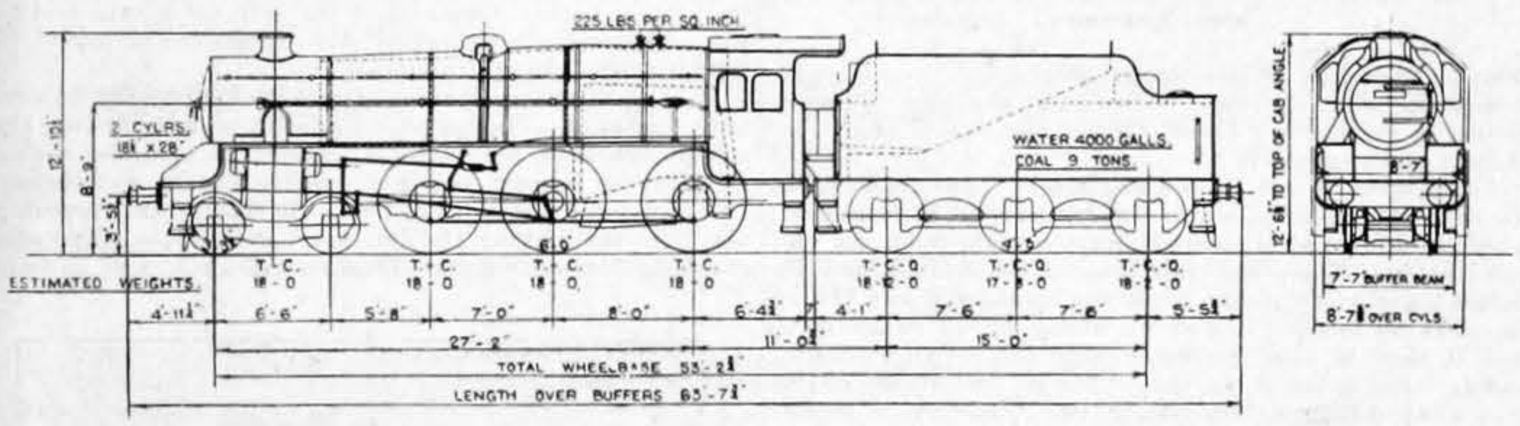
The wheel centres are steel castings with the wheel rim of triangular section, and the tire fixing is of the "Gibson" retaining ring type. The balance weights for the coupled wheels are built up of steel plates on both sides of the spokes and riveted, the requisite weight being provided by filling in between the plates with lead. The axle-boxes for the coupled wheels are steel castings with pressed-in brasses having white metal crowns. The coupled axle-boxes are arranged so that the oil pads can be examined by sliding out the underkeep while the axle-box is in position. Each axle-box is fitted with a dust shield carried on the inside face of the box. A mechanical lubricator supplies the coupled axle-boxes, each of which has an independent oil feed to the crown of the box, with a standard back pressure valve and flexible oil pipe connection. All the laminated bearing springs for the engine and tender are made of silico-manganese steel, the plates being of a ribbed section. The spring links are of the screwed and adjustable type. The four-wheeled bogie is of standard design, the weight being taken through side bolsters and bogie side check spring gear being provided to ensure smooth riding.

A steam brake is provided on each of the coupled wheels and is operated by the driver's vacuum brake valve. The vacuum pump is mounted on the left-hand side of the engine and is driven from the crosshead. The mechanical sanding apparatus is of the trickle type and delivers sand to the front of the leading coupled wheels and to the front and back of the middle coupled wheels. In addition, water de-sanding apparatus is provided, which automatically comes into action, so that after the engine has used the sand in the fore or reverse direction the rails are cleaned with hot water to prevent interference with the track circuits.

The tender has a capacity of 4000 gallons of water and 9 tons of coal. The coal bunker has been arranged so that as far as possible the coal will be self-trimming. A steam brake is provided on each of the six tender wheels and is applied simultaneously with the steam brake on the engine. The tender is also fitted with a hand brake and with water pick-up gear.



L.M.S. 4-6-0 MIXED TRAFFIC ENGINE



4–6–0 *Superheated Mixed Traffic Engine.*

Boiler:	
Barrel	13ft. 10½in.
Diameter outside	4ft. 11 11/16in., increasing to 5ft. 8½in.
Fire-box:	
Outside	9ft. 2 13/16in. by 3ft. 11¼in.
Inside	8ft. 4 13/16in. by 3ft. 2⅛in.; height, 6ft. 8⅝in. and 5ft. 1 11/16in.
Tubes:	
Superheater elements	14, 1⅜in. dia. outs. by 13 S.W.G.
Large tubes	14, 5½in. dia. outs. by 7 S.W. G.
Small tubes	160, 2in. dia. outs. by 11 S.W.G.
	14ft. 3in. between tube plates
Heating surface:	
Tubes	1460·0 square feet
Fire-box	156·0 square feet
Total	1616·0 square feet
Superheater	227·5 square feet
Grate area	27·8 square feet
Tractive effort at 85 per cent. B.P.	25,455 lb.

Estimated weight:	Light.	Loaded.
Engine	65 t. 10 c.	72 t.
Tender	21 t. 11 c. 2 qr.	42 t. 14 c.
Total weight of engine and tender:		
Light	87 t. 1 c. 2 qr.	
Loaded	114 t. 14 c.	

SIXTY YEARS AGO.

IT has frequently been asserted that from the engineering point of view the driving of a tunnel beneath the English Channel would present no unusual difficulties or in other words that political and commercial rather than technical objections have so far militated against its construction. We have heard this assertion disputed in fully responsible quarters and the opinion advanced that the engineering difficulties might be very serious indeed. Sixty years ago the self-same point provided a subject of hot debate among engineers and geologists. On the whole the engineers, as we learn from a leading article in our issue of August 14th 1874, took a hopeful view of the situation. The geologists, on the other hand, while they did not go so far as to assert that the tunnel could not be constructed, entertained grave doubts as to its practicability. Typical of the engineers' attitude towards the scheme was that of Sir John Hawkshaw who observed that "at a sufficient depth it was of no more consequence that the sea might be above the tunnel than a mountain." The geologists admitted that a tunnel under the Channel might be constructed with perfect safety through the London clay but they pointed out that the route which would in that event have to be followed would result in the tunnel being a hundred miles in length. Alternatively the Kimmeridge clay might be followed but it would only be available for about half the distance from shore to shore. A third alternative was to drive the tunnel through the palæozoic rocks but in this case the depth at which it would have to be constructed would prove a bar to the practicability of the scheme. There remained only the lower, or grey, chalk measures. The possibility of utilising that formation turned upon the establishment of its continuity from shore to shore and its freedom from open fissures. Private experiments conducted by Sir John Hawkshaw encouraged the belief that the grey chalk formation was continuous across the Channel but the absence of open fissures in it had not been established and could not be established with certainty without running a considerable length of preparatory driftway. On the whole we seemed to side with the geologists. Until a trial of the nature of the geological formation had been made, we considered that it would be premature to discuss the best form of the tunnel, its materials, mechanical equipment and ventilation. In the meantime, we added, two comfortable steamers were about to be placed on the cross-Channel route and it was possible that in the near future other improved vessels, ferries on a large scale and of novel design, might be built to ply on it. The reform would be a great one and many travellers, we said, might think it sufficient. The two comfortable steamers to which we referred were presumably the double-hulled vessel "Castalia" and Bessemer's swinging-cabin steamer, both of which at that date were rapidly approaching completion.

THE RECENT "GRID" FAILURE.

THE following statement regarding the breakdown of electricity supply on Sunday, July 29th, has been issued by the Central Electricity Board:—

At a meeting of the Central Electricity Board on August 8th consideration was given to a joint report, of which a copy is appended, made to them by the Engineers of the Board and the London Power Company, and to the circumstances attending the widespread failure of electricity supply in South-East and East England on Sunday, July 29th.

On the morning of that day the grid system was deprived simultaneously of the export from two of the three largest power stations in the area, namely, Deptford West and Battersea.

The system has always, even on Sunday loading, sufficient margin of generating plant in operation to make good immediately the loss of the largest station's output to the system, and it has also sufficient spare plant ready to be put into operation to maintain that margin against the unlikely contingency of a second station breaking down.

It had not been contemplated that there could be such an unusual occurrence as the loss of the output of two major stations at one and the same time, and the Sunday disposition of the generating plant in operation had not allowed for such a contingency. Had such an abnormal event happened on a weekday, the disposition of generating plant in operation is such that a widespread failure would have been avoided.

The Board are satisfied that there was a combination of circumstances that is not likely to recur, and there need be no apprehension of any such general failure in future.

JOINT REPORT OF THE ENGINEERS.

The investigations have disclosed that the trouble did not originate at the Battersea Power Station of the London Power Company, although it is true that that station became involved in it.

Every avenue towards elucidating the general failure having been fully explored, the complete inability to discover any other primary cause for the trouble has forced the Engineers to the deduction that the general failure originated with the breakdown of one of the turbines at the Deptford West Station of the London Power Company — a deduction which fully explains the subsequent trouble and how Battersea Power Station became involved in it.

(Signed) JOHNSTONE WRIGHT,
Chief Engineer, Central Electricity Board.
(Signed) S. L. PEARCE,
Engineer-in-Chief, London Power Company.

[The original statement issued by the Central Electricity Board, on which the leading article appearing in THE ENGINEER of August 3rd was based, intimated that the initial fault was caused by the reclosing of a station switch at Battersea, possibly without synchronising.—ED. THE E.]

THE IRON AND STEEL INSTITUTE.

THE Autumn Meeting of the Iron and Steel Institute will be held in Belgium and Luxemburg from Monday, September 10th, to Thursday, September 13th, 1934. On Monday and Tuesday meetings will be held in the Palais des Académies, Brussels.

After a welcome to the delegates by Monsieur Léon Greiner, President, and the members of the Belgian Reception Committee, the following papers will be presented for discussion:—

Monday.—"Belgian Research Committee on the Behaviour of Metals at Elevated Temperatures," by Monsieur H. Dustin; "Contribution to the Study of the Resistance to Chemical Attack of Various Special Steels," by Messieurs A. Portevin, E. Prétet, and H. Jolivet; "Accelerated Cracking of Mild Steel (Boiler Plate) under Repeated Bending: Part II, Further Tests," by Messrs. C. H. M. Jenkins and W. J. West; if time permits, "Some Aspects of the Fatigue Properties of Patented Steel Wire," by Messrs. E. T. Gill and R. Goodacre.

Tuesday.—"The Influence of Silicon and Aluminium on the Resistance of Cast Iron to High Temperatures," by Monsieur H. Thyssen; "Flexibility as a Factor in the Economic Exploitation of Rolling Mills and Some Technical Means for its Realisation," by Mr. G. A. V. Russell; "The Physical Properties of Iron-Aluminium Alloys," by Messrs. C. Sykes and J. W. Bampfylde; if time

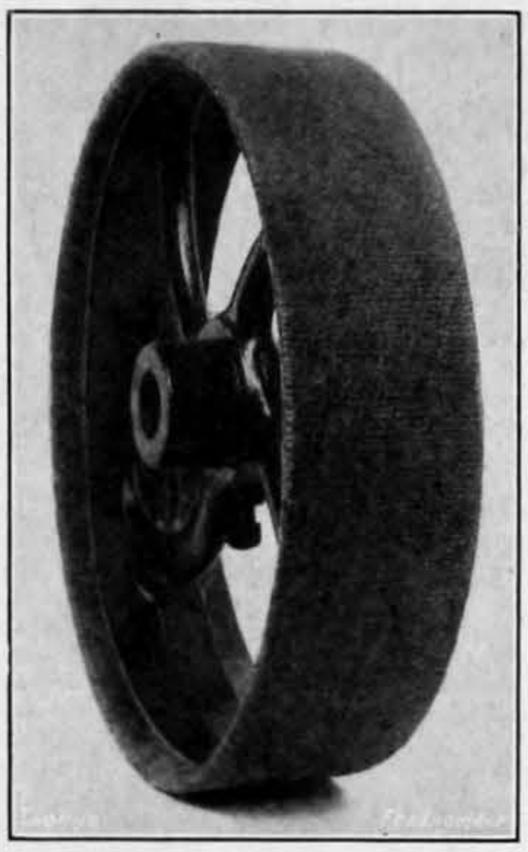
permits, "The Properties of Non-Hardenable Alpha-Iron Steels," by Mr. S. H. Rees.

On Thursday the delegates will meet at the Hotel de l'Arbed, Luxemburg, and after Monsieur Aloyse Meyer has extended a welcome, a paper describing the Iron and Steel Industries of Luxemburg will be presented on behalf of the Luxemburg Reception Committee. Visits and excursions have been arranged to the principal iron and steel manufacturing and engineering establishments in Belgium and Luxemburg.

Non-Slip Bandages for Belt Pulleys.

WE recently examined an improved form of pulley bandage which, it is claimed, does away with slip in power transmission by belt. Although well known on the Continent and America, the system has only recently, we are informed, been put on the market in this country by the Contrasit Company of Great Britain, Ltd., of 109, Kingsway, London, W.C.2. The bandage consists of an impregnated hessian covering, which, in turn, is mounted over a flannel covering, and by means of the special Contrasit solution is made one with the rim of the pulley. The attachment of such a bandage calls for skilled workmanship and the company's trained men are available for such work. The following is, however, a general account of the method adopted.

After all traces of grease have been removed the pulley



PULLEY WITH CONTRASIT BANDAGE

is heated by means of a blow lamp from the centre towards the surface. A flannel bandage which is impregnated with Contrasit fluid is wrapped round the surface of the pulley at a certain temperature. The bandage is then massaged on to the pulley, extreme care being taken to see that no air bubbles remain between the bandage and the pulley. It is then dried off by means of a blow lamp, the temperature of the pulley itself being maintained by application of the blow lamp so that the bandage is thoroughly dried out from underneath.

When the flannel bandage has been dried off an outer hessian bandage, also impreganted with Contrasit fluid, is applied in the same way as the flannel bandage. Care is taken to see that the completed pulley has no high spots, and the pulley is then allowed from twelve to twenty-four hours to set before being put into service. Contrasit bandages may be applied to all types of pulleys, such as wooden pulleys, step pulleys, split pulleys, &c. They are not affected by heat, cold, dampness, or general atmospheric conditions, but they must in all cases, we understand, be protected from the weather.

The impregnating fluid sets so hard that a hammer and chisel are needed to remove it. The life of such a bandage depends naturally on the type of belt drive on which it is employed, but under normal conditions they may last from four to six years. The company is prepared to advise on difficult belt drives, to execute work under guarantee, and to maintain and inspect under contract belt drives fitted with Contrasit bandages.

CATALOGUES.

FISHER AND LUDLOW, Ltd., Albion Works, Birmingham.—"The Age of Steel," a brochure on the firm's steel presswork.

BARRONIA METALS, Ltd., Parsons Green, S.W.6.—New publication B.M. 24, entitled "Copper Alloys for the Engineering Industries."

INGERSOLL-RAND COMPANY, Ltd., 165, Queen Victoria-street, E.C.4.—Catalogue and leaflets on two-stage air-cooled portable air compressors.

HOFFMANN MANUFACTURING COMPANY, Ltd., Chelmsford.—A portfolio showing the best methods of mounting and protecting ball and roller bearings.

NEWMAN, HENDER AND CO., Ltd., Woodchester, Glos.—Catalogue 54 on brass, gun-metal, cast iron and steel valves, cocks, and general steam and water fittings.

WESTINGHOUSE BRAKE AND SAXBY SIGNAL COMPANY, Ltd., 82, York-road, N.1.—Signal catalogue sections on A.C. track feed sets, housings, track circuit insulations.

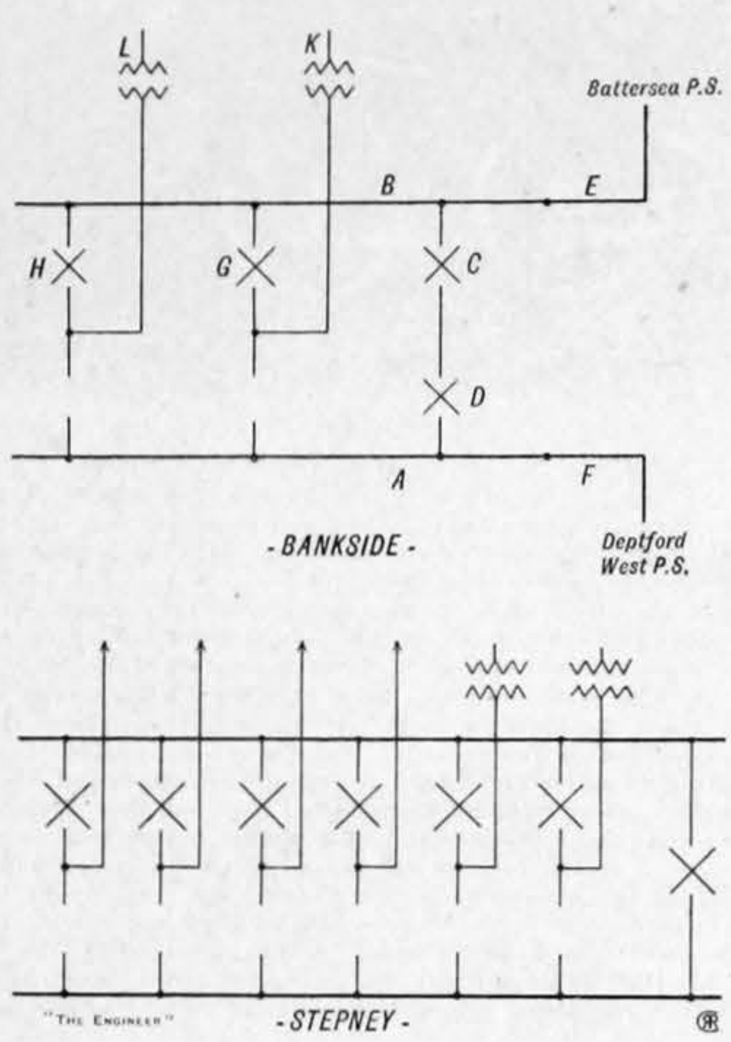
QUEST PRODUCTS, Ltd., Wharton, Cheshire.—Particulars of the composition, manufacture, and use of "Questal," "Bentonite," colloidal clay and bonded products.

NORTH-EASTERN MARINE ENGINEERING COMPANY, Ltd., Wallsend-on-Tyne.—A book dealing in some detail with the construction and manufacture of "North-Eastern" superheaters.

Outdoor Metal-Clad Switchgear and Centrovisory Control Equipment.

ON Friday, August 3rd, we were invited by A. Reyrolle and Co., Ltd., of Hebburn-on-Tyne, to inspect the metal-clad 66-kV switchgear of 1,500,000 kVA rupturing capacity, installed at the Bankside and Stepney grid sub-stations, and to view for the second time the Bankside control station. By reason of the fact that metal-clad gear is very compact it lends itself to use in places where land is expensive, and as it is designed for use outdoors, it does not call for expensive buildings, whilst, on account of its earthed metal enclosure, it can be erected in the vicinity of ordinary dwellings without risk of danger. The first Reyrolle draw-out gear of this kind, designed in 1905 for 6 kV, was followed by metal-clad equipments for higher voltages, and it is well known that a 132-kV installation has now been in service for some time at the outdoor Tongland sub-station of the Scottish portion of the grid.

Like the gear at Stepney and Bankside, which is designed for 66-kV and which is the first of its kind, that at Tongland has the merit of occupying considerably less space



FIGS. 1 AND 2—CONNECTIONS AT BANKSIDE AND STEPNEY

than that needed by the more usual 132-kV equipment associated with the grid. Owing to the limited space available on the two London sites, the use of this type of gear was imperative.

The diagram Fig. 1, drawn as a single-phase diagram for the sake of simplicity, shows the connections at Bankside, where buildings were cleared away to make room for the sub-station. There are two sets of bus-bars A and B, linked together by means of circuit breakers C and D and supplied by feeders E and F, whilst circuit breakers G and H may be used for connecting the transformers K and L to either set of bus-bars. The lay-out at Stepney is somewhat different, comprising two transformer equipments, four feeder equipments, and one bus-bar coupler equipment arranged as shown in Fig. 2. In a city such as London, in which land is valuable and in which the atmospheric conditions are liable to lead to harmful deposits on the insulators, the metal-clad construction offers a number of advantages over the open type of gear. The conductors can be brought nearer together and large clearances are unnecessary for the personal safety of men performing maintenance work, which is considerably simplified.

A view of the switchgear taken in the works when the assembly was practically complete is given in Fig. 3, which gives some idea of how the scheme of connections has been carried out. The two sets of bus-bars in copper tubes are arranged on either side of the inspection platform at the top of the equipment. Connections to the cable sealing boxes at the feeder side of the gear are taken off at intervals from the bus-bars through the circuit breakers which are contained in tanks slung from the framework in three-phase groups. Each phase of the switchgear is enclosed in its own metal casing and is entirely separate from the other phases, thereby providing an effective safeguard against the possibility of a fault on one phase spreading to the other phases. The circuit breakers are suspended so that any three-phase group may be isolated for inspection or, if necessary, taken away without disturbing the other breakers.

A section through one of the switchgear phases is given in Fig. 4, in which the incoming cable is shown connected to the sealing box A on the right. The current passes through the conductors B to the contact C and thence through the circuit breaker contacts D and finally to the bus-bars E. Safety devices of various kinds ensure satisfactory isolation. When a breaker has to be inspected it is first switched off and then lowered bodily, as shown on the left of Fig. 4, thus completely isolating it from the supply and making all its conductors "dead," for it cannot be lowered until the circuit is open. The breakers are lowered by means of an electrically operated truck which forms part of the equipment. When a breaker has to be lowered the truck is run in underneath it and its platform is raised so as to take the weight of the breaker, when cotter pins which normally support the breaker are removed. The truck platform is then lowered and the isolating contacts of the breaker are disconnected from the contacts C, which are associated with the other conductors of the switchgear. As the lowering proceeds the insulators F are withdrawn from the orifices G, and as soon as the isolating contacts leave the mouths of the orifices, metal doors H swing round and close the orifices. Thus even when the circuit breaker has been withdrawn from its working position all live conductors remain completely enclosed. If necessary, the breaker can be lowered further and taken away for inspection, or it may be supported in the isolated position by its cotter pins, which are inserted in slots in the guide posts.

The tank of the breaker can also, if necessary, be removed from the truck and any necessary work can be carried out with perfect safety. When the breaker is raised again to bring it back to its operating position a projection on its carriage engages with a lever and opens the doors H on the orifices leading to the isolating contacts so that the insulators on the circuit breaker are permitted to pass into the orifices.

All the conductors in the fixed portion of the switchgear are insulated with bakelised paper insulators, and in order to ensure additional security the chambers containing the conductors are filled with insulating oil. Where the conductors are long, or where there is likely to be a concentration of electrical stress in the insulation, condenser insulators are provided. These insulators contain a number of specially shaped pieces of metal foil, so arranged that the electrical stresses are distributed as nearly as possible uniformly throughout the insulation, a form of construction which enables the insulators to be made considerably smaller than is possible in the absence of the metal inserts, whilst also enabling the material to be economically disposed to withstand the stresses to which it is subjected. The method of grading the insulation on the conductor according to the stress is shown at B in Fig. 4, where the saving in insulating material is obvious. The insulating oil in the casings ensures that there are no air spaces, and troubles arising from the ionisation of the air in such spaces are therefore avoided. In addition, the oil serves the useful purposes of carrying away the heat generated in the conductors and of preventing local heating with its damaging effect on the insulating materials. It also materially helps to save copper.

Conservator tanks mounted at the top of the switchgear maintain the oil under a small pressure in all the chambers, and also provide for the expansion or contraction of the oil resulting from changes of temperature, whilst, owing to the constant head of oil, moisture is positively excluded.

Since the conductors and their cases change in length as the temperature alters, it is essential to guard against the setting up of mechanical stresses and flexible bellows have therefore been provided, as indicated at J in Fig. 4, to permit of a certain amount of relative movement of the casing parts. One end of the bellows is attached to the conductor casing, whilst the other end is joined to the switchgear main framework.

A comprehensive system of interlocking serves to prevent mistakes. The carriage for isolating and moving the circuit breakers, for example, cannot be operated unless it is in the correct position relative to the switchgear. It consists of three main parts—a raising and lowering platform for moving the breaker vertically, a traversing platform for moving the breaker sideways, and a main

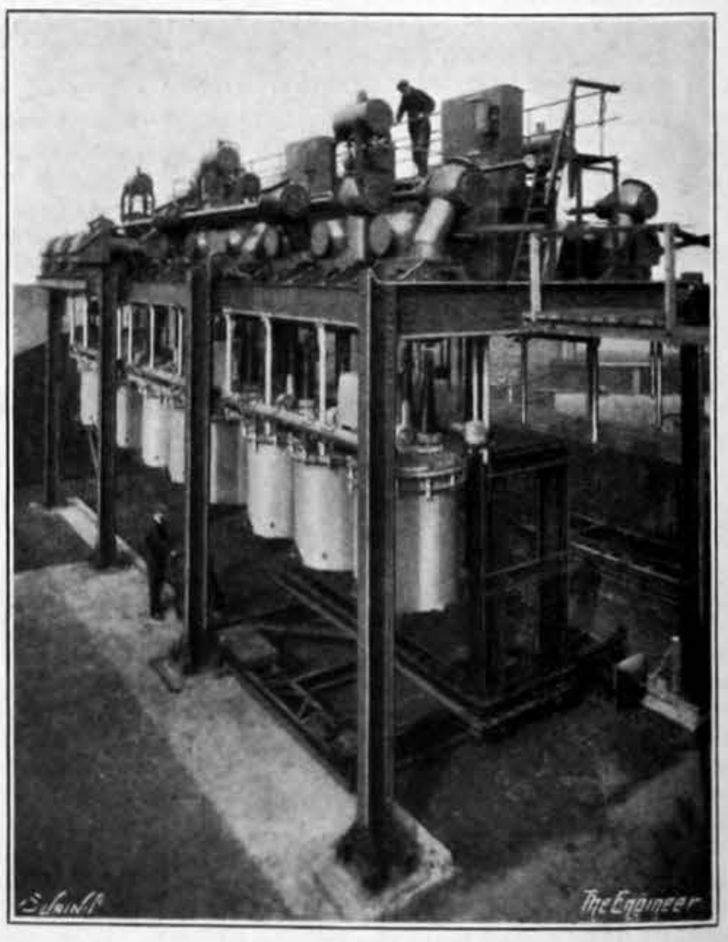


FIG. 3—SWITCHGEAR AT MAKERS' WORKS

platform on which the other platforms are mounted for moving the breaker along the switchgear line. The main platform is operated by a controller, interlocked so that the operating motors cannot be switched on unless the traversing platform is in the centre position and the hoisting platform in the lowest position, thereby ensuring that the circuit breaker to be moved is brought into the central gangway in its lowest position before it is transported

along the line of switches. Thus, it is impossible for the circuit breaker to foul other parts of the switchgear while it is in motion. Moreover, the traversing platform is interlocked, so that it cannot be moved, unless the main platform is correctly located under a switch panel, and the hoisting platform is in its lowest position, thus ensuring that the circuit breakers will be in their correct position for raising after the traversing operation, and that the top insulators on the breakers are clear of the fixed portion of the switchgear before the breakers can be moved sideways.

Another interlock prevents the hoisting platform being raised above the "isolated" position unless it is totally empty or is carrying a three-phase group of circuit breakers. The interlock consists of four plungers, which normally project above the platform surface for co-operating with projections on a group of circuit breakers. When all the plungers are raised, as, for example, when there are no circuit breakers on the platform, the circuit to the motors for working the platform is complete. When all the plungers are depressed, as, for example, when a group of circuit breakers is on the platform, the circuit is also complete. If, however, the plungers are either not all depressed or all raised, the circuit is broken, the primary object of this interlock being to prevent an operator trying to remove a tank from a circuit breaker before the latter has been isolated. In the event of an attempt being made to do this, as soon as the platform begins to be lowered, one of the plungers co-operating with the upper part of the circuit breaker would rise and break the lowering motor circuit, and so prevent further lowering of the platform. As the interlock becomes inoperative when the hoisting platform is below the position a circuit breaker would occupy when fully isolated, it is possible to remove single tanks from isolated circuit breakers.

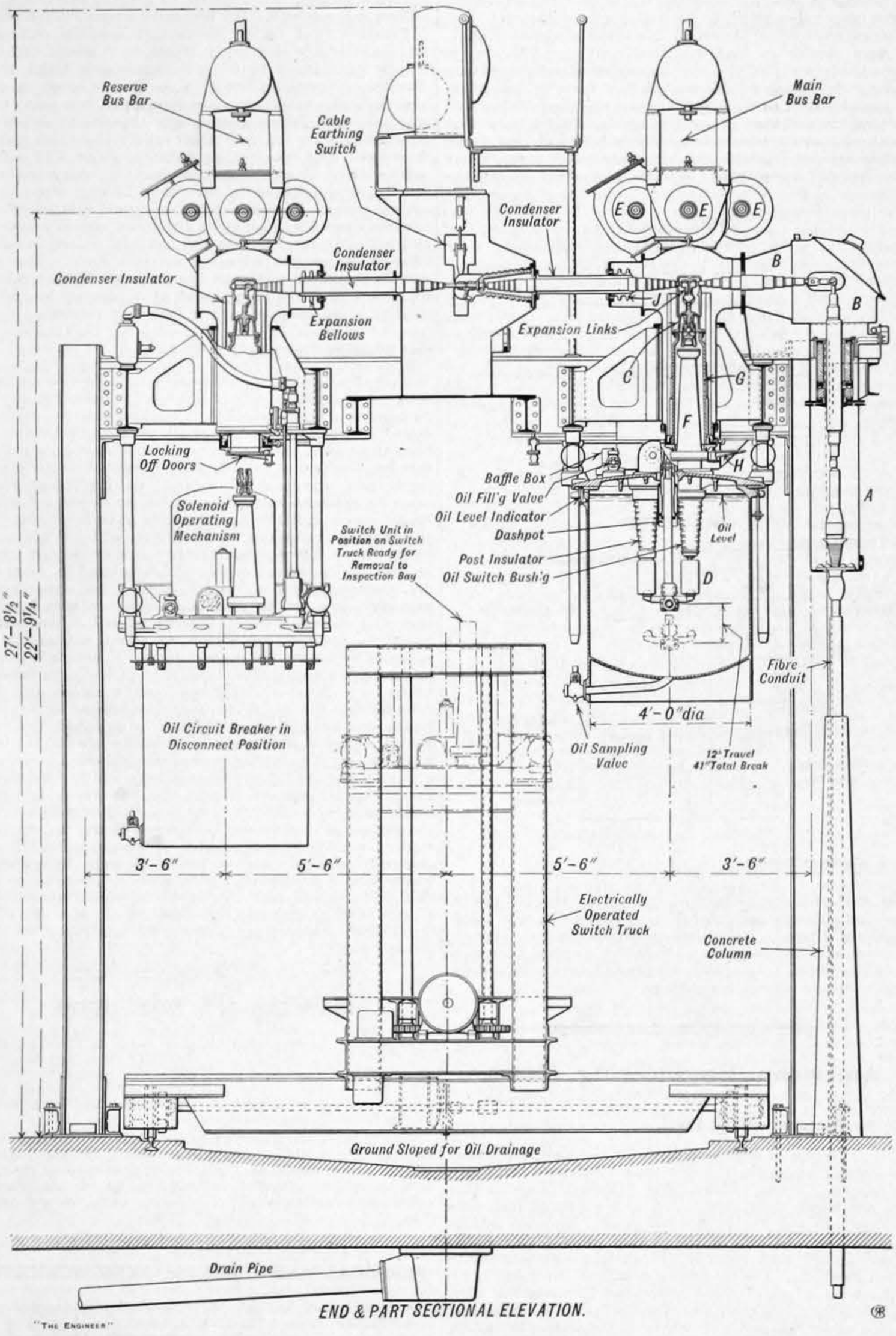


FIG. 4—SECTION THROUGH SWITCHGEAR

The switchgear at Bankside is shown in Fig. 5, from which it will be seen that the equipment has been erected in densely populated surroundings, and in close proximity to oil feed tanks, while Fig. 6 shows the Stepney switchgear, which has been erected in a very confined space without sacrificing accessibility or safety.

As is well known, the control of the South-East and East England sections of the grid is supervised from a control room in London in close proximity to the Bankside power station. The control room was described in a general way in our issue of April 27th of this year. Views of the room were also given in our issue of January 12th. In it equipment is provided for giving the control engineers automatic indication of the conditions existing on the grid network covering the South-East and East England area, together with a hand set system diagram of the entire network and associated undertakers' networks. Telephone communication circuits are also provided to all key points of the system. Automatic indications are received from fifty stations, consisting of all the C.E.B. 132 k and 66 kV switching stations, and from the more important low-voltage connecting links of the grid. The automatic indications given in the control room are signalled through from each controlled station over two pilot wires, hired from the Post Office, the indications provided at the control room being as follows:—(*a*) Conditions of circuit breakers, *i.e.*, "on" or "off"; (*b*) position of transformer tap-changing equipments; (*c*) power transfer through the sub-stations (megawatts and megavars) and direction of flow; (*d*) voltage of circuits at various points; (*e*) the total output of some generating stations; and (*f*) alarm signals in the event of a change of the conditions (*a*) or (*b*), with subsequent revised indication. Facilities are also provided for sending routine instructional signals to certain generating stations. As all the above indications, which are multiplied where there is a plurality of switches, are received from any one station over one pair of wires, it has been necessary, in order to make this possible, to provide selector equipment at both the control and controlled stations. Its duty is to allocate the pilots in turn to each indicating unit (*e.g.*, a circuit breaker) and to cause the selected unit to send a signal according to its condition over the pilots, the signal being allocated in turn to the appropriate indicator in the control room.

For this purpose Reyrolle centrovisory control apparatus is employed. In the control room there is a separate panel for each station to be controlled, and on each panel the system diagram of the controlled station circuits is shown, the diagrams of each station being connected from panel to panel to form a complete system diagram of the network. In the system diagram rotary indicators are inserted in the positions occupied by the circuit breakers to give an indication of their condition at all times. When a circuit breaker is operated at a distant station the corre-

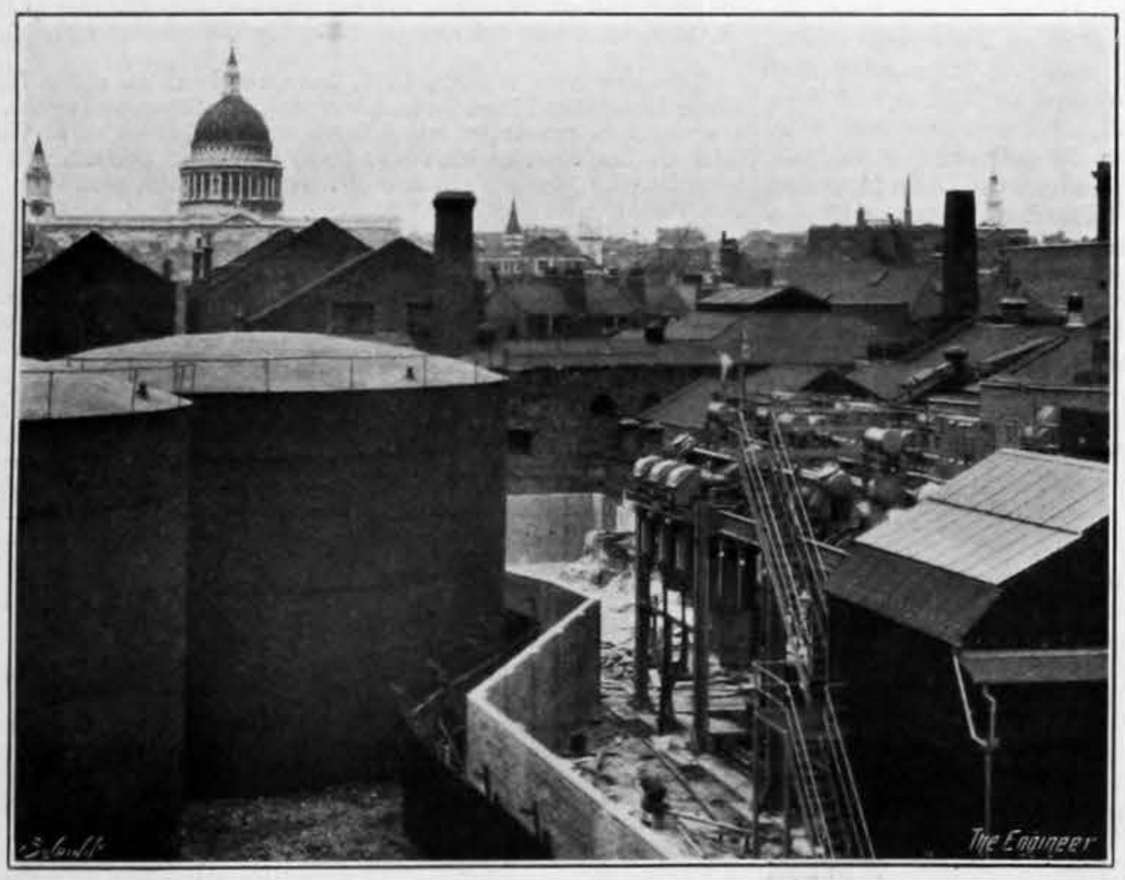


FIG. 5—SWITCHGEAR AT BANKSIDE

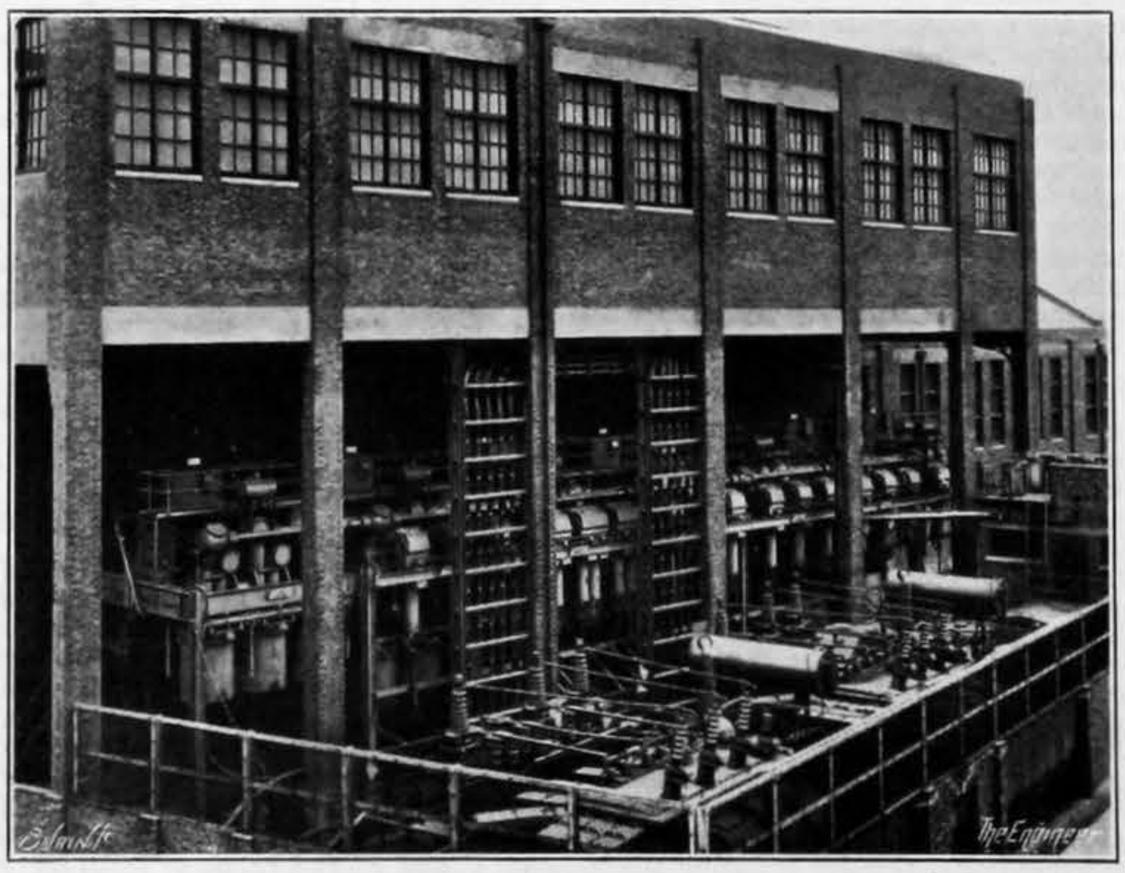


FIG. 6—SWITCHGEAR AT STEPNEY

sponding indicator in the control room turns and indicates the new position. Independent audible and visual alarms are given. Meter and tap-changing equipment position indicators are also mounted on the panel. The latter continuously indicate the position of the tap-changing apparatus, and gives an alarm when a change occurs, whilst the meter readings are initiated as required by the control engineers, and when taken the reading is locked on the meter to facilitate logging it.

At each controlled station there is a centrovisory-control remote station equipment, comprising the necessary selector and signalling apparatus for sending the indications to the control station. The system diagram on the panels is unusual in that the diagram for each station is arranged on the appropriate panel in circular form, a scheme which results in considerable saving in space and

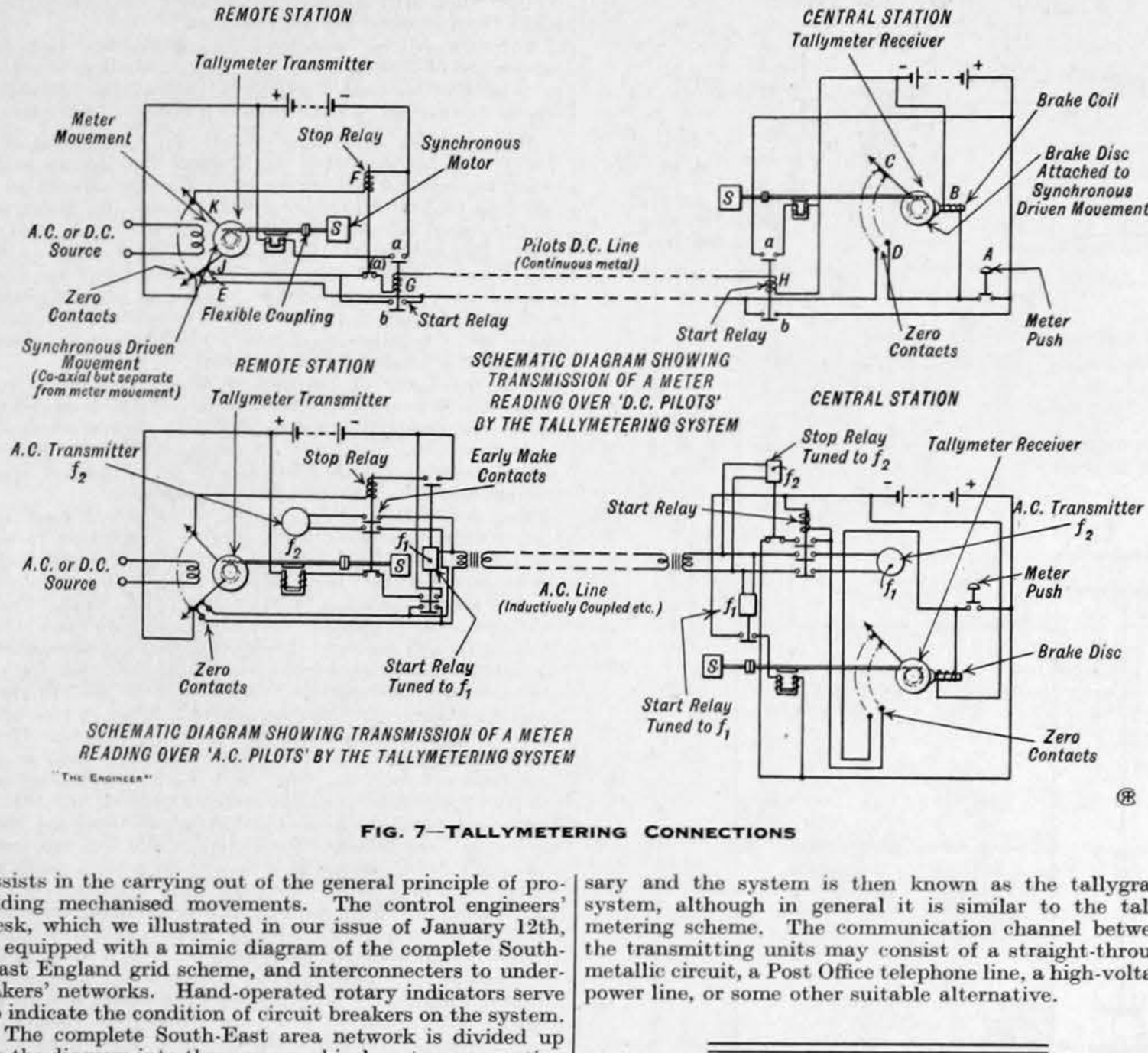


FIG. 7—TALLYMETERING CONNECTIONS

assists in the carrying out of the general principle of providing mechanised movements. The control engineers' desk, which we illustrated in our issue of January 12th, is equipped with a mimic diagram of the complete South-East England grid scheme, and interconnecters to undertakers' networks. Hand-operated rotary indicators serve to indicate the condition of circuit breakers on the system.

The complete South-East area network is divided up on the diagram into three geographical parts, representing the North, South, and London sections, and the generator capacity of each station is recorded, adjacent to each point representing the station, on hand-set indicators. As we explained in the article appearing in our issue of April 27th, in addition to the desk mimic diagram, there is a large wall diagram which is a replica of the desk diagram, the rotary indicators on the wall diagram being electrically operated from the desk. Reyrolle tallymeter receivers at the top of the station panels are used in conjunction with centrovisory control for the indication of meter readings at the control station and for indicating the positions of transformer tap-changing equipments. Immediately below these instruments are the alarm lamps and below these the circular system diagram for each station, and connected from station to station to show the complete network. Below the system diagram are the operating pushes and above the centrovisory control board the master frequency control equipment.

The principle of the Reyrolle tallymeter system is based on the synchronous movements of two indicating pointers or their equivalent, one at the remote station and one at the control station, the movements being started and stopped simultaneously by means of signals transmitted from one station to the other. The apparatus consists of a transmitting unit at one point and a receiving unit at the other, both units being similar and comprising a pointer or arm driven over a meter scale by means of a synchronous motor. The transmitter unit has in addition a meter movement operated by the quantity to be measured and mounted in axial alignment with the motor driven movement. Both motor-driven pointers are started at the same time and they are both arrested when the remote station pointer attains the value indicated by the meter movement. Thus the meter pointer on the receiver unit indicates the appropriate value and is clamped in this position to record the last reading until a new reading is initiated.

Two applications of the system are shown in the diagram Fig. 7. The scheme shown in the upper diagram is used where a plain D.C. metallic circuit is available between the transmitter and receiver, while that shown in the lower diagram is employed when the communication circuit necessitates sending A.C. signals. The operation for taking a reading in the former case is as follows:—On pressing the control station meter push A, the brake coil B is released and the pointer C drops, thereby closing the zero contacts D. The circuit from the positive pole of the battery, through the meter push A, the zero contacts D, pilot, transmitter zero contact E, a break contact (*a*) on the stop relay F, the remote station start relay G, pilot, the control station start relay H, and the negative pole of the battery, is then completed. The two start relays G and H are thus energised and the circuits are made to energise the clutch coils on the transmitter and receiving units, thereby engaging the pointers C and J with their respective synchronous motors. Both pointers therefore travel over the scales until the transmitter pointer J makes contact with the pointer K, which is in a position determined by the quantity to be measured. When the pointers J and K meet, the stop relay F breaks the circuit to the relays G and H, thus arresting the drive of the pointers. The pointer C then indicates the same value as pointer K, and as the brake coil is de-energised it will show this value until a new reading is initiated. The alternative scheme shown in the lower diagram, Fig. 7, is very similar to that described, but the A.C. line is inductively coupled to the transmitting and receiving units. By means of this system any form of indication or signal can be transmitted, such as readings of electrical meters, indications of water levels, transformer tap positions, and engine-room instructions. In the three latter cases the position of the transmitter may be set mechanically or by hand. A meter movement is unnecessary and the system is then known as the tallygraph system, although in general it is similar to the tallymetering scheme. The communication channel between the transmitting units may consist of a straight-through metallic circuit, a Post Office telephone line, a high-voltage power line, or some other suitable alternative.

American Engineering News.

An American Alkali Plant.

WORK is well advanced on the new ammonia-soda alkali works for the American Cyanamid Company at Corpus Christi, Texas, and although construction was not begun until July, 1933, it is expected that production will start in September next. Railway sidings parallel the land side of the works, while a pier 450ft. long and 100ft. wide, with 30ft. of water, will accommodate ocean steamers. On the pier is a transit shed, 300ft. by 50ft., with a portal crane travelling between the shed and the edge of the pier. Electrically operated centrifugal pumps under the pier will deliver to the works 25 million gallons daily of salt water for cooling and other purposes. Brine from the company's salt wells 60 miles distant will flow by gravity through a 14in. pipe line to an open reservoir of 3 million gallons capacity. Lime for caustic treatment of the soda-ash will be produced from oyster shells dredged from great oyster reefs in the bay. Limestone and coke will be delivered by rail. Natural gas from a gasfield owned by the company about 6 miles distant will be delivered through an 8in. pipe line of welded steel. Between the evaporators—of the Swenson type—and the rotary kilns for calcining the oyster shells, will be the causticising plant, with its thickeners and bone classifiers. Four concrete silos or cylindrical bins provide for storing the soda-ash, and are provided with apparatus for packing it in sacks or delivering it in bulk to railway cars. Adjacent is a great vertical kiln in which the limestone—stored in underground bins—will be burned to produce lime and gas. Beyond this are the dryers and kilns for the calcining process. Boilers fired by natural gas and working at 450 lb. pressure, supply two large turbo-generators and also steam for processing operations. The concrete chimney is 220ft. high. The plant buildings are of steel construction with metal sheathing, but the office and laboratory buildings are of brick. High-tension current is obtained from transmission lines.

New York Water Supply.

Although the city of New York has spent millions of dollars in increasing and improving its water supply, it still faces the necessity of further great increase in quantity. Owing to the depression and the city's financial situation the works considered essential by the engineers have been postponed again and again until there is threat of a shortage, as the construction will require several years. Relief has been obtained in one way by a decrease in consumption, resulting from the decline in factory work, business, and housing. An organised survey for and repair of leaks has also had an important, if minor, influence. The safe yield from present reservoirs and wells is estimated at 1039 million gallons daily, while the present consumption is approximately 1017 million gallons. The new source of supply is to be from tributaries of the Delaware River, up in the mountains, with reservoirs on these streams and gravity flow through a long tunnel to a reservoir just north of the city. This, with a minor auxiliary source, is estimated to give an additional 640 million gallons daily. The necessary works will cost about £54,400,000, but under the present financial difficulties there is little prospect for construction. A special organisation is maintained to discover and repair leaks in the distribution system; many leaks are reported in complaints from householders and companies, but many more are discovered in systematic surveys made by aid of the aquaphone. In the past three years the total leakage discovered and stopped aggregated about 122 million gallons daily. Many abandoned service pipes were found leaking, and apparently had been leaking steadily for several years. The per capita consumption is lower than in other large American cities which are partially metered, and it is not probable that any material reduction can be effected by general metering at New York. The only definite means of relief is in the proposed Delaware River supply, with its 90-mile tunnel at depths up to 1000ft., but this work will require from eight to ten years.

Pumping Concrete into Place.

For several years experiments have been made with the pumping of mixed concrete, to deliver it in place without the usual handling by wheelbarrows, carts, or drop-bottom buckets. One of the greatest difficulties has been to prevent segregation of the mix during its passage through the pump and discharge piping, but the experiments have resulted in entire success and pump-placed concrete has been used on a number of important works. Approximately 300,000 cubic yards have been placed in this way, at distances up to 1000ft. and heights up to 100ft. above the pumps. Either single or duplex pumps are used, of the piston type, with cylinders 7½in. bore and 8in. stroke, making about 50 r.p.m. This equipment is mounted on a portable bed-plate together with a petrol engine or electric motor of 25 to 50 H.P. The weight complete, mounted on wheels, is about 5 tons for the single or 8 tons for the double pump. Concrete is poured into a hopper and a valve feeds it to the cylinder for each stroke. A tapered discharge pipe connects the 8in. cylinder with the 6in. or 7in. main pipe leading to the work. Bends and elbows are introduced as required, but each 90-deg. elbow is equivalent in resistance to 40ft. of horizontal pipe. The stiffest consistency handled effectively is that giving a drop or slump of 3in., and the maximum size of coarse aggregate is 2½in. As the concrete forms a solid moving column in the pipe there is no segregation and the discharge is a steady continuous flow. In stopping work, a wooden plug is inserted in the pipe after the last charge of concrete and is forced through by pumping water behind it, the last few yards of concrete being discharged to waste with the flow of cleaning water. The system is quite different, of course, from that of forcing intermittent batches of concrete through pipes by compressed air.

LAUNCHES AND TRIAL TRIPS.

MERKLAND, single-screw steamer; built by Barclay, Curle and Co., Ltd., to the order of the Leith, Hull and Hamburg Steam Packet Company, Ltd.; dimensions, 260ft. by 40ft. by 18ft. 6in.; to carry cargo. Engines, triple-expansion, 15in., 25in., 41in. by 33in. stroke; constructed by North British Engine Works; launch, August 8th.

KIRKLAND, steel screw steamer; built by Caledon Shipbuilding and Engineering Company, Ltd., to the order of Messrs. James Currie and Co., Leith; dimensions, 260ft. by 40ft. by 18ft. 6in.; to carry cargo. Engines, triple-expansion; constructed by Barclay, Curle and Co., Ltd.; launch, August 9th.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

A. C. WICKHAM, Ltd., Coventry, has been appointed the sole agent in the British Isles for Abawerk G.m.b.H. Alig und Baumgartel, of Aschaffenberg, Germany, for the sale of that company's combined jig boring and grinding machines, "Wimet" fine grinding and lapping machine, and precision surface grinding machine.

CONTRACTS AND ORDERS.

The Editor is always happy to print short announcements of contracts and orders in this column provided they are sent to him in time to have news value and that they are likely to interest readers.

HARLAND AND WOLFF, Ltd., have received an order from Elder Dempster Lines, Ltd., Liverpool, for the construction of a new motor passenger vessel for inter-coastal service in West Africa. The vessel, which is to be laid down in Belfast, will be propelled by Harland–B. and W. motor engines, and is to be ready for service early next year.

JAMES COMBE AND SON, Ltd., 9, Southampton-street, London, W.C.1, have received a contract to install at the Pioneer Health Centre, Peckham, an all-electric thermal storage space-warming, air-conditioning, swimming-pool-warming, and hot-water service plant. Messrs. J. Combe recently completed the all-electric plant for the Empire Pool and Sports Arena at Wembley.

KRYN AND LAHY (1928), Ltd., Letchworth, Herts, have obtained a large contract for a total weight of 120 tons of miscellaneous castings from a well-known rolling mill corporation. Some of the items will be of mild steel, some of high-carbon steel, and the remainder of K.L. "Stronger Steel." This contract follows on several others from the same corporation.

AN AVIATION MUSEUM.—The Science Museum Report for 1933 refers, as we stated in last week's issue, to a possible intention, on the part of the Air Ministry, to establish a museum to illustrate the history of aviation. It has been ascertained that this statement arose through a misapprehension of the position. The Air Ministry, we are informed, has been considering the best method of preserving such historical and technical records as would be of permanent value in illustrating the history and development of the Air Service, as the youngest of the three defence services. It would be premature at present, however, to make any formal or detailed announcement on the subject.

Markets, Notes and News.

The prices quoted herein relate to bulk quantities. Unless otherwise specified home trade quotations are delivered f.o.t. Export quotations are f.o.b. steamer. A comprehensive list of the prices of materials mentioned below will be found on the next page.

The American Situation.

Latest American advices state that the severe drought in the prairie states has overshadowed business prospects in the iron and steel industry. However, the Government's emergency plan to slaughter and can 7,000,000 head of cattle will temporarily benefit steel producers, as the containers required will call for about 175,000 tons of tin-plates. The average steel ingot production has improved slightly and is now estimated at 27½ per cent. of capacity. Pig iron production in July is reckoned at 1,225,000 tons, against 1,930,000 tons in the previous month and 1,819,000 tons in July last year. The furnaces in blast on August 1st numbered 75, against 89 a month ago and 106 a year ago, the daily production rate being 36,000 tons, against 48,000 tons last month and 60,000 tons last year. The outlook is not promising and except for the quarterly distribution of orders for material needed for repairs railroad buying is negligible. The rail mills will this month complete the rolling of 700,000 tons of rails purchased with Government financial aid last spring. Steel makers expect little from the railways over the remainder of the year beyond orders for additional cars. Tenders are being taken for 450 subway cars required for New York. The structural shape mills are operating at a higher rate than other heavy finished steel mills, mainly on the demand from municipal works. The tonnage of structural steel placed so far this year is 17 per cent. larger than in the similar period last year. The steel makers disregarded the President's invitation to cut prices on small tonnages required by the Government recently and quoted their code figures. The N.R.A. has ruled that the filing of reduced prices for steel for Government requirements does not make such prices applicable in the open market. Steel makers, however, take the view that the code is a contract and that any reduction, even to the Government, would be a violation of the agreement. Manufacturers of finished steel products find little comfort in the fact that although steel prices generally are 2 dollars to 4 dollars lower than was expected for third quarter delivery, they are still 1 dollar to 4 dollars above second quarter levels. This is leading them to seek further concessions.

Pig Iron.

In spite of the seasonal quietness a fair volume of activity is being maintained in the pig iron industry, particularly on the North-East Coast, where the statistical position is satisfactory. Stocks of Cleveland foundry and forge iron are comparatively light and ironmasters are regulating their output so as to avoid any undue accumulation, although so far there seems no necessity to reduce production. Confidence in the future prevails, and with a good local demand and the resumption of deliveries to Scotland the output of Cleveland is practically absorbed. Supplies of East Coast hematite are readily taken up and the makers appear somewhat reluctant to book far forward at current prices, in view of the possibility of increased production costs. The Cleveland ironmasters have not relaxed their efforts to secure a larger share of overseas business, and the news that a cargo of 1000 tons had been loaded for Italy gave much satisfaction. Prices for home delivery remain steady, but it is understood that exceptionally low prices can be obtained for export. The Midland pig iron trade has been hampered to some extent by the holidays, which have caused some accumulation of stocks at makers' yards. A number of consumers have renewed contracts to cover autumn and winter requirements, and the light castings branch continues to take good deliveries. On the North-West Coast the orders received ensure the disposal of production until near the end of next month. The local demand is well maintained and absorbs rather more than half of the current output. The price position remains steady. In the West of Scotland an active business continues in all grades of pig iron, the call for steel-making iron being more brisk than that for foundry qualities. Values are maintained at 72s. 6d. for No. 1 foundry and 70s. for No. 3 and 71s. per ton for hematite, f.o.t. at furnaces. The price of basic iron has been increased by 2s. 6d. per ton in all districts; but little business has been transacted at the higher rates, consumers having covered their requirements before the advance.

The Steel Position.

Judging by the inquiries for steel received during the past week, the outlook for the remainder of the year is encouraging and in some quarters exceptionally active conditions are expected. An interesting feature was the improved number of specifications for structural steel and in a number of instances delivery within a reasonable period has not been easy to secure. The demand for heavy plates has been quiet, but the thinner sizes have sold fairly well. The Association rates for joists, angles, channels, and plates have been strictly upheld. Boiler plates have been in quiet demand, but a steady routine business has passed in mild steel chequer plates. Owing to the recent contracts for new vessels, good orders will eventually be placed for shipbuilding steel, and several specifications for ship plates and sectional material have already come to hand in the shipbuilding areas. After a quiet interval inquiries for colliery steel have revived. Prices remain unchanged. There has been some irregularity in the distribution of orders for small steel bars, some works having full order books, whilst others have difficulty in maintaining activity. In this department Continental competition has been most intensive, as foreign bars have been sold at £6 19s. 6d. per ton delivered and inclusive of duty, against the English controlled price of £8 12s. per ton. Unassociated makers have, however, secured most of the current business at £7 15s. to £7 17s. 6d.

Scotland and the North.

Business in the West of Scotland proceeds at a fairly steady pace and most of the works are operating at a good rate. The heavy steel works are well placed and many concerns are benefitting from the more active conditions now prevailing at the Clyde shipbuilding yards. The engineering branch has recently secured good orders for various descriptions of work, including oil tanks and locomotives, whilst producers of railway material have taken substantial business in rolling stock and bridge building material. In the tube trade conditions are more encouraging; the weldless department is busy, and there is more doing in butt-welded descriptions. Heavy-gauge steel sheets have been in active request, particularly on export account; but there has again been a scarcity of inquiries for light sheets, makers of which are poorly employed. Continental competition has been felt in wrought iron and re-rolled steel, and although a certain amount of material is turned out each week, in only a few instances is plant fully engaged. Coast Lines, Ltd., have placed an order with the Ardrossan Dockyard, Ltd., for a motor ship of approximately 1600 tons with a capacity of over 120,000 cubic feet. The vessel will be propelled by two British Atlas-Polar marine engines, which will be installed by John G. Kincaid and Co., Ltd., of Greenock. On the North-West Coast there has been a moderate volume of activity and business in pig iron has been satisfactory. The outlook in the steel trade remains good, most orders are replaced as soon as worked off, and there is every indication that busy conditions will continue. There is a steady demand for steel for rails and tubes. Orders have come to hand from Scotland, but business with the Continent remains restricted. Good orders have been received from the Midlands, however, and there was a slight expansion in business with South Wales. The extensive locomotive building programme of the London, Midland and Scottish Railway will call for a considerable tonnage of steel and boilermakers have purchased larger quantities of material during the past week. The demand for bright-drawn steel bars has been sustained and a more active business has passed in steel forgings.

The North-East Coast and Yorkshire.

In spite of a lull in the demand for iron and steel, most works are actively engaged and the opinion seems general that operations during the next few months will equal the rate maintained in the early part of the year. Recently the ironmasters have derived some encouragement from the response from overseas markets, and if payments can be arranged satisfactorily a much better business may be looked for within the next few months. The statistical position of the pig iron industry is good, as stocks are moderate and outputs continue to be fairly well absorbed. Business in steel bars and billets has been on a good scale, and although importations from the Continent have been continued, local concerns on the North-East Coast are understood to be actively employed with little material available for prompt delivery. The situation at the finishing mills gives no cause for concern, but fresh orders will be needed for the autumn and winter months. The sheet trade shows no recovery from the recent depression and export orders remain scarce. In the Sheffield area the works are busy. Holidays have been curtailed owing to the large amount of work in hand, and replacement orders are coming along rapidly. A large proportion of the business is on home account, and, as in other districts, producers are making every endeavour to recover their export trade. The output of open-hearth steel shows no decline, while that of basic steel remains at a high level. Useful tonnages of foundry pig iron have been delivered in this district and some consumers have already covered their requirements up to the end of the year. A limited business has been reported in basic and the demand for forge has also been quiet. Good quantities of both East and West Coast hematite are going into consumption. Business in bar iron is active, principally in common bars. The tool trade is busy on heavy requirements from the commercial motor and engineering works. Numerous inquiries have been received from overseas, but the development of business has been held up to some extent by exchange problems and the restrictions of foreign Governments on the payment of accounts. These problems however, are being gradually overcome, and there are indications that trade will become more active in the near future.

The Midlands and South Wales.

Although operations are not yet fully resumed in this district the outlook gives promise of improvement, and by the end of this week production will become general. The immediate future in the pig iron market seems secure, though forge qualities are less in demand than foundry, and apparently deliveries this month will be smaller than in July. The light castings branch remains one of the brightest sections of the market, and most works are fully occupied. In the engineering division conditions have been rather quieter. The market for finished iron has shown little change and producers here have been helped by the absence of offers of Belgian No. 3 bars. The controlled price for No. 3 grade is £7 10s. and for No. 4 grade £8 delivered. Crown bars are uniformly quoted at £9 12s. 6d. delivered; marked bars, £12 at works; and iron strip, £10 10s. delivered. A number of satisfactory specifications for finished steel accumulated during the holiday stoppage. The demand for the special quality steels required for motor car building has temporarily slackened. The electrical engineering branch, on the other hand, is active and the works are likely to receive further orders in view of the proposed extensions to the grid system. In the raw and semi-crude steel market the position has not altered on the week and business has been too small to indicate to what extent foreign exporters are likely to exploit the market in the near future should the import duties remain unaltered. The controlled rates applicable to the district are upheld—£8 12s. for small bars, £9 7s. for hoops and strip (1 to 4-ton lots in each case), and £5 10s. for soft billets for lots of 500 tons. The demand for sheet bars has been slow. The iron and steel industry in South Wales is back to normal, and with manufacturers well booked prices are firmly maintained. The heavy steel works maintain a fair rate of activity and this will continue for some months to come on good forward bookings. Semis were bought somewhat sparingly and consumers appear to be confining their purchases to small lots for immediate needs. At the higher level of quotations for tin-plates a fair business was reported and the works are operating at about 65½ per cent. of capacity.

Lead and Spelter.

Prices in the lead market have been maintained during the week. In this country the demand from consumers has been fair, and it is expected that the requirements of the battery makers will absorb considerable quantities in the near future. The declaration of a parcel of Mexican lead did not adversely affect the market, and the tone remained firm in spite of the continued shortage of Empire metal. The position on the Continent shows no improvement. Business with Germany is limited owing to the control exercised over imports, and the demand from other countries abroad has been insignificant. In the United States production continues to increase, and stocks now represent a considerable tonnage, probably because of the good prices which have been secured for silver. At the moment, no revival in the demand seems likely, and the position is not clear. . . . In the spelter market prices have shown a slight improvement on balance, and the undertone remains firm. No material change in the position has taken place on the week. The demand in this country has been well maintained considering the time of the year, and the technical position seems sound. As the price is low there is little inducement to sell, and no heavy liquidation is considered likely. The shortage of Empire spelter has resulted in high premiums on duty-free metal for early delivery.

Copper and Tin.

Conditions in the standard copper market have been somewhat irregular; price fluctuations have not been wide and values show little change on balance. On the publication of the United States silver nationalisation order the market became firmer, but in face of a fair amount of selling and liquidation, buyers showed some reserve and prices gradually receded to £29 for the three months' position. The demand continues quiet and no sustained recovery seems likely at present. Although less cheap American copper has been offered in Europe, there is a steady tendency for production outside America to increase, particularly in Canada and Africa, where, it is understood, producers are fully sold. In the United States, although the code authority has arranged sales quotas for the chief producers and the Custom smelters, production is unrestricted, and some concerns have considerable stocks of metal. Most of the manufacturers have pledged themselves to purchase only Blue Eagle copper, and altogether sixty-three copper consuming companies have signed purchasing agreements. . . The announcement that the International Tin Committee had agreed to reduce the quota for the period from October 1st to December 31st by 10 per cent. to 40 per cent. of the standard tonnages was immediately reflected in improved values. Prices advanced to £231 5s. for three months' tin, but afterwards they receded on profit taking, and some of the increase was lost. This reduction in the quota is expected to offset the recent fall in consumption. The increase in stocks at the close of last month no doubt influenced the decision arrived at by the Committee, and also the fact that most of the signatory countries had exported less than usual. It is understood that the Dutch East Indies only have exported their full quota, the total being estimated at about 2200 tons less than the authorised exports. The immediate outlook is uncertain and much depends upon developments in the United States.

The Continental Steel Cartel.

At the recent meeting of the Continental Steel Cartel it is understood that an agreement in principle was reached regarding the inclusion of the Czecho-Slovakian steel industry in the Continental sales organisations for thick and medium plates and universal iron. It is reported that the Austrian industry has also expressed a desire to come to an understanding with the Cartel for the export of similar products. Czecho-Slovakia and Austria were originally represented in the Central European Group in the old Steel Cartel, replaced a year ago by the new organisation which was established for a period of five years. In Germany there is still talk of the British industry joining the Continental Steel Cartel, but the general opinion is that there is little hope of this taking place. Should an agreement be entered into with Great Britain the general opinion is that exports to the international markets should be regulated and import quotas granted to the Continental producers for the British market. According to reports from Essen, there is no prospect of the originally contemplated international sales organisation for thin plate being formed within the Cartel. The principal difficulty is understood to be agreement on the basis period for the calculation of the quotas.

Current Prices for Metals and Fuels.

Makers' official home trade prices, per ton, delivered buyers' stations. Sections, joists and plates are subject to a rebate to home users purchasing only from associated British Steelmakers: joists, 22s. 6d.: plates and sections, 15s. Export orders of 250 tons and over may be subject to special quotations.

PIG IRON.

	Home. (*D/d Teesside Area*) £ s. d.	Export. £ s. d.
N.E. Coast—		
Hematite Mixed Nos.	3 8 0	3 0 0
No. 1	3 8 6	3 0 6
Cleveland— (*D/d Teesside Area*)		
No. 1	3 10 0	3 1 0
No. 3 G.M.B.	3 7 6	2 18 6
No. 4 Forge	3 6 0	2 17 0
Basic (*Less 5/– rebate*)	3 7 6	—
Midlands—		
Staffs.— (*Delivered to Black Country Station*)		
North Staffs. Foundry	3 11 0	—
„ „ Forge	3 6 6	—
Basic (*Less 5/– rebate*)	3 12 6	—
Northampton—		
Foundry No. 3	3 7 6	—
Forge	3 2 6	—
Derbyshire—		
No. 3 Foundry	3 11 0	—
Forge	3 6 0	—
Scotland—		
Hematite, f.o.t. furnaces	3 11 0	—
No. 1 Foundry, ditto	3 12 6	—
No. 3 Foundry, ditto	3 10 0	—
Basic, d/d (*Less 5/– rebate*)	3 7 6	—
N.W. Coast—		
Hematite Mixed Nos.	3 15 6 d/d Glasgow 4 0 6 „ Sheffield 4 5 6 „ Birmingham	

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
Lancs.—		
Crown Bars	9 12 6	—
Best Bars	10 2 6	—
S. Yorks.—		
Crown Bars	9 12 6	—
Best Bars	10 2 6	—
Midlands—		
Crown Bars	9 15 0	—
Marked Bars (Staffs.)	12 0 0	—
Nut and Bolt Bars	7 5 0 to 7 15 0	—
Scotland—		
Crown Bars	9 12 6	9 5 0
Best	10 2 6	9 15 0
N.E. Coast—		
Common Bars	9 12 6	8 15 0
Best Bars	10 2 6	9 15 0
Double Best Bars	10 12 6	10 0 0

STEEL.

	Home. £ s. d.	Export. £ s. d.
London and the South—		
Angles	8 10 0	7 7 6
Tees	9 10 0	8 7 6
Joists	8 17 6	7 7 6
Channels	8 15 0	7 12 6
Rounds, 3in. and up	9 10 0	8 7 6
„ under 3in.	8 14 6	—
Flats, 5in. and under	8 14 6	7 2 6
Plates, ¾in. (basis)	9 0 0	7 15 0
„ 5/16in.	9 5 0	8 0 0
„ ¼in.	9 10 0	8 5 0
„ 3/16in.	9 15 0	8 10 0
„ ⅛in.	9 10 0	8 5 0
North-East Coast—	£ s. d	£ s. d.
Angles	8 7 6	7 7 6
Tees	9 7 6	8 7 6
Joists	8 15 0	7 7 6
Channels	8 12 6	7 12 6
Rounds, 3in. and up	9 7 6	8 7 6
„ under 3in.	8 12 0	7 10 0
Plates, ¾in.	8 15 0	7 15 0
„ 5/16in.	9 0 0	8 0 0
„ ¼in.	9 5 0	8 5 0
„ 3/16in.	9 10 0	8 10 0
„ ⅛in.	9 5 0	8 5 0
Boiler Plates, ⅜in.	8 5 0	7 12 6
Midlands, and Leeds and District—		
Angles	8 7 6	7 7 6
Tees	9 7 6	8 7 6
Joists	8 15 0	7 7 6
Channels	8 12 6	7 12 6
Rounds, 3in. and up	9 7 6	8 7 6
„ under 3in.	8 12 0	7 10 0
Flats, 5in. and under	8 12 0	8 17 6
Plates, ¾in. (basis)	8 17 6	7 15 0
„ 5/16in.	9 2 6	8 0 0
„ ¼in.	9 7 6	8 5 0
„ 3/16in.	9 12 6	8 10 0
„ ⅛in.	9 5 0	8 5 0
Boiler Plates, ⅜in.	8 5 0	7 12 6

STEEL (*continued*)

	Home. £ s. d.	Export. £ s. d.
Glasgow and District—		
Angles	8 7 6	7 7 6
Tees	9 7 6	8 7 6
Joists	8 15 0	7 7 6
Channels	8 12 6	7 12 6
Rounds, 3in. and up	9 7 6	8 7 6
„ under 3in.	8 12 0	7 10 0
Flats, 5in. and under	8 12 0	8 17 6
Plates, ¾in. (basis)	8 15 0	7 15 0
„ 5/16in.	9 0 0	8 0 0
„ ¼in.	9 5 0	8 5 0
„ 3/16in.	9 10 0	8 10 0
„ ⅛in.	9 5 0	8 5 0
Boiler Plates	8 5 0	7 12 6
South Wales Area—	£ s. d.	£ s. d.
Angles	8 7 6	7 7 6
Tees	9 7 6	8 7 6
Joists	8 15 0	7 7 6
Channels	8 12 6	7 12 6
Rounds, 3in. and up	9 7 6	8 7 6
„ under 3in.	8 12 0	7 10 0
Flats, 5in. and under	8 12 0	8 17 6
Plates, ¾in. (basis)	8 17 6	7 15 0
„ 5/16in.	9 2 6	8 0 0
„ ¼in.	9 7 6	8 5 0
„ 3/16in.	9 12 6	8 10 0
„ ⅛in.	9 10 0	8 5 0

Ireland—	Belfast. £ s. d.	Rest of Ireland. £ s. d.
Angles	8 12 6	8 15 0
Tees	9 12 6	9 15 0
Joists	9 0 0	9 2 6
Channels	8 17 6	9 0 0
Rounds, 3in. and up	9 12 6	9 15 0
„ under 3in.	9 2 0	9 4 6
Plates, ¾in. (basis)	9 0 0	9 2 6
„ 5/16in.	9 5 0	9 7 6
„ ¼in.	9 10 0	9 12 6
„ 3/16in.	9 15 0	9 17 6
„ ⅛in.	9 12 6	9 15 0

OTHER STEEL MATERIALS.

Sheets.	Home. £ s. d.	Export. £ s. d.
10-G. to 13-G., f.o.r.	9 0 0	8 15 0
14-G. to 20-G., d/d	10 5 0	9 0 0
21-G. to 24-G., d/d	10 10 0	9 5 0
25-G. to 27-G., d/d	11 2 6	9 17 6

The above home trade prices are for 4-ton lots and over; 2-ton and 4-ton lots, 10s per ton extra; and under 2-ton lots, 30s. per ton extra.

Galvanised Corrugated Sheets, Basis 24-G.

Home.	£ s. d.
4-ton lots and up	13 0 0
2-ton to 4-ton lots	13 7 6
Under 2 tons	15 0 0

Export: £16 12s. 6d. c.i.f. duty paid India.
„ £11 5s. 0d., f.o.b. other markets.
„ Scandinavian Markets free.

Tin-plates.

20 by 14 basis f.o.b. Bristol Channel ports, 18/–.
Tin-plate Bars, d/d South Wales Works, £5 7s. 6d.

Billets.	£ s. d.
Basic, Soft (25·41% C.)	6 0 0
„ Medium (0·42% to 0·60% C.)	6 17 6
„ Hard (0·61% to 0·85% C.)	7 7 6
„ „ (0·86% to 0·99% C.)	8 7 6
„ „ (1% C. and up)	8 17 6
Soft (up to 25% C.), 500 tons and up	5 10 0
100 tons	5 15 0
Rails, Heavy, 500-ton lots, f.o.t.	8 10 0
„ Light, f.o.t.	7 10 0

FERRO ALLOYS.

Tungsten Metal Powder	3/3 per lb.	
Ferro Tungsten	3/– per lb.	
	Per Ton.	Per Unit.
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£23 0 0	7/–
„ „ 6 p.c. to 8 p.c.	£21 12 6	7/–
„ „ 8 p.c. to 10 p.c.	£21 12 6	7/–
„ „ Specially Refined		
„ „ Max. 2 p.c. carbon	£36 0 0	11/–
„ „ „ 1 p.c. carbon	£38 15 0	12/–
„ „ „ 0·70 p.c. carbon	£42 0 0	12/6
„ „ „ carbon free	10d. per lb.	
Metallic Chromium	2/5 per lb.	
Ferro Manganese (per ton)	£10 15 0 home	
„ Silicon, 45 p.c. to 50 p.c.	£13 0 0 scale 5/– p.u.	
„ „ 75 p.c.	£18 to £18 7 6 scale 6/– p.u.	
„ Vanadium	12/8 per lb.	
„ Molybdenum	5/6 per lb.	
„ Titanium (carbon free)	9d. per lb.	
Nickel (per ton)	£200 to £205	
Ferro Cobalt	5/3d. per lb.	

NON-FERROUS METALS.

Official Prices, August 15th

Copper—		
Cash	£28 7 6 to £28 10 0	
Three months	£28 16 3 to £28 17 6	
Electrolytic	£31 10 0 to £32 0 0	
Best Selected Ingots, d/d Birmingham	£32 7 6	
Sheets, Hot Rolled	£58 0 0	
	Home.	Export.
Tubes, Solid Drawn (basis)	9½d.	9½d.
„ Brazed (basis)	9½d.	9½d.
Brass—		
Ingots, 70/30, d/d Birmingham	£29 0 0 to £30 0 0	
	Home.	Export.
Tubes, Solid Drawn, 2/1 alloy	8¾d.	8¾d.
„ Brazed	10¾d.	10¾d.
Tin—		
Cash	£229 15 0 to £229 17 6	
Three months	£229 15 0 to £229 17 6	
Lead	£10 17 6 to £11 3 9	
Spelter	£13 13 9 to £13 16 3	
Aluminium Ingots (British)	£100	

FUELS.

SCOTLAND.

	Export.
Lanarkshire—	
(f.o.b. Grangemouth)—Navigation Unscreened	12/6 to 12/9
„ Glasgow—Ell	13/– to 13/6
„ „ Splint	15/6
Ayrshire—	
(f.o.b. Ports)—Steam	11/6
Fifeshire—	
(f.o.b. Methil or Burntisland)—Prime Steam	13/3 to 13/9
Unscreened Navigation	12/3 to 13/–
Lothians—	
(f.o.b. Leith)—Hartley Prime	12/– to 12/6
Secondary Steam	11/6 to 11/9

ENGLAND.

Yorkshire, Manchester—	
B.S.Y. Hard Steams	17/6 to 20/6
Furnace Coke	13/– to 17/6
Northumberland, Newcastle—	
Blyth Best	13/6 to 13/9
„ Second	13/–
„ Best Small	10/6
Unscreened	12/– to 13/6
Durham—	
Best Gas	14/8
Foundry Coke	19/– to 22/6

Sheffield—	Inland.	
Best Hand-picked Branch	23/– to 25/–	—
South Yorkshire Best	20/– to 22/–	—
South Yorkshire Seconds	16/6 to 18/–	—
Rough Slacks	8/– to 9/–	—
Nutty Slacks	7/– to 8/6	—

SOUTH WALES.

Cardiff—	
Steam Coals:	
Best Admiralty Large	19/6
Seconds	19/– to 19/4½
Best Dry Large	18/9 to 19/3
Ordinaries	18/3 to 18/6
Best Bunker Smalls	13/6 to 14/–
Cargo Smalls	11/6 to 12/6
Dry Nuts	22/– to 26/–
Foundry Coke	24/– to 37/6
Furnace Coke	19/6 to 22/6
Patent Fuel	21/–
Swansea—	
Anthracite Coals:	
Best Large	37/6 to 40/–
Machine-made Cobbles	41/– to 51/–
Nuts	40/– to 50/–
Beans	25/– to 30/–
Peas	19/– to 22/6
Rubbly Culm	10/– to 11/–
Steam Coals:	
Large	18/– to 20/6
Nuts	18/6 to 22/6
Smalls	11/– to 13/–

FUEL OIL.

Inland consumption; contracts in bulk.
Exclusive of Government tax of 1d. per gallon.

Ex Ocean Installation.	Per Gallon.
Furnace Oil (0·950 gravity)	3½d.
Diesel Oil	4d.

Manchester prices ¼d. per gallon extra.

French Engineering Notes.

(*From our own Correspondent in Paris.*)

Mechanical Engineering.

REPORTS upon different industries in the country are being drawn up for the Conseil National Economique, with a view to preparing plans for a settled economic policy, and amongst them is a report by Monsieur Corville, secretary of the Fédération de la Mécanique, upon the mechanical engineering industry, excluding motor car construction, which is dealt with in a separate report. The results of a census of the industry taken in 1931 have not yet been published, so that Monsieur Corville is obliged to take the figures for 1926, showing that there were then about 5000 mechanical engineering workshops and factories in France. Only twenty of them employed more than a thousand men each, and less than a thousand works gave employment individually to more than a hundred hands. All the others were small shops. They are widely disseminated, particularly in the Paris district, in the Loire and Rhône Departments around Lyons and Saint-Etienne, and in the eastern and northern Departments. The total number of men employed in the mechanical engineering industries in 1926 was 333,700, and a further 300,000 found occupation in other metal-working trades. About 15,000 engineers from the State schools were employed in engineering works and factories, their number being probably largely increased by engineers from universities and private institutions. The statement that the figures of employment are now reduced by something like 25 per cent. may be taken as a moderate estimate. The statistics relating to turnovers of different branches of the industry in 1926 would be interesting if they did not bring into sombre relief the probable figures at the present time. The turnover of railway rolling stock builders was 1200 million francs; last year it fell to a fraction of that amount.

Hydro-electric Plants.

Electrical engineering is less effected by the slump than other industries because the national electrification scheme, though retarded by the financial stringency, provides the industry with a certain amount of work, and with the allocation of 600 million francs out of the public works relief fund for rural electrification and the expenditure by the railway companies upon electrical equipment there is promise of more activity in the future. Meanwhile, a report by the Chambre Syndicale des Forces Hydrauliques is fairly encouraging, particularly in view of the progress of electric traction. Plans to be put in hand by the State and the Est railways will provide an additional consumption of 150 million kWh a year, and on the Orleans Railway the work of electrification is proceeding. The report states that during 1933 seven hydro-electric power stations capable of supplying 165 million kWh a year were put into service, and that during the present year six others will be completed with a capacity of 352 million kWh. The electrical supply is at present so largely in excess of requirements that there has been some hesitation in building new dams and laying down additional power plants, but as employment must be provided, and the demand for electrical energy may extend largely when conditions become normal, hydro-electric undertakings figure prominently in the programme of relief works.

A Novel Miners' Strike.

About 85 per cent. of the miners in some colliery districts in the Nord and the Pas de Calais are Poles who were drafted into this country during the years following the Armistice with a view to developing the coal mining industry. When the crisis became acute, and work slowed down and a greater individual output was obtained by the use of machinery, the French miners had to be kept in employment while contingents of Poles were sent back to their country. Those remaining began to feel resentment against the coalowners at the prospect of being obliged to leave in their turn, and when two of them were expelled from the country on the ground of Communist agitation, nearly 200 of their compatriots declared a strike on reaching the bottom of a pit in the Pas de Calais to begin their shift, and detained fifteen French miners who refused to join them. They blocked the cage at the bottom. They remained there thirty-eight hours in the hope that the expulsion order would be cancelled, and then, failing to get satisfaction, they capitulated. Many of the men with their families have been expelled.

Shipbuilding Costs.

At the annual meeting of the Chantiers et Ateliers de Saint-Nazaire (Penhoët), reference was made to the difficulties which French shipbuilders have to face in view of the wide margin of costs existing between gold and sterling countries. The owner has to buy his ships at international prices, and builders must necessarily regard the market from an international standpoint. This is a fundamental difficulty which no legislation has yet been able to overcome. The shipbuilding industry may benefit from the new law requiring owners who receive subsidies to build ships in France but there is the possibility that the additional cost of the ship will absorb the amount of subsidy paid to the owner. In making these statements the object of shipbuilders is obviously to show the necessity of legislation which will enable them to compete on favourable terms with foreign shipyards, but no practical suggestion has yet been put forward that is likely to give them complete satisfaction.

The "Atlantique."

The British underwriters have paid to the Compagnie Sud-Atlantique the sum of a million pounds, to which must be added fifteen months' interest, for the loss of the "Atlantique," which was burnt out in the Channel. They, nevertheless, maintain their appeal against the verdict of the Tribunal de Commerce de la Seine, on the ground that the "Atlantique" was not a total loss and that the ship can be repaired and fitted out in Great Britain at less than the amount claimed.

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.

DYNAMOS AND MOTORS.

412,804. September 14th, 1933.—ALTERNATING-CURRENT MOTOR DRIVES, *The British Thomson-Houston Company, Ltd., of Crown House, Aldwych, London, W.C.2.*

When two or more asynchronous motors are working in parallel through positive couplings and their transmission conditions differ from one another owing to more or less wear, the motors will be differently loaded. Drives of this kind are found, for example, in the textile and paper industries, where machines are driven by a number of asynchronous motors through belt drives or friction couplings. In vehicle drives also the motors are positively connected to one another through the wheel rims, so that with any deviations in the wheel diameter due to uneven wear different loading of the motors must occur. The

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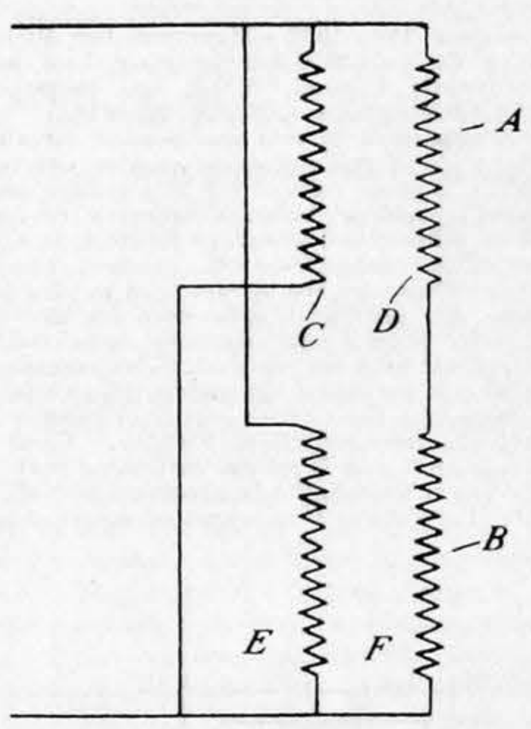
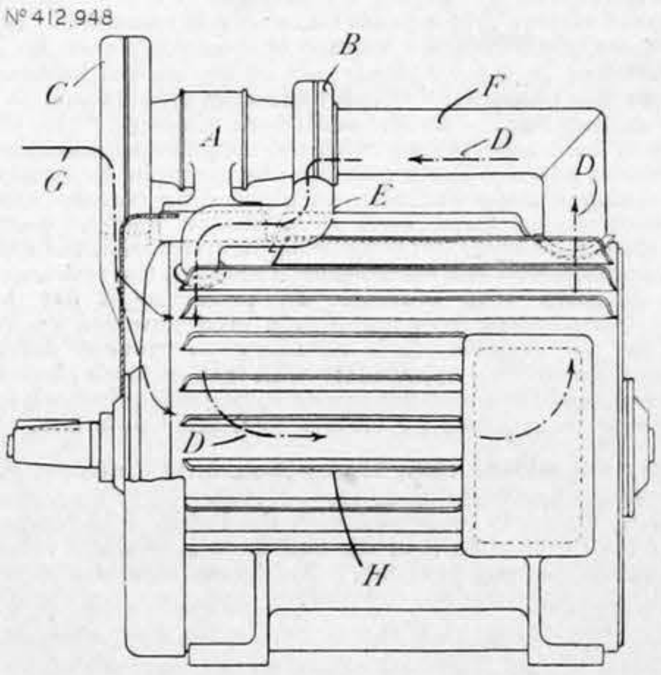


difference in the loading of the separate motors is determined by the amount of the deviation in the transmission conditions. According to the invention, the operation of such positively coupled motors is improved by subdividing the field windings of the motors and connecting the divided windings with the supply voltage partly in series and partly in parallel. For the sake of simplicity only one phase is indicated for each motor. Each phase of the motors A and B is divided into two parallel branches, namely, C D for the one motor and E F for the other motor. The winding branches D and F for the corresponding phases of the two motors are connected to one another in series with the supply, whilst the winding branches C and E are in parallel.—*July 5th*, 1934.

412,948. January 4th, 1934.—METHODS OF COOLING ELECTRICAL MACHINES, *The British Thomson-Houston Company, Ltd., of Crown House, London, W.C.2.*

The machine to be ventilated in accordance with this invention is provided with a motor A driving the internal fan B and the external fan C. The internal fan B causes a circulation of air, as shown by the dotted arrows D, through a pipe E into the interior of the machine, and then withdraws the air from the interior again, through a pipe F, so that a constant circulation

Nº 412,948



of the inner air is set up. The external fan C draws in fresh air, as shown by the arrows G in full line, and forces this fresh air over the casing cover for the machine, provided with ribs H, with the assistance of a guiding hood. The cooling device, according to the invention, is particularly advantageous for motors with wide speed variation or which are used for intermittent service, since it also ensures uninterrupted satisfactory cooling during the intervals in working of the machine.—*July 4th*, 1934.

TRANSFORMERS AND CONVERTERS.

412,846. November 28th, 1933.—REGULATING TRANSFORMERS, Aktiengesellschaft Brown, Boveri et Cie., of Baden, Switzerland.

The single-phase core transformer shown consists of two iron cores A and B connected together by two yokes C and D. The iron cores A and B carry the primary windings E and F and the secondary windings G and H. If voltage is applied to the transformer, the flux runs in the direction of the arrows J. Between the primary windings and the secondary windings a leakage bridge K and L with variable air gap M is inserted and the flux is diverted through the leakage bridge. Consequently the secondary winding is less strongly excited and produces a smaller voltage. The magnitude of the leakage flux is dependent on the reluctance of the leakage bridge or on the size of the air gap, since the iron cross section of the leakage bridge remains invariable. The reluctance of the leakage bridge reaches a minimum when the air gap in the leakage bridge is smallest and a maximum when it is greatest. It is thus made possible by

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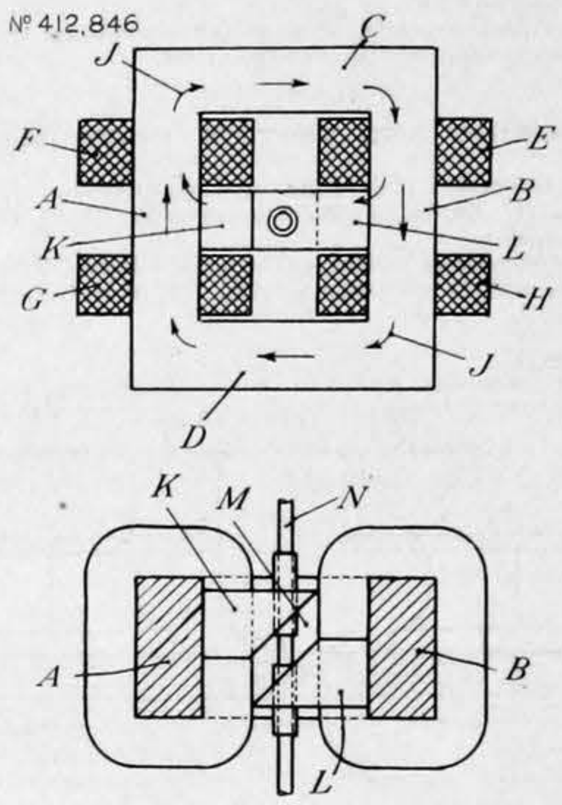

varying the air gap of the leakage bridge to obtain a completely continuous curve for the regulation in the desired range between maximum and minimum. In the case of welding the desired quiet and even burning of the arc is obtained. The leakage bridge for the single-phase transformer is divided into two parts K and L, which, in order to form the air gap, are cut away obliquely at the surfaces facing one another and at the other ends are placed closely against the cores A and B. The sections of the leakage bridge may be relatively displaced by means of a spindle N with left and right-handed threads, so that a greater or smaller air space M is obtained.—*July 5th*, 1934.

BATTERIES AND ACCUMULATORS.

412,625. January 2nd, 1933.—DIAPHRAGMS AND SEPARATOR DIAPHRAGMS FOR ELECTRIC ACCUMULATORS, Compagnie Générale d'Electricité, of 54, Rue la Boetie, Paris, France.

It is known to form porous bodies such as electrolytic diaphragms by agglomerating fibrous and other porous material, such as glass wool, infusorial earth, silica gel, and so on, with porous rubber, the pores of which are of small dimensions. The subject of the invention is a separator diaphragm for accumulators constructed as a single member which is characterised by a diaphragm portion composed of porous material, glass wool, spun quartz, silica, or the like, agglomerated by porous rubber and a separator portion composed of porous rubber which may be provided with or without ribs. A and B denote the electrodes, C the diaphragm portion, and D the separator portion having ribs E. Such a diaphragm is

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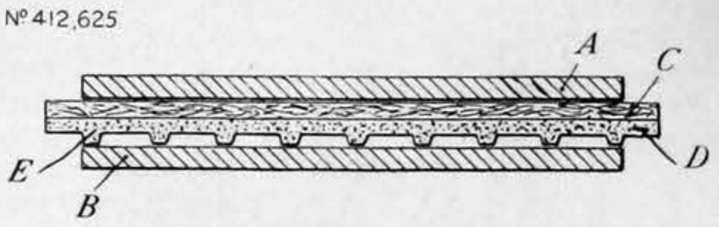

simply produced. Spun glass wool, for instance, is agglomerated by means of latex and the mixture is then vulcanised so as to transform the latex into porous rubber. The vulcanisation can be performed in moulds producing directly the required diaphragm or the vulcanised material may be ultimately cut up into plates of the desired dimensions. The diaphragms thus prepared can be utilised directly in accumulators without necessitating any special eliminatory treatment, the rubber being practically unattackable by the electrolyte. The rubber merely acts to assure sufficient mechanical solidity to the glass wool and the pores in the rubber need not be of small dimensions. In place of glass wool, blue asbestos, spun quartz, silica in all its forms, &c., may be utilised. The porous partitions thus prepared, with or without ribs, are capable of utilisation alone between the accumulator plates, so that they serve at the same time as separators and diaphragms.—*July 2nd*, 1934.

TELEGRAPHS AND TELEPHONES.

412,796. August 30th, 1933.—INSULATED ELECTRIC CONDUCTORS FOR DEEP SEA SIGNALLING CABLES, Norddeutsch-Seekabelwerke Aktiengesellschaft, of Nordenham (Oldenburg), Germany.

This invention relates to deep sea electric signalling cables, the conductors of which are surrounded with a solid non-compressible insulating layer of polystyrol. Polystyrol, which, owing to its good electrical properties, is especially suitable for the insulation of telephone conductors, cannot be used as a

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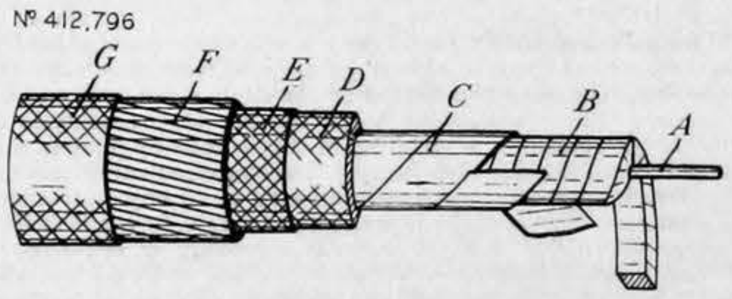

closed layer on the conductor, since it is only slightly flexible and too brittle. As, however, it has now become possible to form polystyrol into bands and cords, it is proposed, according to this invention, to wind strands of polystyrol on the conductor with the adjacent turns abutting against each other, their cross section being such that the air gaps between them are reduced to a minimum. The cords or bands may, for instance, have a square or trapezoidal cross section. One method of carrying the invention into effect is shown. The conductor A is surrounded by a strand B of polystyrol of approxi-

mately square cross section, which is wound thereon in such a manner that a layer of polystyrol is obtained which is free of gaps. A tape winding C is provided thereon, which consists of two flat bands of polystyrol. A water-tight gutta-percha covering D follows next, and is surrounded in a known manner by a layer of jute E, an armouring F of wires of circular cross section, and a layer of jute G. Instead of the tape winding C of polystyrol, use may be made of metal bands serving as a return conductor. A number of insulated conductors according to the invention may be stranded together and the spaces between the conductors be filled by means of extruded strands of, for instance, gutta-percha or mixtures of polystyrol with gutta-percha and like substances, a water-tight sheathing being placed thereon in the usual way.—*July 5th*, 1934.

MEASURING AND TESTING INSTRUMENTS.

412,803. November 17th, 1933.—A LIQUID-LEVEL INDICATOR, J. E. G. Eurich, 2, Stratford-avenue, West Didsbury, Manchester.

For the purpose of indicating the level of liquid in an opaque receptacle, such as a storage battery, a glass device, shown at

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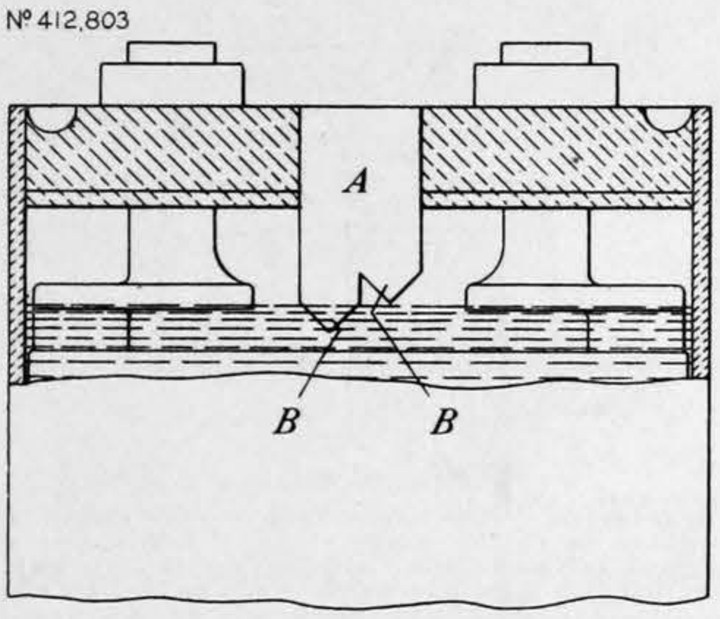

A, is sealed into the lid. The lower end of this device is at approximately the level of the liquid, and is formed with facets B B subtending an angle of 90 deg. The pairs of facets are at different levels. Light passing down the glass will be reflected by the facets, which are not submerged, but those below the liquid level will appear black when viewed from above.—*July 5th*, 1934.

MINING MACHINERY.

412,650. January 14th, 1933.—COLLAPSIBLE PIT PROPS, The Darlington Rolling Mills Company, Ltd., Rise Carr Rolling Mills, Whessoe-road, Darlington; and R. L. Nisbet, 116, Links-road, Cullercoats, Northumberland.

This pit prop is made of two pieces of rolled section A B, joined together by the fish-plates C C. The bolts D D can slide

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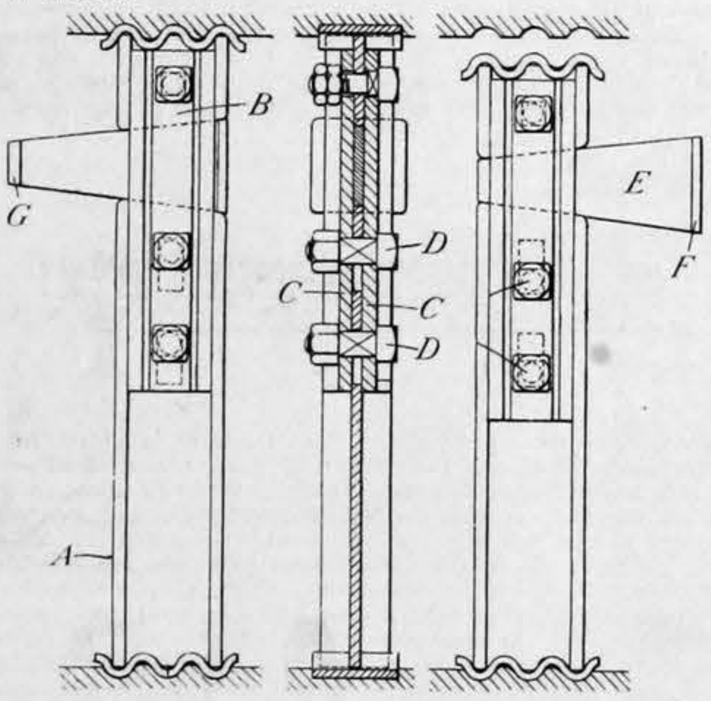

in slotted bolt holes. Between the two sections of prop there is a wedge E, also of rolled section. When the prop is put in position the wedge is driven home until its flange F registers with the flanges of the prop and helps to stiffen it. When it is desired to withdraw the prop the wedge is pulled back by a Sylvester until the small flange G catches and heaves it out.—*July 5th*, 1934.

LIGHTING AND HEATING.

413,077. March 24th, 1933.—THE UTILISATION OF SMALL COAL AND COAL DUST AND SIMILAR FUELS, J. S. Hales, of the Fuel Research Station, Blackwall-lane, East Greenwich, London, S.E.10.

The object of this invention is to provide improved means whereby coal dust or small coal or similar fuel may be better utilised in heating appliances, for instance, open grates. Coal dust or similar fuel or material is placed in containers or coated or covered with material or materials which resist the action of heat for sufficient time to allow part or the whole contents of the container or covering to cake together and form a coherent or semi-coherent mass when heated or placed on a fire or in a stove or furnace. The further action of the fire then consumes or destroys the container or covering or this is done by poking, and the caked contents are then burnt. The containers or quantities of materials to be coated or covered may be of any convenient size or shape. The containers may, for example, be made of thin sheet metal or foil with or without a coating or covering of other material or materials. A fabric or other covering material may be required to increase the strength of the container or covering, and the inventor has found aluminium foil with a suitable paper covering to be suitable.—*July 12th*, 1934.

MACHINE TOOLS AND SHOP APPLIANCES.

412,817. October 13th, 1933.—FORGING MACHINES, A. Schneider, 11a, Arnulfstrasse, Düsseldorf-Oberkassel; and Eumuco Aktiengesellschaft für Maschinenbau, Leverkusen, Schlebusch I, Germany.

This forging machine has more than one set of dies, to work on the work piece successively. Instead of the dies being arranged horizontally, as usual, they are set on an incline, which may have an angle of up to 20 deg. to the horizontal. In this way the force of gravity is used to help in moving the piece from one die

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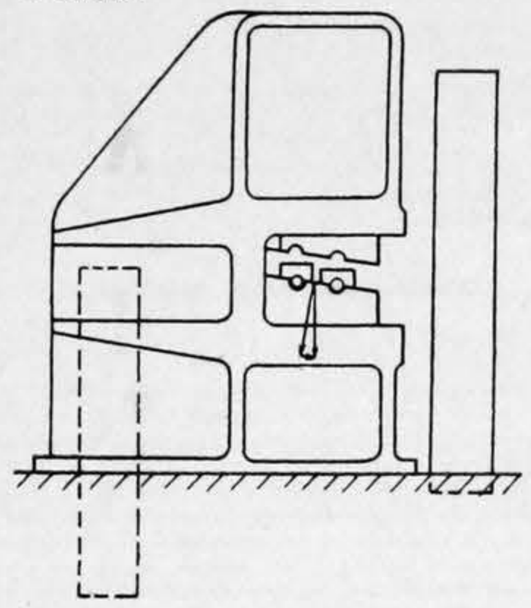

to another. The shifting mechanism is not described.—*July 5th*, 1934.

MISCELLANEOUS.

412,614. December 31st, 1932.—MERCURY ARC RECTIFIERS, The British Thomson-Houston Company, Ltd., of Crown House, Aldwych, London, W.C.2, and Ewart Maurice Weaver, of 8, George-street, Rugby, Warwick.

Apparatus is described in this specification for supplying current to the grids of grid-controlled mercury-arc rectifiers, &c., for obtaining a phase shift of the grid voltage, and comprising a peaking transformer having a saturated core on which, in addition to the primary and secondary windings, an additional winding is carried and excited from a D.C. source. The drawing diagrammatically illustrates the invention as applied to a six-anode rectifier. Six peaking transformers are shown, those supplying opposite phases being similarly connected, except that the primary windings are reversed. The primaries of the six transformers are connected symmetrically, two in parallel across each phase of a three-phase supply of suitable voltage in synchronism with the supply to the rectifier. There are two additional windings A and B on the saturating limb of each peaking transformer. Winding A is associated with the output of the rectifier and winding B is connected across an external

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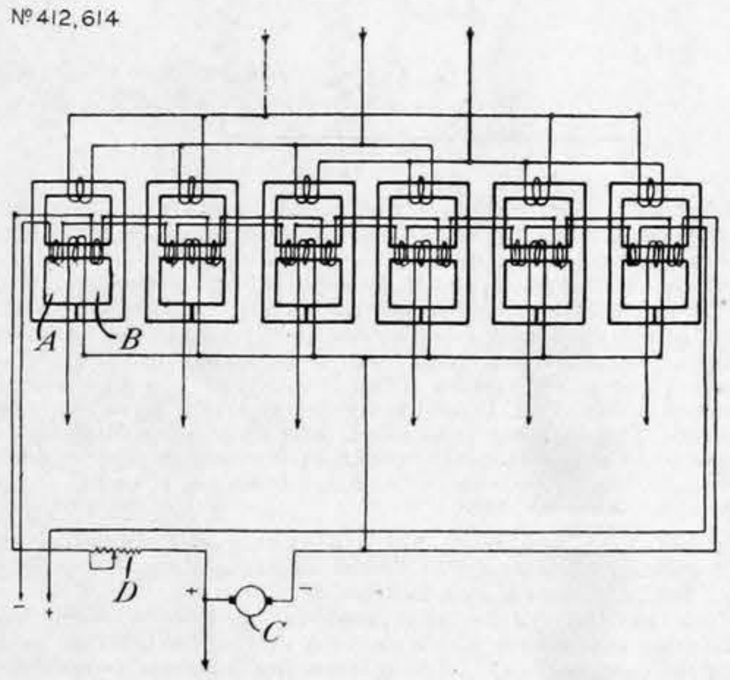

direct-current supply C, and the current can be varied by means of a variable rheostat D. The peaks of voltage occur at the instant in the magnetic cycle at which the saturating core is unsaturated, and by varying the position of this by means of the direct-current flux a phase shift may be obtained. If the wave form of the applied voltage is sinusoidal, then for any movement of 30 deg. on either side of the normal position of the peak the phase shift is approximately proportional to the direct current applied to the additional windings. The phase shift may be caused to vary with the output load condition of the rectifier in a non-linear manner—for example, by supplying the peaking transformer with an alternating current voltage of non-sinusoidal form, such as a peaked voltage containing a third harmonic, or by inserting in series with the direct-current winding on the transformer a resistor, the resistance of which changes with current. In producing a flat compound characteristic between certain predetermined limits of load on the rectifier, it is necessary to prevent the grid voltage from shifting appreciably with load at loads above the maximum load for which flat compounding is required, and this result may be obtained by various methods.—*July 2nd*, 1934.

412,801. September 12th, 1933.—BALL MILL LININGS, *F. B. Dehn*, 103, *Kingsway, London, W.C.2*.

This invention is concerned with the lining of ball grinding mills. Inside the shell A of the mill there is welded a series of longitudinal channel sections B B. These channels serve as

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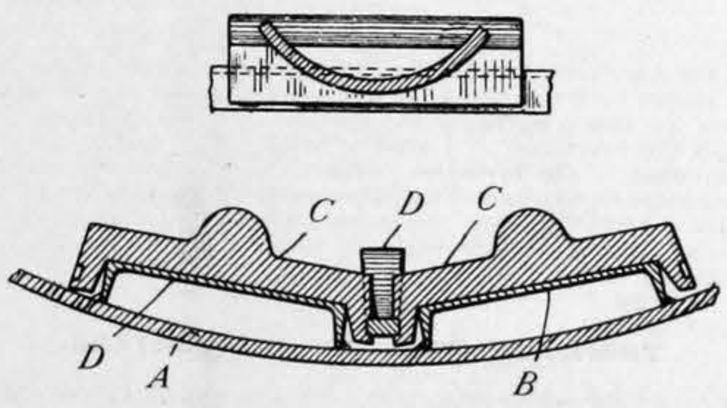

anchorages for the lining, or wearing, pieces C, C. The lining pieces are held in place by keys D, which are driven into curved keyways in their flanges. The arrangement is such that the lining piece can be worn away right down to the anchoring channel without the keyway effect being impaired.—*July 5th*, 1934.

412,712. March 16th, 1933.—MEANS FOR SUPPORTING ELECTRIC CONDUCTORS, Callendar's Cable and Construction Company, Ltd., of Hamilton House, Victoria Embankment, London, E.C.4, and Arthur Paré Brown, also of Hamilton House, Victoria Embankment, London, E.C.4.

The electric conductor-supporting device shown comprises a base A and a U-shaped clamping member B, both formed of insu-

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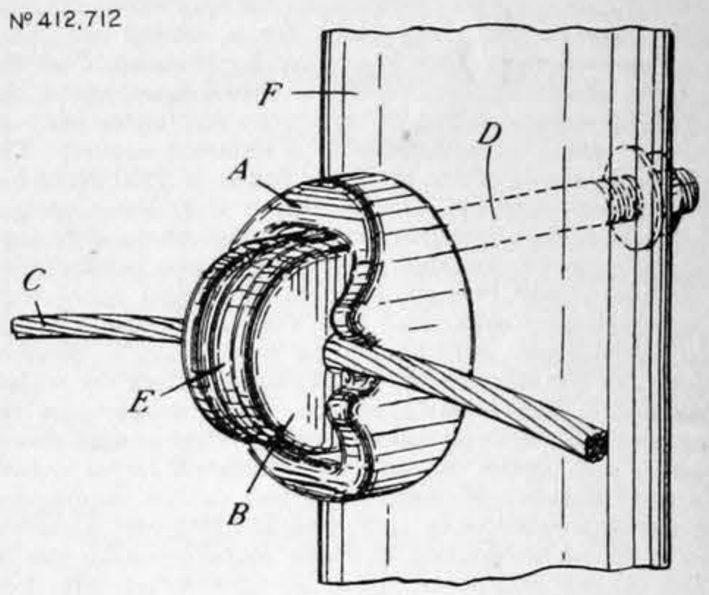

lating material, which fit together so as to clamp a conductor C between them, the clamping being effected by means of a bolt D with a hook end E, which serves to draw the two parts A and B together, and to fix them in position on the surface of a wood pole F. The base A is provided with an aperture in which the U-shaped member B can slide, and which serves also to accommodate the shank of the hook bolt D.—*July 5th*, 1934.

413,202. December 11th, 1933.—MERCURY VAPOUR RECTIFIERS, *The British Thomson-Houston Company, Ltd., of Crown House, Aldwych, London, W.C.2*.

In the operation of mercury vapour rectifiers, especially on railway vehicles, difficulties are often met with because under the influence of jerks and shaking the mercury of the cathode splashes about in the rectifier, and if drops of mercury reach the anodes it may cause back ignition. Furthermore, a conducting part of the cathode may become detached and may lead to the starting of the arc at this part and to its becoming soon disturbed. For avoiding the disadvantages mentioned, according to the invention, in a mercury vapour rectifier, the cathode vessel and the mercury contained therein are set and maintained during

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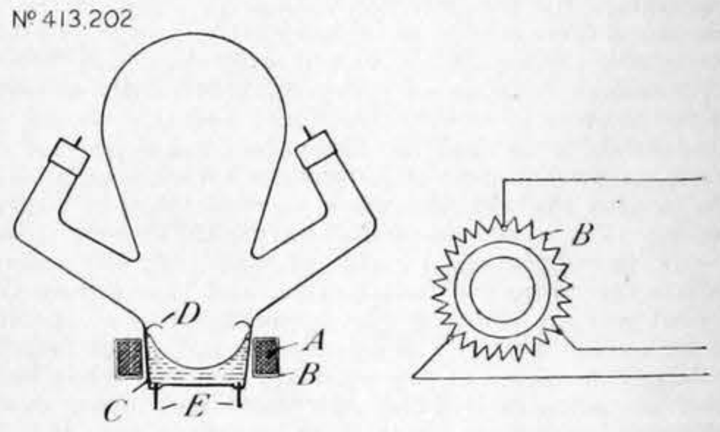

operation in relative rotation. The liquid is thus prevented from splashing owing to shocks into contact with the anodes. Conveniently the rotary movement is effected by a magnetic rotary field, and the cathode container has a turned in upper edge to assist in preventing a splashing out of the liquid. A is a laminated iron body of a rotary field winding B, which surrounds the part C of the rectifier vessel containing the mercury, *i.e.*, cathode container. In the case of rectifiers with metal casings, the cathode container C consists of non-magnetic material, preferably insulating material. The cathode container is provided with a turned-over edge D. The mercury is shown in the position it assumes as a result of the rotary movement. The two current leads for the cathode are shown at E.—*July 12th*, 1934.

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 Monday 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.*

FRIDAY, AUGUST 31ST, TO SUNDAY, SEPTEMBER 9TH.

INST. OF GAS ENGINEERS.—Visit to Second International Gas Conference, Zürich and Swiss Tour. For papers and reports, see page 97.

MONDAY, SEPTEMBER 3RD, TO THURSDAY, SEPTEMBER 6TH.

INST. OF METALS.—Annual Autumn Meeting, Manchester. For programme, see page 61, July 20th.

MONDAY, SEPTEMBER 10TH, TO THURSDAY, SEPTEMBER 13TH.

IRON AND STEEL INST.—Autumn meeting in Belgium and Luxemburg. For programme see page 169.

FRIDAY, SEPTEMBER 21ST, TO SUNDAY, SEPTEMBER 23RD.

WOMEN'S ENGINEERING SOC.—Twelfth Annual Conference of Women Engineers to be held at Norwich.

FRIDAY TO MONDAY, SEPTEMBER 21ST TO SEPTEMBER 24TH.

ASSOC. OF SPECIAL LIBRARIES AND INFORMATION BUREAUX.—Oxford. Programme, see page 10, July 6th.

F.B.I. MISSION TO MANCHOUKUO.—The Federation of British Industries has decided to send an industrial mission in the immediate future to Manchoukuo, for the purpose of studying conditions in that country and of ascertaining whether British industry can co-operate with local interests in its development. The mission will also pay a short visit of courtesy and goodwill to Japan, with the object of establishing friendly contact with the representative organisations of Japanese industry and commerce. The mission will be composed of the following members: Colonel Lord Barnby, Past President of the Federation of British Industries; Sir Charles Seligman, senior director of Seligman Brothers, Ltd., bankers; vice-chairman, Commercial Union Assurance Company; director, National Discount Company; Mr. Guy Locock, Director of the Federation of British Industries; Mr. Julian Piggott, representing the British Iron and Steel Federation.