THE FANNICH SCHEME: NORTH OF SCOTLAND HYDRO-ELECTRIC BOARD.

(*Concluded from page* 68.)

ON leaving the valve house, referred to on page 68, *ante*, the main pipe continues downhill for a distance of 1,520 ft. on an average gradient of 1 in 4·5, the angle changing from about 19 deg. at the top to 6 deg. at the bottom. As will be seen from Figs. 29 and 30, Plate X, it is divided into five sections by concrete anchor-blocks; those at the bottom secure the branch pipes, while the others hold the single pipe at each change of direction or expansion joint. The outside diameter of the pipe is stepped down at intervals from 7 ft. 10 in. to 7 ft. 6 in., while its thickness is increased progressively from $\frac{9}{16}$ in. to $1\frac{1}{16}$ in. At a distance of 56 ft. 6 in. from the bottom it bifurcates into branches 5 ft. 6 in. in diameter, with walls $\frac{13}{16}$ in. thick, which taper in a short distance to 5 ft. in diameter, to join the turbine inlet valves.

There is an expansion joint of the slide sleeve type below each of the four upper anchor blocks, the range of travel of which is adequate for the conditions. These joints are made of mild steel, the sliding parts being machined, coated with zinc and subsequently sprayed with an inhibited oil to facilitate movement and to prevent corrosion. They are double-flanged, so that they can easily be removed and blank flanges inserted during tests on the line. The bends in the anchor blocks are of the lobster-back type and are butt-welded circumferentially and longitudinally. They are all fitted with anchor ribs and webs, and were welded electrically and concreted in position. The ends of the bend sections are fitted with semi-circular butt cover straps and are riveted to the adjoining pipes.

The straight runs of the pipe were made in lengths of 23 ft. 9 in. and were made up of three plates in length and one in girth, which were bent to circular shape, fitted together and butt-welded electrically, both circumferentially and longitudinally. Radiography was systematically used for checking and guiding the welding procedure. After the shop welding had been completed, all the straight lengths and bends forming the pipeline were stress-relieved. By shop-riveting the double-riveted butt cover straps in the semi-circular halves to adjacent lengths, erection on site was facilitated. Welding of the main pipeline on site was avoided as much as possible and was only used for joining the ends of the semi-circular butt straps and the butt welds of the closing lengths of pipe. The resulting lengths are, therefore, smooth and flush inside, apart from the slightly projecting countersunk heads of the butt-strap rivets.

Alternate lengths below the expansion joints are fitted with a mild-steel support of D shape, with the flat side downward. A bronze plate is fitted on each side of the foot of these supports, and they rest on a fixed mild-steel plate which is placed on the top of a concrete plinth. They are, therefore, free to slide as the temperature changes. The considerable total movement of the pipes between the anchor blocks is taken up, however, by the expansion joints mentioned above. The main contractors for the pipeline, as well as for the steel lining of the tunnel were Messrs. Mechans, Limited, Glasgow, W.4.

The water enters the power station at Grudie Bridge, shown in Fig. 31, Plate XI, through a shut-off valve of the butterfly type which is mounted on horizontal trunnions. The main valves are 5 ft. in diameter and are each by-passed by a sluice valve 8 in. in diameter, to equalise the pressure across them. Both the main and by-pass valves are operated by hydraulic servo-motors, in which filtered water taken from the pipeline is utilised. The valves controlling the by-pass valve servo-motors are operated by solenoids, which are actuated by a single push-button. In emergency, however, the main inlet valves can be closed from the alternator floor, 18 ft. above, by turning the pilot valves manually through gearing. The water circuit of the servo-motor includes a valve by which the final closing of the main valve is retarded and water hammer reduced. Both the main and by-pass valves are fitted with electrically interlocked limit switches. These valves were supplied by Glenfield and Kennedy, Limited.

The generating plant installed at Grudie Bridge, for which Messrs. Merz and McLellan, Milburn, Esher, Surrey, were the consulting engineers, consists of two 12-MW vertical-shaft Francis turbines, constructed by the Harland Engineering Company, Limited, Alloa, and designed to operate over a range of 448 ft. to 480 ft. net head and at a maximum gross head of 549 ft. Their maximum efficiency at an output of 12 MW is attained with a head of 495 ft. These conditions were chosen to allow for the time when the reservoir water level is raised, thus increasing the range of net head at full station load from 448 ft. to 514 ft. The position of these machines in the power station is shown in Figs 26 and 27, on page 130, while a view of one of the turbines under construction is also given in Fig. 32, Plate XI, and Fig. 33 on the same Plate shows an alternator with its governor gear. Fig. 24, herewith, shows one of the scroll casings being lowered into position, and Fig. 25 one of the head covers with its gates.

The turbines are almost entirely of welded construction, the draught-tube liners, spiral casings, curb rings, bottom plates, head covers, bearing housings, gate operating rings, connecting rods and pit liners being all fabricated. All parts which will be subject to pressure were stress-relieved. The bottom plates and head covers have renewable wearing plates of mild steel, against the top and bottom faces of the gates, and the curb ring is provided with a renewable cast-steel liner. The cast-steel wicket gates have integral spindles and are connected through cast-steel arms and cast-iron links to the gate operating ring. These links are saw-cut, so that they can break if the gates become jammed during a closing movement of the governor. There is an eccentric piece in the linkage mechanism between each gate and the operating ring, which can be adjusted to take up the wear between adjacent gates.

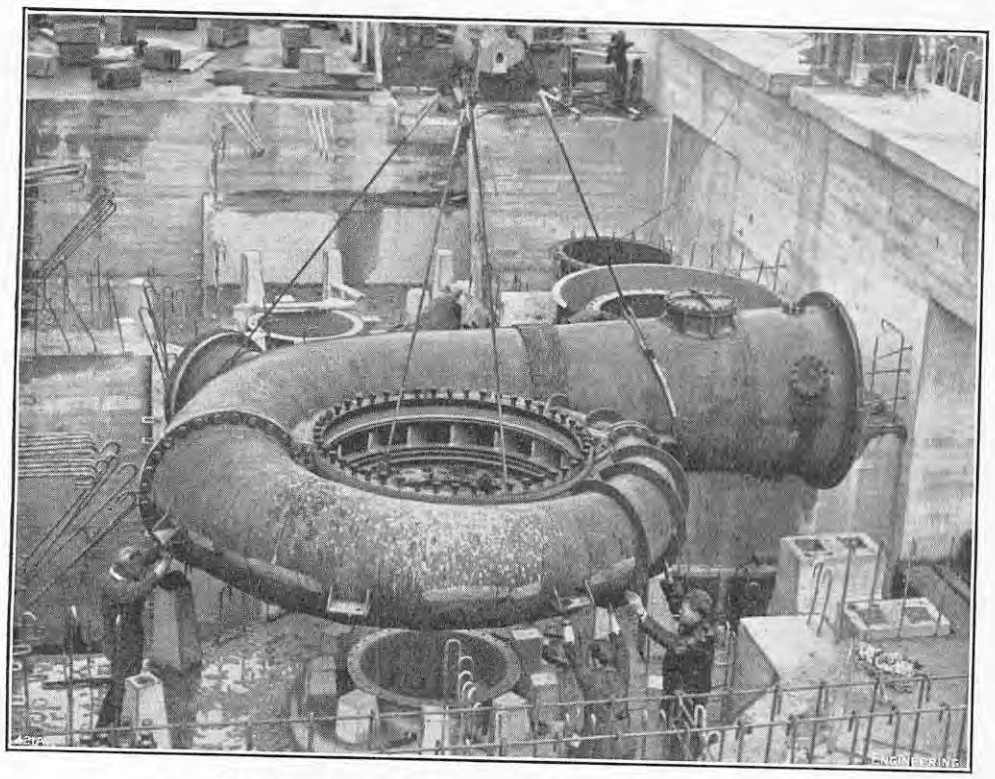


FIG. 24. LOWERING SCROLL CASING INTO POSITION.

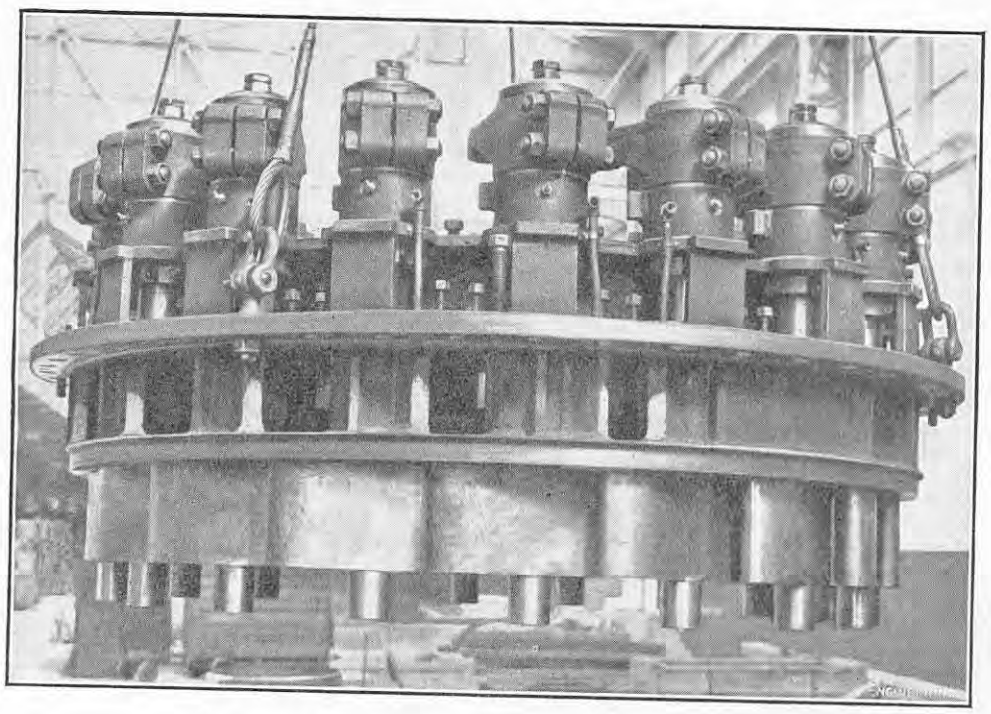


FIG. 25. TURBINE HEAD COVER AND WICKET GATES.

THE FANNICH HYDRO-ELECTRIC SCHEME.

GRUDIE BRIDGE POWER STATION

Fig. 26. PLAN AT ALTERNATOR AND TURBINE FLOOR LEVELS

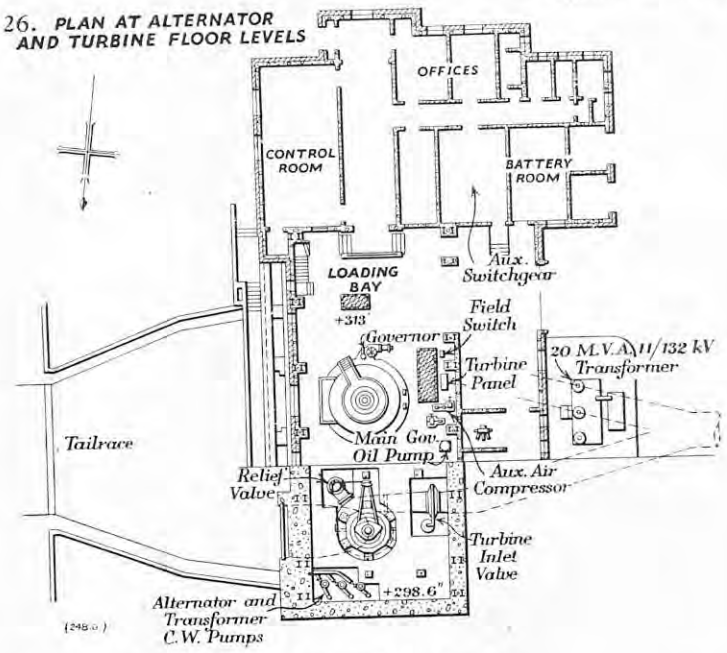


Fig. 27. SECTION

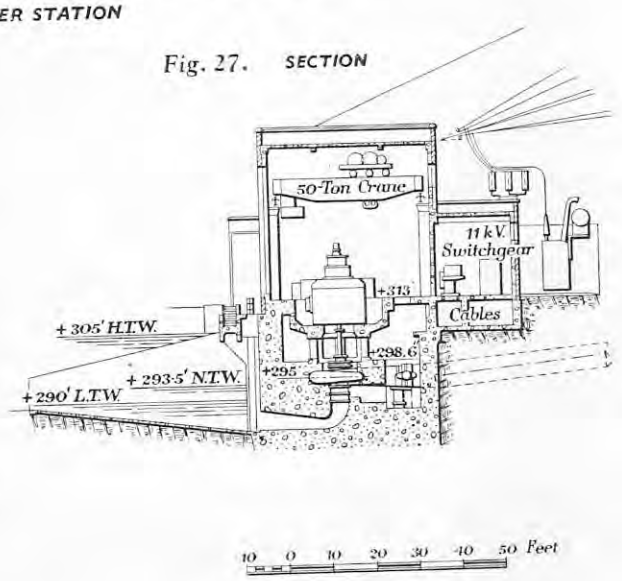
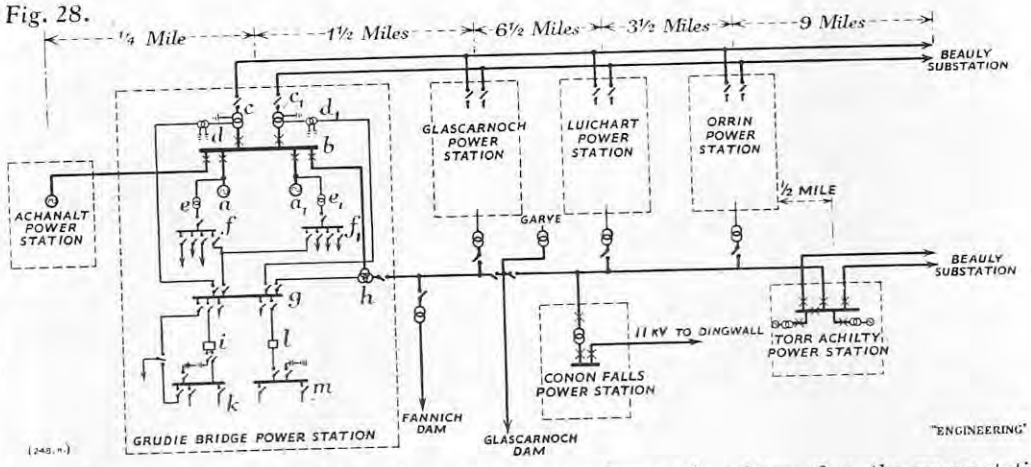


Fig. 28.



The shafts, which are 14½ in. in diameter, are of Siemens-Martin forged steel and are fitted with stainless-steel sleeves where they pass through the packing box. Each shaft is coupled to a cast stainless-steel runner. The main bearings are flow-lubricated from an external supply, which is common to each turbine and alternator. Each bearing is provided with a mercury-in-steel thermometer, the dial of which is mounted on a panel on the alternator floor. The dial of this thermometer has two adjustable electrical contacts, which can be set at predetermined temperatures. One of these contacts energises an alarm system, and the other shuts down the machine at a higher temperature, but before a danger point has been reached.

The quantity of water flowing through the turbines will be measured by reading the differential pressure which exists across a section of the spiral casing between the inner and outer radii of the turbines. This pressure differential is translated into quantity by a mercury column, which varies the resistance of an electrical circuit incorporating an indicating voltmeter, giving a reading directly in cusecs. The instrument, with its integrating and recording instruments, is mounted on a sheet-steel cubicle at alternator floor level. The flow metering equipment will be calibrated during the efficiency trials by the Allen salt-velocity method.

Because of the pipeline conditions, each turbine is fitted with a relief valve which opens when the wicket gates close relatively quickly, so that water is discharged and the velocity of the column is maintained as the load falls. The regulator is closed at a controlled rate, so that the water-hammer pressure does not become excessive. The maximum rise of pressure which occurs if the load is suddenly rejected is 10 per cent. The regulators are operated by clean filtered water taken from the pipeline; if the pressure of this water is lost, they open and thus become "safe."

The speed of each turbine is controlled by a 42,000 ft.-lb. automatic oil-pressure governor, made by the Woodward Governor Company, and sensitive to a change in speed of 1/100th of 1 per cent. The governor flyballs are driven by an electric motor, which is supplied from and runs in synchronism with a permanent-magnet generator driven directly by the turbine. The governor is so designed that the machine can be accelerated evenly up to normal speed, when the flyballs take control. Means are provided for securing the wicket gates automatically when the machine is at a standstill or should the oil pressure fail.

A motor-driven "speeder" enables the speed of the machine to be varied by hand or remotely from — 15 per cent. to + 5 per cent. of normal speed for synchronising and loading purposes. This enables the machines to be synchronised at the low frequencies which now occur during times of heavy loads. There is also a "speed droop" adjustment, which can be set at any value between zero and — 5 per cent. of normal speed, as required by the parallel-running conditions. In addition, a hand-operated load-limiting device enables the oil pressure to be used for starting up or shutting down the machine, and the gates can also be operated by hand gear when no pressure oil is available. The oil is stored in an accumulator, provided with a compressed-air cushion, maintained by oil delivered from a gear-type pump supplied by Messrs. Mirrlees, Bickerton and Day, Limited, Stockport; this avoids the use of a high-pressure air compressor. When the working pressure has been built up in the receiver, the pump unloads and returns the oil to the sump. This pump is driven by a 7½-h.p. squirrel-cage motor, which runs continuously. The receiver is equipped with switches which shut down the generating set when a pre-determined low pressure is reached. The pressure receivers of both units are interconnected.

Each turbine is directly connected to a vertical-shaft alternator, constructed by Messrs. Bruce Peebles and Company, Limited, Edinburgh; a section through one of these machines is given in Fig. 37, on page 132. They are designed for a maximum continuous rating of 13,333 kVA and generate three-phase current at 11 kV and 50 cycles, when running at 500 r.p.m. They have a runaway speed of 875 r.p.m. and a flywheel effect of 490,000 lb. ft. Each has a total weight of 94 tons. They are of the totally-enclosed type, the ventilation system providing for the re-circulation of air within the housing by fans carried on the rotor and cooling being effected by Serck water coolers, which are disposed round the stator frame. In cold weather, the power station can be warmed by admitting hot air from the machines through louvres, the necessary make-up air being drawn in through filters. The generators are mounted in a pit, the bottom of which is about 5½ ft. below the floor level and is supported by a number of vertical struts, which are carried down to the turbine casing. Their total height above floor level is 12 ft. 9½ in.

The stator frames, one of which is illustrated in Fig. 36, opposite, were fabricated from steel plate and were built in two portions to facilitate transport. The laminations are of low-loss silicon steel and are individually insulated with non-inflammable compound. They are built up on dovetailed keys and clamped between segmental end plates, the keys being welded to the inside of the frame after the core had been assembled. Uniform pressure is ensured by steel fingers, which are placed between the core and end plates and extend back on to the frame. The air gap is increased gradually by stepping a number of laminations in the end sections, so as to reduce the flux density and local losses at the end of the core. The stator winding, which is also shown in Fig. 36, consists of diamond-wound coils, which are laid in open slots and insulated to Class B standard. It has two circuits in parallel per phase and is star-connected. The conductor laminations are transposed to minimise the eddy-current losses. The individual coils are covered with impregnated glass tape and are separated from each other by mica. The slot portions of the coils are moulded with Micafolium, which was ironed on hot, and the ends of the wraps, which were tapered off, are sealed with mica tape. The top and bottom coils in the slot are spaced apart with Leatheroid separators. The coils are braced where

THE FANNICH HYDRO-ELECTRIC SCHEME.

(*For Description, see Page* 129.)

FIG. 29. PIPE LINE AND GRUDIE BRIDGE POWER STATION.

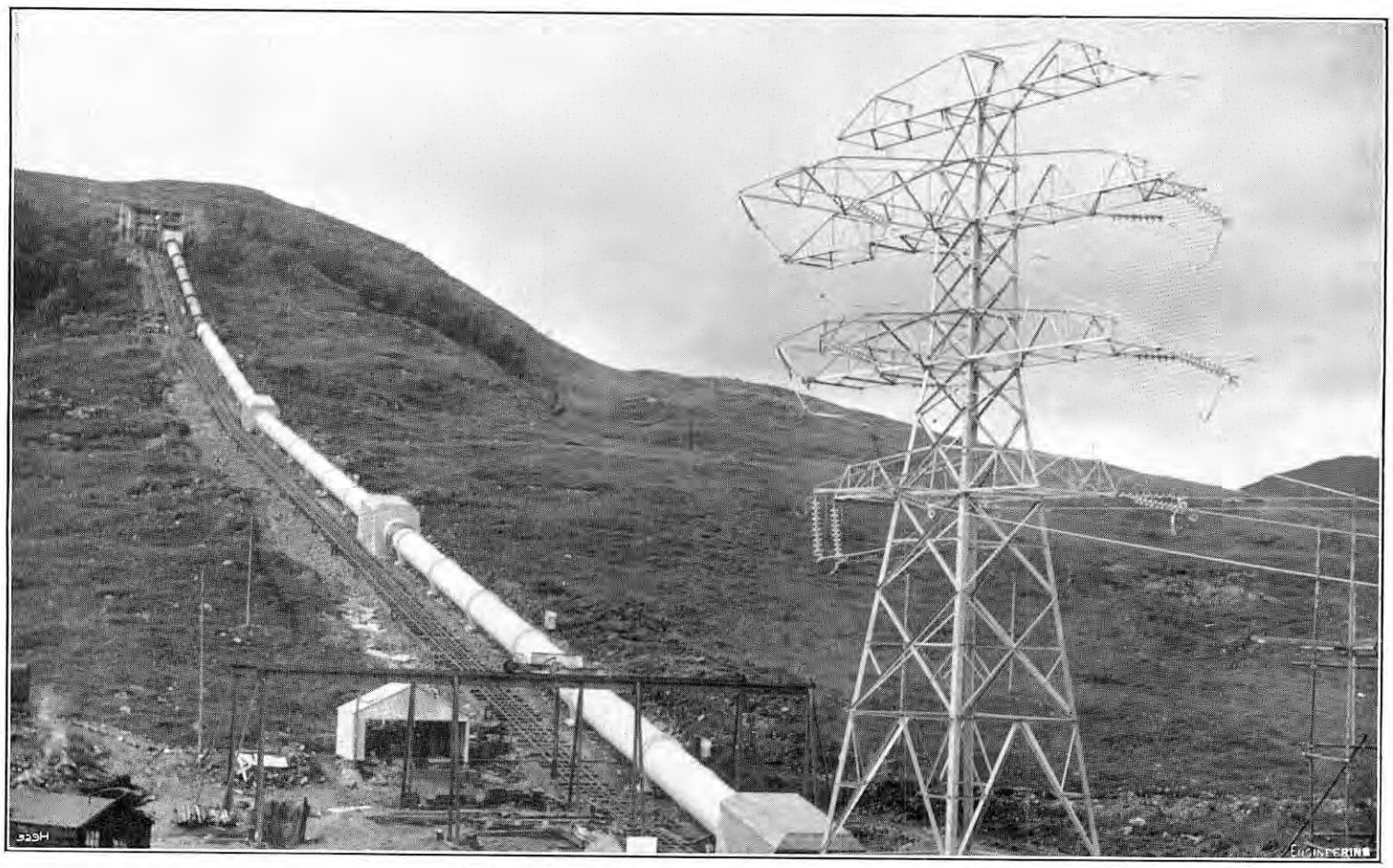


FIG. 30. PIPE LINE AND VALVE HOUSE.

(*To face page* 130.)

THE FANNICH HYDRO-ELECTRIC SCHEME.

(*For Description, see Page* 129.)

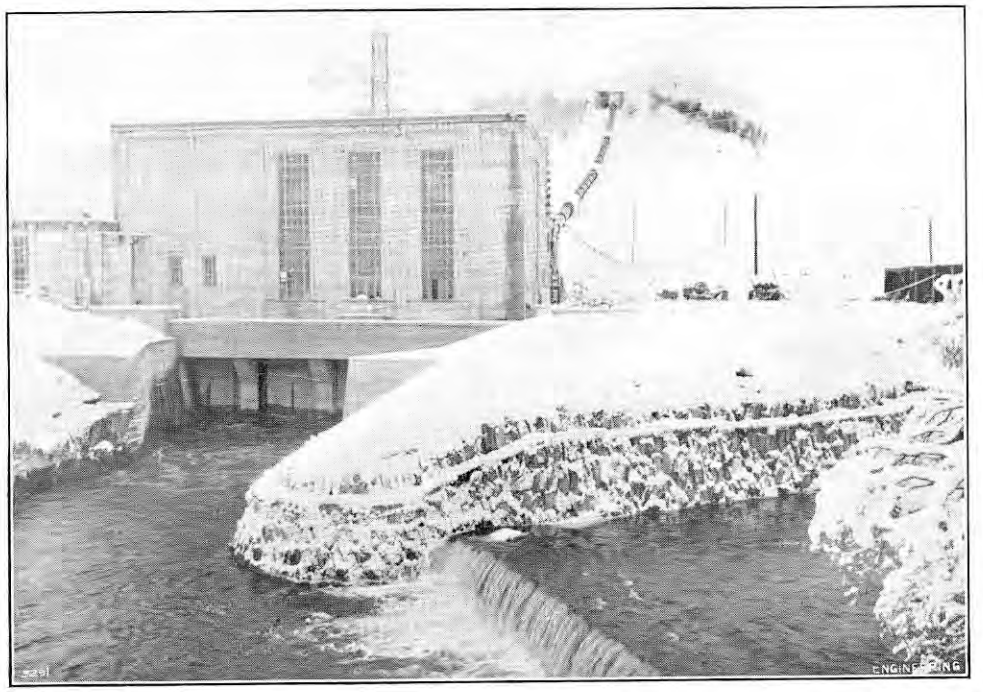


FIG. 31. GRUDIE BRIDGE POWER STATION.

FIG. 32. TURBINE IN COURSE OF ERECTION.

FIG. 33. ALTERNATORS AND GOVERNORS.

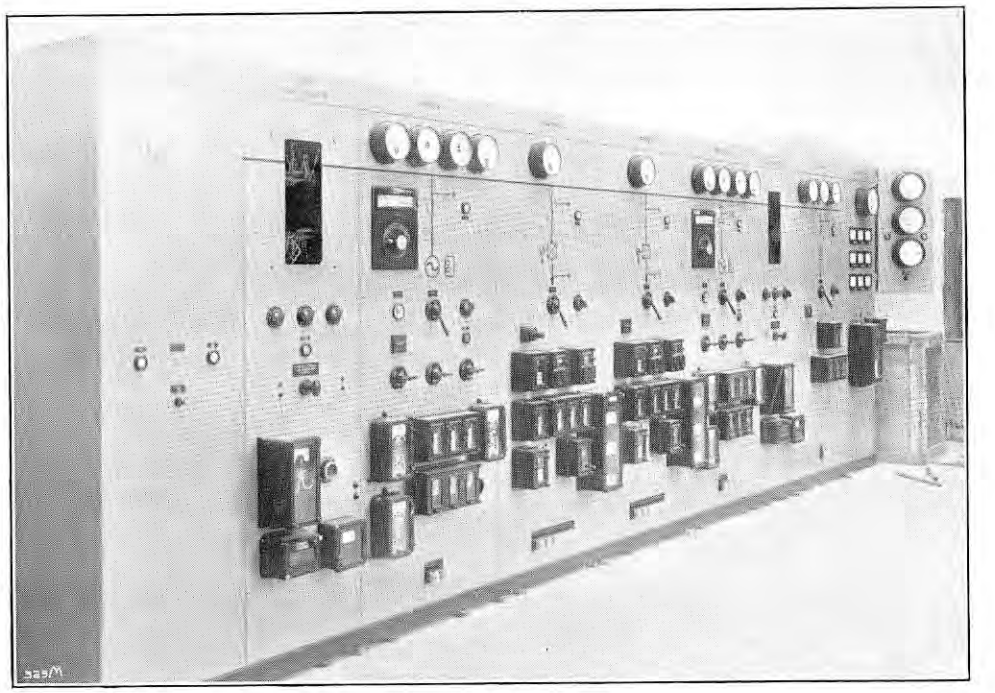


FIG. 34. 11-KV CONTROL AND RELAY SWITCHBOARDS.

(*To face page* 131.)

THE FANNICH HYDRO-ELECTRIC SCHEME.

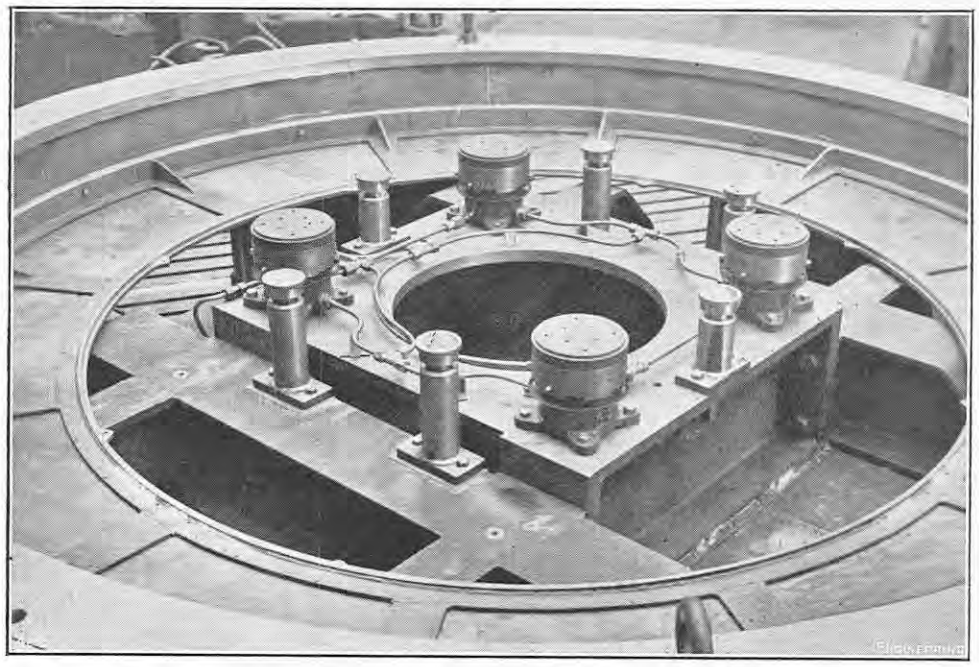


FIG. 35. BRAKING AND JACKING GEAR FOR TURBINE.

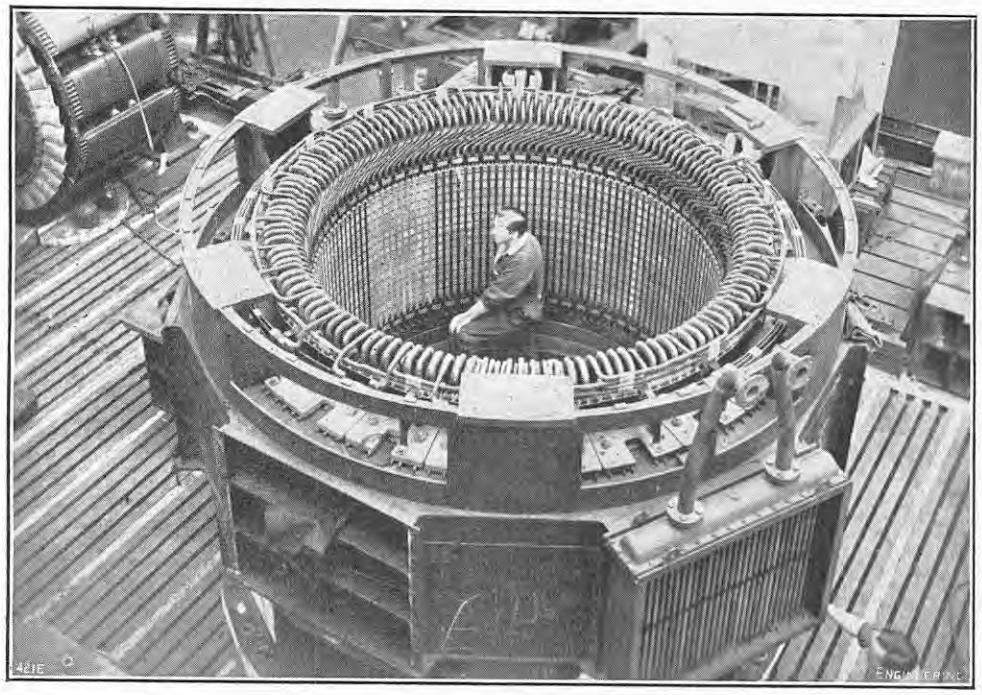


FIG. 36. STATOR FRAME.

they leave the slots by impregnated wooden blocks, which are bandaged to the coils; and the end windings are secured to continuous steel bracing rings, which are insulated and supported by brackets bolted to the end plates, as shown in Fig. 36.

The rotor body was built up from nine rolled-steel plates, which were machined all over, shrunk on to the shaft and secured by transverse bolts. The poles, which were built-up of dovetailed laminations clamped between rounded steel end plates, were pressed and keyed into grooves machined in the assembly. The coils consist of copper strip wound on edge and insulated between turns with asbestos. They are mounted on flanged brass spools with Bakelite washers at the top and bottom. The coils are insulated from the spools by glass cloth and micanite, which was reinforced with Leatheroid. They are mutually braced by V-shaped bronze clamps, which are bolted to the rotor body. The connections are also braced to withstand the centrifugal force at overspeed. A damper winding is provided on the periphery of the poles to damp out any oscillations which may occur during disturbance on the line.

The thrust bearing and upper guide bearing are both mounted above the rotor and form a single enclosed unit, which is carried on a fabricated steel bracket. They are insulated to prevent shaft currents. The thrust bearing, which is of the Michell segmental type, is designed for a load of 85 tons. A second guide bearing is placed below the rotor on two transverse beams, and can be removed to allow the housing to be lowered and access thus obtained to the brakes and jacking gear. All the bearings are flow-lubricated from an overhead distributing box, which is fed from a 400-gallon reservoir at a pressure of 8 lb. per square inch. They carry mercury-in-steel thermometers, which are connected to dials on the turbine panel. These dials have two contacts so that an alarm given when a predetermined temperature is reached, and the machine is shut down before the position becomes dangerous. Oil-flow indicators, with contacts which operate should the circulation fail, are also fitted.

The underside of the rotor is provided with six renewable Meehanite cast-iron brake segments, which are secured by spring-loaded bolts to provide for thermal expansion without buckling. The braking gear, which is illustrated in Fig. 35, consists of four Tangye cylindrical hydraulic jacks, which are fitted with Ferodo pads. For braking purposes, air is admitted to an oil reservoir at a pressure of 80 lb. per square inch; for jacking, oil is pumped by hand to a pressure of 1,000 lb. per square inch, the weight being then transferred to six screw jacks.

Each generator is provided with a main and pilot exciter, which are mounted one above the other on top of the thrust-bearing bracket, as shown in Fig. 33, Plate XI. A Woodward permanent-magnet alternator is also mounted on the extreme top of the assembly for supplying the turbine governor motor, as mentioned above. Self re-setting snap-action over-speed and under-speed mercury switches are fitted. The first of these operates at 30 per cent. above normal speed, and the second is electrically interlocked with the brakes so that these cannot be applied until the speed of the set has fallen to 95 per cent. of normal. Usually, the brakes come into action when the speed has fallen to 50 per cent. of normal.

As will be seen from Fig. 28, the alternators a and a_1 are connected through circuit-breakers to the 11-kV 'bus-bars, b. These circuit-breakers were manufactured by Messrs. A. Reyrolle and Company, Limited, Hebburn, and are of that firm's horizontal draw-out solenoid-operated type. They have a rupturing capacity of 500 MVA and are controlled from a board in the operating room, which is illustrated in Fig. 34, Plate XI. As will also be seen from Fig. 28, the 'bus-bars b are connected to two 20-MVA 11/132-kV transformers, c and c_1. These were constructed by Messrs. Bruce Peebles and Company, Limited, and are of the oil-immersed water-cooled type, mounted on a concrete raft at the back of the power-station above the pipe-line. They are of the conventional core type and are provided with tappings to cover a range of + 15 per cent. in eight steps. Connections are taken from these tappings to a linking chamber, so that on-load tap-changing switchgear can be installed if required. Forced oil-cooling is provided by two pumps, which are mounted on one end of the tank, and auxiliary natural cooling by a small bank of radiators at the other end. Each pump is capable of dealing with the full-load cooling requirements by forcing oil through one of two Serck coolers. Failure of one pump brings the other automatically into action and at the same time an alarm is operated in the power station. Flow alarms are also provided in both the oil and water pipes, which switch the transformer out should conditions become potentially dangerous. Indicators are fitted which give an alarm signal should the windings exceed a certain temperature. The units also have Buchholz protection and are earthed by the 250-kVA 11,000/415-volt earthing transformers shown at d and d_1, in Fig. 28, which also supply the station auxiliaries.

As in any water-power station, the auxiliaries at Grudie Bridge are relatively small in number and capacity, compared with those at a steam-power station. They consist of two governor oil pumps, which are each driven by a 7½-h.p. electric motor, and a stand-by oil pump, which is driven by a 12-h.p. Pelton wheel. There are also three cooling-water pumps, each of which is driven by a 24-h.p. motor; and four lubricating-oil pumps, two of which are driven by 3½-h.p. alternating-current motors and two by 5-h.p. direct-current motors, the latter acting as stand-by. The air compressor for the alternator brakes is driven by a 1½-h.p. motor and the stand-by compressor for the governor by a 5-h.p. Pelton wheel. A de-watering pump is driven by a 7½-h.p. motor, and a drainage pump by a 1½-h.p. motor. Finally, there are four 5-h.p. motors, operating the pumps for supplying cooling oil to the transformers. As some of these motors act as stand-bys to their respective main units, there is considerable diversity in the total auxiliary load.

The circulating-water pumps for the generator, lubrication and transformer oil-cooling systems, as well as the governor oil pumps, are driven by 415-volt motors, which are supplied from the main alternators, a and a_1, in Fig. 28, through the 50-kVA 11,000/415-volt transformers e and e_1, and the unit auxiliary boards f and f_1. Normally, the starters of these motors are latched, so that they run up to speed with the alternator they serve.

Other electrically-driven auxiliaries are supplied from the common auxiliary board shown at *g* in Fig. 28, which can also be energised from the 250-kVA auxiliary earthing transformers *d* and d_1, which are connected to the main 20-MVA 11/132-kV transformers; or from the 3-MVA 33,000/415/11,000-kV linking transformer *h*, which serves a local 33-kV line to Beauly. Selection of one of these sources of supply is made automatically in a predetermined sequence at a selector panel which also provides for switching from one to the other in case of failure. The unit and common auxiliary boards can be connected to either alternator, or direct to the 132-kV line from Beauly, for testing the auxiliaries. They also supply three-phase circuits for lighting and other purposes in the station, as well as two rectifiers, one of which, *i* in Fig. 28, is connected to a 240-volt direct-current board *k* and the other *l* to a 50-volt direct-current board *m*. The first of these supplies six circuits, including those for the standby bearing oil pumps, and the latter nine circuits. The auxiliary boards are equipped with Reyrolle switchgear.

The Grudie Bridge station was originally designed for manual operation only, but subsequently it was decided that, in the later stages of the development of the Conon Valley seheme, all the stations should be remotely-controlled from a central control room at Contin. Each station, however, will also have a small operating room from which it can be manually operated, if desired. Grudie Bridge, being the first station of the group to be commissioned, is so operated at present. Provision is made, however, on the turbine control panels for changing over either from manual to local automatic control by push-buttons in the station or, at a later date, to remote automatic supervisory control over pilot wires from Contin.

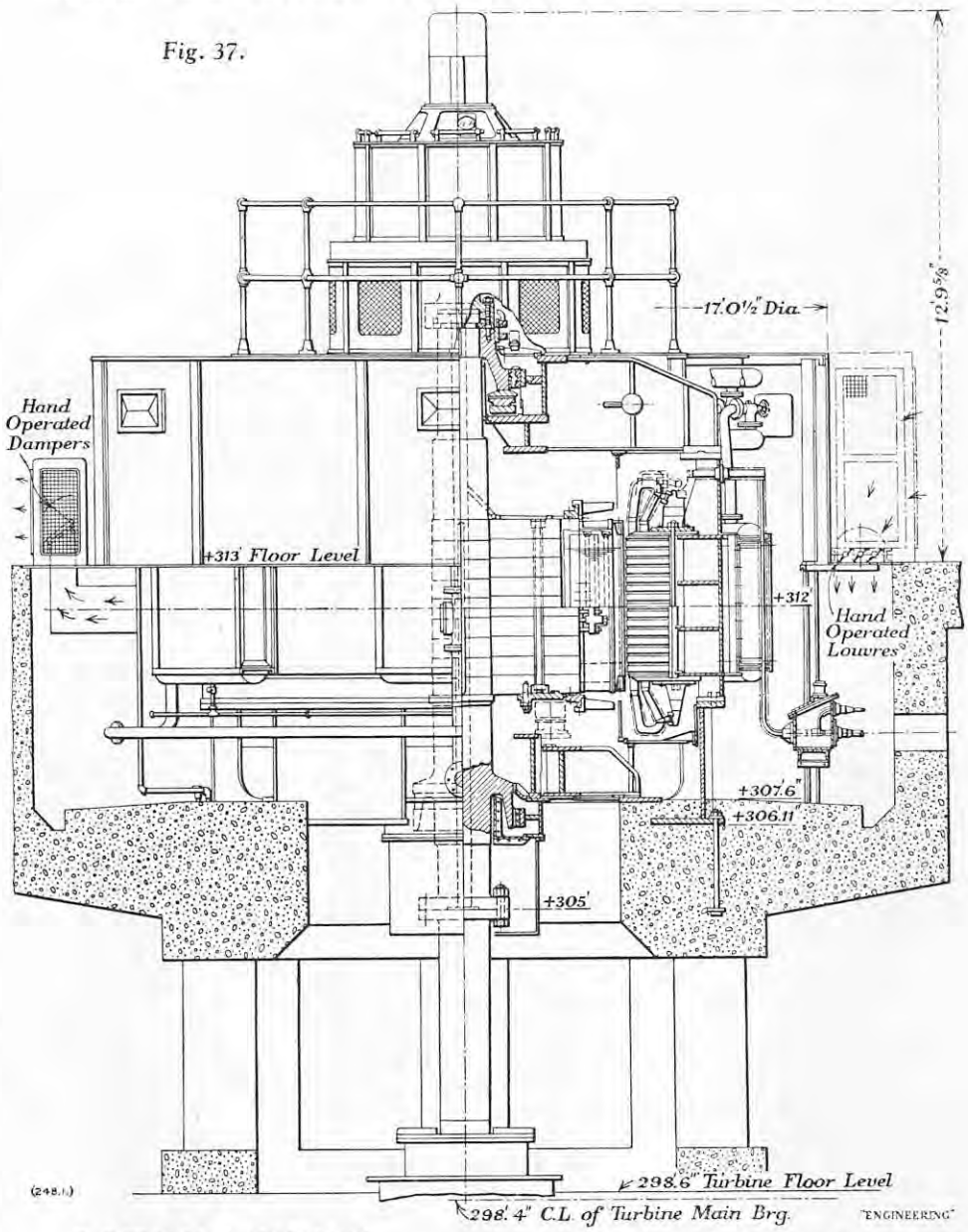
The sequential/parallel system has been adopted for automatic control. In this, the slowest operations in starting the turbine, that is, flushing the bearings from the standby lubricating pumps, raising the governor oil pressure, and opening the turbine inlet valves, form a first stage and are carried out in parallel, thus minimising the overall starting time. When this first stage has been completed, the fact is indicated by oil-pressure switches and also by limit switches on the inlet valves. The turbine guide vanes are then opened and the machine is run up to speed. The normal lubricating and governor oil pumps next take over automatically from the standby pumps; and the final stage of the sequence includes proof of delivery from the normal pumps, and the operation of a voltage regulator energised by the pilot-exciter when the alternator has developed full voltage. At this stage, a signal is transmitted to the control room that the machine is ready to be synchronised. At present, this operation is effected locally, but, as has been said, it will be carried out eventually from the group control centre. Provision is made so that should any of the individual operations in the starting sequence fail, an alarm is given. The whole operation is then cancelled, the machine is returned to its normal shut-down position, and a signal is transmitted to the control room that it has failed to start.

As will be seen from Fig. 28, the output of the station is transmitted at 132 kV over two overhead steel-cored aluminium lines to a new substation at Beauly, nine miles west of Inverness. The outputs of the other stations in the group, with the exception of Conon Falls and Torr Achilty, will also be fed into these lines. The output from Conon Falls and Torr Achilty will be transmitted by an existing line at 33 kV to Beauly. This line will be duplicated between Torr Achilty and Beauly and has been extended in a reverse direction up the Conon Valley to Grudie Bridge. An alternative means of disposing of part of the output of the latter station will thus be provided; and it will also be used as a source of standby supply to all the stations in the group. The line will be used initially for providing power for the civil engineering work at the new sites.

Record Exports of Cycles.—The value of exports of bicycles and motor-cycles for the first half of this year was 19,734,643*l.*, compared with 15,288,502*l.* last year, and the quantities were 1,345,875 bicycles and 46,433 motor-cycles.

THE FANNICH HYDRO-ELECTRIC SCHEME.

Fig. 37.



LITERATURE.

Electromagnetic Waves and Radiating Systems.

By Professor Edward C. Jordan. Prentice-Hall, Incorporated, 70, Fifth-avenue, New York, U.S.A. [Price 10·50 dols.] Constable and Company, Limited, 10, Orange-street, London, W.C.2. [Price 32*s.* 6*d.* net.]

The demand for electronic engineers and graduates in communications subjects generally in the United States is indicated by the number of relevant text-books recently produced by American publishers. This is the third book that we have reviewed, in a comparatively short time, to offer fundamental electromagnetic wave theory and discuss some more or less recent practical applications, and these are but a selection from a relatively large number. Professor Jordan, writing essentially for the advanced graduate student, is always mindful of the practical aspects. Numerous examples are worked out in the text, and he is careful to point out the limitations of theory. In addition to electromagnetic wave theory, his general subject is the theory and practice of aerial design.

The book opens with fundamentals—the M.K.S. system of units, co-ordinate systems, and the essential elements of vector analysis. The study of the time-varying electromagnetic field is introduced by two chapters in which the characteristics of "steady state" electric and magnetic fields are examined in the vector form. After a statement of Maxwell's equations come chapters on propagation, both in an homogeneous medium and when reflected or refracted at a boundary, and on the conception of power density in an electromagnetic field. The special case of the wave equations for propagation between two conducting planes is examined and results in a clear picture of the characteristics of TE and TM waves and of the fundamental TEM wave, and hence of the basic difference between propagation along transmission lines and waveguides. In the chapter on transmission lines, the author reviews the conventional equivalent circuit theory (referred to in one of the few typographical lapses as the "circular" concept) and introduces the subject of the use of sections of transmission line as impedance transformers and matching stubs. There is also a section on the important practical technique of circle diagrams. The detailed analysis of a simple circuit arrangement, using both elementary circuit theory and field concepts, serves to assist the student to appreciate the latter and, by demonstrating the nature of the approximations involved in the simpler approach, to enable him to determine where and how it may be used at the higher frequencies. Again, in dealing with antenna impedance computations, Professor Jordan points out the limitations of such simplifying assumptions as equivalent networks and sinusoidal current distributions, and refers to both the "engineering" approach of some works on broadcast antennas and to more rigorous general solutions such as that due to E. Hallén.

In a chapter on directional characteristics, expressions are derived, first, for the radiation patterns of simple resonant and travelling wave antennæ, and then for multiple arrays. The methods of synthesising a linear array to give a required pattern include the important practical case of designing for a given degree of side-lobe suppression, and there are references to many works on special

aspects of array design. Other chapters deal with the practical techniques of aerial design at frequencies up to 300 megacycles per second, and with radiation from apertures and slots. As a conclusion, ground-wave and sky-wave propagation are discussed, a note being included on the tropospheric reflection associated with certain meteorological conditions, the practical significance of which has yet to be explored.

Survey of Marine Machinery and Boilers.

By P. T. BROWN, M.B.E., M.C. Charles Griffin and Company, Limited, 42, Drury-lane, London, W.C.2. [Price 12*s.* 6*d.* net.]

THE late Mr. P. T. Brown was well known as a practical contributor and critic at the meetings of the Institute of Marine Engineers, which awarded him the Denny Gold Medal in the 1924-25 session. He also delivered several papers before the Staff Association of Lloyd's Register of Shipping, based on his lengthy experience as an engineer surveyor to that Society. Normally, the meetings of the Lloyd's Register Staff Association are private, and the proceedings thereat are confidential; but all who have to do survey work on machinery under construction—especially those who have most of their experience still to gain—should be grateful to the Committee of Lloyd's Register for permitting Mr. Brown to put his notes into book form for a wider circulation. On almost every page they bear the unmistakable stamp of knowledge gained at first hand, so that we are tempted to predict for this little book a circulation comparable in extent, though not, perhaps, in numbers, with that of A. E. Seaton's classic *Pocket-book of Marine Engineering Rules and Tables*, issued by the same publishers. The scope covers the survey of machinery and boilers under construction and on board the ship, and of auxiliary machinery, with the addition of chapters on "The Survey of Mass Production" (though this is rather a misnomer) and "Some Notes on Materials and Their Testing." In the appendix are some typical sketches and tabular arrangements, as guides to inspection routine, and a summary, also in the form of a table, of the main items to be examined, as indicated in the text, the possible defects, and the action recommended.

So far as its matter is concerned, the book is a good one; but its usefulness would be much enhanced, especially to the comparative newcomer to surveying work, if some of the descriptions of procedure had been accompanied by simple illustrations—the sort of sketch that an experienced surveyor would make in his note-book for future guidance, to ensure that no item in his examination was inadvertently omitted, or to explain to someone precisely what he was seeking to establish. In the endeavour to do this without diagrams, the author has sometimes involved himself in rather a tangle of words, even though he has so evidently striven to be clear. This is the more unfortunate since his composition and punctuation leave a good deal to be desired; but, as, in most instances, these shortcomings are typical of a colloquialism which will be familiar enough, readers are not likely to be misled, though any purists among them may wince occasionally.

CIVIL AIRCRAFT INSPECTION PROCEDURES.—The Air Registration Board have issued the following leaflets, which form part of the Civil Aircraft Inspection Procedures: No. BL/6-8, *Degreasing-Trichlorethylene*; No. AL/7-2, *Fabric Covering*; No. PPL/2-1, *Fuel System—Installation and Maintenance*; No. ML/1-1, *Log Books* Copies of the leaflets may be obtained, price 4*d.* each, from the Air Registration Board, Greville House, 37, Gratton-road, Cheltenham, Gloucestershire.

NEW FIGHTER AIRCRAFT FOR THE ROYAL AIR FORCE.—The Hawker Siddeley Group have announced that a new fighter aircraft, the P.1067, designed and constructed by Messrs. Hawker Aircraft, Limited, Canbury Park-road, Kingston-on-Thames, Surrey, has successfully carried out its first trials at the Aircraft and Armament Experimental Establishment, Boscombe Down, Wiltshire, and is to go into production for the Royal Air Force. The aircraft has swept-back wings and is fitted with a Rolls-Royce Avon axial-flow jet engine.

ENGINEERING IN THE FESTIVAL OF BRITAIN.*

VIII.—EXHIBITION OF INDUSTRIAL POWER, GLASGOW.

(*Continued from page* 108.)

IN the Hall of Electricity at the Glasgow Exhibition of Industrial Power there is a series of wall displays, intended to give the layman some idea of the development of this form of energy. They include illustrations of the properties of the lodestone, and the batteries of the Seventeenth Century, as well as of the work of Faraday, a large portrait of whom forms a fitting introduction to the other exhibits. The employment of the steam engine in the early power stations, and the limitations of this form of prime mover, are illustrated, as well as the development of the turbine from a ½-kW Parsons unit to that of a modern 50-MW turbo-alternator, of which a one-sixteenth scale model is shown. The visitor is also instructed in the means by which electricity is at present generated, transmitted and distributed on a large scale, and the types of machines and appliances in which it is consumed. For instance, there is a mural diagram of a 60-MW hydrogen-cooled turbo-alternator, and a display dealing with the historic rivalry between alternating and direct current. A general view of the Hall is given in Fig. 136, on Plate XII. Developments in power cables are traced in an exhibit of the Cable Makers' Association, 52, High Holborn, London, W.C.1, and a model of a 275-kV transmission tower, of which an illustration is given in Fig. 137, Plate XII, is shown by Messrs. Painter Brothers, Limited, Hereford.

Messrs. C. A. Parsons and Company, Limited, Newcastle-upon-Tyne, are showing a model, illustrated in Fig. 134, on page 134, of a similar design to that of the first Parsons turbo-dynamo, constructed in 1884. This machine was of the double-flow type, the steam being admitted into the centre of the cylinder. The blading was designed for operating at a pressure of about 80 lb. per square inch and the exhaust was to the atmosphere. The normal running speed when developing ½ kW was 9,000 r.p.m. A centrifugal exhauster was mounted on the turbine shaft between No. 1 keep and the cylinder cover, and this withdrew air from a leather diaphragm. When the turbine was running at the required speed, a partial vacuum was created in the diaphragm, so that the exhauster was compressed by the atmospheric pressure and a spring attached to a rod was expanded. This rod was coupled to the slide valve controlling the steam inlet, so that any variation in the turbine speed altered the vacuum on the diaphragm and, by moving the rod, caused the slide valve to open or close.

An electrical control, consisting of an adjustable brass swivel attached to a mild-steel bar, covering the end of a copper pipe by a pre-determined amount, according to the vacuum required, was also fitted. This pipe was open to the atmosphere and extended from the top of No. 1 keep to the magneto. When any change in the load altered the magnetic field, this bar either opened or closed the pipe, thus varying the vacuum in the exhauster, altering the position of the diaphragm and moving the slide valve. The exhauster was also connected to the oil inlet port, so that, as soon as the turbine was started, air was drawn out of the oil feed pipe. The oil, therefore, rose to the turbine and when shaft level had been reached, was delivered to the bearings by a pump at the end of the shaft.

At the centre of the top half of the turbine was a small needle valve, which controlled the flow of steam from the inlet belt to a nozzle. This nozzle discharged into the atmosphere at the opposite side of the turbine. The velocity of the issuing steam ejected the leakage steam from the neck glands into small chambers, cast inside the turbine cover, and also drew off any steam leakage from the main steam-inlet slide valve, through a copper pipe connected to the turbine cover.

The same firm are showing a one-sixteenth scale model of one of the two 50-MW turbo-alternators in the Dalmarnock power station at Glasgow. This model is illustrated in Fig. 135, on page 134. The turbines are of the pure reaction type, and have two cylinders with a single exhaust to the condenser. They are designed to operate at a pressure of 600 lb. per square inch and a temperature of 825 deg. F. Each contains 76 pairs of blade rows, of which 48 are in the high-pressure cylinder. All the blading is of stainless iron, that in the high-pressure cylinder being of the end-tightened type with clearances of about ¼ in. over the tips.

The alternators are of the Parsons concentric conductor type and have an output of 62·5 MVA at 20 kV. During winding, thermocouples were embedded in the stators so that the temperatures of the machines could be measured during operation. Electrical stability is ensured by supplying the field of the main exciter with current from a constant-voltage pilot exciter. This machine is embodied in the same frame as the main exciter, the double armature being driven directly from the main shaft. Cooling of the alternator, exciter and slip rings is effected on the closed system by a pair of motor-driven fans in the foundation block.

Steam for feed-heating is tapped from the turbine at four points, where the absolute pressures at full load are about 7·5 lb., 21·5 lb., 54 lb. and 113·5 lb., respectively. The condensate is then heated to a temperature of 320 deg. F., when the turbine is developing its maximum rated output.

Up-to-date switchgear is represented by a 2,500-MVA 132-kV unit of small oil-volume, exhibited by A. Reyrolle and Company, Limited, Hebburn-on-Tyne. It is illustrated in Fig. 140, on Plate XIII, and consists of three separate, but identical, single-phase units, which are operated through a common self-aligning shaft by a mechanism contained in a steel cubicle in line with the circuit-breakers. The supporting compartment of each unit comprises a welded-steel base chamber, filled with oil, and a porcelain insulator, which is held in compression by insulating tie rods. The interphase operating shaft passes through this chamber and engages, by means of serrated splines, with the operating lever, to which links for actuating the moving contacts are connected. The porcelain insulator supports the circuit-breaker compartment and provides the necessary electrical clearance to earth.

The circuit-breaker compartment houses the upper and lower fixed contacts, the moving contact, the turbulator and the Bakelised-paper enclosure, the whole being porcelain-shrouded, oil-filled and mounted on the supporting compartment. The oil inside the circuit-breaker compartment is used to extinguish the arc and is separated from the insulating oil, which fills the supporting compartment and the annular space between the upper shrouding porcelain and the outside of the Bakelised-paper enclosure. This ensures that the carbonised oil from the circuit-breaker compartment does not contaminate the oil in the supporting compartment.

The upper and lower fixed contact fingers are in electrical contact with the top cap and the metal mounting between the two porcelains, respectively; and the metal fittings act as terminals for the incoming and outgoing connections. Two of the upper fixed contact fingers have extended copper-tungsten arcing tips. The moving contact member, which consists of a metal tube, smaller in diameter than the throat entry to the arc-control device, is also fitted with a removable copper-tungsten arcing tip, and, in the closed position of the circuit-breaker, engages with the upper fixed contact in the head of the turbulator. A fixed piston is fitted under the moving-contact tube, so that, as the latter descends when the circuit is broken, the column of oil inside it is injected into the turbulator. This ensures that the pressure generated inside the turbulator has little effect on the acceleration of the contact; a uniform opening speed is thus maintained at all currents. It also enables the amount of cavitation, which occurs as the moving contact withdraws, to be controlled and the efficiency of arc-extinction to be thereby increased. The

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* Articles in this series on the Dome of Discovery, the Royal Festival Hall, the temporary bridges, the "Skylon," civil engineering works, and exhibits at the South Bank Exhibition appeared in the previous volume of ENGINEERING (vol. 171) in the issues of April 13 and 20, May 4, 11 and 18 and June 1, 8, 15, 22 and 29, 1951.

lower fixed contact is in the form of a sleeve through which the moving contact slides. The arc-control device is one of the firm's plate turbulators, the arc being directed towards the vents and thus left in the most favourable position for extinction.

The top chamber contains a silica-gel breather; oil-level indicators, in which fluted glass windows are used to give a clearly visible indication for the circuit-breaker and supporting compartments; and a separator, to prevent the loss of oil by centrifugal action when operating under fault conditions. The domed cover acts as a safety diaphragm. The operating mechanism is housed in a weather-proof welded-steel cubicle, mounted in a convenient position to allow it to be coupled mechanically to the self-aligning shaft of the circuit-breaker. It also contains the protective, control, interlocking and indicating equipment. Control is usually electrical from a remote point, but mechanical control from the mechanism cubicle can also be fitted. The control circuits are so arranged that, once a closing operation has been initiated, it is carried to completion. Closing is effected pneumatically, the opening spring being set at the same time, so that dependence is not placed on the availability of an air supply for tripping. The mechanism is also suitable for high-speed automatic re-closing with a minimum dead time of 12 cycles. It consists of the tripping spring, which is automatically set by the closing piston and is tripped by a high-speed electromagnetically-actuated latch. Air is admitted to the closing cylinder from an air receiver in the mechanism cubicle through a solenoid-operated air valve. This receiver contains enough air for two closing operations. The air valve is sealed by synthetic rubber, which beds on to a metal seat, the latter being treated to prevent the rubber adhering to it. Cushioning at the end of the opening and closing stroke is effected by using the main piston and cylinder in conjunction with the trapped air at either end of the stroke.

One of the phases of the circuit-breaker exhibited at Glasgow has been sectioned and fitted with Perspex windows to show the construction. A gear drive has been added, so that the action of the circuit-breaker can be demonstrated in slow motion, and large windows have been provided in the door of the control cubicle.

Another switching equipment is a 3,500-MVA 165-kV air-blast circuit-breaker of small oil-volume, which is being shown by the English Electric Company, Limited, London, W.C.2. This is set against a mural background depicting a grid substation. Details of this circuit-breaker were given on page 89 of our 171st volume (1951). It comprises three single-phase units, each consisting of a steel receiver base on which is mounted the main interrupter column of hollow porcelain insulators. These insulators support the operating mechanism of the make-switch and interruptor units, as well as the cooler and exhaust units. There are three interrupters on each phase and these are connected in series. In parallel with them are silicon-carbide units for equalising the voltage distribution. At the bottom of each column is an air-blast valve and high-speed electro-pneumatic control valves, and at the other end of the base is a low oil-content porcelain-clad current transformer. The insulator cover carries the make-switch fixed contacts as well as the incoming line terminal and a de-icing device.

The circuit-breaker is opened by admitting air to the piston of the main blast valve, thus allowing air to pass through the hollow support insulator to the interrupter chamber. The interrupter contacts then open and the air blast transfers the arc to the arcing contacts and thence to the cooler chamber, where the gases are expanded, cooled and exhausted. At the same time, air is supplied to the operating cylinder of the isolator, the blade of which is opened after the arc has been extinguished. This blade is closed electro-pneumatically, the action being assisted by a spring bias device.

Switchgear for lower voltages is represented by the 750-MVA 66-kV outdoor oil circuit-breaker exhibited by Messrs. Ferguson Pailin, Limited, Manchester, and illustrated in Fig. 141, on Plate XIII. The cylindrical tank of this equipment is of welded steel and contains all three phases, which are separated by insulating barriers. There is also an insulating lining. The tank is secured to the top plate by bolts, an oil and gastight joint between the two being made by a lubricated asbestos gasket. Winches, attached to the rear of the breaker, are provided for raising and lowering the tank.

The terminal bushings are of the synthetic-resin bonded-paper condenser type and are wrapped directly on to the conductors, the oil-filled porcelain weather sheds being retained in position by spring-loaded mountings. The lower ends of the bushing earth layers terminate below the surface of the oil, thus eliminating any risk of corona. Special care has been taken to prevent the ingress of moisture and yet to allow the oil to expand without causing an undue rise in pressure. The fixed-contact assemblies embody spring-loaded plungers, the lower faces of which engage with cylindrical moving contacts. These fixed contacts are connected to adaptors by flexible copper braids, the adaptors themselves being secured to the lower ends of the bushing conductors.

The operating mechanism, which is housed in the top plate, consists of a system of levers so arranged that a vertical straight-line motion is imparted to each lifting rod. The travel and speed of the contact bars are controlled at the end of the closing stroke by a spring buffer and at the end of the opening stroke by oil-filled dashpots. The arc-control devices are of the cross-jet double-orifice compensated type and are mounted on contact adapters at the lower ends of the terminal bushings. Ring-type current transformers are clamped to the underside of the top plate, where an electric heater is provided for use in tropical countries or where the humidity is excessive. Operation can either be by solenoid or springs, the mechanism being housed in a sheet-steel kiosk, which also contains the necessary control contactors, auxiliary switches and accessories. The kiosk is also fitted with an electric heater.

The principal exhibit provided by Messrs. Bruce Peebles and Company, Limited, Edinburgh, is the 2,000-kVA transformer shown in Fig. 142, opposite. This is being shown without its tank and has a voltage ratio of 33,000/11,000/433 volts. It is fitted with an off-load tapping switch for — 5 per cent. and +7·5 per cent. variations, and with an on-load tap changer to give a voltage variation of ± 8·6 per cent. in 12 steps.

The same firm are showing a 20-h.p. 440-volt three-phase squirrel-cage induction motor. This is fan-cooled and is designed to run at 975 r.p.m. It is suitable for operating in atmospheres where protection from dust, dirt, fumes, drips or splashes is necessary. Other exhibits, which allow the design and construction of the modern electric motor to be studied, are a 250-h.p. totally-enclosed induction motor, with its control cubicle and pedestal, by the Metropolitan-Vickers Electrical Company, Limited, Manchester, and, at the other end of the scale, a ½-h.p. squirrel-cage induction motor contributed by Hoover, Limited, Perivale, Middlesex.

Examples of the equipment which will be used on the 275-kV system mentioned in the first paragraph on page 133 are provided by the terminal bushings shown by the Micanite and Insulators Company,

EXHIBITION OF INDUSTRIAL POWER.

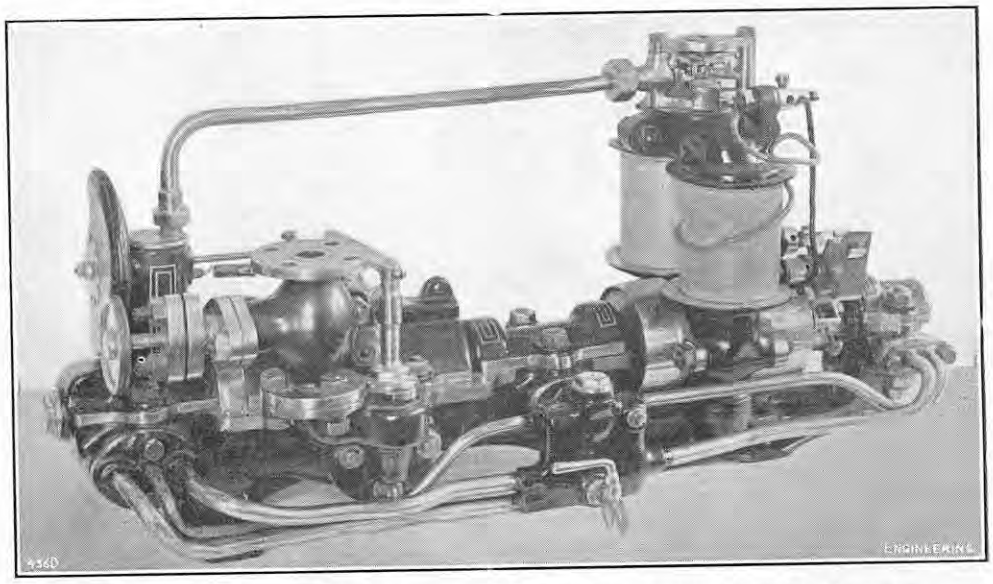


Fig. 134. Model of ½-KW Turbine; C. A. Parsons and Company, Limited.

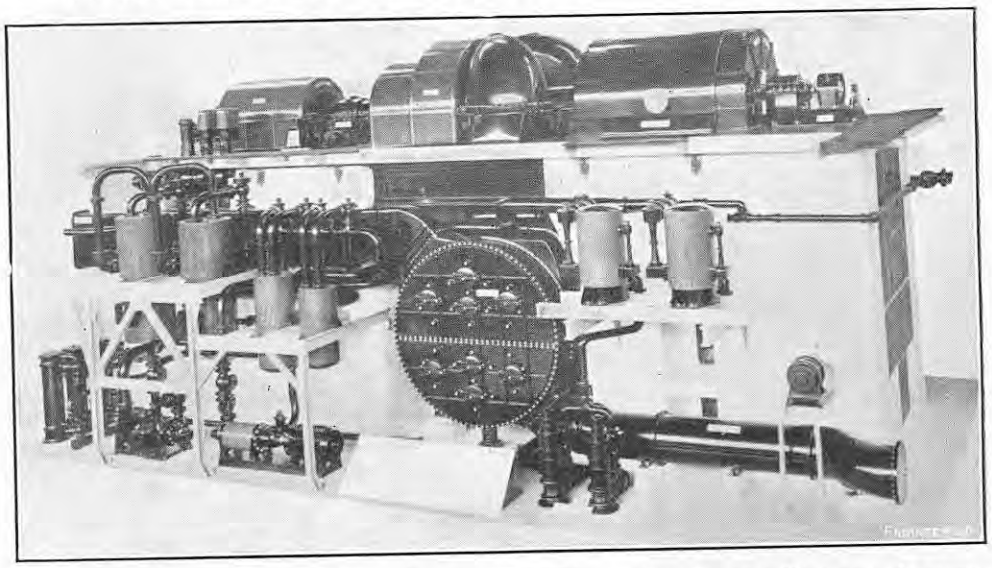


Fig. 135. Model of 50-MW Turbo-Alternator; C. A. Parsons and Company, Limited.

EXHIBITS AT THE EXHIBITION OF INDUSTRIAL POWER, GLASGOW.

(*For Description, see Page* 133.)

FIG. 136. GENERAL VIEW OF HALL OF ELECTRICITY.

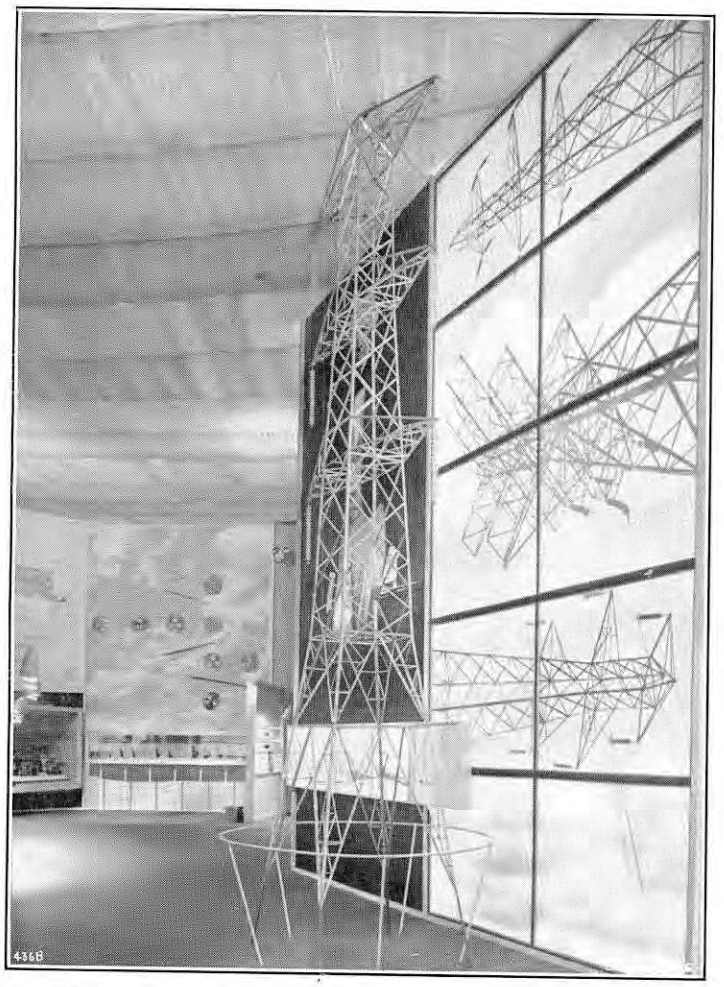


FIG. 137. MODEL 275-KV TRANSMISSION TOWER; PAINTER BROS., LIMITED.

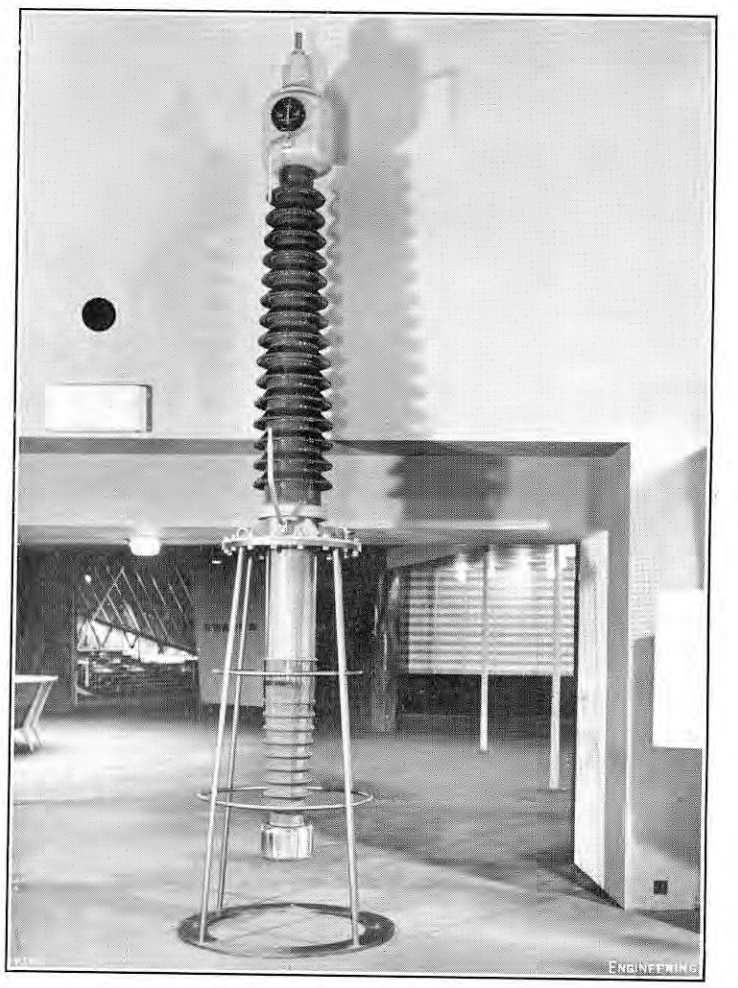


FIG. 138. 275-KV TERMINAL BUSHING; MICANITE AND INSULATORS COMPANY, LIMITED.

(*To face page* 134.)

EXHIBITS AT THE EXHIBITION OF INDUSTRIAL POWER, GLASGOW.

(*For Description, see Page* 133.)

FIG. 139. OUTER GALLERY OF HALL OF HYDRO-ELECTRICITY.

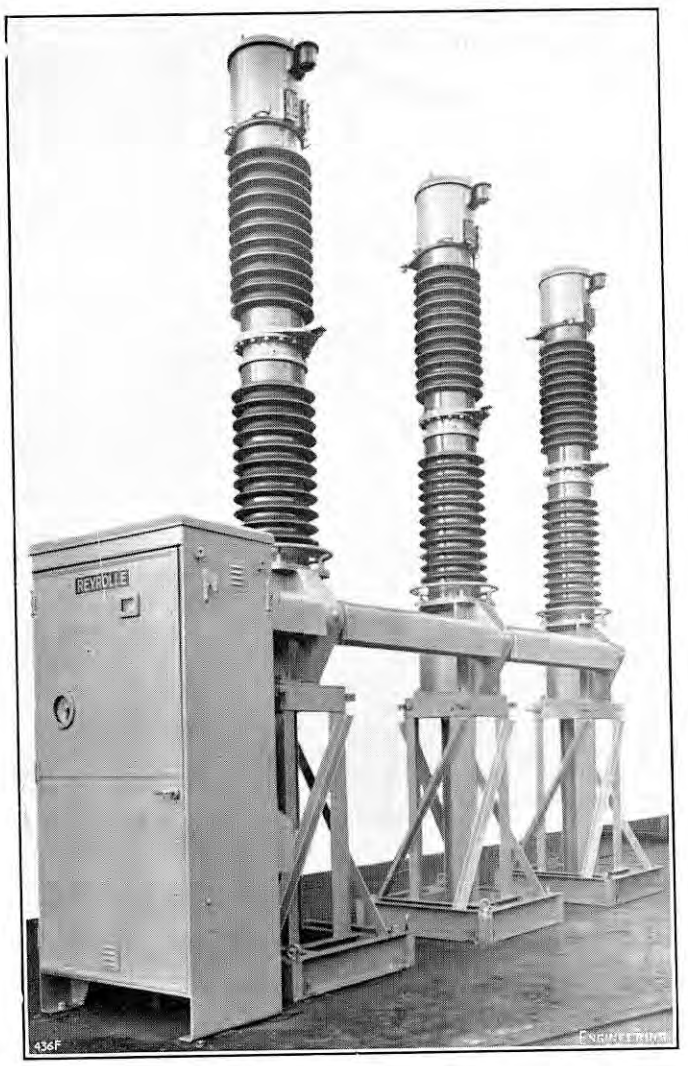


FIG. 140. 2,500-MVA, 132-KV CIRCUIT-BREAKER; A. REYROLLE AND COMPANY, LIMITED.

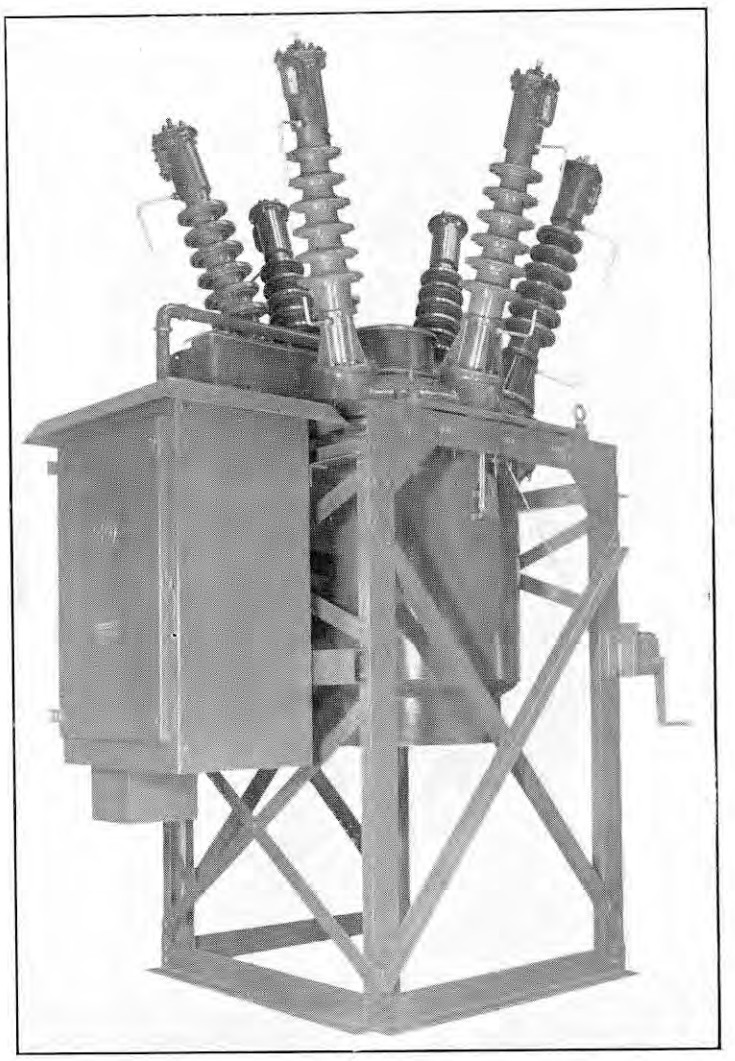


FIG. 141. 750-MVA OUTDOOR OIL CIRCUIT-BREAKER; FERGUSON PAILIN, LIMITED.

(*To face page* 135.)

EXHIBITION OF INDUSTRIAL POWER.

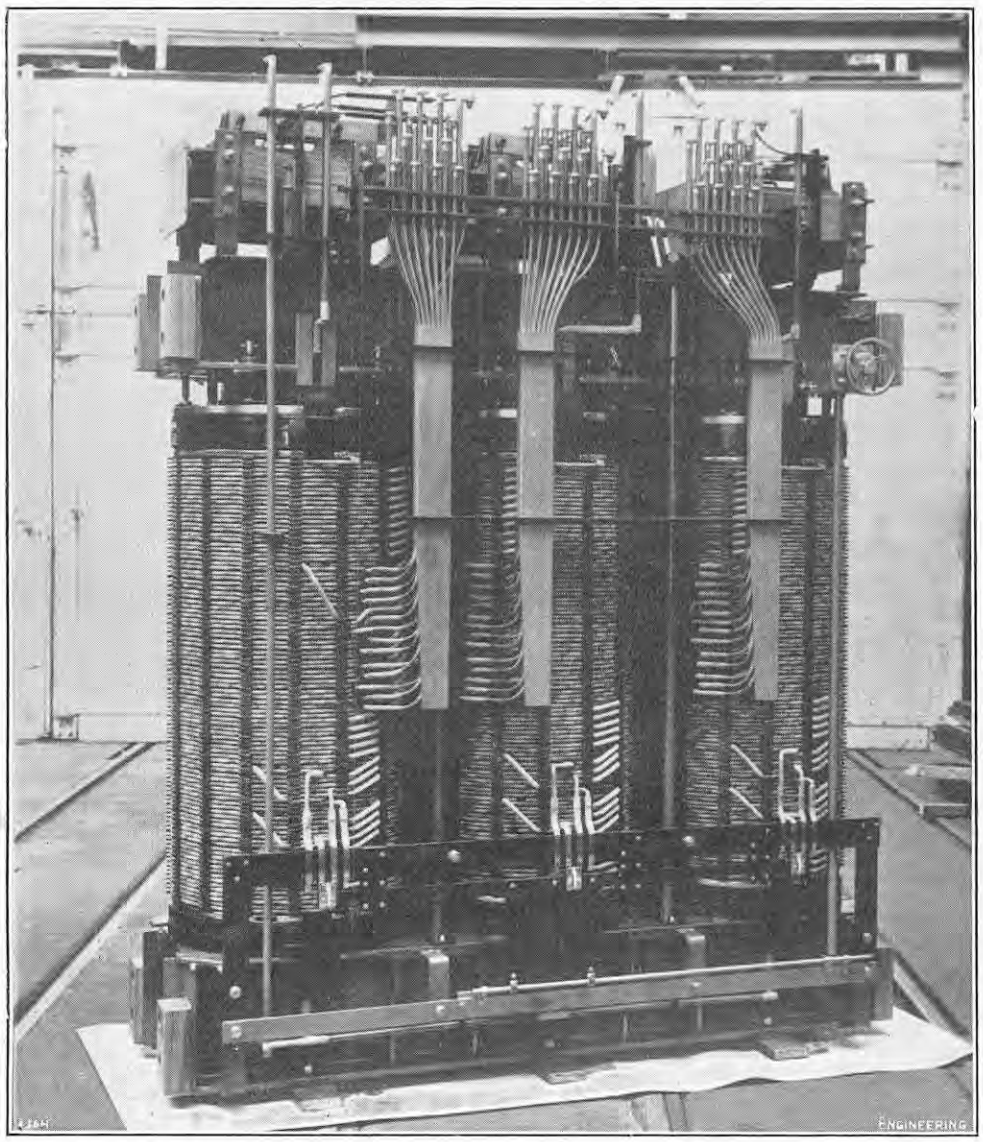


Fig. 142. 2,000-KVA, 33/11/0·433-KV Transformer; Bruce Peebles and Company, Limited.

Limited, Walthamstow, London, E.17, and the Bushing Company, Limited, Hebburn-on-Tyne. In the first of these terminals, the main insulation consists of an interior bushing of paper, which is totally immersed in oil. This bushing is enclosed in a ribbed porcelain insulator at the oil end, and there is a metal flange in the middle with a shedded porcelain insulator at the outdoor end. There is ample room for the oil to expand and the parts are held together through a spring by a brass tube, which carries the interior condenser bushing. The electrical connection to the top terminal is made through a flexible connector inside the cap, and the bushing is sealed against the ingress of water and the leakage of oil. An illustration of this bushing is given in Fig. 138, on Plate XII.

The exhibit of the British Thomson-Houston Company, Limited, Rugby, consists of a working demonstration of a 350-ampere 600-volt mercury-arc rectifier. This is made from glass containing a high percentage of silica to ensure good heat-resisting properties, and may be regarded as a typical example of the firm's designs in this class of equipment.

Electric industrial heating is represented by an air-operated rivet heater and upsetting machine, made by Messrs. Holden and Hunt, Old Hill, Staffordshire, for heavy-duty work. Rivets from $\frac{3}{8}$ in. to 1 in. in diameter can be handled and the transformer rating can be varied from 50 to 350 kVA. By a slight modification to the tooling the machine can be converted into a projection welder.

The Hall of Electricity also contains a number of examples of portable tools and domestic equipment. Among the former, mention may be made of the display of Messrs. Wolf Electric Tools, Limited, Hanger-lane, London, W.5. This consists of examples of the firm's $\frac{1}{2}$-in. and $\frac{3}{8}$-in. heavy-duty portable drills, a pedestal grinder and a 4-in. heavy-duty electric grinder. The $\frac{1}{2}$-in. drill is driven by a 250-watt motor and runs at a spindle speed of 290 r.p.m. on full load. The overall length is only 15 in., and the distance from the centre of the spindle to the outer casing is $1\frac{1}{2}$ in. The $\frac{3}{8}$-in. drill is slightly smaller, but is driven by a motor of the same capacity. The pedestal grinder consists of a $\frac{1}{2}$-h.p. totally-enclosed motor, which is mounted on dustproof ball bearings, and drives two 8 in. by $\frac{3}{4}$ in. by $\frac{5}{8}$ in. grinding wheels, one of which is coarse and the other fine. It is fitted with illuminated eye shields, the lamps for which are either wired to the motor switch or are supplied separately. The whole is mounted on a cast-iron pedestal with a built-in water-pot.

On the weak-current side of the industry, Cinema-Television, Limited, Worsley Bridge-road, London, S.E.26, are showing equipment for automatically detecting the presence of both ferrous and non-ferrous metals in non-metallic material. This consists of a head in which there is a central aperture, so that a conveyor belt carrying the articles to be examined can be passed through it. This head also contains a former on which an oscillator coil and two pick-up coils are wound, the coil system being suspended in a metal casing and connected so that the mutual inductance between the oscillator and pick-up coils is zero. Any metal entering the fields of these coils disturbs this electrical balance, so that a very small voltage is induced in the pick-up coil. This voltage is then fed back to a control unit, where it is amplified and used to operate a relay connected to an alarm system. This control unit consists of a main amplifier and detector, stabilising transformer, main switch and relay unit. The valves in the amplifier are mounted on a cadmium-plated steel chassis, which is contained in a dust-proof casing carried on anti-vibration mountings.

The application of electronics in industry is illustrated by the radio-frequency induction heater, which is being exhibited by Redifon, Limited, Broomhall-road, London, S.W.18. It is being shown in action heating 1-in. billets of stainless steel, and is fitted with push-button control so that visitors can operate a complete heating cycle at short intervals. The equipment consists of an oil-cooled transformer, and power pack and oscillator sections, the two latter forming self-contained units which are bolted together and enclosed in quickly detachable aluminium skins. The switchgear, which is of robust design, is grouped on a sub-chassis, which can be swung out for inspection purposes. Output loading condensers are provided under a removable panel and the power can be controlled by a hand-wheel on the front of the set. This wheel is fitted with a scale, so that it can be set for a pre-determined output. The application of power is prevented by an interlock until the cooling water for the coil is flowing freely. The unit only occupies 30 in. by 30 in. of floor space, and is mounted on wheels so that it can easily be taken to a machine tool for heat-treating the articles as they are produced. The continuous output power of the equipment is 8 kW at a nominal frequency of 475 kilocycles, the maximum circulating current in the work coil being 350 amperes and the maximum voltage 1,000 volts root mean square.

A portable electro-medical short-wave therapy unit is being shown by Radio Heaters, Limited, Wokingham, and a portable diagnostic X-ray unit by General Radiological, Limited, Clipstone-street, London, W.1.

The display in the Hall of Hydro-Electricity at Glasgow is designed to show the rapid growth in the use of water power during recent years; it may be noticed that the story told has a distinctly Scottish setting. As, before the coming of steam, water was one of the few sources of power readily available to industry, factories tended to be established on rivers. With the advent of the steam engine, cities grew up near the coalfields and the depopulation of the countryside, particularly in Scotland, began; this is illustrated in the first section of the Hall. The next section shows how this tendency was checked by the establishment of the Kinlochleven and Lochaber schemes of the British Aluminium Company and later by the Galloway power scheme; and how the activities of the North of Scotland Hydro-Electric Board will have even more productive results in the same direction.

The third section of the Hall deals with the tasks which have to be undertaken by engineers in carrying out hydro-electric schemes. These include the building of dams to impound the water during the dry seasons, its diversion from many sources into the reservoirs thus formed, and the connection of these reservoirs to the power stations by tunnels and pipelines. A mural painting shows the tunnellers at work. The hall then opens into a lofty chamber, the roof of which is curved to suggest the lines of a dam. In the far wall are recesses down which miniature waterfalls stream, and against these recesses are a number of displays showing various aspects of the work involved in carrying out a scheme, most of which are chosen from the Loch Sloy undertaking.

The first recess deals with the preliminary work, such as the building of roads, railways and camps, the opening out of quarries and the erection of temporary power stations, which has to be carried out before operations on the scheme proper are started. The second, third and fourth deal with the construction of the dam, tunnel and power house, and the fifth illustrates the projects of the Board which have been completed already and the principal ones which are now under construction. Finally, examples are given of how the electricity generated will be used and, especially, how its availability

will affect the amenities of those living in the Highlands and perhaps enable the unused raw materials of the north to be developed for founding new industries.

The outer gallery of the hall is illustrated in Fig. 139, Plate XIII. It is dominated by a bronze and brass mural of the water horse or kelpie, the ancient legendary Gaelic creature of the Scottish rivers and lochs. A waterfall descends into the Hall of Civil Engineering. There are also alcoves in which the methods of preserving the beauty of the glens is illustrated by reference to the Glen Affric scheme of the North of Scotland Hydro-Electric Board, and how sport is protected by the provision of fish ladders. Future sources of power are dealt with in other alcoves, the possibilities of using wind and peat being illustrated. There is also a model of the Severn barrage, to indicate that there may be sites for utilising tidal power on the west coast of Scotland.

Included among the exhibits are a $\frac{1}{48}$th-scale model of the Loch Sloy power station, with one turbine and one alternator sectioned, which is shown by the English Electric Company, Limited. Further models, relating to the same scheme, are of a 45,500-h.p. water turbine and alternator, main transformer, and half the main switching station at Inveruglas, as well as of the landscape round Loch Sloy. This scheme was fully described on page 1 *et seq* of our 170th volume (1950), but it may be recalled that it consists of a reservoir with a capacity of 1,200 million cub. ft. from which water is taken through a $1\frac{3}{4}$-mile tunnel and pipelines to a power station containing four 32·5-MW sets. Francis turbines, which form the prime movers of these sets, operate under a gross head of 900 ft. to 710 ft., and current is generated at 11 kV when they are running at 428 r.p.m. The output is stepped up to 132 kV in an outdoor substation and controlled at a switching station at Inveruglas about a mile away by pneumatically-operated circuit-breakers with a rupturing capacity of 1,500 MVA.

The cascades of water mentioned above and the various fountains and jets have necessitated the installation of five single-stage pumps with a total duty of 3,500 gallons per minute. These were supplied by the Harland Engineering Company, Limited, Alloa, and are driven by squirrel-cage motors manufactured by the same firm. Pumps are also represented in a typical station for industrial or public utility undertakings. This consists of plant also manufactured by the Harland Engineering Company, as well as of auxiliary equipment by Belmos, Limited, Bellshill, Lanarkshire; Glenfield and Kennedy, Limited, Kilmarnock; and George Kent, Limited, Luton. The main exhibit is a vertical "Electroglide" single-stage pump with an integral electric motor, a section of the pump casing being cut away to expose the impeller, neck rings, bearings and shaft. The fabricated casing is strengthened to support the motor and is designed so that radial thrust is minimised. It has axial suction branches, and its radial delivery branches enable the delivery take-off to be arranged in the most convenient position. The end cover, which may be of fabricated steel, cast iron or bronze, according to the duty, contains the stuffing box, neck ring, and sealing and balance connections.

The single-entry overhung impeller is of cast bronze and is balanced dynamically. A long shaft-mounting boss is extended through the stuffing box and is fitted with a removable stainless-steel sleeve where it passes through the pump gland. The impeller is "blind" at the suction end, thus eliminating contact between the liquid and the driving shaft. Neck rings of leaded bronze are fitted on both sides of the impeller and the back neck-ring leakage is discharged to atmosphere or to the suction side of the pump, so that the gland operates against low pressure. The gland packing rings are retained in a housing in the end cover and a lantern ring is provided for use where a grease sealing, clean-water or internal sealing is required. This gland is adequate for operation on a positive suction head and, in certain circumstances, it is possible to operate the pump without gland and packing. The high-tensile steel pump shaft is an extension of the motor driving shaft and is machined to receive the impeller, which is secured to it by a keyway, nut and impeller cap. The valve headstock is designed to allow the manual operation of a 10-in. sluice valve in the delivery pipe.

The motor, which is also of Harland manufacture, is designed to operate as a common unit with the pump. Its end-cover is bolted directly to the casing, which acts as a stool in vertical units. The motor is controlled by an automatic air-break star-delta contactor switch, which is installed in a sheet-steel housing with a triple-pole isolating switch in a separate compartment.

The set is provided with Telerecorder equipment, which includes a circular moving-coil milli-ammeter receiving indicator. The direct-reading flow integrators are in a circular case and are continuously in operation. Their movement consists of a watt-meter motor, which is provided with heavy jewelled bearings, spring-cushioned to prevent damage by vibration. In the strip chart recorders the pen tracing is on separate widths of chart for each point. The chart drawing unit is a slow-speed synchronous motor.

The connection between the generation of electric power by water and agriculture is illustrated in the Hall by a number of examples of motor-driven equipment. These include milking, butter-making and shearing machines, as well as cream separators and portable tools of various kinds. Among these, mention may be made of the small hammer-mill for producing animal feeding stuffs and poultry foods, which is exhibited by Messrs. Christy and Norris, Limited, Chelmsford. This consists of a series of swing hammers of high-carbon steel with four cutting edges, the life of which can be increased by reversing them from side to side and end to end. They are carried on a spindle which is mounted in ball and roller bearings and are driven by a 3-h.p. motor, fitted on a pivot base and driving through a Vee-belt. The machine is provided with a suction feed, which incorporates an iron and stone trap. There is also a cut-out device which shuts it down automatically when the supply of corn from the grain hopper ceases. The meal is delivered into bins pneumatically by a fan, a two-way valve being fitted so that two or more bins can be dealt with simultaneously.

Messrs. E. H. Bentall and Company, Limited, Maldon, Essex, are showing a root cutter consisting of a series of chopping knives which are mounted on steel slicer blades. Each blade and knife forms a separate detachable unit which can be replaced separately. The knives pass through slots which are designed to prevent choking and to assist the passage of the sliced roots into a delivery spout. The cutter is operated by a 1-h.p. electric motor and has an output of about 3 tons or 2 tons per hour, depending on whether a clearer is fitted or not. It can be mounted on rubber-tyred wheels.

(To be continued.)

Iron and Steel Allocation Scheme.—The Minister of Supply has made an Order calling for returns of iron and steel consumed during the first half of 1951, corresponding stocks, and estimated requirements for the following nine months. The object is to collect information on which the allocation of steel can be based, and two returns are called for. Return A is required if an undertaking consumed 25 tons or more of non-alloy iron and steel in the half year; a separate return is needed of all the iron and steel, including alloy iron and steel, consumed and held in stock in each of the undertaking's works and stockyards. Return B is required if an undertaking consumed either 5 tons of alloy iron and steel or 1,000 lb. of high-speed steel in the half year. A separate return is needed of all the alloy iron and steel, including high-speed steel, consumed and held in stock at each of the undertaking's works and stockyards. Returns are not required from works using iron and steel only for the main processes of iron and steel manufacture; for iron castings other than alloy-iron castings; or from scrap merchants, stockholding or distributing merchants; or from warehousemen. All returns must be made not later than August 22, on official copies of the forms set out in the second schedule to the Order. Copies of these forms are being sent directly to all steel-using firms whose names and addresses are known. Firms which have not received copies by August 8 must write immediately to the appropriate Regional Controller, Ministry of Supply, who will send forms at once. Copies of the Order—the Iron and Steel Utilization (Information) Order, 1951—are obtainable from H.M. Stationery Office.

THE INTERNATIONAL CONFERENCE OF NAVAL ARCHITECTS AND MARINE ENGINEERS.

(*Continued from page* 117.)

The technical sessions of the International Conference of Naval Architects and Marine Engineers were resumed on the morning of Thursday, June 28, when a paper on "The Characteristics and Development of Naval Fuel Oils" was presented by Mr. M. Blanchier, of the Association Technique Maritime et Aeronautique. The chair was taken by the President-elect of the Institution of Naval Architects, Viscount Runciman of Doxford.

Naval Fuel Oils.

The purpose of his paper, Mr. Blanchier said, was to review certain fuel characteristics to which the technical aspects of fuel utilisation lent a special significance. Sulphur, for example, was one of the most undesirable elements to be found in any fuel, whether for combustion in Diesel engines or under boilers; if its presence had to be tolerated to avoid undue restriction of supplies, nevertheless it was essential to ensure that the proportion of sulphur should not exceed a certain percentage—it was suggested, 2 per cent. Again, the adverse effects of introducing sodium into boilers was well known only a small proportion of sea water should be tolerated in fuels. Moreover, the ash content should be fixed. At the present time, however, the question which raised the most serious difficulties was that of pumping fuels at low temperatures; there was no standard method for determining in advance the pour-point of a mixed-base fuel—i.e., a fuel with an asphalt-paraffin base—though investigations were proceeding, as a result of which it was hoped to develop such a method. Some modern cracking processes tended to leave in the fuel oil a certain amount of lighter hydrocarbons, an excessive quantity of which could be dangerous, especially when burners were being lighted; the explosibility of such vapours should be controlled, and should not rise above half the lower limit of explosibility of the natural gas. There was a tendency, too, in modern specifications, to ignore the asphaltic content of a fuel; but, for its complete combustion, asphalt required a fairly high temperature, and as fine a pulverisation as possible. As soon as the asphalt content rose above 10 per cent., the heating and pulverisation became insufficient to ensure proper combustion, and small dry pellets were formed in the furnace. The use of heavy fuel oils in Diesel engines depended on their purity, the principal characteristics of which were a low ash content and a low sulphur content. Adequate arrangements for heating the oil to a suitable viscosity for injection were also necessary. No special technical problem was raised by those requirements.

Commander (E) L. E. S. H. Le Bailly, R.N., who opened the discussion, said that, during the past two years, he had worked with Mr. Blanchier, trying to ensure that the fuels and lubricants used by the Western European Allies were interchangeable and, where possible, even to a standard specification. So far as the Royal Navy was concerned, thanks to the wisdom and foresight of Lord Fisher, Prince Louis of Battenburg, and the then First Lord of the Admiralty, Mr. Winston Churchill, Britain had pioneered the use of liquid fuel. In those days, and for several years afterwards, the navies did not have to worry very much about fuels, but, since then, the whole world situation had changed, and any navy which did not give very serious consideration to fuel problems would be guilty of something worse than short-sightedness. Some of those problems were purely combustion problems; others, such as handling problems, both at sea from ship to ship and on board ship (and naval ships used fuel as an instrument to correct heel or trim, following enemy damage) were possibly purely naval problems. Ships had to be designed to suit the fuels which would be available in two or three or four years' time, which was not made easier by the vigour and speed with which the petroleum

industry moved; of all the great industries, it seemed to be the most relentless in the way that it discarded out-of-date techniques and processes. The British Admiralty, encouraged by a long and happy association with the Anglo-Iranian Oil Company, turned to the British petroleum industry as a whole with their problems, and the industry had met them wholeheartedly. The Admiralty Oil Quality Committee consisted of representatives of the industry, independent petroleum technologists of note, and Admiralty representatives; and the Admiralty felt that there was no better advice available than the industry was giving them. He disagreed with the author regarding the importance which he attributed to the effect of sulphur on personnel. His own experience, in both peace and war, suggested that, if the ventilation systems of ships were such, or if the enemy damaged a ship so much, that funnel gases got into the machinery spaces, 1 or 2 per cent. of sulphur did not make much difference.

A matter which should be brought into the paper was the effect of the compatibility requirement on the availability of fuels. To tie down the fuels required in the Navy between the two reference fuels that the author mentioned meant that there was, on either side of those fuels, a considerable margin of incompatible fuels which, in an emergency, might be needed. The author referred to the testing of fuel at a temperature of 200 deg. F.; future combustion designs envisaged a viscosity which appeared to require a temperature of 220 to 230 deg. F., which meant that the test did not simulate future conditions. Fuel users would look forward to the petroleum industry's answer to Mr. Blanchier's statement, at the beginning of the paper, to the effect that the quality of fuel, by reason of present-day refining practice, was steadily deteriorating.

Mr. H. F. Jones thought that all fuel suppliers would agree that there should be restrictions on the water content of the fuel, but that the overall aim should be no sea water in the fuel. However, that purpose was not achieved, nor were the restrictive limits of much use, so long as ballasting with sea water or displacement of the fuel oil by sea water continued. In connection with sulphur content, the author referred to trouble due to corrosion of the boiler drums, of the boiler tubes, and of the "platework." The term "platework" was rather broad—perhaps due to translation—and the author did not specifically mention troubles in the low-temperature zones, such as the preheaters and economisers; more information on that would be welcome. There was a reference to conditions where an ash content of 1 part per 1,000 corresponded to a wastage of 1,500 kg. of brickwork per ton of fuel consumed; the author corrected the latter figure to 1·5 kg. He spoke of two-thirds of the ash from the fuel being sulphate of soda, and perhaps he was assuming that all that sulphate of soda reacted on the alumina in the fireclay. That was highly improbable, particularly as a portion of the sodium was deposited on the water tubes. The author also stated that experiments to find a method suitable for breaking up emulsions on an industrial scale by the application of Sinnopon had been successful. Had its use facilitated the separation of water by centrifuging, or had it made separation by centrifuging more difficult? It was also stated that "the general heating system must be capable of raising the temperature of all the fuel to 30 deg. C. (about 86 deg. F.) "even under the most severe temperature conditions, which in Europe had been fixed as 1 deg. C. for sea water and 8 deg. C. for the atmosphere." Surely, the atmospheric temperature under the most severe conditions would be below that of the sea water? Perhaps the figure for the atmospheric temperature should be — 8 deg. C. ?

In the final section of the paper, dealing with the use of boiler fuels in Diesel engines, the author had stated that, whenever the temperature at any part of the engine in contact with the combustion gases fell below the dewpoint—somewhere in the region of 175 deg. C.—sulphuric acid condensation with a solution of sulphur dioxide might take place; and he pointed out that the temperature in a crankcase was obviously much lower. Mr. Jones questioned that 175 deg. C. was the dewpoint of sulphuric acid; but the crankcase derived some benefit from oil mist protecting the parts from attack by sulphur. Gas oil was mentioned as being contaminated with sulphur. Gas oil had a small amount of sulphur in it, which resulted from the crude and remained as a distillate; the author's statement might give the idea that it was added, or was in the form of pollution.

Mr. H. T. Lorne gained the impression that too much emphasis was being placed on the bad points of Middle East fuel oil; there were instances in which they were very satisfactory. Fuel oils were known to contain sulphur, and it was gratifying to note that 3½ per cent. at least was tolerable. A good deal more than 3½ per cent. was tolerable; the specification of that figure by the French Navy was purely an interim measure. In a year or two, they would be saying that 4½ per cent. was perfectly satisfactory. It was suggested that no more than 2 per cent. of sulphur should be allowed in fuels for Diesel engines; fuels of much greater sulphur content had been used with complete satisfaction. Admittedly, with the increasing loads on boilers, the problem of deposits might arise in a different form in the future from that of the past; but a drive should be made to restrict the sea-water contamination.

A lot of emphasis was placed—he believed, wrongly—on measuring the highest pour-point that could be obtained for a fuel. By proper heat treatment, the "pumpability" of fuels could be greatly improved; and the pour-point might not be an indication of the "pumpability" or performance of the fuel. In most cases, with the waxy asphaltic types of fuel oil from Middle East crudes, the pumpable limit has been 20 deg. below the apparent pour-point. Rather than spend time fixing on the highest pour-point that could be got, more effort should be applied to handling the fuel under normal conditions. The author's statement on the bad effect of modern oil-processing was far too sweeping. Undoubtedly, in the past, some processes caused fuel deterioration, but that was not true to-day. Only certain types of cracking processes caused deterioration of fuel oils, and there was strong reason to believe that other types improved them; the author might well find that great improvements would be effected by the introduction of modern cracking processes. With regard to vanadium in the ash: the author had quoted vanadium contents of up to 0·05 per cent. in heavy fuel oils from Iraq; but Iraq fuel oil had a vanadium content of no more than about 40 parts per million; so it seemed that the figure of 0·05 per cent. must be a misprint.

Mr. C. W. G. Martin said that there had been much misconception about deterioration in quality. Admiralty fuels had become higher in viscosity, but there was good reason for it. Generally speaking, fuels had not deteriorated; in many cases, the major companies were quoting specifications superior to those they quoted before the war. Sulphur was not an "impurity." The word "impurity" meant to him something introduced accidentally, or deliberately for some ulterior motive. Sulphur occurred not only in gas oil, but in the heavier fuels as well. It could be taken out of oils, but it was not possible economically to take it out of residual fuels. Of course, it could be burned.

Some work at Thornton Research Station had given results in which there was no evidence to suggest that conditions might worsen comparatively suddenly with sulphur contents above 3½ per cent.; he mentioned that work to follow up the remark of an earlier speaker, that there was no particular magic in 3½ per cent. as the sulphur limit. He was also much concerned by the attempt to restrict the sulphur content of oils used in Diesel engines to 2 per cent. It was illogical that fuels should have 3½ per cent. of sulphur when used in a boiler, and only 2 per cent. in a Diesel engine. There were 36 motorships in the Anglo-Saxon Petroleum Company's fleet running on fuel oil with a sulphur content of between 2 per cent. and 3 per cent., without any adverse effect as compared with ships in the same fleet running on marine Diesel fuel.

There was a good deal to be said for the ash limitation of 0·1 per cent. in the fuel for warships, but the author seemed to be in error when he said that two-thirds of the ash was sodium sulphate. Mr. Martin doubted whether an ash content of 0·1 per cent. was equivalent to sea-water contamination of 2 per cent. and he could not believe that the amount of natural ash present in any fuel oil could have the same deleterious effects on the refractories as had sea water. Teepol, as a means of separating water from fuel oil, was effective in a critical concentration; beyond that, it might do more harm than good. A good deal of laboratory work had been done with additives, but so far it seemed inconclusive. The author appeared to be worried because people did not mention asphalt content in fuel oil specifications; that omission, however, was understandable, because the asphalt determination was a laboratory solubility test and had little to do with the burning properties of the fuel. Asphaltic bitumen would burn perfectly well with the proper equipment.

Mr. H. Gamlen was of the opinion that sulphur in fuel oil, or in solid fuels, was undesirable in either a boiler or a Diesel engine; and still more so in numerous other types of installation, such as steel furnaces and glass processing furnaces, etc. In commercial practice, it was difficult to set up arbitrary limits for sulphur and other constituents. Merchant ships, especially, must take such fuels as were available, consistent with the economics of fuel-oil production. Even the United States Navy, which had special Navy fuel, had not eliminated the problems of sulphur, combustion deposits or sludge. With regard to emulsified oil and water, the problem of de-emulsifying without danger of re-emulsifying was now being handled to the complete satisfaction of the user. In the United States and on the Continent, many hundreds of ships were having their fuels treated at very low cost, and they were using both Diesel oil and boiler fuel. According to the majority of fuel-analysis certificates, sulphur was listed in its metallic form; but sulphur could hardly exist in its metallic form in fuel oil. Its presence in oil was usually in a combination such as carbon disulphide, sulphates, etc. It had been shown in many papers and lectures over the previous 20 years that the dewpoint had a long range of temperature, depending on the amount of water present, for example. When starting a boiler from cold, the amount of sweating and deposition of sulphurous and/or sulphuric acid was dependent on the existing circumstances. The formation of sulphur compounds took place, for the most part, at quite normal temperatures; for instance, at the boiler metal temperature.

In the case of superheater tubes, Mr. Gamlen continued, an entirely different set of circumstances prevailed, so that the sulphates could actually become plastic; and, as the spaces between tubes became closed, impedance was offered to the flow of gases out of the boiler, to set up a new order of circumstances quite unrelated to the sulphur compounds. If the gases could not get out of the boiler, a reducing atmosphere, high in CO_2, was created to cause a chain of reactions. There were many records of samples of fuel oil, taken from ships' tanks, where the combined sulphur and sulphates averaged 8·8 per cent. for a whole year; yet these so-called undesirables had been and were being successfully controlled by safe and simple chemical means. For instance, by correct treatment it was possible and practical to remove water-soluble sulphate by precipitation and centrifugal separation. The vanadium content of fuels was undoubtedly an excellent catalyst. Among thousands of samples of deposits of combustion analysed over the previous 20 years, they had found vanadium quite frequently, in amounts from 0·2 to 8 per cent., in the form of V_2O_2. Sulphates were usually water-soluble, though he would not recommend that water should be used, for obvious reasons. It was possible, however, that the water content of fuel served the purpose of dissolving soluble sulphates, provided that the precipitated water was separated chemically from the fuel before it entered the boiler furnace or Diesel engine.

Mr. Blanchier did not reply to the discussion orally.

(To be continued.)

MIXED-TRAFFIC 2-6-4 TANK LOCOMOTIVE.

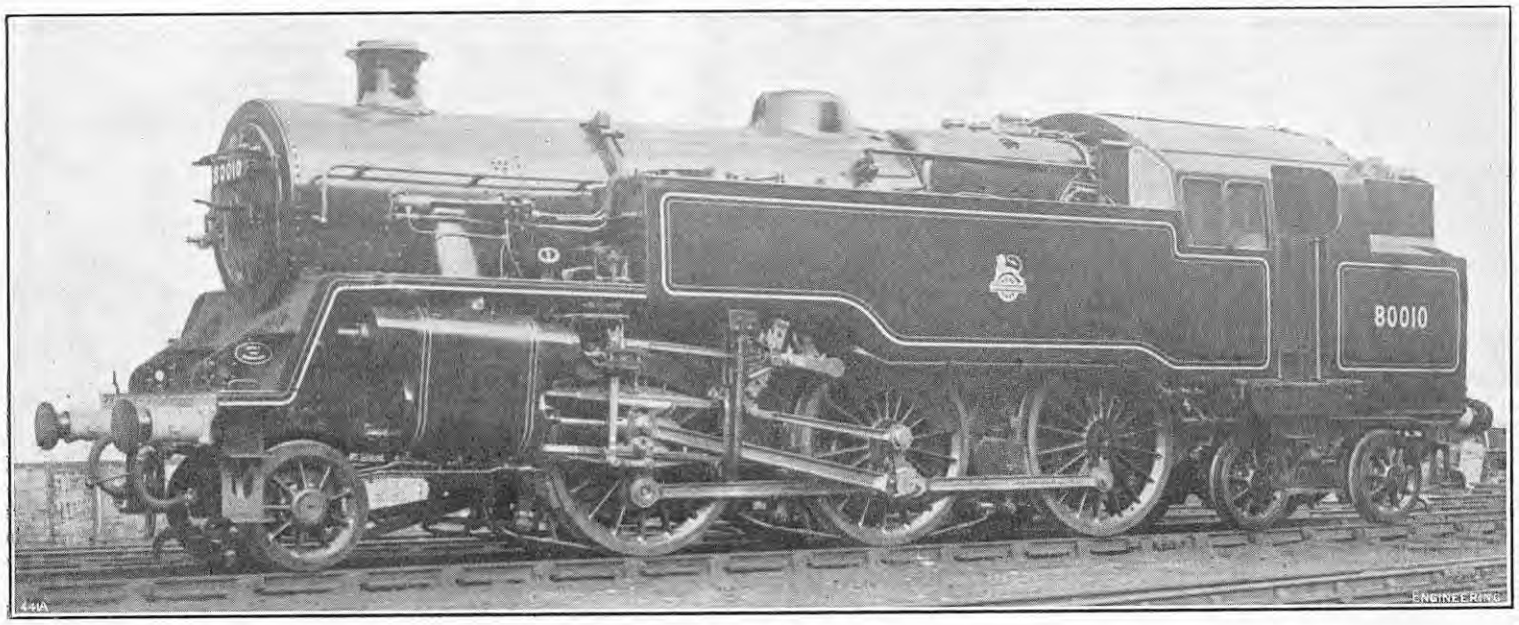


Fig. 1.

Fig. 2.

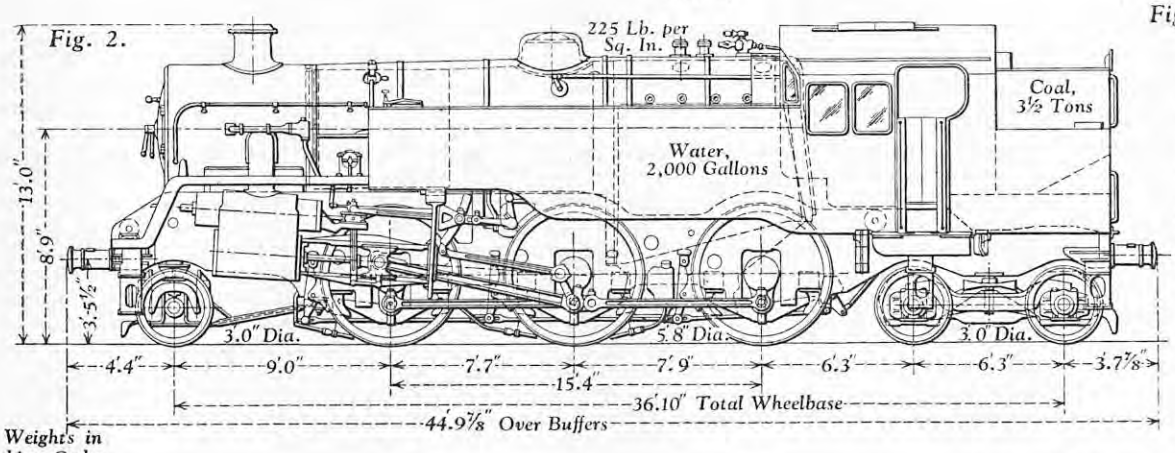
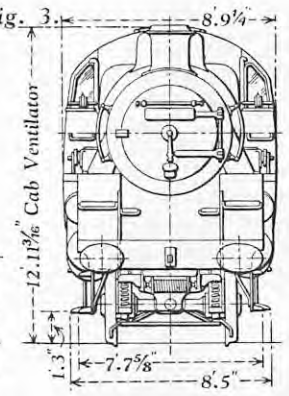


Fig. 3.



Weights in Working Order, Tons	13·1	17·35	17·95	17·75	20·5	*Total* 86·65 Tons

(441 B) *Total Empty Weight* 69·4 *Tons*

MIXED-TRAFFIC 2-6-4 TANK LOCOMOTIVES, BRITISH RAILWAYS.

The photograph and drawings reproduced on this page are of the fourth type of British Railways standard locomotive of which details have so far been published. It is a class-4 2-6-4 tank engine, corresponding in size and power to the class-4 4-6-0 locomotive of which a description was given in Engineering for June 22. The dimensions, etc., on which the tractive effort depends are the same; thus, there are two outside cylinders, 18 in. by 28 in.; the coupled wheels are 5 ft. 8 in. in diameter; the boiler pressure is 225 lb. per square inch; and the tractive effort is 25,100 lb. The adhesion factor is 4·73 and the braking power is 44·2 per cent. Other principal dimensions, together with weights, are given in Figs. 2 and 3. The features of the new design which are characteristic of the British Railways' family of standard locomotives are apparent: the taper boiler with top-feed, the foot-framing set high, the shape of the cab—and the chimney—and the arrangement of the motion; though, as it is a 2-6-4 tank engine, a two-bar crosshead has been used in conjunction with a motion bracket which also supports the expansion link. On the class-4 4-6-0 engine a single-bar crosshead and a separate expansion-link bracket have been used, and the radius rod is suspended from a link in front of the expansion link.

The new engine, No. 80,010, is the first of 44 which are being erected at the Southern Region's Brighton works this year; 10 are also to be built by the London Midland Region at Derby. The manufacture of the details of the locomotives being built by the Southern Region is divided between the works of that Region—Eastleigh, Ashford and Brighton. The 54 locomotives will be allocated as follows:—Scottish Region, 21; Southern Region, 10; Eastern and North Eastern Regions, 3; and London Midland Region, 20. They have been designed and built under the direction of Mr. R. A. Riddles, C.B.E., member for mechanical and electrical engineering, Railway Executive. The parent office for the design of this class is Brighton, but certain sections have been designed at Swindon, Derby and Doncaster. The work of designing the new locomotive has been carried out in the Brighton drawing office concurrently with the design of the class-4 4-6-0 locomotive. The tank engine is intended for short-distance working, such as suburban and cross-country passenger trains, and the shorter distance freight workings, and will have almost universal availability over main and secondary lines throughout Great Britain. Many of the details of the two class-4 types are interchangeable, and various features of the design, including nearly all the fittings, are common with those of the other British Railways' standard types.

The boiler is of the same general design as that of the L.M. Region class-4 2-6-4 tank engine, except that the staying has been redesigned to accommodate the higher boiler pressure, which has been increased from 200 lb. to 225 lb. per square inch. The shell is of ordinary quality steel plate and the barrel is made of two rings, the second of which is tapered. The front barrel ring is rolled from $\frac{9}{16}$ in. plate and the second ring from $\frac{5}{8}$-in. plate, the outside diameter being 4 ft. 9 in. at the front and 5 ft. 3 in. at the firebox end. The smokebox tubeplate is of the drumhead type, $\frac{3}{4}$ in. thick. There are 21 large flue tubes, $5\frac{1}{8}$ in. in outside diameter, 7 s.w.g. thick, and 157 small tubes, $1\frac{3}{4}$ in. outside diameter, and 12 s.w.g. thick. The length between tube-plates is 12 ft. 3 in. The Belpaire firebox has outside dimensions at the bottom of 8 ft. 6 in. in length and 4 ft. $0\frac{1}{2}$ in. in width. The grate area is 26·7 sq. ft. The inner firebox is of copper, the wrapper plate being $\frac{9}{16}$ in. thick and the tubeplate 1 in. thick. The outer steel wrapper plate is $\frac{9}{16}$ in. thick. Throat and back plates are of the vertical and of the sloping type, respectively. All the firebox water-space stays are of Monel metal, fitted with steel nuts inside the firebox, but the roof, longitudinal and transverse stays are of steel. The superheater elements, supplied by the Superheater Company, Limited, Haymarket, London, S.W.1, are $1\frac{3}{8}$ in. in outside diameter and 10 s.w.g. thick. The boiler heating surfaces are as follows: tubes, 1,223 sq. ft.; firebox, 143 sq. ft.; total evaporative, 1,366 sq. ft.; and superheater, 246 sq. ft. The free flue area is 3·78 sq. ft.

The grate consists of seven rocking sections, each fitted with 14 renewable firebar units. The front four and rear three sections of the grate can be rocked from the footplate independently, the arrangement being such that the full travel of the lever may be used for fire dropping when the locomotive is standing over a pit, or a limited movement used when in road service for disturbing the fire to eliminate ash and break up clinker. The self-emptying ashpan has two flap doors in the lower section, operated from ground level. Front and rear damper doors are provided, and are controlled by screw gear and handwheels mounted in the cab. The regulator is located in the dome and is of the vertical-grid type with an operating shaft placed transversely across the boiler and mounted in a stuffing box in the second barrel ring. An external rod is employed for the connection to the regulator handle. Feed water is delivered through two top-feed clack valves placed at approximately 30 deg. on each side of the vertical centre-line of the front barrel ring, and passes over two inclined trays which deflect it round the inside of the barrel clear of the tube bank. A steam manifold is fitted on the firebox top outside the cab, and two safety valves are located on the firebox top in front of the manifold. A blowdown valve is fitted at the front of the firebox throat-plate immediately above the foundation ring, for manual operation from ground level; it is supplied by the Everlasting Valve Company (Gt. Britain), Limited, 125, Balham High-road, London, S.W.12. The smokebox is supported by a fabricated saddle, and has a self-cleaning arrangement which consists of plates and a wire-mesh grid arranged to prevent accumulation of ash and the emission of large particles of unburnt fuel. The blast pipe has a plain circular cap $4\frac{3}{4}$ in. in diameter, which also contains four Cardew-type blower nozzles.

The engine has $1\frac{1}{4}$-in. steel plate frames braced by horizontal and vertical stretchers, the majority of which

are fabricated. The axlebox guides are steel castings riveted to the frame plates and are provided with manganese-steel liners. Lugs integral with the guides are provided for the pin-jointed cross-stays which maintain the correct distance between the frames. The boiler is carried in the frames by rigid attachment between the smokebox and the saddle, and by a downward extension at each back corner of the firebox foundation ring resting on shoes supported by a cross-stretcher, to permit longitudinal expansion. Expansion angles of the type fitted to the side of the firebox are not employed. The foot-plating is carried at the forward end on brackets attached to the smokebox, and at the back end on brackets which also carry the mechanical lubricators. The engine is fitted with plain-bearing axleboxes to all wheels. The coupled-wheel axleboxes are steel castings, with pressed-in whitemetalled horseshoe brasses, and sliding underkeeps with pads supplied with oil from a mechanical lubricator. Guide wearing faces are provided with manganese-steel liners welded to the axlebox and lubricated by grease. The coupled-wheel springs are of the laminated type with carbon-steel plates. Underhung spring brackets with solid tension links, cottered at the top and bottom, and rubber damping pads, are provided, weight adjustment being made by fitting cotters of suitable depths.

The cylinders are of cast iron and are fitted with 10-in. piston valves, operated by Walschaerts valve gear, giving a maximum travel, in 75 per cent. full forward gear, of $6\frac{37}{64}$ in., with a steam lap of $1\frac{1}{2}$ in. and a lead of $\frac{1}{4}$ in. The box-type piston head has two rings, with a bronze spring-loaded slipper on the underside to minimise wear of the piston head and cylinder barrel. Lubrication of the cylinders and piston valves is by atomised oil supplied from a mechanical lubricator. The valve gear is lubricated mainly by grease, and plain bearing joints are used, except for the return-crank rod big-end, which is equipped with a Skefko self-aligning ball bearing. Screw reversing gear of the conventional type is fitted, but for convenience in operation the cab handwheel is arranged with a bevel-gear drive at 45 deg. to the axis of the reversing screw. Steam-operated cylinder cocks are provided.

The coupled wheels are 5 ft. 8 in. in diameter and the tyres have the lip fastening adopted for all B.R. standard locomotives ; 40 per cent. of the reciprocating masses are balanced. Steam sanding is provided to he leading and driving coupled wheels for the forward direction and to the driving wheels also for reverse running. The bogie employs laminated springs for compensating beams and side bolsters. Side-play control is effected by means of double helical springs. The wheels are 3 ft. in diameter and the axleboxes are whitemetalled bronze castings, lubricated with oil but not mechanically. The axlebox guide faces are grease-lubricated. Helical bearing springs are used in the pony truck, with two nests of springs, each nest consisting of two springs, one inside the other, arranged on either side of each axlebox. The load is transmitted to the axlebox by means of a yoke and shoe. Side-play control is effected by double helical springs, and helical springs are also employed for the side-movement retarding gear fitted fore and aft of the truck centre on the axle centre-line.

The steam brakes may be operated by means of a separate steam brake valve or in conjunction with the vacuum brake. The coupled wheels only are braked, with a single block on each wheel. The water pick-up is provided for both forward and backward running on engines operating in the London Midland Region only, but provision is made for fitting the gear on all engines if required. The cab, although designed to suit the smaller of the B.R. loading gauges, follows the approved layout for all the standard locomotives. All the driving controls are grouped for easy access and operation in the left-hand driving position, the vacuum-brake, blower and sanding valves being mounted on a pedestal, which also serves as a firehole screen, to the right of the driver. Two live-steam injectors are fitted on the right side of the engine, under the cab, with steam and water controls grouped within easy reach of the fireman. The cab front windows are inclined at 37 deg. to the front plate, thus affording an improved outlook for forward running. The tanks and bunker are of welded construction. Each tank has curved sides and a pressed U-shaped bottom, forming a structure of considerable rigidity, and is supported at the forward end on the outside slide-bar bracket and at the rear on a frame bracket.

CHEMICAL SOCIETY RESEARCH FUND.—Applications for grants from the research fund of the Chemical Society should be submitted not later than Thursday, November 1. Forms of application and information on the regulations may be obtained from the General Secretary, The Chemical Society, Burlington House, Piccadilly, London, W.1. Applications from Fellows of the Society will receive prior consideration. The fund is used for assisting research in all branches of chemistry.

DEVELOPMENTS IN THE SHORT-CIRCUIT TESTING OF SWITCHGEAR.

THE Association of Short-Circuit Testing Authorities (ASTA), which was formed in 1938 for the purpose of co-ordinating the short-circuit testing and certification of British switchgear and other apparatus, has recently greatly developed the technique of this work, through the collaboration of the manufacturers and in co-operation with the Department of Scientific and Industrial Research and other technical associations. It may be recalled that the primary object of this body has been to establish common standards of performance and testing, with the result that the ASTA certificate of short-circuit rating is now recognised throughout the world as the hall-mark for certified apparatus

Since 1938, the various testing stations have accumulated much information upon which the Association has drawn from time to time to secure uniformity in the form of the tests. It has also incorporated this information in booklets, which have been published for the guidance of its members. The technique of short-circuit testing has now, however, reached such a high state of development that it feels that certain of these publications should be made generally available, especially since increasing interest is being taken in the work

The booklets that have been published are :—"Interpretation of Standard Rules Governing the Short-Circuit Testing and Certification of Oil Circuit-Breakers" ; "Interpretation of Standard Rules Governing the Short-Circuit Testing and Certification of Low and Medium Voltage Electric Fuses for Alternating Current Circuits" ; "Rules Governing the Short-Circuit Testing of Circuit-Breakers which are not included, or have features not provided for, in B.S. 116 : 1937 and B.S. 936 : 1940" ; "Rules Governing the Short-Circuit Testing of High-Voltage Electric Fuses for Alternating Current Circuits" ; "Rules for the Short-Circuit Testing of Circuit-Breakers in Combination with Back-up Fuses" ; and "Rules for the Short-Circuit Testing of Power Transformers, Current-Transformers, Reactors and Resistors."

These publications fall into two categories : Interpretations of existing British Standards in relation to the short-circuit testing of apparatus to ensure uniformity of test procedure and judgment of performance between test stations ; and rules for the short-circuit testing of apparatus not yet covered by a British Standard to ensure uniformity of testing. In general, each contains : information required by the Testing Authority for the purpose of identifying the apparatus to be tested ; the information and results to be recorded by the Testing Authority ; permitted deviations from the strict requirements of the appropriate specifications, such as may be necessitated by the test plant limitations ; and the assessment of performance as judged by the behaviour of the apparatus during test and its condition after test. The "Rules" publications also include fundamental terms, method of rating and criteria of severity. In publishing the "Interpretations," the Association wishes to emphasise that in no way do these modify or conflict with any British Standard. They do, however, amplify points which cannot, of necessity, be covered by a general standard specification. The "Rules" publications for apparatus not covered by British Standards are not intended to be final and will be subject to revision on the issue of such standards.

Copies of these publications are available on application to the secretary, Association of Short-Circuit Testing Authorities (ASTA), 36, Kingsway, London, W.C.2, price 5*s*. each, post free.

RESEARCH FELLOWSHIPS.—A committee representing the Royal Society and the University of Sheffield have appointed Dr. B. A. Bilby as Sorby Research Fellow from October 1, 1951, to work in the Metallurgy Department of the University of Sheffield on martensitic transformation and deformation twinning in crystals. Also, a committee representing the Royal Society and the Armourers and Brasiers Company have appointed Dr. A. J. Kennedy as Armourers and Brasiers Company Research Fellow from October 1, 1951, to work at the Royal Institution of Great Britain on transient creep in polycrystalline metals.

PEAT PRODUCTION IN IRELAND.—Between 1941 and 1947, the shortage of coal in Eire led to an increase in the production of peat from some 3½ million to 6 million tons per annum. Plans for the development of 20 large bogs by electrically-driven or Diesel-engine driven machinery were also made and some details of this equipment are given in a pamphlet received from Metropolitan-Vickers Electrical Company, Limited, Trafford Park, Manchester, 17. The 1950-60 programme envisages an extension of the scheme of peat-winning to produce another million tons per annum, of which the greater part will be used for the generation of electricity.

NEW VESSEL FOR THE HARWICH-ZEEBRUGGE TRAIN-FERRY SERVICE.

THE ferryboat service between Zeebrugge and Harwich, which is owned and operated by British Railways, was inaugurated in 1924. The service is used exclusively for the conveyance of merchandise and enables goods to be conveyed rapidly and regularly by means of through wagons without off-loading at the sending stations on the Continent or the receiving stations in Great Britain. The advantages of through conveyance of merchandise, particularly perishable goods, are obvious, as refrigerated wagons can be used throughout and the packing cases can be considerably lighter than those used when the goods are transhipped at the British and Continental terminals ; in some cases, packing can even be dispensed with altogether.

At the outbreak of war in 1939, three vessels were in service on the Harwich-Zeebrugge route, but these were soon requisitioned by the British Government and put into use for the conveyance of ambulance trains and military stores between France and England. They were employed on this class of work until 1940, when they were taken over by the Admiralty and converted for special naval duties. As a result of enemy action, two of the three vessels were lost and only the Essex Ferry remained at the end of the war. Subsequently, she was reconverted and resumed service on the Harwich-Zeebrugge run in August, 1946. With only one vessel in service, however, sailings had to be restricted considerably and it proved difficult to cater for the large tonnage of traffic to be conveyed. As a consequence a second vessel, the Suffolk Ferry, was constructed and entered service in September, 1947. With the two ferries available, it became possible to operate a more frequent service and daily sailings were resumed.

The Essex Ferry is an oil-burning steamer of 3,000 indicated horse-power, 363 ft. in length, with a beam of 61 ft. 6 in. and a gross tonnage of 2,755. The Suffolk Ferry, on the other hand, is a Diesel ship of considerably larger dimensions, the beam remaining the same at 61 ft. 6 in., but the length increased to 405 ft., the gross tonnage, as a consequence being 3,134. Both vessels are provided with four sets of railway track converging into two lines at the after end. On the Essex Ferry the two side tracks are 238 ft. in length and the centre tracks 316 ft., giving a total track length of 1,108 ft., but on the Suffolk Ferry, owing to her greater length, the two outer tracks have a length of 223 ft. and the two inner tracks a length of 340 ft., the total track length in this case being 1,126 ft. The number of wagons that can be accommodated varies, naturally, according to their size and type, but, on an average, the number conveyed on each voyage is between 32 and 38. Both vessels have a speed of 13½ knots and, owing to their wide beam, are steadier at sea than might be expected. Modern navigating devices, such as radar and Decca equipment, are installed and it is the operator's proud boast that departures, as a consequence, are seldom interrupted as a result of bad weather.

Since its resumption the train ferry service has become even more popular than before the second World War. It has been used for a variety of purposes, ranging from the transport back to England of British locomotives used on the Continent during and after the war, to the carriage of fruit in insulated wagons. It has also conveyed a large number of new goods wagons built in England for use on Continental railway systems ; in fact, the demand for conveyance of goods by the train-ferry service has grown to such an extent that it has been found necessary to replace the third vessel operating prior to 1939, and on March 8, 1951, the Norfolk Ferry, a motorship and sister vessel to the Suffolk Ferry, was launched from the Clydebank yard of Messrs. John Brown and Company, Limited, this vessel subsequently entering the ferry service in the middle of July. Commissioning of the Norfolk Ferry will enable the number of sailings to be increased considerably and allow the vessels to be laid up at definite intervals for periodic examinations and overhauls.

As a result of the experience gained with the Suffolk Ferry, the new ship has a similar form below water but the forward superstructure has been modified. A photograph of the Norfolk Ferry, taken during her trials on the Clyde, is reproduced in Fig. 1, on page 140, from which it will be seen that the upper deck extends almost the whole length of the vessel and serves, therefore, as a cover for the main deck on which the wagons are secured. The Norfolk Ferry has an overall length of 397 ft. 6 in., a maximum breadth, measured over the fenders, of 61 ft. 6 in. and a depth, measured to the upper deck, of 34 ft. 9 in. In view of the heavy load carried on the train deck, namely, 1,200 tons, the construction of the vessel is exceptionally robust. The frames are spaced at 2 ft. throughout the length of the ship and consist mainly of standard bulb angles interspersed at regular intervals with heavier built-up sections. The train deck, or hangar deck as it is

TWIN-SCREW MOTORSHIP FOR HARWICH-ZEEBRUGGE FERRY SERVICE.

JOHN BROWN AND COMPANY, LIMITED, CLYDEBANK.

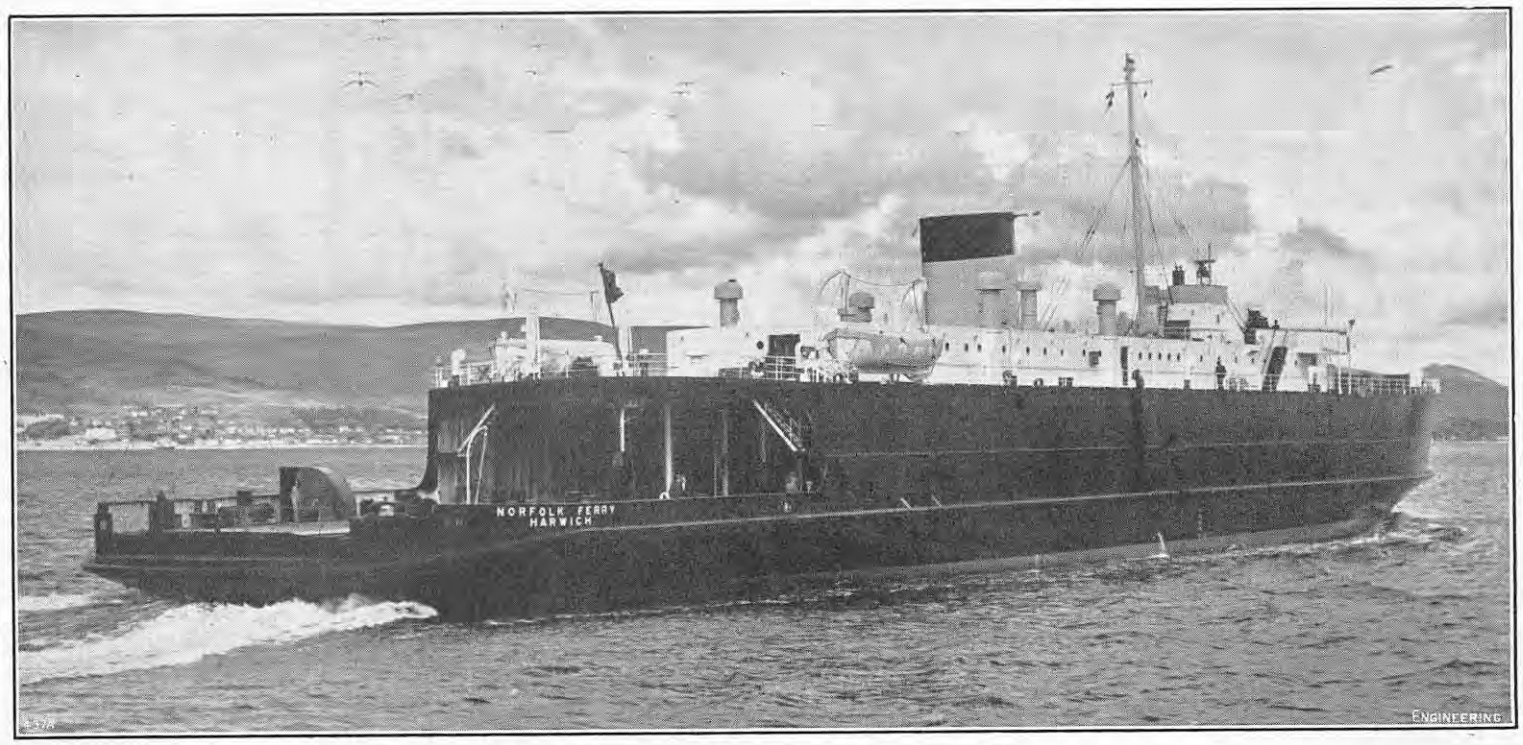


Fig. 1. "Norfolk Ferry" on Acceptance Trials.

usually referred to, is supported at the centre by H-section stanchions; these are flanked at each side by longitudinal bulkheads stiffened by bulb-angles, while between each of these bulkheads and the ship's side is a further line of H-section stanchions. The upper deck, or roof of the hangar, is also supported by a line of H-section stanchions spaced approximately at equal intervals along the ship's centre line. The tops of the stanchions are joined by a heavy H-section girder to which the transverse members forming the supporting structure for the upper deck are connected. This form of construction will be clear from an examination of Figs. 3 and 4, on Plate XIV, the former illustration showing a general view of the hangar looking forward and the latter, part of the starboard side of the hangar.

There is no double bottom but deep tanks installed at the fore and after ends of the vessel, together with the fore and after peaks, are arranged for the carriage of water ballast. Fuel oil is carried in a cross bunker situated forward of the engine room below the engine-room stores, and fresh water in tanks at the after end of the engine room and forward of the fuel-oil tank, respectively. Capacity is provided for 187·5 tons of fuel oil, 141·2 tons of fresh water and 742·7 tons of water ballast. The fuel ready-use tanks for the main engines and generators are situated in the hangar along the ship's centre line and aft of the main uptake casing; they can be seen together with the uptakes in Fig. 4. Refuelling the vessel is quite simple, as it only entails shunting a tank wagon on to the hangar deck in a position above the fuel tanks and connecting it to the refuelling line disposed at the side of the hangar.

The vessel is propelled by twin screws, each driven by a Brown-Sulzer Diesel engine of the trunk-piston type. They are six-cylinder units having a bore and stroke of 480 mm. and 700 mm., respectively, and developing approximately 1,465 b.h.p. each at 200 r.p.m., with a mean indicated pressure of about 76 lb. per square inch. The two-stroke cycle is, of course, employed and the scavenge air is supplied by a double-acting tandem-piston scavenge pump situated at the forward end of the engine, the pistons working in two cylinders placed one above the other. The bore of the cylinders is 960 mm. and the pistion stroke 400 mm., and the air is led to the working cylinders by a rectangular scavenge trunk arranged over the full length of the engine. In general, the engines follow standard Brown-Sulzer practice, the engine frame and bedplate being iron castings suitably ribbed to give the requisite strength and rigidity and the crankshaft machined from a single mild-steel forging. The fuel-injection pumps are of the single-unit type operated by a camshaft in the normal manner and are arranged to deliver to injectors installed in the cylinder heads, there being a separate head for each cylinder. Some of the injectors can be seen in Fig. 7, opposite, which shows the cylinder heads for the port engine. Lubricating oil is used to cool the pistons, the oil being delivered to the piston crowns through stand pipes and returning through sight glasses arranged along the side of each engine. Normally, fresh water, circulated within a closed system, is used for cooling the cylinder jackets and heads, but provision is made for the circulation of sea water in an emergency.

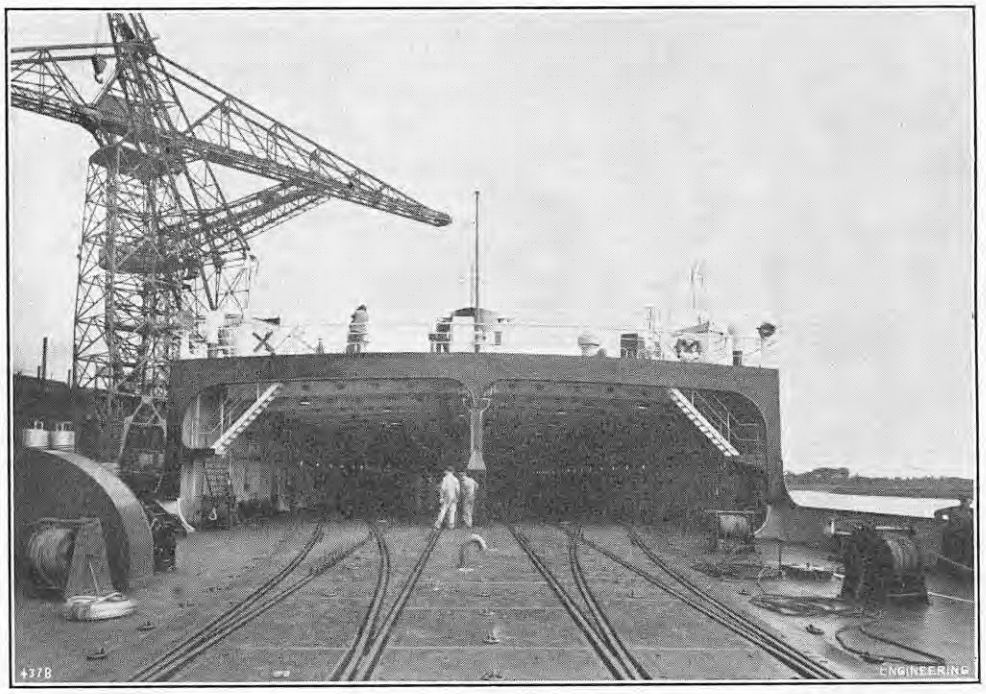


Fig. 2. Hangar Deck, Looking Forward.

A feature of these engines is the simplicity of the control gear; that for the port engine is illustrated in Fig. 5, opposite. It is situated at the forward end of each engine and comprises in each case a fuel-regulating lever, together with a combined starting and reversing lever. The fuel-regulating lever is fitted with a small handwheel arranged to operate a bevel-gear assembly which, in turn, rotates a worm meshing with a fixed quadrant, thus enabling a specially accurate control of the engine speed to be obtained. Starting air is supplied by three Reavell two-stage air compressors, each capable of delivering 100 cub. ft. of air per minute against a pressure of 450 lb. per square inch. They are each driven at 600 r.p.m. by a Laurence Scott 47-h.p. electric motor and the air is delivered into two large air-storage bottles arranged at the forward end of the engine room.

Current for the engine-room auxiliary machinery and the ship's services generally is provided by three Davey-Paxman Diesel engines coupled to Bruce-Peebles 220-volt generators, each set having a continuous rating of 125 kW. The engines are four-cylinder four-stroke units having a bore and stroke of 9·5 in. and 12 in., respectively, and a maximum governed speed of 650 r.p.m. One of the sets is illustrated in Fig. 6, opposite. Steam for the ship's services is supplied from a Cochran boiler having a diameter of 4 ft. 9 in. and a height of 11 ft. 9 in., and designed for an evaporation of 1,000 lb. an hour at a pressure of 100 lb. per square inch. Ancillary equipment supplied in connection with the boiler includes two Weir reciporcating feed pumps, an air pump for the auxiliary condenser, and a Wallsend low-pressure oil-burning plant. Three Drysdale Vertoil pumps, each of 53 tons per hour capacity, are installed for

TWIN-SCREW MOTORSHIP FOR HARWICH-ZEEBRUGGE FERRY SERVICE

JOHN BROWN AND COMPANY LIMITED, CLYDEBANK.

(*For Description, see Page* 139.)

FIG. 3. GENERAL VIEW OF HANGAR DECK LOOKING FORWARD.

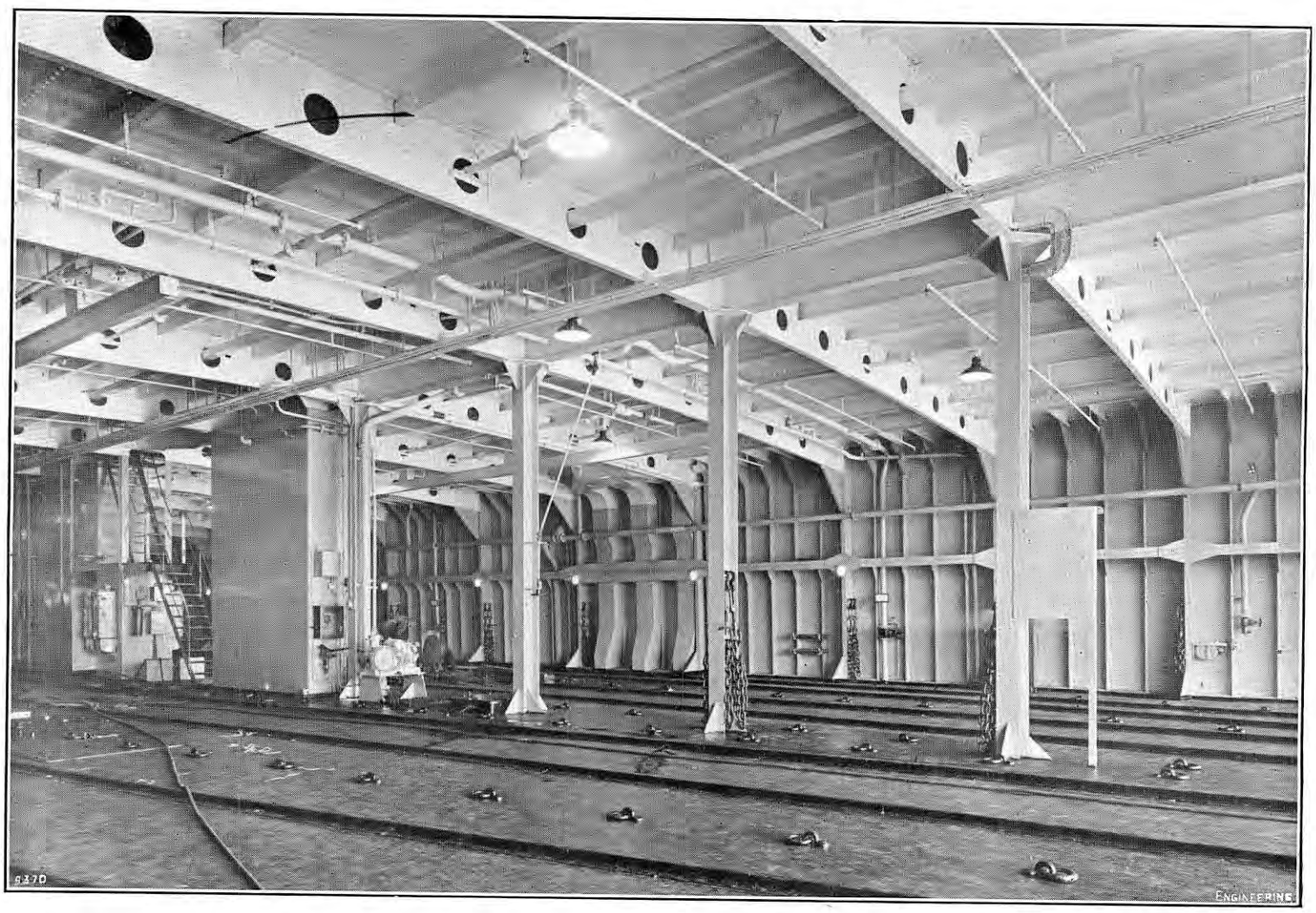


FIG. 4. VIEW OF HANGAR DECK LOOKING TO STARBOARD.

TWIN-SCREW MOTORSHIP FOR HARWICH-ZEEBRUGGE FERRY SERVICE.

JOHN BROWN AND COMPANY, LIMITED, CLYDEBANK.

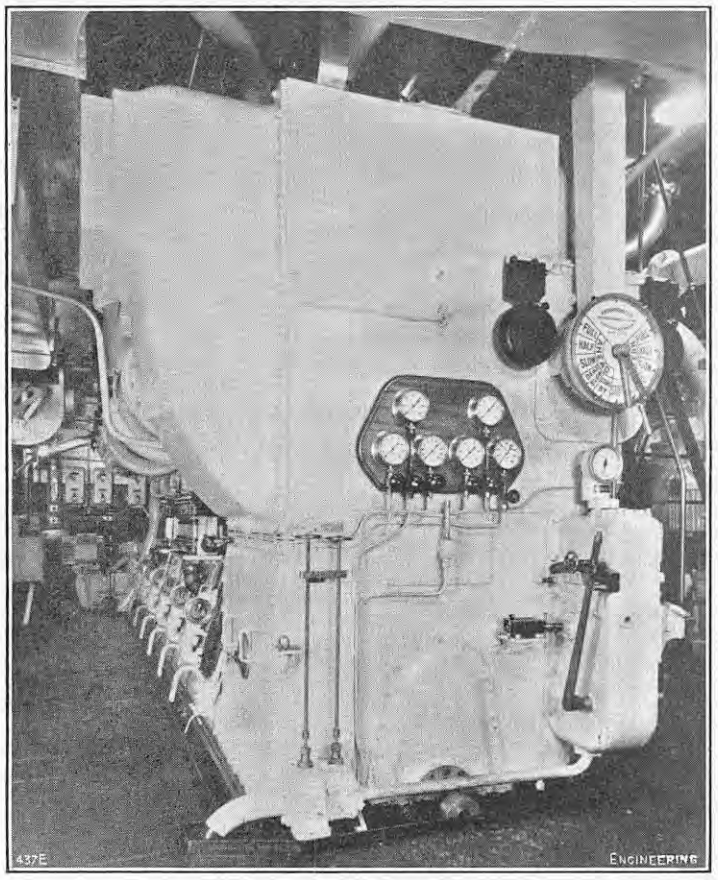


FIG. 5. STARTING PLATFORM, PORT ENGINE.

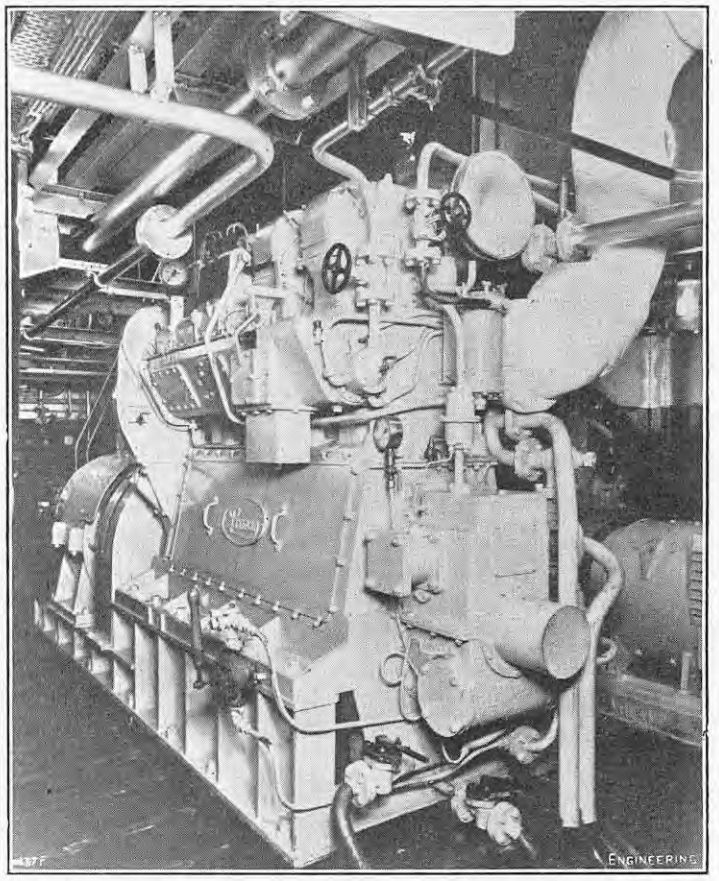


FIG. 6. AUXILIARY DIESEL-DRIVEN GENERATOR.

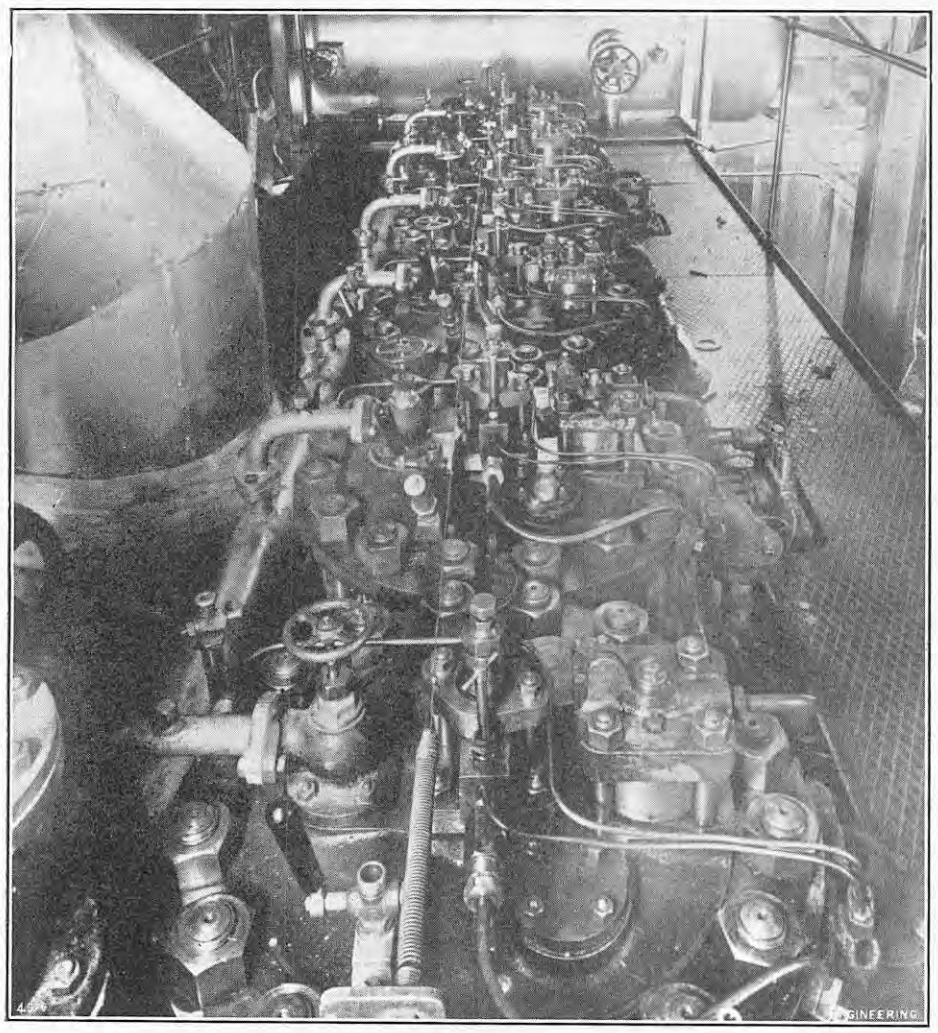


FIG. 7. CYLINDER TOPS, PORT ENGINE.

supplying oil under pressure to the forced-lubrication system, these pumps also circulating the oil through the piston-cooling system. Fresh-water circulation for the cylinder jackets and heads is maintained by two Drysdale vertical pumps of 120 tons per hour capacity, while two similar pumps of 180 tons per hour capacity circulate sea-water through the various Serck coolers used in connection with the engine-cooling system and through the auxiliary condenser. Other auxiliary machinery installed in the engine room includes bilge pumps, ballast pumps and general service pumps, a Victor oily-water separator and fuel-oil transfer pumps. Three De Laval centrifugal purifiers are provided, two of which are used for fuel and the third for lubricating oil.

Although designed essentially for the transport of goods wagons across the North Sea, provision has been made to carry twelve passengers. They are accommodated in two-berth cabins situated along the starboard side of the upper deck and, in view of the ample space available, the cabins are much larger than usual. The officers are accommodated in single-berth cabins on the opposite side of the upper deck, while the master's cabin and day-room is situated at the forward end of the same deck. There is a large and comfortable dining saloon aft of the passengers' cabins, and this is used by both the officers and passengers. The crew are accommodated in the after end of the deckhouse on the upper deck, the amenities including separate cabins, messrooms, etc. As already indicated, the navigational equipment is comprehensive; it includes a Cossor radar set, a continuous depth recorder and the Decca navigating system. Good manœuvrability is ensured by fitting twin rudders.

Four lines of railway track are provided for the accommodation of freight wagons on the hangar deck, the four lines converging into two embarkation tracks at the after end as shown in Fig. 2, opposite. Each outer track has a length of 219 ft. and each inner track a length of 347 ft., the total standage available for wagons, therefore, being 1,132 ft. At present, existing facilities are being used at both terminals, but work has commenced on the construction of a new terminal in the outer harbour at Zeebrugge. When completed, this will dispense with the necessity for vessels to pass through the lock into the Bruges Canal, and the time taken for a round voyage will be reduced by about two hours. The new terminal is expected to be ready by the summer of 1952.

NOTES FROM THE INDUSTRIAL CENTRES.

SCOTLAND.

Shipbuilding Contracts.—There has been a slackening in the demand for new tonnage from Scottish shipyards recently, but shipbuilders report that the number of inquiries has not diminished. Shipbuilding contracts announced since the beginning of the year have amounted to about 1,400,000 tons deadweight.

Grass-Drying at Forres.—A new industry for the town was begun at Forres recently when grass-drying plant at Plasmon Mills was put in operation. The new venture is expected to prove of considerable benefit to farmers in the counties of Moray and Nairn. Transport costs, for example, will be reduced, as, hitherto, grass for drying has had to be sent to Turriff, Aberdeenshire, where the nearest plant was situated.

Waste Water and Effluents.—The committee appointed by the Secretary of State for Scotland to consider on what conditions, and subject to what financial arrangements, industries should be permitted to discharge waste water and effluents into the sewerage systems of local authorities, has decided to seek evidence from all persons and firms interested. Those wishing to submit their views on this question should communicate with the secretary, Mr. T. B. Skinner, Department of Health for Scotland, St. Andrew's House, Edinburgh, 1, before September 30.

Coke for Industrial Use.—In an endeavour to maintain the supply of coal suitable for industrial coke, the Scottish Division of the National Coal Board is conducting an extensive programme of boring operations to ascertain whether the known seams of such coals are continued at greater depths. A bore was recently begun at Culross, on the north bank of the Forth, and the Divisional Board expect to sink others at Comrie and Blairhall Collieries in the near future. On the south of the river, two bores at Airth and Grangemouth are proceeding, the former having now reached 800 ft. and the latter 2,500 ft.

Absenteeism at End of Holiday Period.—Most steelworks in Glasgow and Lanarkshire reported poor attendances on July 16 and 17, the scheduled days for the resumption of work. The failure of their workpeople to resume their duties was interpreted by the managements of most firms as a further indication of the unacceptability by employees of one week's vacation as sufficient, under present-day employment conditions. Production during the ensuing week was restricted to about one-third of the works' total capacity. Repairs and overhauls of plant, rendered necessary by the continuous working during the first half of the year, were completed, however, in sufficient time for full production to have been resumed on the scheduled days.

Pollution of Rivers.—Lord Morrison, Parliamentary Secretary to the Ministry of Works, stated in the House of Lords on July 26, that the Government were considering the introduction of an amending Bill to deal with the pollution of the rivers Tweed and Esk. Speaking on the report stage of the Rivers (Prevention of Pollution) (Scotland) (No. 2) Bill, the Earl of Selkirk had objected that the rivers which flowed between England and Scotland were not provided for in either the English or the Scottish measures dealing with river pollution.

CLEVELAND AND THE NORTHERN COUNTIES.

North-East Coast Industrial Situation.—Conditions in the North-East Coast iron and allied trades continues to be disturbing and the prospect of any early change for the better cannot yet be reported. Business is very quiet, not owing to a lack of buyers, but because of the reluctance of sellers to increase their already extensive commitments. The position regarding raw materials is slightly more hopeful, but supplies are still insufficient to meet the large requirements of potential consumers. Imports of ore from abroad are increasing steadily, but stocks in the hands of merchants are at low levels. Iron and steel scrap is still wanted in vastly larger quantities than are available. There are many complaints of the inconvenience caused by the shortage of pig-iron. Pressure for increased deliveries of semi-finished steel, to meet the needs of the re-rolling mills, continues, and there is a larger demand for all classes of finished steel products than sellers are able to meet.

Training Scheme for Apprentices.—The Marshall Richards Machine Co., Ltd., have announced that they will soon commence the training of apprentices at their works at Crook, County Durham. Youths without a secondary-school education, as well as those possessing a general schools certificate, will be eligible for apprenticeship with the firm, provided that they show a standard of ability sufficient to profit from the course. The company established the works at Crook about five years ago, and have since organised a staff of skilled technicians and draughtsmen, whose guidance, under the scheme, will be placed at the disposal of apprentices.

LANCASHIRE AND SOUTH YORKSHIRE.

Sheffield Holiday Period.—Industrial employees in Sheffield take their annual holidays in the week preceding the Bank Holiday week and thus combine their annual vacation with the statutory holiday. These employees, some 50,000 in number, will resume work on either Tuesday or Wednesday next, and the interval will be utilised by the maintenance men in the firms concerned for the execution of much-needed repair and overhaul work on plant and machinery. The principal exceptions to the general rule regarding holidays are the works of the United Steel Companies, Ltd.; employees of Steel, Peech and Tozer have had their holidays already, while the operatives at Samuel Fox & Co., Ltd., will not commence their holidays until August 10.

Italian Labour for the Coal Mines.—It is estimated that, in all, about 46 Yorkshire collieries will require to employ some of the Italian men who have been recruited for service in British coal mines. The executive committee of the Yorkshire area of the National Union of Mineworkers has invited branches in its area to express their views regarding the admission of Italians to the union. The question of up-grading certain classes of miners, such as haulage men, to the coal face has yet to be settled.

South Yorkshire Coalfield.—It is stated in the survey report of the West Riding County Council, made in connection with the Council's development plan, that South Yorkshire coal will become increasingly difficult to work. Production in the rich thick seams declined between 1938 and 1944, but increased in the thinner seams. In order to maintain the present level of output, the decreased production in the thicker seams would have to be counteracted by increased workings elsewhere.

British Miners Tour of Ruhr Coalfield.—Twenty South Yorkshire miners left Britain last week for a fortnight's tour of the Ruhr coalfield. Part of the time will be spent with German miners at a summer school at Bochum, where joint discussions on trade-union and industrial problems will be held. Ten of the men went at their own expense, while the other ten went as representatives of the Yorkshire area of the National Union of Mineworkers.

THE MIDLANDS.

New Iron Foundry.—Work has commenced on the preparation of the site for a new iron foundry at Tame Bridge, near Walsall, Staffordshire. The foundry, which is being built for W. and T. Avery, Ltd., Soho Foundry, Birmingham, 40, is on a 122-acre site. An ordnance factory was built at Tame Bridge during the war, and part of the area has been developed as a trading estate. The new foundry will be built on the eastern side of the estate on land which is to be levelled for the purpose. The firm will transfer their foundry work from Soho to the new plant when it is completed. The old Soho Foundry premises were built in 1795, and though greatly extended since that time, are now inadequate for the company's needs. The new foundry will be completely mechanised. Labour will be transferred from the old works to the new and, as the majority of the 250 operatives at present employed live about half-way between the two sites, no difficulty is anticipated in this connection. Welfare arrangements will include a canteen and washing facilities similar to those provided at pit-heads.

Coal Production in Nottingham.—Prior to assuming his new office as chairman of the National Coal Board, this month, Sir Hubert Houldsworth, D.Sc., has arranged to visit each of the six areas of the East Midland Division and meet the officials, technicians and colliery workmen who have known him as their divisional chairman since the State took over in 1947. At a formal farewell to the pit consultative committees, at Bestwood, in the centre of the Nottingham pits which comprise No. 6 area, he referred to that area as a particular example of "splendid achievement." He stated that it was recognised as the "most productive area of the most productive division" in the British coalfields.

Dismantling a Branch Railway Line.—The 3½-mile branch railway line from Hampton-in-Arden to Whitacre, Warwickshire, is being dismantled. This short line, which connects the Birmingham to London main line, via Rugby, with the main line between Birmingham and Derby, was built as a link between the old Midland and London and North Western systems. It was closed in 1917, and has since been used only for the storage of wagons.

Proposed New Reservoir.—The town council of Wolverhampton has been recommended by its water committee to construct a new reservoir at Goldthorn Hill, within the borough boundaries. A reservoir already exists on the site, but it is about 100 years old, and besides having a capacity which is too small for present-day requirements, it cannot be relied upon to remain water-tight. It is proposed that the new reservoir shall be of the reinforced-concrete covered type, and it is estimated to cost 107,440*l*.

Women Employed on Permanent-Way Maintenance.—Owing to the prevailing shortage of permanent-way employees in the Midlands, British Railways have engaged women for this work. There are at present, however, 300 vacancies for permanent-way workers in the Midlands, so that the engagement of these women is only a partial solution to the problem. They will be employed on lighter tasks, such as oiling, weeding, and trimming ballast, thereby releasing men for heavier duties.

SOUTH-WEST ENGLAND AND SOUTH WALES.

Shortages of Raw Materials.—An assurance from the Government that industries in South Wales would be given some priority for supplies of raw materials, to enable them to carry on, was referred to by Sir Percy Thomas, the chairman of the Welsh Board for Industry, at last week's meeting of the Board. A deputation from the Industrial Association of Wales and Monmouthshire which attended the May meeting of the Board, expressed its doubt regarding the ability of many Welsh industries to carry on, in view of the shortages of raw materials. Sir Percy stated that the arguments presented by the Association had been referred to headquarters in London and a reply had been received that the Government would pay due regard to the interests of firms in Wales and their problems. Although no definite promise was made, the Board had been assured that the Government would not throw away lightly all that had been achieved in the development areas during the past five years.

Electric Motors for the United States.—The first instalment of an order for small electric motors, valued at 500,000 dollars, was inspected by the Lord Mayor of Cardiff, Alderman Robert Bevan, when he visited the local factory of the Hopkinson Electric Co., Ltd. He was informed that the order involved the manufacture of 6,000 motors of between 1 h.p. and 7½ h.p. and that they were required for pumping water in farms and rural houses in all parts of the United States. The factory was at present employing 500 operatives, and the management hoped to extend it to twice its present size, when some 1,500 people could be offered employment.

Employment at Margam Steelworks.—Provided that sufficient supplies of raw materials are forthcoming, the West Wales steel industry need have no fear that the inauguration of the new works of the Steel Company of Wales, Ltd., at Margam, Port Talbot, will cause serious unemployment, according to a statement by Mr. E. H. Lever, chairman of the company, last week. He pointed out that such a shortage of manpower existed in the tinplate industry that Italian labour had had to be imported. He was attending a conference at the Iron and Steel Corporation's headquarters, convened at the request of the Swansea Corporation, to discuss measures to mitigate the effects of the closure of works in the area. The Iron and Steel Corporation expressed their anxiety that the volume of tinplate production in the hand mills should be maintained and that every effort should be made to keep the mills supplied with an adequate tonnage of tinplate bars.

Mining Development Scheme.—Further details of the Mardy-Aberdare mining scheme, which will cost 5,000,000*l*., have been given recently by Mr. Geoffrey Morgan, the general manager of No. 4 area of the National Coal Board. He stated that it was expected that the first connection with Mardy from Bwllfa would be made next September. The scheme would take more than 2,000 men from the Ferndale pit and some 800 more from the Aberdare pit. A preparation plant for washing and sorting the coal would be erected in due course at a cost of about 500,000*l*.

Factory for Canadian Firm.—Protracted negotiations between the Fromson Construction Co. of Canada, Ltd., Manchester, and Cardiff Corporation have led to the conclusion of an agreement for building a factory for the company on the Corporation's industrial estate. The factory will be constructed in three sections, the first of which will cover 35,000 sq. ft. and will be commenced early next year. It will be engaged in the manufacture of light steel products.

NOTICE OF MEETING.

IT is requested that particulars for insertion in this column shall reach the Editor not later than Tuesday morning in the week preceding the date of the meeting.

ASSOCIATION OF SUPERVISING ELECTRICAL ENGINEERS.—*South-West London Branch:* Tuesday, August 14, 8.15 p.m., St. George's Hall, St. George's-road, Wimbledon. "Carbon Brushes for Electrical Machines," by Mr. C. T. Lawrence.

CONTRACTS.

GUY MOTORS, LTD., Fallings Park, Wolverhampton, have received an order from the Nizam's State Railway, Secunderabad, Hyderabad, for 60 Guy "Otter" Diesel-engined road-vehicle chassis.

VAUGHAN LIFT ENGINEERING, LTD., 5, Crompton-way, Crawley, Sussex, have obtained an order from the New Zealand Ministry of Works for two 10-ton overhead travelling cranes for Roxburgh Power Station, New Zealand.

MURAD DEVELOPMENTS, LTD., Aylesbury, Buckinghamshire, have secured an order from the United States for one thousand of the firm's new 1-in. high-speed capstan lathes, to the value of approximately two million dollars.

METROPOLITAN-CAMMELL-WEYMANN MOTOR BODIES, LTD., Vickers House, Broadway, London, S.W.1, have received an order from the State of Cordoba, Argentina, for 150 Olympic Transit-type 40-seater 'buses. These vehicles, which are additional to the 300 'buses ordered by the Argentine Ministry of Transport as part of the Ministry's contract with Leyland Motors, Ltd., referred to on page 79, *ante*, will be constructed at the Elmdon factory of the Metropolitan-Cammell Carriage and Wagon Co., Ltd. The 200 Metropolitan-Cammell-Weymann mark II 40-seater two-door 'buses, which also form part of the Argentine contract with Leyland Motors, will be constructed by WEYMANN'S LTD., Addlestone, Surrey.

Among contracts recently awarded to the BRUSH-ABOE GROUP OF COMPANIES, Duke's-court, Duke-street, St. James's, London, S.W.1, is one from the Argentine Ministry of Industry and Commerce for electrical equipment for 15 power stations in Argentina. This order includes 30 Diesel engines, constructed by MIRRLEES, BICKERTON AND DAY, LTD., Stockport; 30 Brush 533-kW alternators, complete with Brush switchgear; water coolers, supplied by HEENAN AND FROUDE, LTD., Worcester; and power-station accessories, including motor-driven fuel-oil transfer pumps. The Electricity Commission of New South Wales has placed an order with the Group for ten turbo-charged Mirrlees engines, each driving a 920-kW alternator connected to a transformer. An evaporative cooler and generator switchgear panel will be provided for each set. An order has been placed by the Department of Naval Defence, Canada, with the VIVIAN DIESEL ENGINE WORKS, Vancouver, in which the Group has acquired a controlling interest, for 33 Vivian 250-kW Diesel generating sets.

A.C.V. SALES, LTD., Southall, Middlesex, have obtained orders from overseas for a number of products of the A.C.V. Group, including one from their West Australian agents, Flower Davies and Johnson, for three Regal mark III chassis for Freemantle Tramways, and another, from their Australian distributors, A.E.C. (Australia), Ltd., for 316 chassis, comprising 76 Regal mark III, 48 Monarch, 102 Matador, 84 Mammoth Major-Six, and six Mammoth Major-Eight. Orders received through other distributors, include 25 Regal chassis and 30 truck chassis, of different types, for various operators in the State of Sao Paulo, from Knowles and Foster, Sao Paulo; 75 Regal chassis and 42 truck chassis, mainly of the Matador type, for Brazilian users, from Wilson, Sons and Co.; 14 chassis, comprising two Regal mark III, four Monarch, six Matador, and two Mammoth Major-Six, for users in South Africa, from Dowson and Dobson; and 14 Matador chassis, and two articulated Mammoth Major-Six chassis, all of which will be fitted with Bonallack cabs, from the Sometal Co., their distributors in Portuguese West Africa. The firm's New Zealand distributors, Cory-Wright and Salmon, have booked an order for 39 'buses from the Christchurch Tramway Board. The chassis for these vehicles will be the A.E.C. Regal mark IV and the complete bodies will be supplied by CROSSLEY MOTORS, LTD., Stockport, Cheshire.

NEW DESTROYERS FOR VENEZUELAN NAVY.—The keels of two destroyers for the Venezuelan Navy were laid at Vickers-Armstrongs shipyard at Barrow-in-Furness on July 24, in the presence of His Excellency the Venezuelan Ambassador. The vessels, which will be of 2,600 tons each, will be named Nueva Esparta and Zulia. The contract for a third destroyer, also of 2,600 tons, was signed at Caracas, Venezuela, on July 24. As in the case of the other two, the new vessel will be constructed at Barrow.

BOOKS RECEIVED.

Report Writing. By PROFESSORS CARL G. GAUM, HAROLD F. GRAVES, and LYNE S. S. HOFFMAN. Third edition. Prentice-Hall, Incorporated, 70, Fifth-avenue, New York, U.S.A. [Price 5 dols.] Chapman and Hall, Limited, 37, Essex-street, Strand, London, W.C.2. [Price 35*s.* net.]

Fundamentals of Automatic Control. By G. H. FARRINGTON. Chapman and Hall, Limited, 37, Essex-street, Strand, London, W.C.2. [Price 30*s.* net.]

Stainless Iron and Steel. By J. H. G. MONYPENNY. Volume One. *Stainless Steels in Industry.* Third revised edition. Chapman and Hall, Limited, 37, Essex-street, Strand, London, W.C.2. [Price 45*s.* net.]

School Arithmetic. By W. P. WORKMAN. Fourth edition, revised by G. H. R. NEWTH. University Tutorial Press, Limited, Clifton House, Euston-road, London N.W.1. [Price, with answers, 8*s.*; without answers, 7*s.* 3*d.*]

Electronic Element Chart. By LLEWELLYN OULTON. University of London Press, Little Paul's House, Warwick-square, London, E.C.4. [Price 1*s.* 6*d.*]

The Neglect of Science. Essays Addressed to Laymen. By F. E. SIMON. Basil Blackwell, 49, Broad-street, Oxford. [Price 8*s.* 6*d.* net.]

Sheet Metal Shop Practice. By LEROY F. BRUCE. The American Technical Society, Drexel-avenue at 58th-street, Chicago 37, Illinois, U.S.A. [Price 4 dols.]; and the Technical Press Limited, Gloucester-road, Kingston Hill, Surrey. [Price 32*s.* net., postage 10*d.*]

The Railway Fuel and Traveling Engineers' Association. Fourteenth Annual Proceedings. 1950. Offices of the Association, Room 1213, 139, W. Van Buren-street, Chicago 5, Illinois, U.S.A. [Price 10 dols.]

Wärmelechnische Rechungen für Industrieöfen. By DR.-ING. WERNER HEILIGENSTAEDT. Third revised edition. Verlag Stahleisen, August-Thyssen-Strasse 4, Düsseldorf, Germany. [Price 44 D.M.]

PERSONAL.

SIR JOHN H. E. WOODS, G.C.B., M.V.O., permanent secretary to the Board of Trade since 1945, is shortly taking up an appointment with the English Electric Co., Ltd., Queen's House, Kingsway London, W.C.2, and its associated companies.

MR. H. C. W. ROBERTS has been appointed by the Minister of Fuel and Power to be H.M. Chief Inspector of Mines, with effect from August 1. He succeeded SIR ANDREW M. BRYAN, B.Sc., M.I.Min.E., F.R.S.E., Chief Inspector since 1947, who has become a full-time member of the National Coal Board.

MR. G. R. PETERSON, B.A., M.I.E.E., technical executive assistant to Sir John Hacking, M.I.E.E., deputy chairman (operations) of the British Electricity Authority, has been appointed by the Authority to be generation operation engineer in the department of the chief engineer. In this position, he succeeds MR. J. A. VICE, O.B.E., A.M.I.E.E., M.Inst.F., who retired recently.

MR. A. H. MARSH, A.M.I.E.E., senior assistant engineer (construction) of the South-East Scotland Division of the British Electricity Authority, has been promoted generation engineer (construction) of the Division, in place of MR. J. HAGEN, A.M.I.E.E., who retired on July 1. Mr. Marsh's appointment became effective on July 11.

Appointments made recently by the Railway Executive, with the concurrence of the British Transport Commission, include that of MR. J. F. HARRISON, M.I.Mech.E., M.I.Loco.E., previously mechanical and electrical engineer, Eastern and North Eastern Regions, as mechanical and electrical engineer, London Midland Region, at Derby. MR. K. J. COOK, O.B.E., M.I.Mech.E., M.I.Loco.E., formerly mechanical and electrical engineer, Western Region, has been made mechanical and electrical engineer, Eastern and North Eastern Regions, at Doncaster. MR. R. A. SMEDDLE, M.I.Mech.E., M.I.Loco.E., until recently deputy mechanical and electrical engineer, Southern Region, has been appointed mechanical and electrical engineer, Western Region, at Swindon. MR. J. BLAIR, previously carriage and wagon engineer, London Midland Region, has been appointed carriage and wagon engineer, Scottish Region, at Glasgow. MR. H. RANDLE, M.I.Mech.E., carriage and wagon engineer, Western Region, has been appointed carriage and wagon engineer, London Midland Region, at Derby. MR. G. T. SMITHYMAN, A.M.I.Mech.E., assistant to the works superintendent for production planning, London Midland Region, has been promoted executive officer for carriage and wagon production on the headquarters staff. He will be located at Derby.

London Transport Executive has appointed MR. C. E. DUNTON, M.A.(Cantab.), M.I.C.E., formerly technical planning officer, as civil engineer, and LIEUT.-COL. KEITH BRINSMEAD, D.S.O., M.I.C.E., M.I.Mech.E., previously permanent way engineer (railways) as assistant civil engineer (permanent way). Col. Brinsmead will be responsible for all matters relating to the design, construction and maintenance of the Executive's permanent way. MR. H. RAINE, until recently assistant to the chief engineer, has been promoted assistant civil engineer (general).

MR. A. J. BEANLAND, B.Sc.(Tech.), A.M.I.E.E., A.M.I.P.E., has been appointed assistant general manager of the Trafford Park Works of Lancashire Dynamo and Crypto (Mfg.), Ltd., as from September 1 next.

MR. J. B. SCOTT, D.F.C., A.I.E.E., general sales manager of the plant division of Crompton Parkinson, Ltd., Aldwych, London, W.C.2, has been elected an executive director of the company and will take up a new appointment as assistant sales director (home) on October 1 next. On the same date, MR. C. A. J. MARTIN, G.C., M.C., B.A., A.M.I.E.E., will become general sales manager of the plant division, and his present appointment, as product sales manager F.H.P. motors, will be taken over by MR. R. V. POWDITCH, O.B.E., A.M.I.E.E., who is now product sales manager for Nelson stud welding.

MR. B. E. TERRY, A.M.I.Mech.E., A.M.I.P.E., has been appointed technical manager for the plastics division of E. K. Cole, Ltd., at Southend.

MR. P. C. ALLEN, chairman of the company's plastics division, MR. A. T. S. ZEALLEY, chairman of the company's Billingham division, CAPTAIN R. C. TODHUNTER, purchases controller, and MR. E. A. BINGEN, the company's solicitor, have been elected directors of Imperial Chemical Industries, Ltd., Buckingham-gate, London, S.W.1.

MR. R. A. HARDING has been appointed general manager to Macrome, Ltd., Wolverhampton. MR. N. D. PENTLAND has been made sales manager to the company, and MR. P. N. ROGERS has been elected as the directors' special representative.

MR. J. W. MARTIN, sales manager of Whessoe, Ltd., Darlington, has been elected a director of the company but will remain at the company's London office, 25, Victoria-street, S.W.1.

MR. W. STRACHAN and MR. C. H. TUCKER have been elected directors of the Bristol Aeroplane Co. (Housing), Ltd., a subsidiary of the Bristol Aeroplane Co., Ltd. Mr. Strachan, who was the company's works manager, has become works director, and Mr. Tucker, formerly the secretary, has been made sales director. MR. A. C. FURSE-ROBERTS, A.C.A., has been appointed secretary.

CAPTAIN J. SUMMERS, O.B.E., chief test pilot to Vickers-Armstrongs Ltd., has retired after 22 years' service in that position. LIEUT.-COM. M. LITHGOW has been appointed chief test pilot at the company's Supermarine Works, and MR. G. R. BRYCE has been made chief test pilot at Weybridge Works.

MR. F. N. PRANGNELL, of the company's overseas staff, who has been in England on leave, has been appointed by A. Reyrolle & Co., Ltd., Hebburn, County Durham, as their representative for India, Pakistan, Burma, and Ceylon. His headquarters, to which he has now returned, are at 12, Misson-row, Calcutta.

MR. G. K. NIELD has been promoted public relations officer to the Canadian Pacific Railway, 62-65, Trafalgar-square, London, W.C.2, in succession to MR. CHARLES W. STOKES, who retired under the company's age limit on July 31.

The COZY STOVE CO., LTD., 26, Nassau-street, London, W.1, has joined the selling organisation of RADIATION GROUP SALES, LTD., solid-fuel division, 7, Stratford-place, London, W.1. The stoves are being manufactured at the Radiation Production Centre, Belper, near Derby.

MATTERSON LTD., Shawclough, Rochdale, have transferred their representation in the Midlands to the BARNOL ENGINEERING CO., LTD., 83, Newhall-street, Birmingham, 3 (Telephone: Central 2760). This firm is a new associate company of Inspecting Engineers, Ltd., which has been Messrs. Matterson's technical representative for a number of years.

OLDHAM AND SON, LTD., Denton, Manchester, have concluded an arrangement with the DEWEY AND ALMY CHEMICAL CO., Cambridge, Massachusetts, U.S.A., for the Dewey Co. to manufacture Oldham Fibrak battery separators in the United States under licence. Separators for American requirements will be manufactured at a new plant now being erected near Boston, which is expected to commence large-scale production in a few months' time. They will be distributed by the Dewey Co. in the United States and Canada under the trade mark "Darak."

POWELL DUFFRYN CARBON PRODUCTS, LTD., Hayes, Middlesex, a subsidiary of Powell Duffryn, Ltd., and the GREAT LAKES CARBON CORPORATION, New York, have formed in the United States a jointly-owned company, BRITISH-AMERICAN CARBON CORPORATION, for the manufacture and sale of carbon, graphite, and products made from these materials. The new company will be the sole producer in the United States of carbon and graphite manufactured directly from coal by the Powell Duffryn "Delanium" process. MR. WILLIAM J. CRAWFORD, formerly of the Great Lakes Corporation, will be President of the new company, whose offices will be at 18, East 48th-street, New York.

PLYMOUTH "B" POWER STATION.

Fig. 1. General View of Station and Site.

NEW POWER STATIONS FOR THE B.E.A.: XXIII.—PLYMOUTH "B."

The Plymouth "B" station of the British Electricity Authority, the ultimate capacity of which is to be 180 MW, adjoins the existing "A" station on the west bank of the Cattewater, the estuary of the River Plym. The site covers nearly 15½ acres, the landward side being the bed of a limestone quarry, while on the seaward side is a derelict timber wharf. An aerial view of the station in course of construction is given in Fig. 1. The main buildings, for which Messrs. John Laing and Son, Limited, London, N.W.7, are the principal contractors, are of steel frame construction with brick and concrete filling. The ancillary buildings are of reinforced concrete with brick cladding and, with the coal store, are founded on the bed of the old quarry. The initial installed capacity of the station is 90 MW and the present buildings, with one 300-ft. chimney, are being erected to house that amount of plant.

Coal will be brought in by sea to a new reinforced-concrete wharf, 600 ft. long, covering the intake and discharge works for the cooling water. This wharf will accommodate two 2,500-ton colliers, as well as ash barges, and the berth and river approaches are being dredged so that berthing can be effected at any time between flood and half ebb tides. The coal will be taken either to the boiler-house bunkers or a store by conveying plant with a capacity of 350 tons per hour. Unloading facilities which, in an emergency, can supply the "A" station with up to 150 tons per hour, will also be provided. The coal store will have a capacity of about 33,000 tons and fuel will be taken from it by drag scrapers with a capacity of 200 tons per hour. The main contractors for this portion of the plant are International Combustion, Limited, Woburn-place, London, W.C.1.

The steam-raising plant will ultimately consist of six Yarrow boilers, each with a capacity of 320,000 lb. of steam per hour at a pressure of 600 lb. per square inch and a temperature of 850 deg. F. They will be fired with coal-pulverising equipment installed by International Combustion, Limited, and the ash-handling plant will be made by Babcock and Wilcox, Limited. Eventually, there will be six 30-MW turbo-alternators, three of which are now being constructed by Metropolitan-Vickers Electrical Company, Limited, at Trafford Park, Manchester. Fig. 2 is a view inside the turbine room showing No. 1 set being erected. The high-tension and low-tension switchgear is also being manufactured by the same firm.

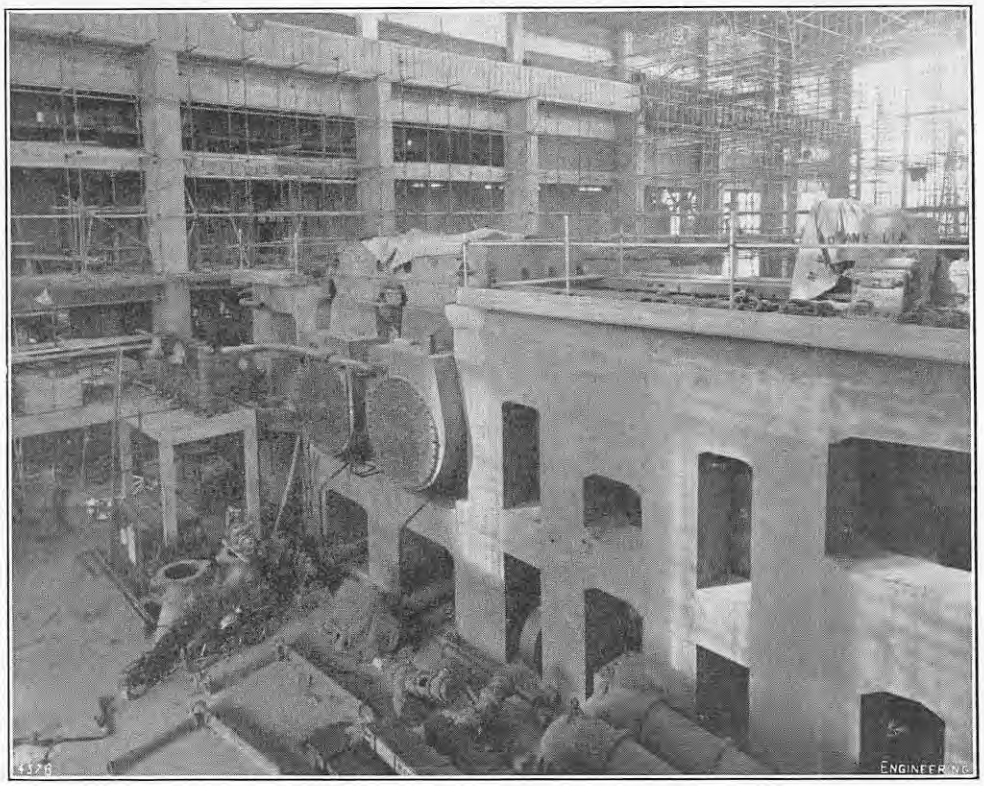


Fig. 2. No. 1 Turbo-Alternator Under Erection.

ENGINEERING,

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ADVERTISEMENT RATES.

Terms for displayed advertisements on the green art paper wrapper, on the inside black and white pages and in the buff art paper two-colour supplement, as well as for insets, can be obtained on application to the Manager. The pages are 12 in. deep and 9 in. wide, divisible into four columns 2¼ in. wide. Serial advertisements will be inserted with all practicable regularity, but absolute regularity cannot be guaranteed.

The charge for advertisements classified under the headings of " Appointments Open," " Situations Wanted," " Tenders," etc., is 10*s.* for the first four lines or under, and 2*s.* 6*d.* per line up to one inch. The line averages six words and when an advertisement measures an inch or more, the charge is 30*s.* per inch. If use is made of a box number the extra charge is 1*s.* per insertion, with the exception of advertisements appearing under " Situations Wanted." Series discounts for all classified advertisements can be obtained at the following rates:—5 per cent. for six; 12½ per cent. for thirteen; 25 per cent. for twenty-six; and 33⅓ per cent. for fifty-two insertions.

TIME FOR RECEIPT OF ADVERTISEMENTS.

Classified advertisements intended for insertion in the current week's issue must be received not later than first post Wednesday.

" Copy " instructions and alterations to standing advertisements for display announcements must be received at least 10 days previous to the date of publication, otherwise it may be impossible to submit proofs for approval.

The Proprietors will not hold themselves responsible for advertisers' blocks left in their possession for more than two years.

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ENGINEERING

FRIDAY, AUGUST 3, 1951.

VOL. 172. No. 4462.

THE COSTING AND EVALUATION OF RESEARCH.

THE extent to which industry generally has become research conscious was illustrated by a recent conference organised by the Industrial Research Committee of the Federation of British Industries. The conference was attended by some 130 research directors and managers. A few came from research associations, but the majority were connected with industrial firms. Engineering and chemistry were naturally strongly represented, but the range also covered glass, carpets, bricks, bottles, and metal and paper containers. The conference, a report of the proceedings of which has just been published,* was held at Ashorne Hill, Leamington Spa, Warwickshire, from November 10 to 12, 1950. As indicated by its title, this was the second conference of this type convened by the Federation. The first was held in March, 1949, and some account of its proceedings has appeared in these columns.† It was broadly concerned with the application of the results of research; the second conference was concerned with what, from the research manager's point of view, is a more domestic matter: the costing and financial control of research.

Dr. S. Whitehead, the Director of the Electrical Research Association, who attended the conference, pointed out that a great many of the benefits derived from research go to the community as a whole. This is, of course, true and is the basic justification for grants of public money to the research associations. The results of research carried out by commercial firms also are of ultimate benefit to the community as a whole, but that is not sufficient reason for research work being undertaken. The duty of the directors of a company is to look after the interests of the shareholders and the justification for undertaking research is that it may add to the prosperity of the firm. Benefit to the community generally is not properly a first object, although an incidental advantage which that benefit may carry is that the operation of an active research department may add to the prestige of a firm and thus contribute to its commercial success. A number of speakers in the discussions at the conference referred to the necessity of convincing non-technical directors about the value of research, and clearly a demonstration that some particular research has shown a handsome financial return is a useful argument in cases of this kind. If, however, it is to be shown that a specific research has more than paid for itself, it is clearly necessary to know how much it has cost and one of the objects of the conference was to discuss methods of costing.

The conference was divided into three main sessions. The first dealt with the planning and budgeting of research; the second with the costing of research; and the third with the evaluation of research. These aspects of the matter are clearly all closely connected. The funds made available to a research department will normally be determined by the board of directors and unless the board is prepared to allot a round sum and leave its distribution to the research manager, as in many cases is probably done, it may be necessary to produce figures showing how the funds available have been distributed among the various research projects in hand. This will necessitate some kind of costing system, and is a matter on which very wide differences of opinion were expressed during the conference. A research department may, and probably will, have many matters under investigation at the same time and many workers, particularly those of supervisory status, may well be occupied with a number of different projects in the course of a day. It will probably be difficult for them to report what proportion of their time was devoted to each, and they may well find the filling-up of time-sheets an irritation. Some speakers used such sheets; others would have nothing to do with them. A point on which there was fairly general agreement, however, was that a costing system in a research department need not be very accurate; within 10 per cent. appeared to be accepted as satisfactory.

It was suggested by one speaker, and not contested by others, that in a typical budget for a research department some 65 to 75 per cent. of the total cost represented salaries, and 3 per cent. special apparatus. Fresh figures were put forward in connection with chemical research and it would appear that in some branches of heavy engineering, apparatus might well demand a considerably higher proportion of the cost. In all cases, however, salaries must represent a very important item and in major and important researches, it would seem desirable that some method of determining the staff time spent on them should be used. A procedure of this kind is obviously necessary in connection with researches carried out for an associated company or for a Government department as part of a development contract.

Cases of this kind must presumably be worked out in monetary terms, but as Dr. P. Dunsheath remarked, in a final address summing-up the results of the conference, the difficulties of expressing the

* *Report of the Second Conference of Industrial Research Directors and Managers. The Planning and Financial Control of Industrial Research*, Federation of British Industries, 21, Tothill-street, London, S.W.1. [Price 3*s.*]

† ENGINEERING, vol. 168, page 480 (1949).

value of research in pounds, shillings and pence are practically insuperable. In the session devoted to the evaluation of research, it was pointed out that in attempting to work out the value of a piece of research which had ultimately been carried through to development stage and had taken its place in commercial manufacture, although it might be possible to estimate the value of the work that had been done, the decision about what part of that value should be attributed to the research department might be difficult or impossible to reach. Much of the credit for successful commercial application might be due to the development department, the works, or even the sales organisation. In almost all cases, the stage between the completion of a piece of research and the utilisation of its results by the firm's customers would cover a number of years, so that any attempt to evaluate the value of the work of a research department, or of any particular piece of research, involved long-term considerations.

One of the suggestions which was put forward as a means of evaluating research was that the number of patents which had resulted from the work of the research staff might be used as a measure. This is probably not very satisfactory. Extremely valuable work may be done in investigating difficulties which crop up in manufacturing processes or in assessing the value of new or substitute materials. Activities of this kind do not necessarily lead to the taking-out of patents. Another aspect of the work of a research department, the value of which it is probably impossible to assess, is that work on a certain problem may incidentally provide information which proves of great value in the solution of some quite different problem; in such a case, the charging of time to one or other particular investigation cannot be more than an approximate guess, although it may be within the 10 per cent. error which is apparently accepted as a satisfactory order of accuracy in working out the cost.

Dr. Dunsheath, in the final summing-up referred to above, pointed out that in twenty minutes he was required to survey matter which was equivalent in extent to nearly 150 columns of *The Times*. It is not clear that this amount of matter appears in the report, but there is certainly far more than can be even mentioned in this article. Apart from working out costs from which the allocation of funds to a research department may be determined, and apart from the evaluation of particular researches for the purpose of convincing a board of directors that they are desirable, every director of a research department will desire that the funds with which he is entrusted are expended in the most efficient way. For this purpose, it is certainly desirable that he should have a reasonably accurate idea of the relative costs of the various activities of his department and some method of determining how much work and time is going into each piece of research is necessary. The very many suggestions, agreements and disagreements which appear in the report of the conference, constitute an extensive survey of this difficult subject from which a research director, who will probably find his particular ideas both accepted and combatted, will certainly derive instruction and find interest. There was a good deal of discussion about the relative methods of costing small *ad hoc* researches, as well as those of a fundamental nature lasting possibly a number of years. This latter class is most likely to arise in scientific industries such as those concerned with some chemical and engineering problems. Research departments of such industries may also have to deal with small specific researches, but departments serving craft industries may find that all, or most, of their work is of the *ad hoc* class. The methods of costing and evaluation used will necessarily depend on the size of the department and the type of activity with which it is concerned, but managers of departments of any size or class will find much in the report worthy of study.

NEW PROBLEMS FOR THE STEEL INDUSTRY.

Mr. Hugh Dalton, the Minister of Local Government and Planning, in a speech made on Saturday last, is reported to have said that "My friend Gaitskell's speech [on the limitation of company dividends], whatever else it has done, has thrown the Stock Exchange into complete disorder, and that is good fun, anyhow." As an indication of the attitude of mind of one of His Majesty's Ministers, the remark is interesting, though hardly reassuring; but it must leave the ordinary elector, whatever may be his personal political views, wondering whether such open merriment at the discomfiture of others is quite the reaction appropriate in a Minister of the Crown. It also leaves a suspicion that the latest development in the management of the nationalised iron and steel industry may be regarded in a somewhat similar spirit of enjoyment; and that the fact that Mr. S. J. L. Hardie, chairman of the Iron and Steel Corporation of Great Britain, has undoubtedly "scored off" some of those who had debarred his representatives from a complete participation in all the innermost councils of the British Iron and Steel Federation, may rank in political eyes as of more importance than any effect it may have on the industry.

What has happened, briefly summarised, is that, at the recent annual general meeting of the Sheffield firm of Messrs. Thos. Firth and John Brown, Limited, a representative of the Iron and Steel Corporation voted against the re-election of two of the directors, and gave an even clearer indication that five other directors ought to retire. Lord Aberconway, the chairman of the company, was asked to continue in office, but declined to do so in the absence of the seven directors who were being thus dismissed. All seven of these directors, as well as Lord Aberconway, are also on the board of Messrs. John Brown and Company, the Clydebank shipbuilders, and it is ostensibly an objection to the persistence, in the steel industry, of multiple directorships which prompted the Corporation's opposition to their continuance in office on the board of the now nationalised, but formerly associated, firm of Messrs. Thos. Firth and John Brown, Limited. The seven directors affected are Sir Arthur Matthews, the managing director; Mr. Eric Mensforth, deputy managing director; Sir Allan Grant, a former managing director for 15 years; the Hon. Charles McLaren, son and heir of Lord Aberconway; Mr. S. W. Rawson, who was appointed recently to be Director General of Machine Tools; Mr. J. Wortley Fawcett; and Mr. Mark M. Firth. All of them have had a long association with the industry and, indeed, were commonly regarded as a very strong team, possessing between them an exceptional knowledge of the heavier branches of steel production, especially of heavy forgings.

The matter is best explained, and its significance emphasised, by quoting verbatim Lord Aberconway's letter to Mr. S. J. L. Hardie, as it was communicated to the Press. It was dated July 26, and read: "Dear Mr. Hardie, In view of the fact that the representative of the Iron and Steel Corporation of Great Britain, who attended yesterday afternoon the annual general meeting of Thos. Firth and John Brown, Limited, voted against the re-election to the board of Sir Arthur Matthews and Mr. Mark Firth, and stated to the Board that the Corporation had decided that they wished Sir Allan Grant, Mr. S. W. Rawson, Mr. Eric Mensforth, the Hon. Charles McLaren and Mr. J. Wortley Fawcett to retire from their directorships, these gentlemen have sent in to the secretary of the Company their resignations from the Board.

"You paid me the compliment of saying that you wished me to retain my chairmanship of the company. We all felt, and I myself felt and expressed to you, our willingness jointly to remain with the company if we could be of any help to the Corporation. You do not desire the help of the above-mentioned of my colleagues, and I feel that, without their technical and business knowledge, I should not be of any help to you. I, therefore, am resigning my chairmanship and directorship of the Company.

"I should add that I am in profound disagreement with the policy expressed in your action. To take three members of the Board only: Sir Arthur Matthews is one of the leading men in the country, probably in the world, on the manufacture and treatment of difficult forgings, such as those in which the company specialises; Mr. Rawson has been connected with steel for 36 years and, because of his experience and ability, has been made Director-General of Machine Tools by the Government; Mr. Eric Mensforth is one of the most brilliant of our younger engineers. All these three have held executive positions with the company, have contributed greatly to its development, and have a special and detailed knowledge of its affairs. By your action you are depriving the company of their invaluable services.

"Some of the directors mentioned above are on the Board of John Brown and Company. They were appointed to the Board of Thos. Firth and John Brown because of their knowledge and ability. They have never sought to influence the policy of Thos. Firth and John Brown in the interests of John Brown and Company. There never has been an occasion where such an action has been even contemplated. I may say that it is generally acknowledged that the company has been well managed, and that it is one of the leading and most skilled producers of the more difficult alloy steels, forgings and other products. John Brown and Company are the biggest customers of Thos. Firth and John Brown, and I will do all I can to see that such orders as we can give shall continue to be placed with the latter company, so that the friendly relations shall be continued. I propose to send this letter to the Press to-morrow, Friday. Yours very truly, Aberconway."

The policy of the Iron and Steel Corporation, to which Lord Aberconway alluded, had been revealed earlier, when it resulted in the resignation from the board of the English Steel Corporation (formerly an association of Vickers with Cammell Laird and Company) of five directors who were also directors of companies in the Vickers Group or of Cammell Laird and Company; and it may be expected that similar action will be taken in the case of other nationalised steel companies, if any of their directors have seats on the boards of concerns which are still privately owned. It is a truism that no man is indispensable, and, though there are instances in plenty of firms which have languished because some strong personality has died or, for some reason, has severed his connection with them, there are innumerable other cases in which the departure of some key man has brought to the top someone, previously little known outside of his own organisation, whose qualities have proved not less adequate than those of his predecessor. We do not recall, however, any parallel case to the present; if, as seems probable, the policy of the Corporation, as now revealed, is a general one, to be applied throughout the industry. It was the declared intention of the Iron and Steel Corporation when it was constituted, that individual firms should preserve their independent identities in the interest of their goodwill: but goodwill is an intangible sort of asset at any time, very much bound up with the personalities of those in control. No such sweeping changes have been made in the other nationalised industries; and it may well be that customers of the iron and steel industry, who have based their opinion of it on personalities known to them, may feel uneasy at the prospect of having to deal with new men in every steel firm.

NOTES.

THE TECHNICAL PERSONNEL COMMITTEE.

IN the House of Commons, on July 26, the Minister of Labour (Mr. Alfred Robens, M.P.) stated, in reply to a question, that it had been decided "to reconstitute the Technical Personnel Committee which, under the chairmanship of Lord Hankey, dealt so successfully with questions of scientific and technical manpower during the last war and during the immediate post-war period." The new Committee, which would have rather wider terms of reference than the old one, would review the requirements for scientists and engineers, and especially those arising from the defence programme, in relation to the available supply; and it would consider what more could be done to meet "certain important overseas needs for people of the same type." Lord Hankey had agreed, the Minister continued, to serve as chairman, and the other members would be Sir Arthur Fleming, C.B.E., Sir Wallace Akers, C.B.E., and Captain A. M. Holbein, C.B.E., nominated by the Federation of British Industries; Sir Edward Appleton, G.B.E., K.C.B., F.R.S., representing the Universities; Sir Arthur Trueman, F.R.S., chairman of the University Grants Committee; Professor S. Zuckerman, C.B., F.R.S., nominated by the Lord President of the Council as "representative of Science"; Mr. S. L. Lees, of the Treasury; Mr. E. A. Berthoud, C.M.G., of the Foreign Office; Mr. R. A. Whittle, M.C., of the Colonial Office; Mr. S. A. ff. Dakin, of the Board of Trade; Mr. A. C. B. Symon, C.M.G., O.B.E., of the Commonwealth Relations Office; Mr. H. M. D. Parker, C.B.E., of the Ministry of Labour; Mr. W. D. Wilkinson, C.B., C.B.E., of the Ministry of Supply; and Mr. E. D. T. Jourdain, of the Lord President's Office. Mr. A. J. S. James, of the Ministry of Labour and National Service, is to be the secretary of the Committee. The terms of reference are, firstly, "To consider, make recommendations and deal with questions relating to the home and overseas demand for the available supply of scientific and technical personnel of professional or approximately professional standards, including the making of recommendations on its economic use and the need for increasing the available supply"; and, secondly, "In connection with the overseas demand for such personnel: (*a*) to make recommendations upon appropriate steps to promote the recruitment from the United Kingdom of persons required to assist the economic development of under-developed countries; and (*b*) to consider any special steps which are required to provide opportunities for training in the United Kingdom of persons from under-developed countries." It is stated that the Committee (though apparently without power to co-opt) will be empowered "to invite representatives from other Government Departments or outside interests to be present when matters of concern to them are being discussed."

ADVISORY COUNCIL ON SCIENTIFIC POLICY.

The fourth annual report of the Advisory Council on Scientific Policy, which has just been published by the Stationery Office (price 9*d*. net), covers the period April, 1950, to March, 1951. The Council's function is "to advise the Lord President of the Council in the exercise of his responsibility for the formulation and execution of Government scientific policy." Since its formation, the Council has been largely concerned with assessing what measures are necessary for ensuring an adequate supply of scientifically-trained persons to government service and to industry, and, in its previous report, had reached the conclusion that the post-war expansion of the universities sufficed to ensure that enough scientists were being trained to meet current requirements. Changing world conditions, however, and, in particular, the rearmament programme, have altered the situation, and the Council now concludes that the demand for scientists will outstrip the supply. The Council also stresses the need for more technologists in industry and holds that an expansion of the facilities for higher technological training is essential if the nation is to maintain a leading position in industry. As an indication of the progress made, it is stated that there are now some 11,000 students in the applied-science departments of British universities, compared with less than half that number before the war. The Council has also considered, as special problems, the measures which must be taken to safeguard the public against the increasing use of potentially-toxic substances in the preparation of foodstuffs, etc., and the possible uses and probable economic importance of atomic energy. In the second case, the Council concludes that there are reasonable prospects that atomic power can be developed on a large scale at a cost not widely different from that of the power derived from coal, but that a number of technical problems must be solved before this can happen. It stresses the importance, however, of improved methods of coal utilisation. On the subject of atomic power stations, it is thought that the initial costs of such installations would be considerably higher than those of coal-burning stations, but that the fuel costs might be less. In the Council's view, however, it will be at least a generation before atomic power can contribute substantially to the nation's power resources.

ANTICIPATORY BREACH OF CONTRACT.

A case which illustrates a possible danger of entering into contracts with local authorities has recently been reported *sub nom. William Cory and Son, Ltd.* v. *City of London Corporation* (1951) 2 All. E.R.85. We draw attention to it because, at first sight, the law as there applied appears to bear very harshly on the contractor, while a close examination shows that the matter may not be so serious. The facts were sufficiently remarkable. In 1936, the plaintiffs contracted with the Corporation of the City of London to remove refuse in lighters and barges "fitted with temporary coverings and coverings to be secured to the permanent coverings," and to comply with the by-laws of the port health authority for the Port of London as to the removal of refuse. In April, 1948, when the contract had still some 20 years to run, the Corporation, as port health authority, altered their by-laws, the alteration coming into force in November, 1950. One of these by-laws required every vessel transporting refuse to be provided with permanent coverings and close-fitting hatches covered with waterproof sheetings. To comply with these by-laws of 1948 would have been prohibitively onerous to the contractors, who would have had to spend 400*l*. or 500*l*. on every barge, and could no longer have used the barges to load coal on their return up-river. In these circumstances, they informed the City Corporation in September, 1948, that they regarded the publication of the by-laws as a refusal by the Corporation to allow the contract to run its normal course, and as enabling them to treat the contract as at an end. It may here be interposed that, where there is a contract in force, one party may do something which the other is entitled to regard as an anticipatory breach of contract, and so enable the other to consider his obligation as terminated. A dispute having arisen, there was an arbitration. One of the questions which fell to be answered by the arbitrator was whether the publication of the by-law amounted to such a repudiation of the contract as to enable the contractors to treat the agreement as being at an end in September, 1948, although the by-law did not come into operation until November, 1950. This question came before the Lord Chief Justice, who held that the contract had not been repudiated. His decision has been upheld in the Court of Appeal. Lord Justice Asquith pointed out that, inasmuch as the City Corporation are an authority bound by statute to make such by-laws as may be necessary to prevent nuisance arising to the danger of the public health, they cannot divest themselves from the performance of that duty. Any contract having that object would be void and of no effect. Consequently, Messrs. Cory, having agreed to "at all times observe and comply with" the by-laws made by the Corporation, could not be heard to say that a by-law which would have effect to render their contract more onerous in the future was enough to entitle them to act as if they were no longer bound. This is not to say, however, that Messrs. Cory became liable to carry out the contract after November, 1950, on the terms agreed upon in 1936. It is a well-known principle of law that a man may be discharged from liability under a contract on the ground that its performance may be "frustrated" owing to the disappearance of a foundation which the parties assumed to be at the basis of their contract. For example, where performance of a contract has been rendered impossible by an Act of Parliament passed after the contract was made, the promissor is excused from performing his promise, unless it appears that he intended to bind himself with reference to the future state of the law, the presumption being that the parties intend to contract with reference to the law as existing at the time when the contract is made. In the case under notice, Messrs. Cory had no reason to suppose (in 1936) that, by 1950, by-laws would come into force which would impose upon them a very heavy additional burden, and in *Unger* v. *Preston Corporation* (1941) 1 All. E.R.200, Mr. Justice Cassels held that frustration may occur where performance becomes virtually impossible owing to a change in the law. Such a change may be effected by statute direct or at the instance of a local health authority, making by-laws under powers conferred by statute. We have said that, at first sight, the decision appears to be a serious matter for the contractors: but it is fairly obvious that they could not be held bound to perform their contract on the terms agreed in 1936 when the new by-laws came into force in 1950. The Court of Appeal, at any rate, has not said so; indeed, the question was not raised. Nor is it possible to imagine that the City Corporation would seek to impose such a heavy liability on the firm.

ASLIB ANNUAL CONFERENCE.

The annual conference of Aslib is to be held from Friday, October 5, till Monday, October 8, at Ashorne Hill, Leamington Spa, Warwickshire. On Saturday, two sessions will be devoted to the efficient planning of special libraries. The first session, with Mr. F. H. Perkins, B.Sc., M.I.Mech.E., in the chair, will consider the selection of staff and the allocation of duties; there will be three speakers, Mr. B. C. Vickery, M.A., Mr. C. W. Hanson, B.Sc., and Mr. J. J. Graneek, M.A., representing, respectively, small and medium industrial-research libraries, and a large university library. At the second session, Professor R. S. Hutton, D.Sc., will be in the chair; the speakers are Mr. J. B. Reed, B.Sc., who will discuss planning the library for the user, and Mr. A. B. Agard Evans, M.Sc., who will speak on training the user. On Sunday, October 7, at the first session, Mr. E. J. Carter, B.A., A.R.I.B.A., will present a survey of post-war achievement in national and international bibliography; Mr. C. Le Maistre, C.B.E., M.I.E.E., will be in the chair. Aslib subject groups will be discussed at the second session, the chair being taken by Miss Barbara Kyle, The final session will be in the form of "Any Questions?" with Miss Mildred Couldrey, B.A., in the chair; the panel of experts answering the questions comprises Mr. D. V. Arnold, B.Sc., F.L.A., Miss Ruth Jacobs, B.S. in L.S., Miss Barbara Kyle, Mr. F. A. Sharr, B.A., F.L.A., and Mr. E. N. Simons. Further particulars of the conference may be obtained from the Director, Aslib, 4, Palace-gate, London, W.8.

LLOYD'S REGISTER SHIPBUILDING RETURNS.

The returns of ships under construction during the quarter ended June 30, published by Lloyd's Register of Shipping, show that, in Great Britain and Northern Ireland, during the quarter, 70 steamers and motorships, totalling 346,211 tons, were completed; 79 ships, of 414,138 tons, were launched; and work was begun on a further 79, of 382,478 tons. Work was suspended on five ships, but their aggregate tonnage only amounted to 1,350 tons. At the end of June, 345 ships, of 100 tons gross and upwards, totalling 2,114,319 tons, were under construction; 95 of these were fitting out afloat, and 250 were still to be launched. Including those mentioned above (but excluding China, Poland and Russia), there were under construction in the world 1,214 vessels, of 5,331,214 tons gross; 181 of these were tankers. It is noted that tankers represent 38·4 per cent. of the work in hand, on a tonnage basis: not far short of the total tonnage under construction in the British Isles, which is 39·7 per cent. of the world total. Tankers building in the British Isles at the end of June numbered

101, of 1,181,755 tons—an increase of 29,432 tons over the total for the previous quarter, and 55·9 per cent. of the total tonnage in hand. Britain was building nearly four times the tonnage of any other country, Japan coming second, with 520,665 tons, and France third, with 439,363 tons. No other country had in hand as much as 400,000 tons, though Germany was approaching this figure, with 387,853 tons—an increase of 126,568 tons over the previous quarter. Of the ships building throughout the world at the end of June, 24 steamers and 91 motorships were between 6,000 and 8,000 tons each; 15 steamers and 51 motorships between 8,000 and 10,000 tons; 38 steamers and 112 motorships between 10,000 and 15,000 tons; 20 steamers and 23 motorships between 15,000 and 20,000 tons; seven steamers and six motorships between 20,000 and 30,000 tons; and there was one steamer of greater size—the United States, of 51,500 tons, the largest vessel built in the world since the war. Of the total under construction in Great Britain and Northern Ireland, steamers totalled 695,019 tons and motorships 1,419,300 tons. The corresponding figures for vessels under construction abroad were: steamers 898,852 tons and motorships 2,318,043 tons. Throughout the world, at the end of June, 63·3 per cent. of all new construction was under the inspection of Lloyd's Register; and, in Great Britain and Northern Ireland only, 92·4 per cent.

Iron and Steel Consumers' Council.

The Minister of Supply, Mr. G. R. Strauss, has made the appointments to the Iron and Steel Consumers' Council, which has been set up under the Iron and Steel Act, 1949, to consider any matter, including prices, affecting the interests of consumers. The appointments are: independent chairman, Sir William Palmer, K.B.E., C.B.; members of the Council (eight representing iron and steel consuming industries), Sir Amos Ayre, K.B.E., Mr. Ralph Bennett, Mr. A. L. Shuttleworth, Sir Andrew McTaggart, Mr. C. M. Spielman, M.C., Mr. Robert Arbuthnott, M.B.E., T.D., Mr. W. Moray Lines, and Mr. W. D. Wilson, B.E.M.; (three representing iron and steel merchants and stockholders), Mr. M. C. Wade, M.C., Mr. J. W. Annetts, and Mr. H. Basil Darby; (three representing workers in consuming industries), Mr. W. B. Beard, O.B.E., Mr. J. Tanner, and Mr. F. Hayday; and, representing nationalised industries, Sir John Hacking and General Sir Daril G. Watson, G.C.B., C.B.E., M.C. The Iron and Steel Corporation of Great Britain have nominated Sir John Green and Mr. W. H. Stokes, C.B.E., two of their members, to serve on the Council. The appointments were made by the Minister after consultation with appropriate bodies representing consumers. The Council may consider questions concerning any of the principal products of the publicly-owned industry and will report their conclusions to the Corporation. In particular, the Council must consider matters arising from representations by consumers or referred to it by the Minister or the Corporation. The Council may appoint committees, which need not include its own members, to consider local or sectional problems. The Minister has decided, after consultation with the appropriate organisations, that the private section of the iron and steel industry shall not be represented on the Council. These organisations will continue to discuss problems of common interest directly with the Iron and Steel Corporation. The offices of the Council will be at 1, Chester-street, London, S.W.1.

World Power Conference.—At a meeting of the International Executive Council of the World Power Conference, held in Paris last month, it was decided to accept an invitation for a sectional meeting to be held at Rio de Janeiro in the period July to August, 1954. It will be the first time a World Power Conference has been held in South America. The topics to be discussed will centre round the special power and fuel problems of tropical and sub-tropical countries. The Council also decided to admit the German Federal Republic and Japan as members of the World Power Conference. At the recent annual general meeting of the British National Committee, Dr. A. Parker, C.B.E., Director of Fuel Research, Department of Scientific and Industrial Research, was elected to fill the vacant post of honorary secretary.

OBITUARY.

DR. J. T. BATEY.

In last week's issue, on page 116, *ante*, we recorded the death, on July 23, of Dr. John T. Batey, for many years the managing director of Messrs. R. and W. Hawthorn, Leslie and Company, Limited, Newcastle-on-Tyne; and we now give below an outline of his exceptionally long connection with the shipbuilding industry on Tyneside.

John Thomas Batey was born in Newcastle-on-Tyne on July 28, 1862, so that his death occurred only five days before his 89th birthday. He was educated at Newcastle Grammar School and also on the Continent, and then entered upon a five years' apprenticeship to shipbuilding in the yard of Andrew Leslie, at Hebburn, which is now that of Hawthorn, Leslie and Company. It may be noted that this shipyard will attain its centenary in 1953; the amalgamation with the engineering firm of R. and W. Hawthorn took place in 1885. John Batey spent nine years in the Hebburn yard. As an apprentice, he had attended evening classes at the School of Science and Art in Newcastle, and obtained first-class honours and a bronze medal in the naval-architecture examination at South Kensington. This brought him an appointment as lecturer in the school at Newcastle, and a position of responsibility in the drawing office at Hebburn, while he was still in his twenties. In 1889, however, he crossed the Tyne to Low Walker, to become chief draughtsman in the shipyard of William Dobson and Company, a post which he held for 12 years. In 1901, he returned to Hawthorn, Leslie and Company as chief draughtsman; but only for a few months in that capacity, as he was made general manager before the end of the year. A directorship followed in 1907, and in 1921, on the death of Sir Herbert B. Rowell, he succeeded to the position of managing director, which he occupied with notable success until his retirement in 1936.

Dr. Batey—who had received the honorary degree of D.Sc. from the University of Durham in 1935—was one of the oldest members, and possibly the oldest, of the North-East Coast Institution of Engineers and Shipbuilders, to which he was elected in 1885, a year after its foundation. In 1924, the Institution elected him a Fellow in recognition of his services to Tyneside shipbuilding, and President in 1934, an office which he held for two years. He was also a member of 52 years standing of the Institution of Naval Architects, serving on the Council for many years and being elected vice-president in 1938. After four years as chairman of the Tyne Shipbuilders' Association, he was elected in 1923 to the Central Board of the Shipbuilding Employers' Federation, and subsequently to the Board of Trade Advisory Committee, the Merchant Shipping Advisory Committee, and the Technical Committee of Lloyd's Register of Shipping. He was one of the earliest supporters of standardisation in shipbuilding and engineering, and was a member of the British Engineering Standards Association, now the British Standards Institution. His death, following on those of Mr. J. Denham Christie and Sir Rowland F. W. Hodge, may be fairly regarded as the end of an era in Tyneside shipbuilding in iron and steel, for he provided a direct link with those who built up the industry on the North-East Coast.

Economics of Metals.—In connection with a special general meeting, the Council of the Institute of Metals, 4, Grosvenor-gardens, London, S.W.1, have arranged a whole-day discussion on "Metal Economics," which will take place at the Park Lane Hotel, Piccadilly, London, W.1, on Wednesday, October 17. The morning session will be devoted to "Primary Resources of Ferrous and Non-Ferrous Metals," and the afternoon session to "Scrap, Reclamation, Secondary Metals, and Substitute Materials." Both ferrous and non-ferrous metals will be dealt with throughout the meeting, especially at the morning session, but the papers and discussions will have a strong non-ferrous basis, largely because the Institute is concerned only with non-ferrous metals. An informal conversazione and exhibition will be held in the evening of October 17 at 4, Grosvenor-gardens, and a series of visits to works and laboratories in the London area has been arranged for the morning of Thursday, October 18.

THE ROYAL AGRICULTURAL SHOW AT CAMBRIDGE.

(*Concluded from page* 120.)

Potato-harvesting machinery can be used far more efficiently if the haulm is destroyed first, as this prevents clogging of the mechanisms and makes the hand-pickers' work much easier. Several machines designed for this purpose were being exhibited at the Royal Show, an outstanding example being furnished by that illustrated in Fig. 31, opposite, which was being shown on the stand of the manufacturers, Messrs. P. B. Bettinson and Company, Limited, Holbeach, Lincolnshire. As will be seen from the illustration, it has been designed to fit on to the front of a standard tractor and is driven from the belt-pulley power take-off. There are two horizontal cutters fitted to a subframe bolted to the tractor, the design being such that the height of the cutters above the ground can be adjusted to suit local conditions. Both cutters are fitted at the lower ends of vertical spindles and the drive is transmitted to the top of one spindle by a single V-belt, further V-belts arranged across the front of the machine connecting the two spindles together. The mechanism is of strong but straightforward construction, damage being prevented by the incorporation of an over-run safety clutch in the drive. Depth adjustment is accomplished by moving the cutters and their supporting framework on vertical guides, the actuating mechanism, which consists of a screw gear and attendant bell-crank levers, being arranged so that it can be operated from the tractor seat. The machine can, of course, be used for other duties, such as the removal of carrot tops, beet tops, etc., and the dispersal of weed growths.

A somewhat different machine for destroying potato haulm was being demonstrated on the stand of Pest Control, Limited, Harston, Cambridge. This machine is known as the Rotoflail, and, as its name suggests, employs a number of flails to disintegrate the haulm. It is illustrated in Fig. 32, opposite, from which it will be noted that the flails are mounted on a horizontal shaft; this is driven from the power take-off of the towing tractor and the flails strike the haulm and batter it to a fine mulch. Solid-rubber flails are used and they are connected to the rotor shaft so that they can be removed and replaced easily. The rotor shaft is mounted in sealed bearings and, when at work, rotates at a speed of 700 r.p.m., being driven from the power take-off through an extension shaft fitted with universal couplings, a bevel gearbox, a cross-shaft and a chain-and-sprocket assembly, the last-named transmitting the drive from the cross-shaft to the rotor. The frame is built up from welded channel-section steel members and, as will be seen from the illustration, the complete unit is supported by two landwheels fitted with pneumatic tyres. The width of working is 7 ft. and the height of the flails above the ground can be adjusted directly from the tractor seat. All moving parts are suitably protected by sheet-steel covers, but on the machine illustrated the rotor cover has been removed so that the flails can be seen. Use of the Rotoflail is by no means limited to potato-haulm pulverisation, as it can be employed equally well for clearing long grass and rubbish in orchards, breaking up the straw left behind by combines, and the eradication of bracken. Furthermore, there appears to be no reason why it should not be used for topping such root crops as carrots and mangolds, and it is understood that such a use is envisaged by the manufacturers.

The exhibits on the stand of Messrs. Hayters, Limited, Spellbrook, Bishops Stortford, included a novel form of grass-cutting machine intended originally for use in orchards. This machine, which is illustrated in Fig. 33, opposite, is designed for attachment to the Ferguson tractor linkage and comprises three horizontal cutter heads arranged below a steel guard. The drive for the cutters is taken from the tractor rear power take-off by means of three V-belts, the flat pulley normally fitted to the belt-drive attachment being replaced by a three-groove V-pulley wheel. The three belts are connected to a countershaft arranged along the

EXHIBITS AT THE ROYAL AGRICULTURAL SHOW, CAMBRIDGE.

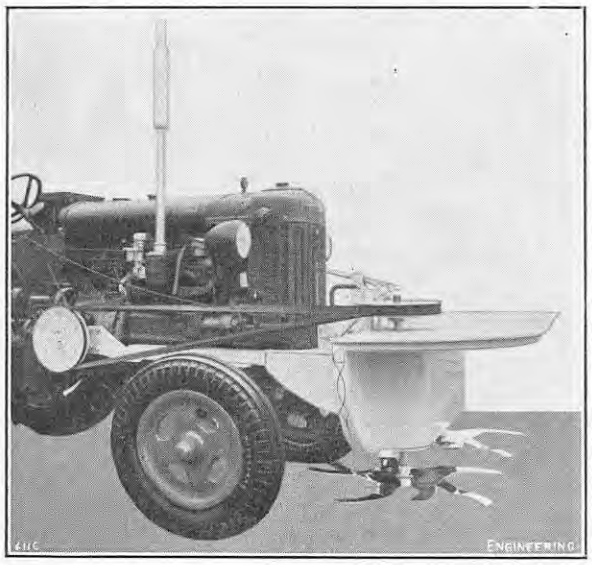


FIG. 31. POTATO-HAULM CUTTER; P. B. BETTINSON AND COMPANY, LIMITED.

FIG. 32. POTATO-HAULM PULVERISER; PEST CONTROL, LIMITED.

FIG. 33. ROTARY GRASS CUTTER; HAYTERS, LIMITED.

FIG. 34. "REVOLUTION" SIDE-DELIVERY RAKE; A. B. BLANCH AND COMPANY, LIMITED.

top guard plate and further V-belts transmit the drive to the individual cutters. Each cutter assembly consists of a vertical steel shaft, running in heavy ball races, the top end of which is fitted with the driving pulley and the lower end with a Duralumin plate having four cutting blades bolted to it. The complete machine is supported at the rear by two landwheels, fitted with solid-rubber tyres, mounted in ball-bearing castors, and although the forward end of the machine is connected to the tractor linkage it is not designed to be raised by the hydraulic power lift. To enable the unit to be used either directly behind the tractor or towards one side, two drive pulleys are fitted to the transverse countershaft, the total offset available being 22 in. This is a valuable feature as in orchard work it can cut close to the trees without risk of damaging the machine. Although intended primarily for use in orchards, it can be used for many other purposes, such as clearing thistles from pastures, topping marshland grass, and for grass cutting on aerodromes, public parks, etc.

A new form of side-delivery rake and swath turner was being shown by Messrs. A. B. Blanch and Company, Limited, Crudwell, Wiltshire. This machine, which has been designated the Revolution, is illustrated in Fig. 34, on this page, from which it will be seen that it is designed for towing behind a tractor. It is of simple but robust construction and as the tine wheels obtain their drive from contact with the ground and crop, there are no drive chains, sprockets or gears. The complete unit is mounted on pneumatic-tyred wheels and the tine wheels are independently sprung so that they can follow closely the contours of uneven or undulating ground. At the end of rows the tine wheels are lifted clear of the ground by the movement of a lever located near the tractor driver and although capable of covering two five-foot or two six-foot swaths, the transport width is only 7 ft. For swath turning, the centre tine wheel is replaced by a swathboard and to give adequate clearance between the swathboard and the wheels when turning a heavy hay crop, the second and fourth tine wheels are mounted on sliding bearings.

A new light tractor capable of performing, on a reduced scale, all the duties carried out by heavier tractors was being exhibited at the Royal Show for the first time by Tractors (London) Limited, Bentley Heath, Barnet, Hertfordshire. This machine, which is known as the Trusty Steed, is illustrated in Figs. 35 and 36, page 150, which show it equipped with pneumatic-tyred rear wheels and half-track equipment, respectively. It is a compact but sturdy unit which, owing to its comparatively small size, is easy to manœuvre in confined spaces. The power unit consists of a single-cylinder four-stroke air-cooled petrol engine having a capacity of 596 c.c. and developing a maximum of 14·5 brake horse-power. The power is transmitted to a three-speed gearbox by a chain, the ratios of the various speeds being 2·32 to 1 in first gear; 1·55 to 1 in second and 1 to 1 in top gear. The engine and gearbox are assembled as a single unit which is held to the chassis by four bolts, but means are provided for pivoting the gearbox in relation to the engine

EXHIBITS AT THE ROYAL AGRICULTURAL SHOW, CAMBRIDGE.

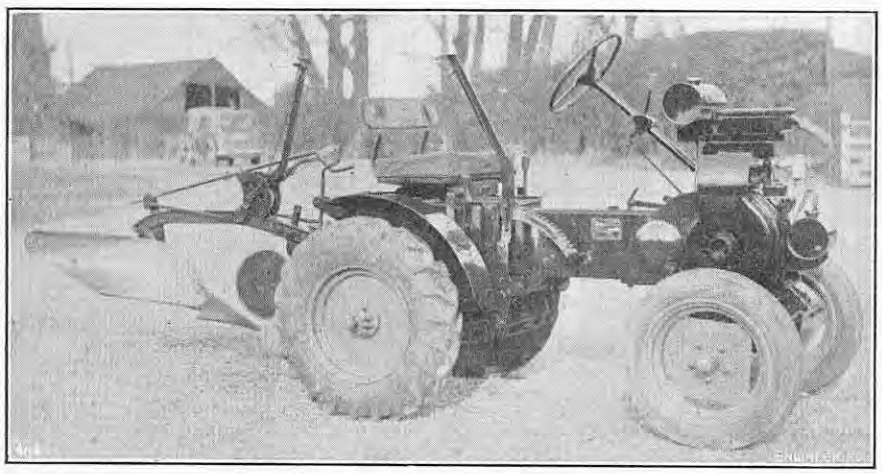


Fig. 35.

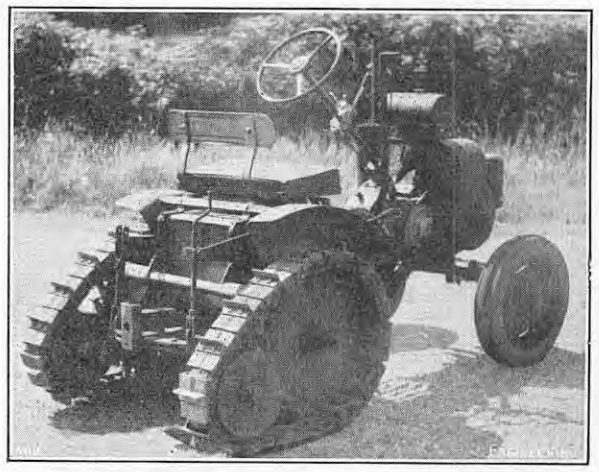


Fig. 36.

Figs. 35 and 36. "Trusty-Steed" Four-Wheel Tractor; Tractors (London) Limited.

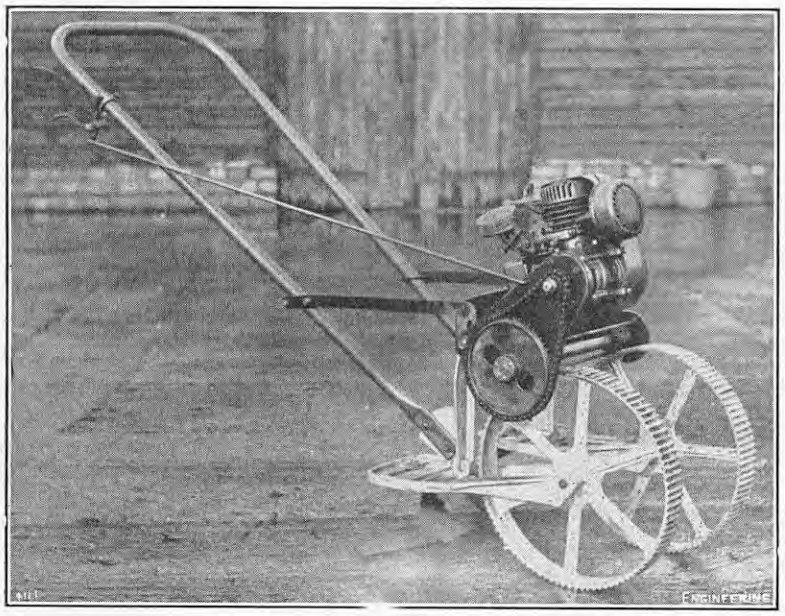


Fig. 37.

Fig. 38.

Figs. 37 and 38. "Mowmotor" Attachment; Tractors (London) Limited.

so as to adjust the tension of the primary chain. A multi-plate clutch is used to transmit the drive to the gearbox and this is mounted on the gearbox input shaft, withdrawal being effected by a pedal in the normal manner.

A roller chain is used to transmit the drive to the rear of the tractor, the chain being enclosed in a case located towards one side of the chassis. The chain is connected by a sprocket to a countershaft which, in turn, is connected by two further chain and sprocket assemblies, to the final-drive units, the latter consisting of two spur reduction gears driving the rear wheels. To permit the drive to the rear wheels to be disconnected independently, the sprockets which transmit the drive to the rear wheels are connected to the countershaft through dog clutches which can be brought into and out of engagement at will by means of hand levers located one at each side of the driver's seat. Brake drums are mounted on each final-drive pinion shaft and back plates with internal-expanding shoes are bolted to the transmission-casing base-plate, the linkage being designed so that the brakes can be applied independently by further movement of the dog-clutch operating levers or together by a pedal.

The front-axle beam is of the centre-trunnion mounted type with bolted-on adjustable extensions fitted with the usual form of stub axles. Marles steering gear is fitted as standard and the track rod and drag link is locked at the different widths by quick-release clamps. The chassis is of welded construction and is designed so that mid-mounted tools can be used when required. The drawbar hitch is placed well forward of the back axle and is mounted on trunnion brackets which can be adjusted for height. A linkage system connects the rear end of the drawbar to the hand-lift lever, which is arranged so that both mid-mounted and rear tool bars are raised and lowered simultaneously. Lateral movement of the mid-mounted toolbar is restricted by the lifting arms but these in no way interfere with the floating action when at work. A belt-pulley power take-off is provided at the rear of the tractor, the unit comprising a 6-in. diameter pulley of $3\frac{1}{4}$ in. face width chain driven from the countershaft; the normal speed of the pulley is 1,100 r.p.m. when the tractor is in top gear. When fitted with pneumatic-tyred wheels, the weight of the complete machine is approximately 1,200 lb., the wheelbase $51\frac{1}{2}$ in., the overall length 78 in., and the height, to the top of the steering column, 59 in.

Tractors (London) Limited were also showing a neat little unit designed to convert hand-propelled implements, such as lawn-mowers and hoes, into power-driven machines. It is known as the Mowmotor and is illustrated in Figs. 37 and 38, on this page, in which it is shown fitted to a hand-propelled hoe and an ordinary roller-type lawn mower, respectively. It consists of a single-cylinder air-cooled two-stroke petrol engine, having an output of $\frac{1}{3}$ h.p., which drives a friction roller through a roller chain and sprocket assembly. The unit is mounted on a pivoting bracket and the friction roller is brought into contact with either the driving wheels of the hoe or the roller of the mower by allowing it to swing down about the pivot; the movement is controlled by a lever fitted to the handles. In the case of a side-wheel type of mowing machine, the bracket is clamped in the base of the handle in much the same way as for the hoe illustrated in Fig. 37.

There were, of course, many more implements exhibited at Cambridge than have been referred to in our article; it should be emphasised, therefore, that those mentioned have been chosen because they were either new or have not been described previously in Engineering. Like its predecessors, the show was very well organised, and there were certain improvements over last year's arrangements, particularly in the signposting. The main avenues in the implement yard, however, were still only labelled at the ends, so that any visitor passing from one avenue to another at any intermediate point was confused as to his whereabouts. The ban on re-admission also is somewhat aggravating as it precluded visitors from returning to the car parks for any article left in their cars. Also, the organising committee might well review the arrangements for the last day. According to the programme, the show was due to close at 6 p.m., but many stands were totally dismantled early in the afternoon, and by 5 p.m. the show ground was filled with vehicles sent to collect the exhibits. This was unfortunate for those unable to visit the show until the last afternoon and should not be permitted. These criticisms are, however, small matters, and the Society are to be congratulated once again on the general excellence of the arrangements.

THE JOINT ENGINEERING CONFERENCE, LONDON.

(*Continued from page* 72.)

ON Tuesday, June 12, the three sessions, at the Institutions of Civil, Mechanical and Electrical Engineers, dealt with road planning and safety, progress in radio for aviation, and radio masts and towers, respectively.

ROAD PLANNING AND SAFETY.

Mr. G. T. Bennett, O.B.E., B.Sc., M.I.C.E., presenting his paper on "Road Planning and Safety," said most people thought of the road system as having commenced with the Roman period, but the belief was growing that before that time there had been roads in England on quite an extensive scale and that our ancestors had not been quite such barbarians as the Romans purported them to have been. Nevertheless, the system which the Romans had left behind them had lasted very largely up to the present day, and it made one wonder why a similar thing could not be done now. The next great period of road building had come with the turnpike era. The steam locomotive was invented, however; the railways were built, and the turnpike system had become bankrupt after some years. With the development of the internal-combustion engine there had been a tremendous awakening, since the motor car became a normal method of travel; but the road system had been entirely unsuitable because of its history. No one could say that, after the end of the First World War, no effort had been made to deal with the situation. Taxation of motor-cars had brought in a large sum of money, though, unfortunately, the whole of the money had not been used on the roads. The grant system of financing the roads, however, had led to the position in which 250,000,000*l.* were being collected every year and only about 70,000,000*l.* were being spent on the roads.

Engineers believed that transport was so vital to the country, and that the reduction of the costs of transport would make such a tremendous contribution to the cheapening of the goods which the country produced, that it was necessary to have the best road system in the world. This was more necessary in England than in any other country in the world; the ports and the towns were all very close together. What engineers would wish to see would be a backbone system like the old Roman system or the German *autobahnen* system, a system of motorways specially built for vehicles and from which pedestrians and cyclists would be excluded. Apart from that, they would wish to see all the main roads of the country fitted up with double carriageways, cycle tracks where there was considerable cycle traffic, and proper footways. They would wish to see through-traffic taken out of the towns and villages and carried by by-passes. They would like to see roads of lesser value treated according to their importance, made safe and made reasonably commodious for the traffic using them.

He had suggested that it might be a good idea to build a single motorway and charge a toll on it. In making this suggestion, he had rather trailed his coat. He was quite sure that if the suggestion were put into effect, even with the present high taxation on road transport, people would flock to use such a road and it would pay for itself. If such a road were built, it would at least settle whether any roads would pay for themselves if they were made safe and commodious. Before concluding, he wanted particularly to mention the question of safety. The subject of road safety had been bedevilled always by a misunderstanding about the meaning of the word "cause"—the cause of accidents. In this matter it was common to say that the cause of any accident was the fault of some person who was involved. With that he would agree, as probably would most people; it was indeed very seldom that there was a road accident in which one could not find one or both, or all the persons involved, to be to some extent to blame. On the other hand, it did not follow from this that there was nothing that the road engineer or the vehicle designer could do to prevent accidents from occurring. If there was something lacking, if there was something that could have been done to prevent an accident, it could be called a cause just as much as could the absence of commonsense or carefulness on the part of the individual. However, the statistics on which most reasoning on this matter had been based so far were produced by the police, who could not be expected to say anything about the road. Thus, their figures showed that only 1 per cent. of accidents were due to road defects and 99 per cent. were due to human carelessness.

The chairman, Dr. W. H. Glanville, C.B.E., observed that it was a curious thing that the paper on "British Mechanical Road Transport Vehicles, 1851-1951," by Mr. Shearman and Mr. Winter, had hardly mentioned the roads, and to-day, the paper had dealt with roads but it hardly mentioned vehicles. In a sense this illustrated the manner in which the road problem was sometimes regarded; it was not looked upon as a complete whole. Road transport was responsible for spending about 10 per cent. of the national income, a very considerable slice, and therefore it was something that ought to be looked upon as a whole.

DISCUSSION.

Mr. H. S. Andrew, who opened the discussion, said that he wished to make two quotations from the London and Home Counties Traffic Advisory Committee's Report to the Ministry of Transport on London traffic congestion. The first quotation was to the effect that there had been no major street improvement in inner London since 1905, when Kingsway and Aldwych had been completed and opened to traffic; and the second was to the effect that, notwithstanding the country's present heavy commitments, especially on defence and housing, the Committee considered that certain works were essential and should be put in hand at the earliest possible moment unless the traffic of London was to be brought to a standstill. That was the London picture. The author had given the national picture extremely ably. The words with which the paper concluded could not be emphasised too strongly: "Meanwhile, highway engineers should do everything in their power to demonstrate the vital contribution to prosperity which an adequate road system would represent."

Mr. J. Shearman said he quite appreciated the author's remarks about the need for rubbing out the black spots on the roads, but he suggested that the author should not forget the wonderful work that had been done in providing an adequate and excellent surface for the roads over which people enjoyed their motoring nowadays. Mr. A. J. Samuel (deputy chief engineer, Ministry of Transport) observed that he did not know whether anyone had worked out what would be the cost of the author's proposals. His calculation was that the first item, 3,000 miles of motorways, would cost 450*l.* million. The country had come out of a big war, and not only were the roads in a poor state, but the railways were in a position which was not much better, the country was short of electric power and there was a great deal of money being spent on rearmament. Mr. R. R. W. Grigson said that the author was not proposing anything more ambitious than had been embarked upon in Germany in 1933, and surely no one could say that we in this country were more impoverished than the Germans had been in the inter-war years.

Mr. G. H. Lanchester, speaking as a motorist who had motored before the roads had been made for motors, suggested that, as the roads were improved, so the motorists would go on increasing their speeds, and there would always be the proportion of road aclidents that were due to misjudgment of the driver or some other person.

Colonel M. J. P. O'Gorman considered that the principle on which traffic safety could be achieved was that of making all movement on the road predictable. If the movement of other traffic which the motorist saw before him was predictable, the motorist would predict and would take care not to get in the way of the other traffic.

PROGRESS IN AIR RADIO.

The paper on "Forty Years' Progress in Air Radio" was presented by Air Commodore C. S. Cadell, C.B.E., M.A., A.M.I.E.E., and Dr. B. J. O'Kane, B.Eng., A.M.I.E.E. Mr. H. Bishop was in the chair. Before 1918, medium-frequency techniques were, said the authors, developed in air radio to the stage of becoming operationally reliable. A period of consolidation followed during which commercial flying gradually began to emerge, and the tempo increased in the late 'thirties with the introduction of the master oscillator and crystal transmitters; and aircraft bonding and ignition shielding became the standard practice. Telecontrol of target aircraft in flight also became common; the "voice from the air" was used operationally; television transmission was successfully demonstrated, but discarded; direction-finding was greatly developed; the coastal radar chain was extended from Aberdeen to Southampton by the outbreak of war; and a primitive air interception radar equipment had been flown.

Enormous advances were achieved during the 1939-45 war, of which the most important was the experience gained in pulse techniques. This knowledge had profoundly influenced air strategy and revolutionised air tactics. By 1945, few operational sorties were undertaken without the aid of airborne radar or ground radar control and, while communication techniques in aircraft had changed much less in comparison, there was an increasing demand for very high-frequency speech channels. An equipment giving 336 channels at 90 kilocycles spacing was developed and was the first equipment to use "crystal saving." A further feature was the widespread use of ionospheric prediction to ensure that operators in the air employed the optimum available frequency.

Although there had been no major advance in telecommunication systems since the war, new types of equipment had been introduced which showed marked technical and operational advantages. Perhaps the most striking change was the introduction of "miniaturised" equipment. This considerably reduced the volume and weight of individual units, thus offsetting to some extent the increasing number required to meet the needs of present-day traffic control. The greater use of very high frequencies for this purpose made it necessary to employ multi-channel equipments. In addition to air-to-ground communication, intercommunication facilities must be provided and development work had been carried out to improve intelligibility and reduce the effect of aircraft noise. Technical progress on navigational aids had been hampered by lack of international agreement on the system to be adopted, but the direction-finding equipment was now fully automatic and in many cases bearings on two beacons could be taken simultaneously.

Long-range navigation was a problem that had not been completely solved. Both the Loran and Consol systems were in use, the former operating at a frequency of about 2 megacycles and the latter at 250 kilocycles. Both systems suffered from the disadvantages inherent in those frequencies. Other aids in use were microwave early warning (M.E.W.) radar equipment and the airfield surface movement indicator (A.S.M.I.), as well as altimeters and airborne primary radar. With the increasing speed of aircraft, however, the air traffic control system would have to be modified very considerably in congested areas; and the new equipment, both in the air and on the ground, would inevitably be of greater complexity. A possible solution would be to cover a congested area with a "carpet" of ground radar equipment, which continuously reported the position and height of all aircraft. The aircraft would carry a transponder which, when interrogated, would give the aircraft's identity and possibly other information such as height. An automatic computer at the control centre would compare the aircraft's three dimensional track with the "ideal" track for the selected lane and would signal corrections automatically to the aircraft. It would also give warning of impending collisions and record all messages passed. Instructions would be given by an impulse signalling system or pictorial displays. With this system the aircraft would have to carry an approved short-range navigational aid, a very high frequency impulse telephony transmitter-receiver and a transponder. In addition, a landing aid would be required and a long-range aid would be necessary on certain routes. Whatever system

of control was adopted, speed of communication would be essential and information from remote radar stations would in certain cases have to be relayed.

Discussion.

Mr. F. S. Barton, in opening the discussion, expressed the belief that there was much more drama in the early days than was stated in the paper. Very high frequencies had been adopted in order to enable a simple quarter-wavelength rod to be used; and their advantages, which were proved about 1933, were freedom from atmospherics and loss of side range. They had also enabled designers to capitalise on other subsidiary work, such as electromagnetic microphones. He thought that the Gee system had been dismissed too lightly as it did great service during the war.

Air Vice-Marshal Addison said that the present dependency on aero-navigation meant a crowding of frequencies and consequently interference. That interference was being increased deliberately; and the question therefore arose whether the use of electronics in air navigation, particularly military navigation, would not have to be reconsidered. There was a tendency nowadays to "clutter up" aircraft with "black boxes" to the detriment of the pay load or the number of bombs carried.

Sir Victor Tait called attention to two matters which were at present of considerable importance to civil aviation. One was the greater use of higher frequency radio telephony, for which we had not got suitable equipment, and the other was the development of distance-measuring equipment.

Major B. Binyon pointed out that the first operational artillery reconnaissance by radio took place in January, 1915, and not in 1916, as stated in the paper. Nor was the set used, which had an ordinary open spark gap, that which was illustrated. Among the difficulties of the early workers was the prejudice of pilots against having anything on the aircraft which could not be used directly for attacking the enemy. Another difficulty was that it was always the worse type of machine which was allocated for experimental purposes.

Air-Commodore W. E. G. Mann, in dealing with air traffic control, said that they should be careful not to concentrate on a system designed to meet the most difficult conditions in the London area, but one which was flexible and capable of economically meeting requirements along the Commonwealth and Empire routes, where the weather was better and the traffic density less.

Mr. R. H. Woodhall asked whether the saving in weight on the radar transformers was the only reason for using a 1,600-cycle instead of the standard 400-cycle supply. Actually, the weight of the additional inverters would increase the weight of the power conversion plant. He also asked why the voltage and frequency of the supplies from the inverters to the radar equipment had to be controlled within $\pm$ 1 per cent., as many radar installations were operated from engine-driven alternators the output of which varied in a ratio of 1 to 2.

Mr. C. Orde pointed out that with the increase in the speed of civil aircraft it would be necessary to increase the speed of communication throughout the system for the sake both of safety and operating efficiency. Radio equipment was no longer merely an accessory and should be carefully considered from the outset. He believed that in future it would be necessary to justify not only the first cost of aircraft equipment, but the space and weight which had to be subtracted from the totals available.

Air Vice-Marshal O. G. Lywood criticised the accuracy of the record of early work given in the paper. More had been done by the Royal Flying Corps than was suggested. The use of very high-frequency had been an important factor in winning the Battle of Britain.

Dr. O'Kane, in reply, said that there was no doubt that Gee was a very valuable device and agreed that the high-range altimeter for pressure-cabin flying should have been mentioned. He did not think there was any particular reason for using 1,500 cycles for the radar equipment. The reason for installing radar equipment in civil aircraft was that it enabled a specific journey to be completed in the right time.

(To be continued.)

LABOUR NOTES.

Reductions in direct taxation are urgently needed to provide an incentive to industry, according to a memorandum presented to the Royal Commission on the Taxation of Profits and Income by the British Bankers' Association. On this question, the Association states that beyond a certain point there is a direct conflict between the need to provide incentives and the attempt to redistribute the national income by means of progressive taxation. The opinion of the bankers is in no doubt that, "with the present steep graduation of rates of direct taxation, that point has been reached and passed." If a reduction in direct taxation cannot be achieved by economies in public expenditure, the Association continues, it is obvious that there should be a change "to some considerable extent" from direct taxation to indirect taxation. There might, for example, be a withdrawal of the subsidies, which at present overburden the budgets both of the Government and of the local authorities, and which may be regarded as indirect taxation of a negative character.

The debt owed by British industry and national prosperity to the enterprise, initiative and vigour of individuals, who, from small beginnings, have built by great commercial and industrial concerns, can scarcely be exaggerated. As examples of such men, the Association refers to Jesse Boot, Thomas Lipton and William Morris, and states that all the ability and enterprise of such industrial organisers would have been unavailing if they had been unable to accumulate the necessary capital, in growing volume, out of their retained taxed profits. The Association feels that, if leaders of this calibre cannot emerge in this country, British industry will become stereotyped and stagnant, and the prizes of industrial efficiency "will pass to other nations whose taxation policy is less suicidal."

Wage increases granted to United Kingdom employees during the first six months of the present year reached an all-time record. In all, 7,098,000 workpeople, about one-third of the country's total working population, received net increases in their full-time wages totalling 2,785,300*l.* a week, representing an average of very nearly 8*s.* a head. During the corresponding months of 1950, according to the *Ministry of Labour Gazette* for July, some 2,304,000 workpeople received net increases in their full-time wages amounting to 385,000*l.* a week. In the period between January and June this year, 1,102,000 persons in the building and contracting industry received weekly increases aggregating 562,000*l.* net; in the transport and communications industries, 1,114,500 persons received increases amounting to 486,000*l.*; in the distributive trades, 443,000 operatives obtained increases totalling 175,000*l.*; and, in the textile industry, 625,000 workpeople obtained increases of 237,000*l.* in all. Increases received during the six months by employees in the engineering, shipbuilding and electrical-goods group of industries were comparatively small. A total of 182,000 persons received increases aggregating 80,900*l.* In the paper and printing industry, 256,000 operatives obtained increases in their wages amounting to 102,000*l.* a week.

During June last, the changes in the rates of wages, which came into operation in the United Kingdom, resulted in an aggregate increase that was estimated by the Ministry of Labour to amount to 314,000*l.* a week net in the full-time wages of 1,176,000 workpeople. The principal increases in that month affected persons employed in retail distribution by co-operative societies, personnel in the iron and steel industry, employees in the printing industry, and manipulative grades in the Post Office employed outside the London area. Many other classes of workpeople also received increases, including persons engaged in rubber manufacture, those employed in the retail food trades in Scotland, and operatives in rayon-yarn factories. In the iron and steel industry, there were small increases, payable under sliding-scale arrangements based on the index of retail prices. In the printing industry, many classes of operatives obtained advances in their wages. In the London district, minimum rates were increased by amounts ranging from 10*s.* to 20*s.* 6*d.* a week for men in certain occupations, and by 8*s.* for women. Elsewhere, the increases were generally 10*s.* or 12*s.* 6*d.* for men, and 8*s.* for women.

There were advances during June in the figures for each of the four categories into which the index of rates of wages is divided. At the end of the month, the index stood at a level of 119 for all employees, and at 118, 122, and 124, for the men, women and juvenile classes, respectively. These figures represented an advance of one point during June for each of the four classes. This index measures the movement, month by month, in the level of full-time weekly-wage rates in the principal industries and services in the United Kingdom, compared with their level on June 30, 1947, which is taken as 100.

An advance, by one point, also took place in the figures of the interim index of retail prices during the month ended June 19. At that date, the level of the index was 125 for all items and 136 for food only, compared with figures of 117 for all items and 127 for food only in mid-January, 1951. This index measures the average changes, each month, in the United Kingdom prices of goods and services which entered into the expenditure of working-class households before the war. It was commenced on June 17,1947, the level at that date being taken as 100.

There was a definite upward trend in the severity of industrial disputes in progress in the United Kingdom during June, according to the statistics issued by the Ministry of Labour. There were, in all, 184 stoppages in progress, of which 25 were in being before the month began and 159 were commenced during the month. Some 84,800 workpeople were involved in the 184 stoppages and they lost a total of 304,000 working days. During the preceding month, there were 192 strikes, but only 59,400 workpeople took part and the loss of working days as a result of them numbered rather fewer than 202,000. The comparative figures for June, 1950, show that there were 146 stoppages in that month and that 28,700 persons took part in them, with a loss of 95,000 working days. Of the 184 stoppages in progress during June last, eleven were still in being when the month ended. Of the remaining 173, the Ministry report that 94 lasted two days or less, 21 lasted three days, 27 lasted between four and six days, and 31 were in progress for more than six days.

Trade disputes beginning during the period January to June last numbered 898, in which some 237,000 persons took part and over 1,220,000 working days were lost. The corresponding figures for the first six months of 1950 show that 761 disputes were begun, in which 148,000 workpeople were involved and 588,000 days were lost. During the first half of the present year, there were 50 stoppages in the engineering industry, in which 14,800 operatives were concerned and 61,000 days were lost; and in the shipbuilding and ship-repairing industry there were 48 stoppages, with 4,000 men involved and 25,000 days lost.

Fresh demands by the three principal railway unions for a 10 per cent. increase in wages for operating, maintenance and clerical staffs were submitted to the Railway Executive on Tuesday last and a meeting between representatives of the two sides of the industry is expected to take place next week to discuss the joint claims. Similar claims were presented to the London Transport, Hotels, Road Haulage, and Docks and Inland Waterways Executives on behalf of members of the three Unions employed by these Executives. Well over 500,000 railway and allied employees belonging to the National Union of Railwaymen, the Associated Society of Locomotive Engineers and Firemen, and the Transport Salaried Staffs' Association are affected by the demands, which, if conceded in full, would involve the Executives of the British Transport Commission in an addition of around 20 million pounds to their annual bill for wages and salaries.

In addition to subscribing with the other two unions to the joint claims, the Associated Society of Locomotive Engineers and Firemen is asking for an increase in the rates of overtime paid to locomotive staffs who are employed at week-ends. In this connection, the Society's demands amount to time-and-a-half payment for Saturday afternoons and double time for Sundays. Under present agreements, work on Saturdays is paid for at single time rate and that on Sundays at time-and three-quarters rate. Mr. J. G. Baty, the general secretary of the A.S.L.E.F., stated on Tuesday that these additional payments were "absolutely essential," if adequate services were to be maintained. Locomotive men employed in the railway workshops are not concerned in the present claims, although separate demands on their behalf may follow at a later date. Some sections of the engineering staffs are affiliated to the Confederation of Shipbuilding and Engineering Unions. A claim for a 10 per cent. advance for supervisors in railway workshops was submitted to the Railway Executive on July 30. Much stress is being laid by the unions on the labour shortage from which the railway service is now suffering and allege that many railwaymen are leaving British Railways for service in other industries, where the remuneration is higher. The unions have requested that their claims should be given "very early consideration."

EXPERIMENTS ON THE "LUCY ASHTON"

Fig. 8. THRUST CALIBRATING GEAR

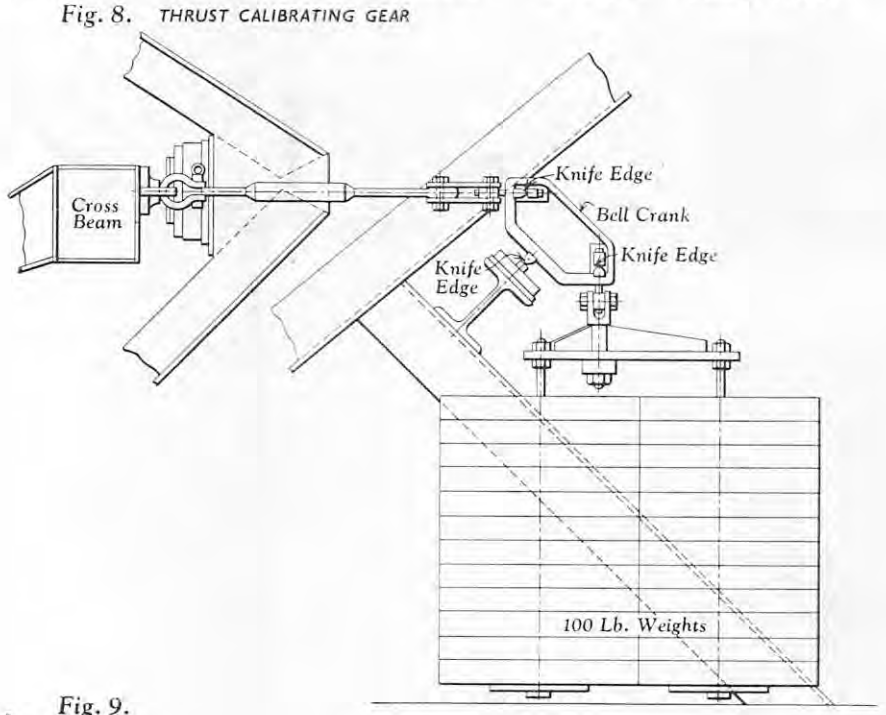
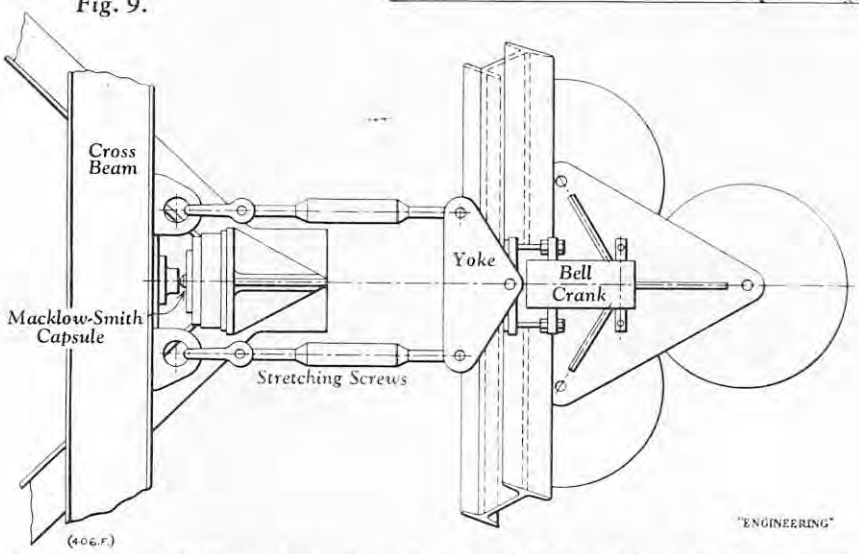


Fig. 9.



RESISTANCE EXPERIMENTS ON THE "LUCY ASHTON."*

By SIR MAURICE E. DENNY, Bt., K.B.E.

(*Concluded from page* 123).

ACCURATE measurement of thrust was, of course, of vital importance. Macklow-Smith hydraulic load-measuring capsules† were finally chosen. The capsule consists of a shallow cylinder and piston enclosing a small quantity of hydraulic fluid, with a pressure connection led to a remote-reading pressure gauge on the instrument panel in the engine control room. Instead of a gland between the piston and cylinder, however, the seal is made by an annulus of rubber, bonded to the walls of the cylinder and piston. When load is applied to the outer face of the piston, the pressure on the enclosed fluid rises; the rise is registered on the pressure gauge and is a measure of the applied force. The displacement of the piston under the maximum applied thrust is extremely small—less than a hundredth of an inch—with the result that the resistance set up by the rubber bonding is negligible and, in any case, is accounted for in the calibration of the device. The effect of the rubber-bonded seal, therefore, is to produce what is equivalent to a "frictionless" piston and cylinder and overcomes any doubt or difficulties that might arise due to friction or sticking in a conventional packed gland or lapped ram. Moreover, this type of capsule is very robust and accommodating in that tests have shown that its operation is not adversely affected if the application of the load is not strictly axial, which was an important consideration in this shipborne installation. The pressure connection between the capsule and the pressure gauge was made with a flexible hydraulic tube, $\frac{1}{16}$ in. bore. Each engine was fitted with its own thrust-measuring device on these lines. The capsules were rigidly mounted immediately in front of the forward cross-members of the engine cradles, and in line with the axis of the engines.

The pressure gauges were 10 in. in diameter, graduated in 10 lb. of thrust and were fitted with a high-quality copper-beryllium Bourdon tube and jewelled movement, designed to suit the range of thrust delivered by the engines. The gauges were fitted on the engine control panels in the lower compartment of the sound-resisting cabin.

Each individual sealed thrust-measuring unit, comprising capsule, flexible capillary tubing and pressure gauge, was carefully calibrated before installation in the ship. In the first place, this was carried out in the laboratories of the de Havilland Engine Company, and subsequently, to an accuracy of $\pm$ 5 lb., in the dead-load calibrating machine at the National Physical Laboratory. This dead-load machine is a national standard. During the course of the trials, frequent calibrations were also carried out *in situ* by means of the calibrating gear, which is shown in Figs. 8 and 9, on this page, and also in Fig. 10, on page 154. This comprises a bell-crank lever mounted on a heavy cross-beam, some 2 ft. forward of the capsule. A vertical hanger with scale pans is attached to a horizontal yoke connected to the forward cross-beam of the engine cradle by two links. These links are in the same horizontal plane as the axis of the engine and, as the arms of the bell-crank are of equal length, the addition of dead weights to the scale pan will simulate an engine thrust of equal magnitude. The bell-crank pivot is mounted on a knife edge, as also are the connections to the arms. In this manner, an overall calibration of the engine suspension and capsule can easily be carried out at any time. The engine suspension is illustrated in Fig. 14, on page 155.

In the course of the trials, the calibrating gear and scale pans remained permanently in position, the weight of the latter inducing sufficient initial tension in the system to maintain stability and alignment of the various links, etc. Experience showed that there was close correspondence between the standard N.P.L. calibration and those subsequently carried out *in situ* on the ship, after making due allowance for differences in the ship installation for items such as the scale-pan weights and the pressure head due to the difference in level between the capsule and the recording gauge in the engine control room. The de Havilland Engine Company supplied the thrust-measuring and calibrating equipment, and gave advice and assistance in the installation of the gear.

Ship speed was obtained in the usual manner by sighting mileposts on shore, but, in addition to the usual visual sighting by observers with stop-watches, a novel photographic or "photo-finish" device was used. This instrument is a theodolite with a camera attachment which takes a film record of the observations. A photograph showing the general appearance of the instrument is shown in Fig. 12, on page 154. Its use enabled the ship speed with respect to the land to be determined with a very high degree of accuracy. The instrument was trained on each pair of mileposts, as they were approached, by means of a sighting telescope, and a moving film record was taken over a period of several seconds, to cover the transit of the front and back posts. On the film, most of the frame is taken up by an ordinary photograph of the front and back posts, but on the left-hand edge is a thin strip on which are simultaneously photographed various counters mounted on a small panel inside the theodolite. At the middle of this strip is the time counter, operated at half-second intervals by means of a contact clock. The camera speed was about 14 frames per second, so that there were generally seven frames of film between the half-second changes in the counter readings. It was possible to locate the alignment of front and back posts to within one frame of film; then, by interpolation on number of frames, the time at which the transit took place could be very accurately determined—certainly, to an accuracy of one-tenth of a second. In general, it was found that there was good agreement between times recorded by the visual observers with stop-watches and the ciné-theodolite; in the evaluation of speed, however, the latter times were always used as being the more accurate.

A special mast was fitted on the ship to take the wind-measuring instruments, which consisted of a carefully-balanced wind-vane and a cup anemometer. These instruments were fitted on a small cross-tree at the head of the mast, as shown in Fig. 11, on page 154. The mast had been used as a portable wireless mast on aerodromes. It was constructed of laminated and resin-impregnated paper tubes arranged in telescopic form, and was extraordinarily light and robust, easily adjusted for height and, consequently, eminently suitable as an instrument mast. Both the mast-head anemometer and the wind vane had electrical transmission to indicating dials fitted on a recording panel in the wheelhouse. To insure against electrical breakdown, wind speed was also measured by an observer with a hand-anemometer, stationed on the wings of the bridge as far away as possible from obstacles that might interfere with the airflow. This hand anemometer was also of the cup type. The wind vane at the mast-head was also read visually, for the same reason.

A continuous record of rudder angles was taken during the mile runs, and here again both visual and automatic recording was adopted. With regard to the latter, an electrical transmitter was attached to the rudder head, which recorded rudder movement on a dial on the instrument panel in the wheel-house. Direct visual observations of rudder angles were also made by means of a pointer attached to the quadrant, in conjunction with a large graduated ssale of degrees, which could be read through the windows of the wheel-house.

An "automatic observer" was fitted in the wheel-house. This consisted of a panel of instruments which was photographed every 10 seconds during the mile runs by means of a specially-designed 35-mm. film camera. The panel included the remote reading dials for wind speed, wind direction and rudder angles, and a small magnetic compass and a centre-second clock. The latter, which also gave the time of day, facilitated correlation of the results. A typical photographic record showing the various dials is given in Fig. 13, on page 155. The wind direction is indicated by the dial in the top left-hand corner and the wind speed by that in the bottom left-hand corner. To the right of this is the rudder-angle indicator and in the bottom right-hand corner is the time clock.

To explore the velocity distribution in the boundary layer, two Pitot logs were fitted in the ship's bottom, close to the middle line, one 72 ft. 6 in. and the other

* Paper (comprising Part I—Full-Scale Measurements of a report by the British Shipbuilding Research Association), presented to the International Conference of Naval Architects and Marine Engineers, at a meeting in London, June 26, 1951. Abridged.

† One of these capsules was illustrated and described in ENGINEERING, vol. 170, page 573, (1950).

RESISTANCE EXPERIMENTS ON THE "LUCY ASHTON."

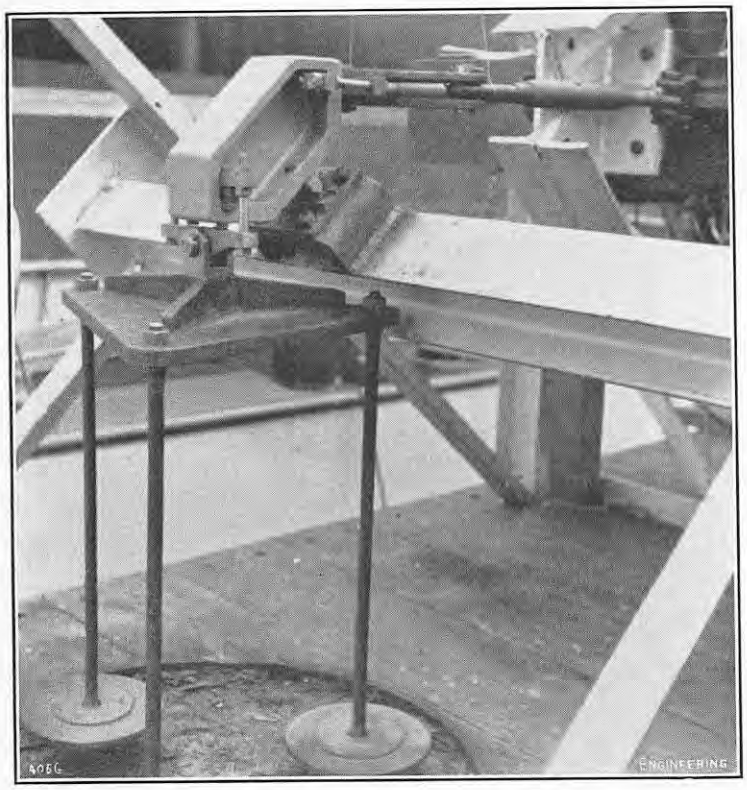


Fig. 10. Thrust-Calibrating Gear.

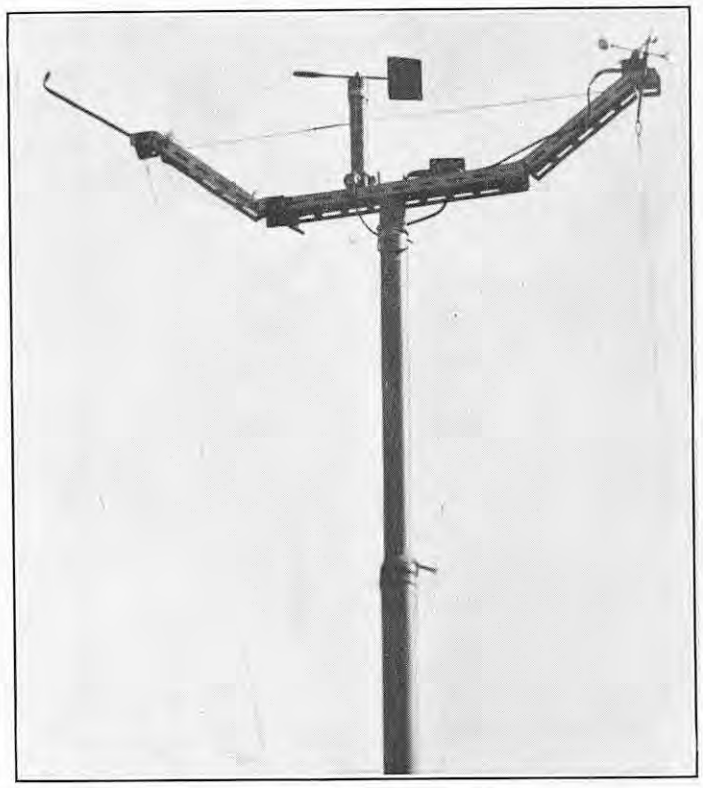


Fig. 11. Mast with Wind Vane and Anemometer.

97 ft. 4 in. from the forward perpendicular. The position of these logs is indicated in the elevation, Fig. 2, page 122, *ante*. These logs were of the type made by the British Pitometer Company and were supplied by that firm. The log consists of a hollow brass rod of streamline section, with a pressure orifice facing forward which measures the combined static and dynamic head, and orifices at the side which measure the static head only. These pressures are then connected to a mercurial differential manometer, on which readings of dynamic head alone are obtained, which is a measure of the speed of the log through the water. The rod passes through a gland in the ship's bottom and can be traversed to any position up to 3 ft. from the surface of the hull, thus enabling the velocity distribution in the boundary layer to be determined. It is necessary to calibrate these logs in the first place by making runs on the mile with the logs in the fully extended position, i.e., with the pressure orifice well clear of the frictional belt. An illustration of one of these logs in the extended position is shown in Fig. 15, opposite.

As previously mentioned, when the vessel was docked in preparation for the trials it was found that, after scraping and cleaning, the steel bottom was pitted to some extent and quite rough to the touch. Bearing in mind the importance of surface roughness on skin frictional resistance, the bottom was carefully treated and prepared to make it comparable with that of the freshly painted plates of a new steel ship. First, two thin layers of rivet cement were applied to the bottom, with an interval of several days between the applications to allow the layers to dry thoroughly. Two coats of ordinary red-oxide paint were then applied which was to be the basic surface throughout the trials. This treatment produced quite a good surface, which was considered comparable with, but not superior to, that of a freshly-painted new ship.

With regard to the arrangement of the plating, there were three longitudinal overlapped seams per side below the waterline. The plates were $\frac{1}{4}$ in. thick and the edges were sharpened somewhat to make the seams comparable with similar seams on a new ship. The butts of the plates were fitted with inside straps and were flush on the outside. The rivet heads had been worn almost flush in the course of the ship's long service and what little was left of them was generally covered by the applications of rivet cement to the hull, referred to above. The only excrescences on the hull surface were the longitudinal overlapped seams of $\frac{1}{4}$ in. thickness.

In view of the importance of surface roughness, it was decided to make roughness measurements on the hull as far as possible before each trial. In some instances, where the trial had been unduly prolonged due to inclement weather, similar roughness measure-

Fig. 12. Cinḗ Theodolite.

ments were also made after the trial to confirm whether or not there had been any deterioration of the surface in the course of the experiments. Two types of gauge were used to measure the roughness, both of which had been developed by the Metrology Division of the National Physical Laboratory, Teddington. In the first place, the staff of this Division carried out the measurements and gave valuable assistance in the course of the trials.

The wall-roughness gauge used consists of a steel probe of 0·125 in. radius and has a working traverse of about 12 in. The movements of the probe normal to the surface under examination are recorded autographically on a paper strip at a vertical magnification of 10. The horizontal traverse is full size. This instrument is most useful for recording local unfairness in the plating, or long-period "waviness." Due to the relatively large size of the ball probe, however, it is not suitable for recording short-period roughness or the quality of paint surface. For records of this nature, an aerofoil gauge was used. This is a much more sensitive instrument than the wall gauge and was designed by the Metrology Division of the N.P.L. for the examination of the surface finish of aerofoil surfaces. In this case the probe has a radius of $\frac{1}{32}$ in. and its vertical movement is magnified 18 times and transmitted to a scribing point which makes a record on a smoked-glass plate. The maximum traverse of the probe is 6 in., but this is reduced six times on the trace recorded on the smoked-glass plate. Subsequent optical enlargement of the record is made to facilitate the analysis. Comprehensive and systematic records were made with these gauges over the underwater surface of the hull; typical records for the red-oxide and aluminium-paint surfaces are reproduced in Figs. 16 and 17, on page 156. Fuller details of these records and their implications will be given in subsequent papers.

In the course of the trials, it became known that bituminous aluminium paint would probably give a smoother surface than the ordinary red-oxide paint generally used. Sample plates were therefore prepared and tested in the Talysurf machine at the Royal Technical College, Glasgow, which showed that this was the case. These preliminary tests showed an improvement of the surface finish of the order of 40 per cent. in favour of the aluminium paint. It was then decided to add to the programme a series of tests in which the hull was treated with this paint to ascertain whether it had any beneficial effects on the resistance. When treated with this aluminium paint, the hull surface appeared to be smoother and harder than the red-oxide paint, and this was borne out by roughness records taken with the aerofoil gauge, a typical specimen of which is reproduced in Fig. 17, on page 156. The average values of the measured roughness for freshly-painted red oxide and aluminium paint were 0·009 in. and 0·006 in., respectively. Little comparative information exists on the roughness of the hulls of new vessels, but Dr. G. Kempf quoted a figure of 0·012 in. for freshly-painted ships in a paper before the American Society of Naval Architects and Marine Engineers in 1936. This is of the same order as that measured onthe red-oxide paint surface on the Lucy Ashton.

After considering the measured mile facilities available in the Clyde area, it was decided to run the trials on the measured course in the Gareloch, which is a sheltered inlet off the Firth of Clyde. This had almost all of the desirable features for trials of this kind, including absence of strong tides, reasonably good

RESISTANCE EXPERIMENTS ON THE "LUCY ASHTON."

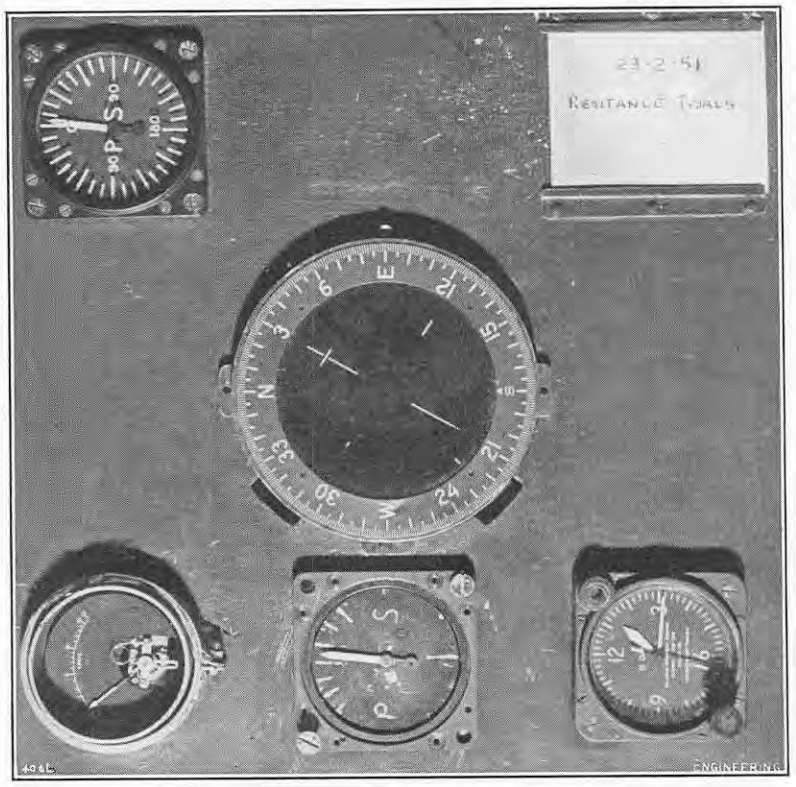


FIG. 13. AUTOMATIC OBSERVER RECORD.

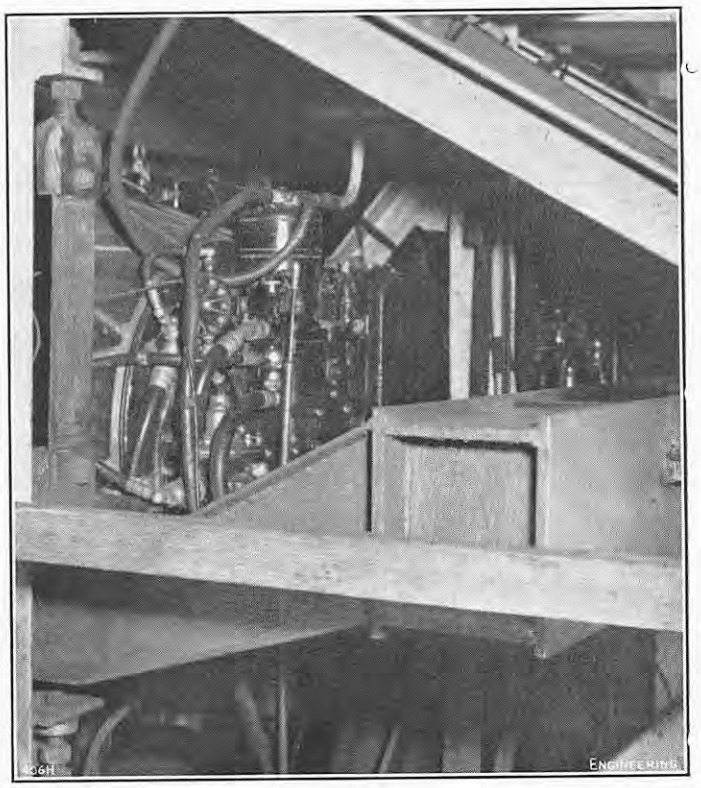


FIG. 14. ENGINE SUSPENSION.

shelter from winds, and adequate depth of water. On the measured course and the approaches, the depth of water was nearly uniform and about 17 fathoms. In addition, there was very little traffic in the loch and it was conveniently placed as regards docks, slips, and Denny's shipyard, where the ship was refitted. The course was one nautical mile in length and was equipped with posts at the half-mile and also at the quarter-mile at the southern end only. The mile was re-surveyed before the trials and the position of one of the posts was altered slightly to obtain the maximum possible accuracy.

It was originally intended to run these trials only under ideal weather conditions. Owing to continuing inclement weather during the autumn of 1950, and bearing in mind the inevitable deterioration of the hull surface with the passage of time, it was occasionally necessary to run in natural winds of speeds up to about 10 knots. The latter figure was regarded as a maximum, to be exceeded only in exceptional circumstances. On any particular day, the decision as to whether trials were possible or not depended on the special weather forecasts obtained from Renfrew Aerodrome, and observations on the spot of prevailing weather and water conditions.

Many factors, such as the number of hours of daylight, the amount of fuel required, etc., had to be considered before deciding upon the number of runs, the thrusts and their appropriate engine settings, etc. The thrust gauges were calibrated before and after each day's running, the automatic observer instruments and ciné-theodolite equipment were checked, and watches synchronised and tested. Immediately before and after trials the draughts were read, readings of water temperature and density were obtained, and samples of water were occasionally taken from which the viscosity of the water was determined. In general, the variation of viscosity with temperature was found to agree with the results published by Lyle and Hoskins.

Double runs were made over the measured course (that is, with and against the tide) and the following observations taken :—

(*a*) Time at start of mile.

(*b*) Time over half-mile and mile by each of two observers using binoculars and stop-watches (each observer had two stop-watches, one recording the time of the first half-mile, and the other the time over the full mile). Photographic records of each crossing of the posts were also taken by the ciné-theodolite.

(*c*) Wind speed by an observer with a hand anemometer stationed on the wings of the engine gantry, taken at quarter-minute to half-minute intervals during the mile ; also by the electric anemometer at the mast-head, transmitting to the automatic observer.

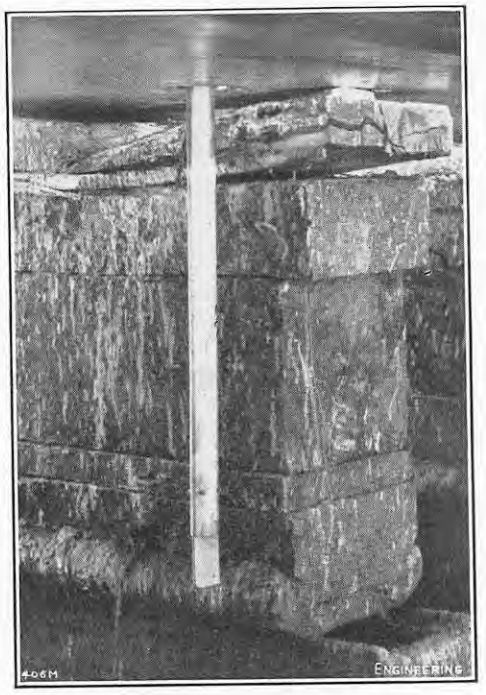


FIG. 15. PITOMETER LOG.

(*d*) Wind direction, observed from a vane, which was also transmitting to the automatic observer.

(*e*) The helm angle, which was transmitted to the automatic observer and also read continuously from a helm indicator at the stern by an observer in the wheel-house. The magnitude of helm angle was recorded to a base of time.

(*f*) The Pitometer log was lowered and read at the end of the mile run, but before altering course for the turn, to obtain a check on the water speed for tidal analysis.

(*g*) The required engine thrust settings were made during the approach to the mile and no further throttle adjustments were made until the mile was completed. The gauges were then read every quarter-minute during the approach and the mile run.

(*h*) Photographic records were taken of the instruments on the automatic observer panel at intervals of approximately 10 seconds from the last quarter-mile of approach to the end of the mile.

(*i*) Visual records were taken of the sea surface conditions during the tests.

(*j*) The amount of fuel consumed during each run was determined by tank soundings at the beginning and end of each run.

(*k*) Change of trim during the mile runs was noted by means of a trim board.

At the end of each day, all thrust gauges were calibrated, fuel was taken on board as required, and the main starting batteries were charged overnight.

The times on the mile were taken at the half-mile as well as the full-mile posts, as a precaution to ensure that the vessel was fully up to speed when running over the mile. To ascertain the minimum length of run necessary in approaching the mile, acceleration trials were carried out ; the results of one of these in which the ship was accelerated from rest up to a speed of 13·7 knots is shown in Fig. 18, on page 156. In this instance, steady speed was reached in about $\frac{3}{4}$ mile ; generally, in the course of the trials, at least one mile of straight approach to the measured mile was obtained. In the acceleration trial referred to, the distance run and the speed were measured by means of a floating log or drogue.

Experience showed that the ship could be handled and manœuvred without difficulty, and, in the pilot's view, the behaviour of the ship did not differ to any appreciable extent from that of a normal ship. The whole technique of taking and recording the various observations described above and in the previous sections worked quite smoothly and there were few teething troubles. The Rolls-Royce engines behaved extremely well, and experience during the mile runs showed that, for a given throttle setting, the delivered thrust remained remarkably constant. It will be noted that the precaution was always taken of supporting electrically-transmitted automatic records by corresponding visual observations, to insure against electrical breakdown. Experience on a few occasions proved this to be a wise precaution. The trials were conducted by a team drawn from the staffs of the B.S.R.A. and from the experiment tank and engine works of Messrs. Denny, at Dumbarton.

Analysis of all the data obtained is a lengthy process, and for this reason it is not possible to present complete resistance results at this stage. Moreover, the corresponding model experiments to complete the ship-model comparison are not yet available. Some resistance results are, however, given below.

It is desirable to assess the accuracy possible in these experiments. Speed can be measured to a considerable degree of accuracy and at 10 knots this is of the order of one-tenth of one per cent. To determine the speed through the water necessitates correction for tide, and it is not a simple matter to resolve the separate effects

RESISTANCE EXPERIMENTS ON THE "LUCY ASHTON."

Fig. 16. WALL ROUGHNESS GAUGE RECORDS

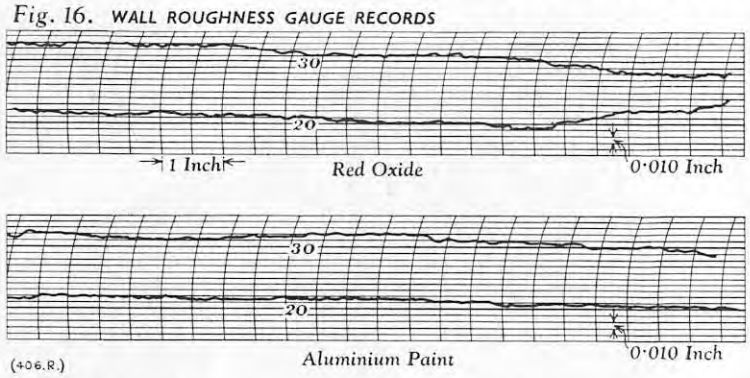


Fig. 17. AEROFOIL GAUGE RECORDS

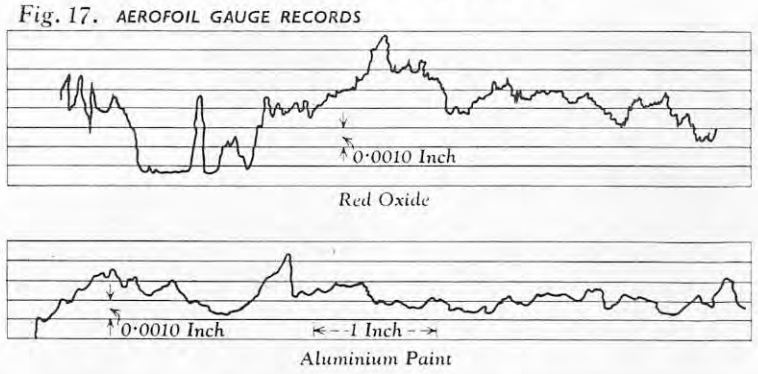


Fig. 18. ACCELERATION DIAGRAM

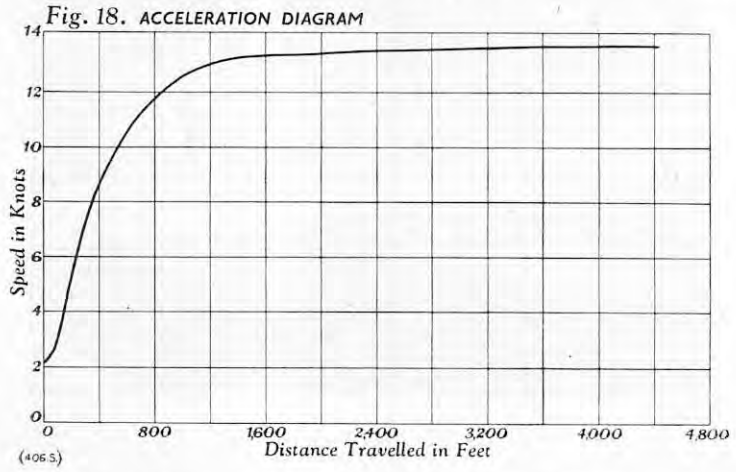


Fig. 19. RESISTANCE CURVES: NAKED HULL, SHARP SEAMS

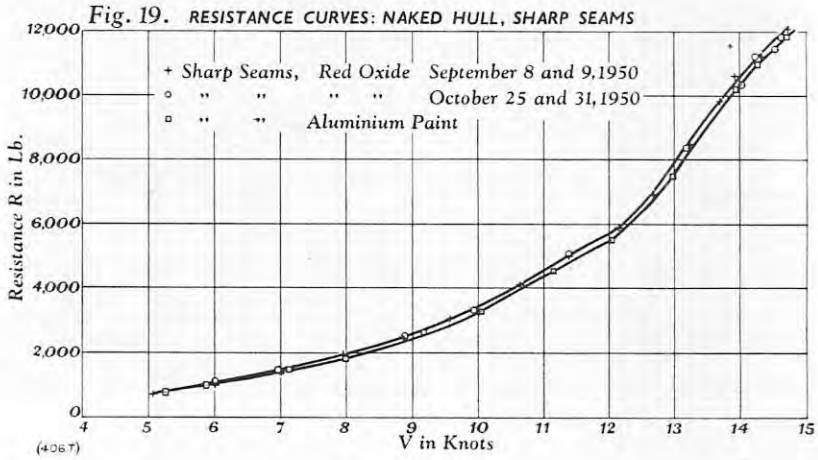


Fig. 20. RESISTANCE CURVES: NAKED HULL, SHARP SEAMS

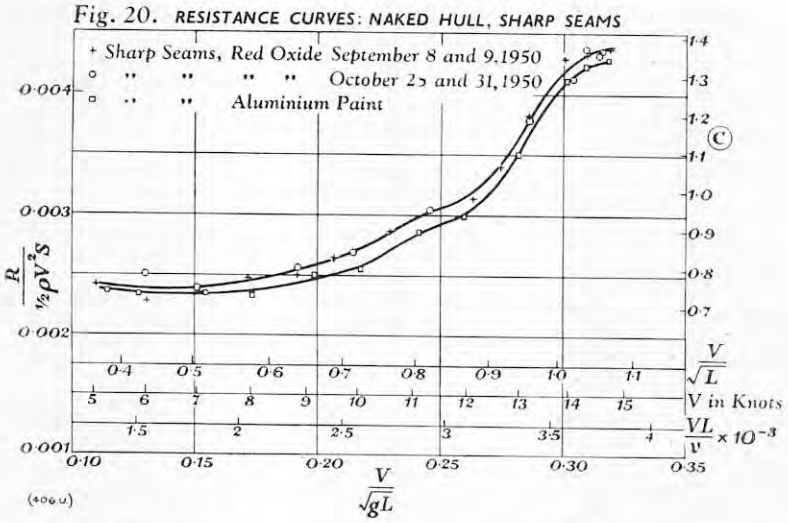


Fig. 21. RESISTANCE CURVES: NAKED HULL, FAIRED SEAMS

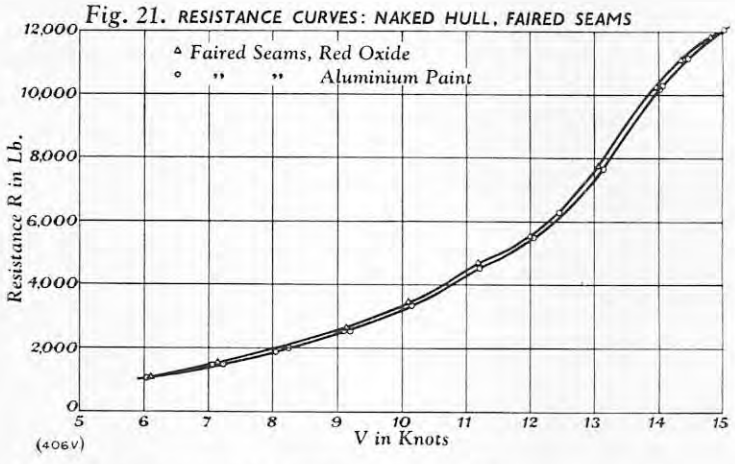


Fig. 22. RESISTANCE CURVES: NAKED HULL, FAIRED SEAMS

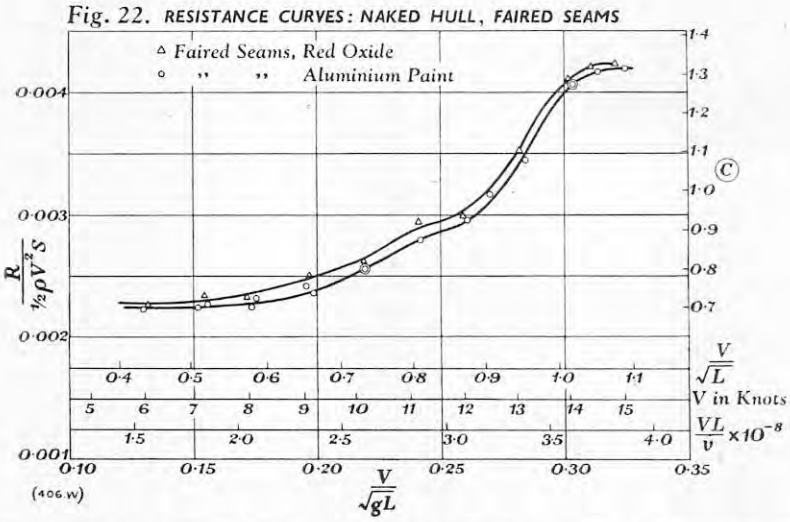
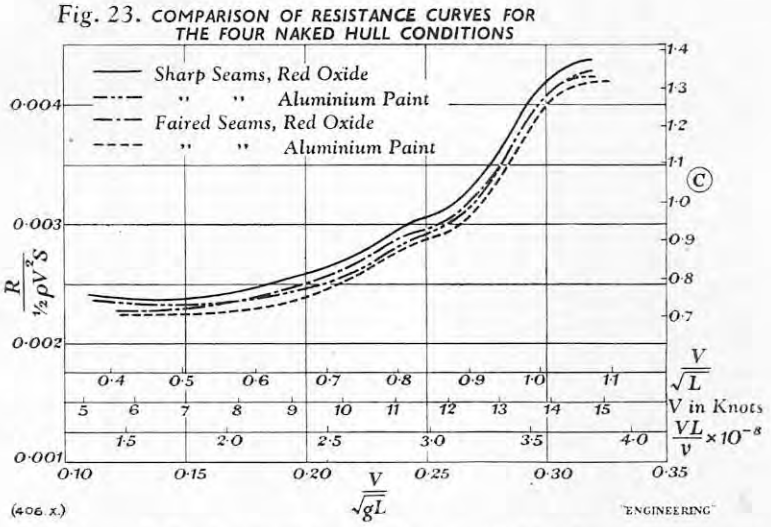


Fig. 23. COMPARISON OF RESISTANCE CURVES FOR THE FOUR NAKED HULL CONDITIONS



of wind and tide. Thrusts delivered by the jet engines were measured to an accuracy of approximately ± 5 lb. for each engine. At low speeds of about 5 knots, where only two engines are used, this error would amount to about 1½ per cent. on resistance, and at top speeds of about 14¾ knots, where four engines are used, it would amount to about one-sixth of one per cent. Rudder angles were negligibly small, thanks to skilful course-setting and course-keeping on the part of pilot and quartermasters.

The most difficult correction is that for the effect of wind. Attempts were made to measure the wind resistance of the hull when moored to a buoy in natural winds of various velocities. In the wire securing the vessel to the buoy a Macklow-Smith capsule was fitted, and the gauge readings showed considerable fluctuations, as is to be expected, in natural winds. From an analysis of the many readings obtained in this way, it was possible to arrive at a fairly reliable figure for the resistance due to a wind blowing from directly ahead. With relative winds at various angles to the

vessel's centre line, the correction is not determinable from measurements on the ship, and to obtain further and more accurate information on this point a special model was constructed and tested in the duplex wind tunnel of the Aerodynamics Division at the National Physical Laboratory. With this combination of full-scale and model results, the wind and air resistance of the hull can be computed over a wide range of wind directions from dead ahead to dead astern. The accuracy of the corrections for the effect of wind and air resistance is a little difficult to estimate, but the maximum error involved is not more than about 1 per cent. of the ship resistance over the whole speed range.

In view of their interest, however, and to give an indication of the general quality and accuracy of the results obtained, resistance curves for the four naked-hull conditions 1, 2, 5 and 6, enumerated earlier in the paper, are presented. These are: sharp seams with red-oxide paint; sharp seams with bituminous aluminium paint; faired seams with red-oxide paint; and faired seams with bituminous aluminium paint.

In Figs. 19 and 20, opposite, the experimental observations for the two sharp-seam conditions are plotted; in Fig. 19, in the form of pounds resistance against speed in knots and in Fig. 20, in the non-dimensional form $\frac{R}{\frac{1}{2}\rho V^2 S}$ against Froude number $\frac{V}{\sqrt{g L}}$ and Reynolds number $\frac{V L}{\nu}$, S being the wetted surface of the hull, and other symbols having the usual significance. In Fig. 20, scales of ©, speed in knots and $\frac{V}{\sqrt{L}}$ (knots and feet are also given. Figs. 21 and 22 give similar presentations for the two faired-seam conditions referred to above. The estimated wind and air resistance has been deducted from the experimental observations and they have been corrected to a standard temperature of 59 deg. F. and a mean displacement of 390 tons.

Referring to the curve for the sharp seams and red-oxide paint, shown in Figs. 19 and 20, it will be noted that the experimental observations refer to two separate trials carried out with an interval of seven weeks. The reason for this was that, after the first trial in this condition, tests were subsequently carried out with dummy bossings and then dummy "A" brackets, and then the naked-hull condition was repeated in order to confirm whether this basic curve of comparison had been maintained. The close correspondence of the two sets of observations shown in Figs. 19 and 20 shows that this was the case and is a striking confirmation of the accuracy of thrust measurement.

To facilitate comparison between the results for the different conditions, the four resistance curves have been brought together in Fig. 23, opposite, in the non-dimensional form of presentation, and for clarity, in this instance, the experimental observations have been omitted. The following remarks refer generally to Fig. 23.

Comparing the curves for the sharp-seam conditions, it will be noted that the smoother aluminium-paint surface has slightly less resistance; on the average, about 3½ per cent. less than the red-oxide paint. On the basis of the estimated skin friction resistance, which is perhaps the better criterion for this effect, the average difference amounts to about 5 per cent. Referring now to the results for the two faired-seam conditions, it will be noted that the smoother aluminium-paint surface has again slightly less resistance; on the average, about 3 per cent. less than the red-oxide surface. This is of the same order as the improvement of 3½ per cent. obtained in applying aluminium paint to the sharp-seams and red-oxide condition.

Comparing next the sharp-seams and red-oxide curve with that for the faired-seams and red oxide, it will be noted that the seam fairing has reduced the resistance slightly and, on the average, the reduction amounts to about 3 per cent. The fairing consisted of a wedge of composition 3 in. wide, i.e., 12 times the thickness of the overlapped plating, which was ¼ in. It has to be mentioned here that, when the ship was docked for inspection after this trial, it was found that about 25 per cent. of the seam filler was missing and the gaps were fairly evenly distributed throughout the length of the ship. There was no evidence to suggest when the missing filler came away, but, assuming the very worst circumstances, i.e., that only 75 per cent. of the filler was intact when the trial began, then, by simple proportion, it seems not unreasonable to suggest that the complete filler might have improved the resistance by 4 per cent. at the most. In other words, the improvement would appear to lie between 3 and 4 per cent. and, as it is more likely that the missing filler came away late in the trial rather than early, the former figure of 3 per cent. is probably the more correct.

The improvement due to seam-fairing can also be independently assessed by comparing the curves for sharp seams with aluminium paint and faired seams with aluminium paint. On the average, the latter is about 2½ per cent. less than the former, which is of the same order as the reduction obtained when the seams were faired in the red-oxide paint condition and appears to confirm the lower figure of 3 per cent., referred to in the previous paragraph. It is clear, therefore, that the effect of fairing the seams, taken by itself, is to reduce the total resistance by about 3 per cent. and the separate effect of the application of the smoother aluminium paint is to reduce the total resistance by about the same amount.

The combined effect of fairing the seams and applying the smoother aluminium paint is given by direct comparison of the curves for sharp seams with red oxide and faired seams with aluminium paint and, on the average, the overall improvement amounts to about 6 per cent. This confirms the above statements, and is an important and interesting result.

In the non-dimensional presentation given in Fig. 23, it will be seen that, apart from some local deviations, there is, in general, distinct parallelism between the various curves. This will tend to diminish somewhat the percentage difference between the curves at high speeds due to the rising resistance coefficient $\frac{R}{\frac{1}{2}\rho V^2 S}$ or ©. In the above discussion, however, only the mean percentage differences over the whole speed range have been quoted, which were considered to be the simplest and most convenient method of comparison at this stage.

Also of interest are the results obtained with a deteriorated aluminium-paint surface due to the ship having been laid up at the buoy in the Gareloch for a period of 40 days during December and January. Before putting the ship on the slip in preparation for the next trial condition, the opportunity was taken to make a few runs on the mile, and the increase in resistance due to the bottom deterioration was found to be of the order of 3½ per cent. on the total resistance. On the basis of skin-friction resistance, this increase is of the order of 5 per cent. On slipping the ship, it was found that there was no visible evidence of fouling apart from the fact that the hull was covered with a light scum, which was slimy to the touch. There was also appreciable exfoliation of the top coat of aluminium paint, which was ascribed to the paint having been applied in frosty weather.

Thickness and velocity gradient of the boundary layer were recorded at two positions in the forward half length under the flat of bottom by means of the Pitometer logs. Acceleration trials were also conducted in the Firth of Clyde to determine the minimum lengths of approach for the measured mile, and the virtual inertia factors.

In conclusion, it has been shown that the direct measurement of the full-scale resistance of the Lucy Ashton has been achieved with a high degree of accuracy over the speed range of 5 to 15 knots. For the measurement of full-scale ship resistance, the trials have shown that propulsion by means of aircraft jet engines is eminently suitable in that the delivered thrust, and therefore the resistance, can be very accurately measured; and that the ship can be handled and manœuvred on the measured mile with the same facility as any other vessel with conventional means of propulsion. In the light of the above, it is considered that this method of carrying out full-scale trials overcomes the difficulties in resistance and speed measurement inherent in towing, which has been the method adopted by previous experimenters in this field.

The trials have emphasised the importance of the effect of the condition of the hull surface on the resistance. Using the resistance of the clean, naked hull with sharp seams and red-oxide paint as the basis of comparison, the preliminary results have shown that fairing the seams reduced the total resistance by about 3 per cent.; that, when the hull was painted with bituminous aluminium paint, the total resistance was reduced by about 3½ per cent., which is equivalent to about 5 per cent. on the estimated skin-friction resistance; and that, when the seams were faired and the hull painted with bituminous aluminium paint, the total resistance was reduced by about 6 per cent. The improvement in resistance with the aluminium paint surface has been borne out by roughness measurements, which have shown this surface to be smoother than that of the red-oxide paint.

Trials run with the naked hull with a bituminous aluminium-paint surface, after the ship had been laid up for 40 days, showed that the total resistance had been increased by about 3½ per cent. On the basis of estimated skin-frictional resistance, this amounts to about 5 per cent. Subsequent docking showed that there was no evidence of fouling apart from a thin coat of slime, and the increase in resistance was to be ascribed to this and to the deterioration of the paint surface. The results give definite proof of the sensitivity of full-scale ship resistance to small roughnesses and emphasise the importance of obtaining the smoothest possible surface on the finished ship.

THE HEAT TREATMENT OF WELDS IN PIPELINES.*

By A. H. GOODGER, M.Sc.Tech., A.R.I.C.

(*Continued from page* 127).

In 1944, the Pipe-Line Committee of the Welding Research Council carried out a large number of tests on approximately 100 test joints, oxy-acetylene welded by expert firms. The pipes varied from 2 in. nominal bore and 10 s.w.g. wall thickness to 8 in. nominal bore and ⅜ in. thick, representing the usual range of heating piping. Normalising was found to have little effect in most cases on the reverse-bend tests of sound welds, and showed a very slight improvement on slightly unsound welds. It was considered that soundness of weld had more effect on bend tests than normalising in the thicknesses tested. A number of notch-sensitivity tests were made on sub-standard impact test pieces in the welded and in the normalised conditions. Some of the results obtained are given in Table III, herewith.

TABLE III.

Bore.	Wall.	Rod.	Treatment.	Unwelded Average.	Centre of weld Average.
In.	In.			Ft.-lb.	Ft.-lb.
6	¼	A	As welded	20·2	11·7
6	¼	A	Normalised	19·3	18·0
6	¼	B	As welded	20·0	7·7
6	¼	B	Normalised	20·2	11·7
8	⅜	A	As welded	18·2	10·3
8	⅜	A	Normalised	18·5	18·3
8	⅜	B	As welded	18·2	10·3
8	⅜	B	Normalised	18·2	16·3

Some of the figures shown as averages contained some low results, two of these, making up the average of 7·7, being each 4 ft.-lb. They were not unsound. There is a distinct improvement shown by normalising, the improvement in each case being over 50 per cent. and in one case considerably more. The Committee considered that, with pipes of the maximum thickness tested, where the pressure and temperature conditions did not exceed 250 lb. per square inch and 425 deg. F., the normalising of oxy-acetylene welds could be waived, in spite of the improvement in impact resistance. It was considered that pipe-lines carrying steam at higher pressures and temperatures had more arduous working conditions; the pipes would be thicker, probably less flexible and certainly subject to much greater variations in temperature at times, resulting in much higher thrusts and consequently higher bending stresses.

As the wall thickness increases, the improvement in notch-sensitivity after normalising is considerable, and still more so with low-alloy steels. For this reason, the draft British Standard for oxy-acetylene welding of pipe-lines recommends normalising of all pipe-line welds for service conditions over 250 lb. per square inch and 425 deg. F. (220 deg. C.). Admittedly, the dividing line is an arbitrary one, as with all heat-treatment requirements; there is never a sharp change in physical properties, but the figures chosen have much to commend them.

This requirement of normalising applies to all the steels except molybdenum-vanadium steel and austenitic steels which are not normally oxy-welded. Normalising, as will be obvious from the nature of the atomic re-arrangement, can only be carried out on metals with critical points; metals like copper and austenitic steels are not susceptible to normalising. Normalising obviously tempers heat-affected zones where they exist and, if the welded part is cooled uniformly and slowly, also completely removes internal stress. It is usually only applied to oxy-acetylene welds; arc welds can be normalised, and this is sometimes done where it is more convenient than stress relief.

The main effects of stress relief on arc welds are tempering and removal of internal stress. The prevention of stress corrosion naturally follows the removal of stress. In most metal arc-welds there is little reason for grain-refining as the cooling of the fused metal is rapid, leading to a fine grain size, and there is little overheating of parent metal. For this reason the heat treatment after welding is usually confined to relief of stress at temperatures below the lower critical point, so that no important structural change occurs, provided the time is not unduly prolonged. At the temperatures used, there is little serious scaling or distortion

The temperature generally used is within the range 600 to 650 deg C (1,110 to 1,200 deg. F.). In this range the metal is sufficiently plastic to allow the internal stresses to diminish by means of a process of creep. Reference to the British Welding Research Association document FE14/14, from which the curve,

* Paper presented at the summer meeting of the Institution of Heating and Ventilating Engineers held in Buxton, on June 19, 1951. Abridged.

Fig. 8, is taken, will show that stress relief is practically 98 per cent. complete on carbon steels at 650 deg. C. L. E. Benson has shown recently that, for low-alloy steels, a stress relief of over 80 per cent. is obtained in three hours at 650 deg. C. Increasing the time to six hours gave only a slight increase, and stress relief was practically complete at 675 deg. C.

It is not necessary for a pipe or other welded construction to be completely stress-free to reduce the tendency to fracture to nil; complete stress relief is only necessary for fabricated machine parts requiring dimensional stability. There are serious objections to stress relief at temperatures approaching 700 deg. C. and over, as spheroidisation is likely to occur and the creep resistance of most high-temperature steels would be much impaired. Some existing specifications advise the use of temperatures over the lower critical point, but metallurgists interested in creep-resisting steels take great exception to such a treatment. One specification calls for the heating of a low-chrome molybdenum pipe in the range of 1,325 deg. to 1,375 deg. F. (718 deg. to 746 deg. C.) for one hour per inch of thickness. Such a treatment is likely to reduce the creep resistance to what it would be after completing its useful creep life.

The ideal way of heat-treating pipe welds would be to heat-treat the whole pipe, but this would be expensive and unnecessary. A quite satisfactory and the least expensive way is to heat-treat (at a suitable temperature) a band embracing the weld. At 650 deg. C., stress relief will not be complete, but the creep properties will not be seriously impaired as they would be at slightly higher temperatures. Normalising of a pipe weld is again a compromise. The maximum temperature reached is usually 900 deg. C. or over at the weld, but there is a steep temperature gradient on each side. The curve, Fig. 9, shows the gradient in a pipe 14 in. outside diameter and 1 in. thick. There is a zone approximately 4 in. long in which the pipe is heated between 700 deg. C. and the upper critical point. There will be a narrow zone in which damage to creep properties will occur, but, by keeping the time as short as possible, the effect will not be serious. A narrow band of relatively low creep resistance, supported on each side by steel of satisfactory creep resistance, does not lead to any trouble. At Brimsdown, where all the joints were completely oxy-welded in a chrome-molybdenum steel for service at 2,000 lb. per square inch and 950 deg. F. (510 deg. C.), all the welds, some as much as $1\frac{5}{8}$ in. thick, were normalised. In 15 years the piping has been completely trouble-free.

Any overheated structure produced by the welding of the oxy-base run is effectively normalised by the subsequent runs of arc-weld metal; so the heat treatment necessary is stress relief, not normalising.

Stress corrosion is the name given to cracking or local corrosion, sometimes both, which takes place when a selective corroding agent attacks a metal containing a local area of residual stress. In such a class come season-cracking of brass and cupro-nickel tubes, nitrate cracking of steel, cracking of gas mains by gas liquors, caustic cracking and several allied forms of attack. It is a function of the magnitude of the residual stress and the particular corroding agent, and is not necessarily affected by temperature or working stress. It may occur at atmospheric temperature and pressure. Piping carrying liquids liable to set up stress corrosion should have the welded-joints stress-relieved.

Two examples of stress corrosion of arc-welded steel joints are given in Figs. 10 and 11, on this page. The first is a case of attack by concentrated sulphuric acid on the stressed areas near a weld, the wall thickness being $\frac{5}{16}$ in.; here is both cracking and corrosion along Lüders lines. The second case is of caustic-soda attack near a weld on $\frac{1}{4}$ in. material. In neither case would any attack have occurred if the welds had been stress-relieved. The attack in both cases was at zones of residual tension. It is to be noted that the width attacked in both cases is about $2\frac{3}{4}$ in. on each side of the weld centre.

With oxy-acetylene welds, all that is required is to normalise the steel with enlarged grain size, and this will be accomplished if a band not less than $\frac{1}{2}$ in. on each side of the weld reinforcement be included. The residual stress in an arc-welded pipe is usually determined by cutting rings and seeing how much they open or close on slitting. This method gives an average stress through the wall, and the usual stress-distribution diagram shows a high-tension peak at the weld, rapidly passing to compression on each side. It is probable that, in many cases, there may be tension on the inside of the wall and compression outside, or vice versa, depending on weld technique. Such a stress distribution would account for the very wide zone of attack in each of the stress-corrosion specimens illustrated; this attack is located in areas of residual tension. To be quite sure of freedom from stress in cases where stress corrosion is possible, the pipe should be stress-relieved over a band about 3 in. each side of the weld centre. For ordinary purposes of steam and power lines, it is usual to recommend heating a zone symmetrically over the weld centre equal in width to three times the width over the weld reinforcement. This seems to have worked quite satisfactorily.

For preheating, the appliances used may be oxy-acetylene or other gas torches, gas muffle furnace or perforated gas rings, electric resistance preheaters, or induction heating coils. Whatever method is used, the heat input and the temperature reached should be under control and easily maintained.

The preheating required to assist oxy-acetylene welding can often be done by a second operator, using an ordinary welding torch. It is more convenient to use special muffles, encircling the pipe, suitable ring furnaces, which can be supplied with propane or even acetylene from cylinders, are shown in Fig. 12, opposite. It is necessary to have the joint area raised to the required temperature before welding starts and to maintain the temperature at least until the first run is completed. It is usually advantageous to keep the preheating furnace going to maintain the temperature round the joint during the whole of the welding. Similar methods can be used for preheating thick-walled pipes where the bottom run is to be an oxy-base run, but, if desired, electric resistance preheaters or even induction heating can be used. Resistance preheaters may take the form of insulated coils, or the heating elements may be enclosed in sheaths like flat-irons, using several of these wired in parallel to encircle the pipe (see Fig. 13).

Similar methods and appliances can be used for preheating for arc welding; induction heating from a coil has been used frequently. The current is supplied either from a transformer, working at 50 cycles from the normal supply, or from a motor-generator, which may be a welding generator. The heating effect is more readily obtained with higher periodicity, but it is more convenient to work from the mains through a transformer. The current required at 50 cycles for a pipe 1 in. thick and 10 in. outside diameter is about 2,000 amperes at 12 volts, and the time taken to reach 200 deg. C. from cold is about 15 minutes. Such a method, using an asbestos-covered coil of 0·5 sq. in. cross section, is shown in Fig. 14, on the opposite page.

For pipes up to 4 in. bore, oxy-acetylene welds can be readily normalised with ordinary welding flames. It is possible to normalise pipes of 6 in. bore in this way, but care is necessary and better results are obtained by using a muffle. For pipes up to 6 in. bore, and thicknesses not exceeding $\frac{3}{8}$ in., the normalising can be done sectionally; but it is inadvisable for larger or thicker pipes, owing to the stresses set up on cooling. The normalising of large pipes by a number of gas burners was described by the author in a paper presented before the Institution of Mechanical Engineers.* Normalising with induction coils is not so easy, as the high temperatures required lead to breakdown of insulation. I. A. Rohrig has described a method of normalising using a coil of partly flattened and water-cooled copper pipe to carry the current.

Stress relief is difficult to effect satisfactorily with separate flames, as one of the desirable features in stress-relieving is uniformity of temperature distribution. Any of the other methods are satisfactory and a suitable muffle is shown in Fig. 15, on the opposite page.

(To be continued.)

Fig. 8. PERCENTAGE STRESS RELIEF IN MILD STEEL AT DIFFERENT TEMPERATURES

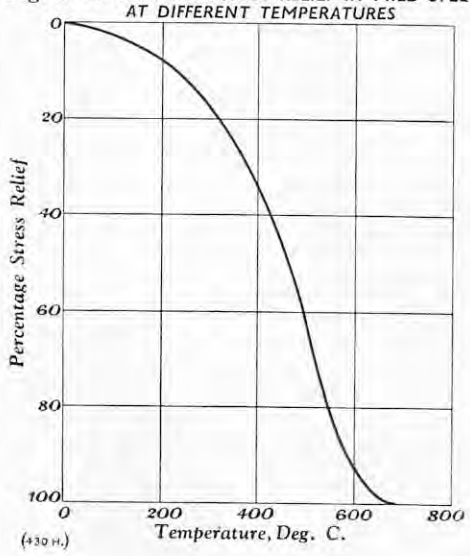
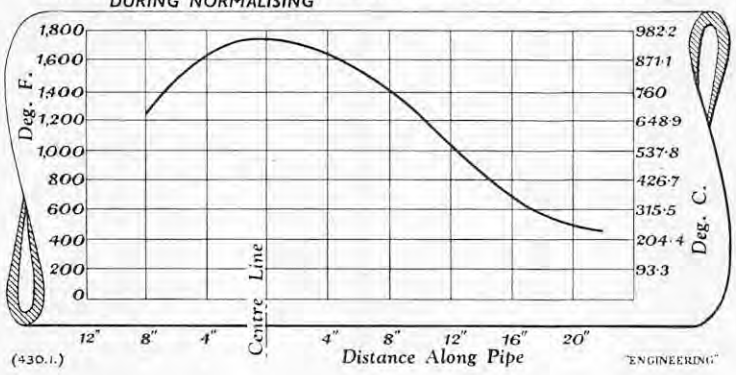


Fig. 9. TEMPERATURE GRADIENT IN A PIPE 14" OUTSIDE DIA., 1" THICK, DURING NORMALISING



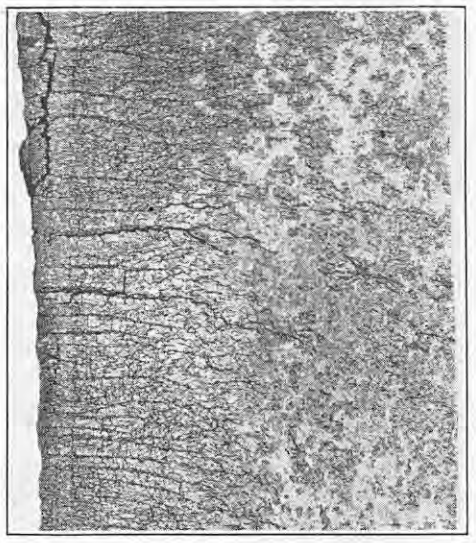


FIG. 11. STRESS CORROSION DUE TO CAUSTIC SODA; WELD ON LEFT.

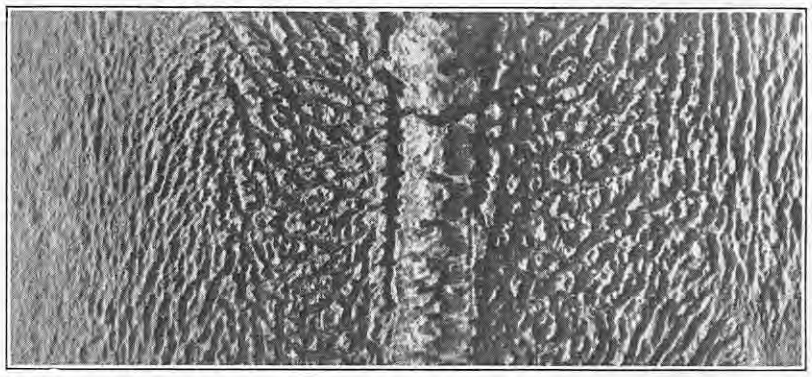


FIG. 10. STRESS CORROSION DUE TO SULPHURIC ACID.

NEW TOWNS.—The Central Office of Information have prepared for the Ministry of Local Government and Planning a leaflet on the 14 new towns being built in Great Britain. It is intended to serve as a preliminary guide for visitors.

* "Examination and Tests of Welded Parts for Steam Power Plant." *Proc. I.Mech.E.*, vol. 142, page 261 (1940).

HEAT TREATMENT OF PIPELINE WELDS.

(*For Description, see Opposite Page.*)

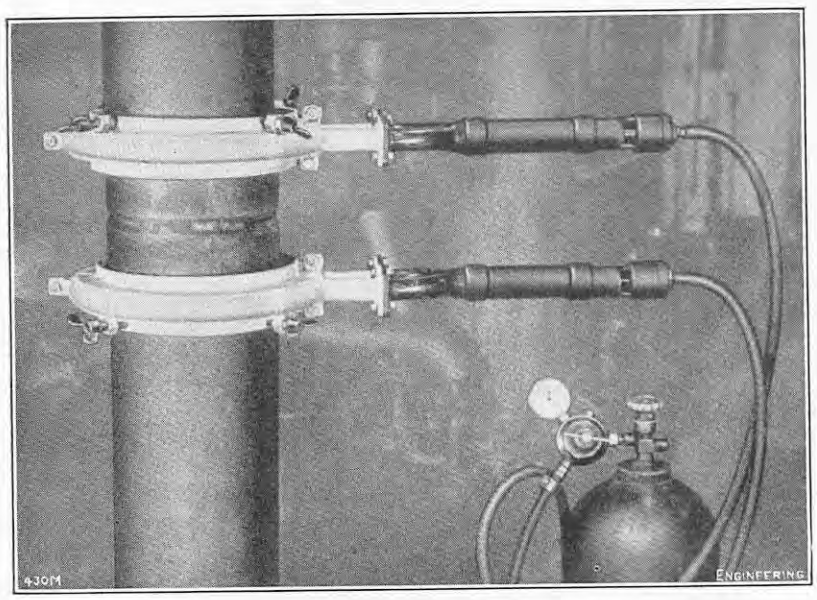


FIG. 12. GAS-RING BURNERS FOR PREHEATING WELDS.

FIG. 13. ELECTRICAL-RESISTANCE PREHEATERS FOR WELDS.

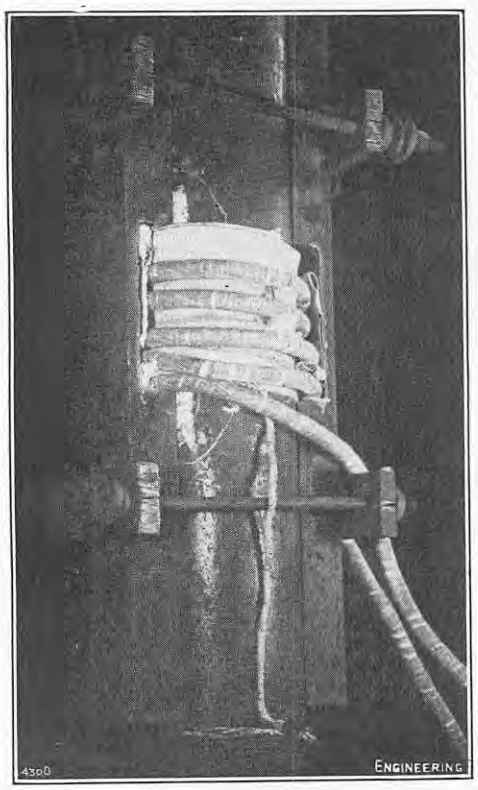


FIG. 14. INDUCTION METHOD OF PREHEATING.

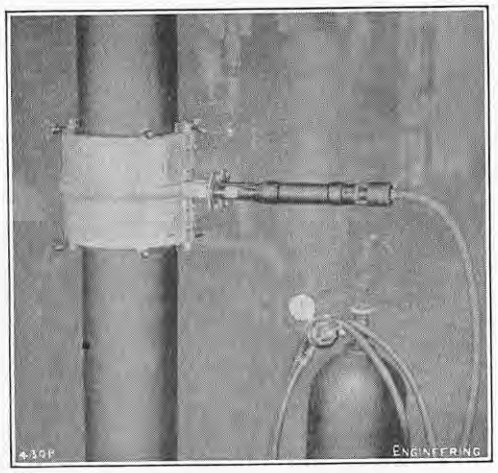


FIG. 15. GAS MUFFLE FOR STRESS RELIEVING.

TRADE PUBLICATIONS.

Electro-Hydraulic Thrusters.—The application of electro-hydraulic thrusters is dealt with in a pamphlet received from the Metropolitan-Vickers Electrical Co., Ltd,, Trafford Park, Manchester.

Neon Indicator Lamps.—Details of some additions to their range of neon indicator lamps are given in an illustrated leaflet issued by the Acru Electric Tool Manufacturing Co., Ltd., 123, Hyde-road, Ardwick, Manchester, 12.

Photo-Electric and Timing Equipment.—Elcontrol, Ltd., 10, Wyndham-place, London, W.1, have revised and extended their range of photo-electric equipment and have issued a leaflet describing the units available. The firm's range of electronic timers, which has been extended also, is described in data sheet D.4.

Hydrogen Coolers for Turbo-Generators.—Details of the hydrogen coolers they make for use with turbo-generators are given in a leaflet issued by the Metropolitan-Vickers Electrical Co., Ltd., Trafford Park, Manchester.

Electric Truck, Tractors and Forklifts Trucks.—A folder issued by Ransomes Sims & Jefferies, Ltd., Ipswich, gives leading particulars of the battery-powered trucks and tractors manufactured by them for industrial service, and thus forms a useful introduction to their complete catalogue on this subject.

Time Switches.—Venner Time Switches, Ltd., Kingston By-pass, New Malden, Surrey, have sent us three leaflets relating to their products. Leaflet M.5 gives details of a synchronous motor; that numbered V.9, illustrates the mechanical arrangement and describes the principles of operation of the type E.R. clock; and leaflet T.S.26 lists the " B " range of Venner time switches.

Earth-Moving Equipment.—Full details of their Model 462 1½-cubic-yard earth-moving machine are contained in a brochure published by Ransomes & Rapier, Ltd., Waterside Works, Ipswich. The 462 machine is mounted on tracks and can be supplied with front-end equipments for operation as a shovel, dragline, grab or crane, all of which are readily interchangeable on the working site. The brochure, in addition to showing the various jobs on which the machines can be employed, contains useful information on its construction and method of operation.

Commercial Vhicle Gearboxes.—An outline of their Model 437 gearbox is given in a leaflet published recently by David Brown & Sons (Huddersfield), Ltd., Huddersfield. The 437 gearbox is a new product intended for use on vehicles having a maximum laden weight of 5½ tons and a maximum engine torque of 1,600 lb./in. There are four forward speeds, the ratios of which are: 5·72 to 1 in first gear; 3·17 to 1 in second; 1·78 to 1 in third; and 1 to 1 in top gear. The leaflet contains a detailed specification and the illustrations include a drawing showing a sectional elevation and setting out the principal dimensions.

TECHNICAL SERVICES AT THE RADIO SHOW, 1951.

SEVERAL special technical services have been arranged in connection with this year's Radio Show, which is to open at Earl's Court, London, on Tuesday, August 28. They include a closed-circuit radio-frequency television distribution system, whereby either the normal broadcast programme, films or live programmes picked up in an exhibition studio can be relayed; a sound reinforcement system for radiating musical programmes and announcements; a medium-wave radio-frequency signal on a closed circuit of higher than average quality for the use of exhibitors in special demonstration enclosures; the superimposition on this network of a high-quality audio-frequency signal for demonstrating magnetic tape recorders, amplifiers and loudspeakers; a technical control room; and a service for preventing electrical interference to the services in the exhibition.

The control room will be soundproof, but will be provided with glass panels so that it can be seen in operation. The television distribution system will enable any one of the three programme sources to be selected. After demodulation, these will be passed through faders and used to remodulate a small transmitter which, in turn, will feed distribution amplifiers through coaxial cables. An average signal level of one millivolt ±3 decibels will be available at each output at an impedance of 70 ohms unbalanced. Carrier frequencies of 61·75 and 58·25 megacycles will be used for vision and sound, respectively, to enable programmes to be distributed inside the exhibition while Alexandra Palace is radiating. The film-scanning equipment will enable 35-mm. films to be employed and the results passed at radio frequency to the distribution panels. The sound reinforcement system will embody slot-type loudspeakers operated at a low level, and capable of being independently varied.

The studio equipment, which will be designed to permit normal British broadcasting practice to be followed, will be arranged on a console whence pre-amplifiers, the main amplifiers and the loudspeaker networks will be fed. Arrangements will be made so that the public can hear not only the programmes, but also the producer's instructions and other " behind the scenes " activities. The radio demonstration rooms will be supplied through a coaxial system at 1,030 kilocycles ±150 cycles, so that normal broadcast receivers may be operated under conditions closely simulating those in the average home. The signal will be provided by modulating a local transmitter with programmes recorded on magnetic tape. The high-quality audio-frequency signals, mentioned above, will generally consist of musical programmes, the overall frequency response from input to any outlet being within ±3 decibels from 20 cycles to 16 kilocycles. The harmonic distortion will be less than 1 per cent. at any frequency between 20 cycles and 3 kilocycles up to an output level of 1 volt root mean square. All forms of noise and hum will be −50 decibels at the same output. In this way it is hoped to provide a signal which will enable exhibitors to demonstrate high-quality apparatus.

NOTES ON NEW BOOKS.

Tables for Conversion of X-Ray Diffraction Angles to Interplanar Spacing.

United States National Bureau of Standards. Applied Mathematics Series No. 10. The Superintendent of Documents, U.S. Government Printing Office, Washington 25, D.C., U.S.A. [Price 1·75 dols.]

This book of tables will be found useful whenever the methods of X-ray diffraction are being employed as, for example, in identifying chemicals or determining crystal structure. The interplanar spaces, d, may be obtained directly from the tables in terms of the wavelength, λ, of the incident radiation and half-angle, θ, between the incident and diffracted rays, these quantities being related by the formula $\lambda = 2\,d \sin\theta$. The first six tables give the values of d for values of θ between 0 and 90 deg., at intervals of 0·01 deg. They were calculated by using the $K\alpha_1$ wavelengths for X-ray targets of molybdenum, copper, nickel, cobalt, iron and chromium, respectively, the wavelengths employed being those adopted at the international conference sponsored by the British Institute of Physics in London in July, 1946. The last two tables contain a re-arrangement of the data for copper and iron. In these, spacing values are given for the argument $2\,\theta$ from 0 to 180 deg., at intervals of 0·02 deg. They are included for convenience in the use of diffraction equipment calibrated in terms of the angle 2θ deg.

The Nomogram.

By H. J. Allcock and J. Reginald Jones. Revised by J. G. L. Michel. Fourth edition. Sir Isaac Pitman and Sons, Limited, Pitman House, Parker-street, Kingsway, London, W.C.2. [Price 18s. net.]

This is the fourth edition of a book which first appeared in 1932 and which has established itself firmly in the intervening years as one of the best accounts of the subject available. Although nomography is by no means a new branch of mathematics, the use of nomograms seems never to have become widespread, possibly because those who would find them most useful have been wholly ignorant of the subject, or lacked the necessary mathematical background to construct them. Recently, however, the publication of new works on nomography seems to indicate a growing awareness and interest in the subject. There are, undoubtedly, many occasions in engineering design work estimating, etc., as elsewhere, where the labour of repetitive calculations involving working formulæ would be greatly eased were nomograms employed. In this new edition of the work, the earlier text has been revised and new material has been inserted, including a chapter on the connection between intersection and alignment nomograms, in which the theory is based on the well-known principle of duality, which is of such power and importance in projective geometry. It is not necessary to read and to understand all the book in order to be able to construct nomograms; as the beginner will find, much can be accomplished by mastering the first essentials. Those who wish to proceed further, however, will find this book stimulating and helpful.

Calculus.

By Professor Lyman M. Kells. George Allen and Unwin, Limited, Ruskin House, 40, Museum-street, London, W.C.1. [Price 28s. net.]

There are many good books on elementary calculus and several have enjoyed a well-deserved reputation among British Students for some time. Any newcomer to the lists, therefore, faces strong opposition, and must either be of outstanding merit or contribute something new if it is to succeed in a large way. The present volume, by a professor of mathematics at the United States Naval Academy, is a second edition of an American book, and is, therefore, not entirely new, but it has not been published before in Great Britain. A perusal of its 500 pages shows that it covers the familiar ground in an efficient manner, starting with basic concepts and introducing in turn differentiation, simple integration, partial differentiation, multiple integration, infinite series and ordinary differential equations, interspersed with chapters on allied subjects. The author has evidently been at pains to make the subject clear to beginners, and the earlier chapters, in particular, are illustrated with numerous diagrams and sketches. All the chapters contain a very large number of examples for solution, and the student who solves them all will not fail to have grasped the theory. Much of the delight in mathematics belongs to the realm of æsthetics and there is no branch of science where the mode of presentation of the material on the printed page is more important. The present volume is clearly printed, but whether it is necessary or desirable in a book of the kind to illustrate the fundamental concept of a moment by a sketch depicting children on a see-saw, or harmonic motion by sketches of a tuning fork, a pendulum clock, a weighted spring and a dynamo, is a matter for readers to decide.

AIR REGISTRATION BOARD.

In setting airworthiness standards for the turbine-powered aircraft, it is necessary to know more about gusts and icing conditions at high altitudes than is known at present; careful testing is required, with the enormous powers available from jet engines, to ensure adequate safety margins; and, since the working life of a civil aircraft is higher than ever before, and the working stresses are tending to increase, in relation to the fatigue strength of the materials in current use, it is necessary to guard against the possibility of fatigue troubles. These statements were made by Lord Brabazon of Tara, Chairman of the Air Registration Board, in the 14th annual report of the Board,* which has been published recently.

It may be recalled that the Air Registration Board was incorporated in 1937, as a result of recommendations by the Gorell Committee of 1933, to undertake certain of the functions relating to the airworthiness of civil aircraft, which prior to that date had been dealt with by the Air Ministry. The Board, which has offices in the United Kingdom and in many parts of the world, is made up of representatives from the air-line operators, the constructors, the insurers, and the public; its principal functions are, briefly, to compile and publish national airworthiness requirements and to represent the United Kingdom's views at meetings of the International Civil Aviation Organisation; to investigate the airworthiness of new types of aircraft, engines and equipment; to approve constructors of aircraft and equipment; to examine maintenance engineers; and to survey aircraft for the issue and renewal of certificates of airworthiness. Within the past year, it is stated in the report, the final arrangements have been made for the Board actually to renew certificates of airworthiness, and to issue and renew maintenance engineers' licences; hitherto, these functions have been carried out by the Ministry of Civil Aviation on the recommendations of the Board.

The trend of airworthiness requirements is towards a closer linking with the operational use of the aircraft; for example, performance requirements take into account runway lengths and local obstacles, the atmospheric temperature, etc. Maximum performance and maximum economy are required under widely varied conditions. To remove the dangers arising from potential defects in the complex equipment fitted in modern aeroplanes, the Board is requiring many more hours of flying before an aircraft is put into service. The International Civil Airworthiness Organisation (I.C.A.O.) has agreed to accord to the British proposals for performance requirements a status equal to that of existing I.C.A.O. requirements; ultimately, the Board hopes that the international standards finally agreed will be closely similar to the British proposals. The Board has, therefore, embodied the proposals in a new issue of the "aeroplanes" section of the British Civil Airworthiness Requirements, published in January. The new issue also includes new requirements on the reliability of windows in high-altitude aircraft, and in relation to fire risks and the provision of better protection in crashes.

Recommendations for the issue of normal category Certificates of Airworthiness were made for the Handley Page Hermes 4 and de Havilland Heron air liners during the year; and investigations on the third Comet aircraft, which will be the first to qualify for a full normal category certificate, are well advanced; the first two Comets had been granted certificates in the special category during 1950. Fifteen piston engines, two jet engines, and five propeller-turbine engines, have been satisfactorily type-tested. It appears to be likely that the larger engines to be type-tested in the near future will all be gas turbines; there are, however, no indications that the small piston engine will be replaced by the gas turbine. Several propellers with new types of blade construction are under development, and the Board expect to approve at least one of them in the near future. New propeller-control systems, associated with automatic feathering, are also under investigation. Three auxiliary-drive accessory gearboxes have been approved. Considerable work has been done on the airworthiness of helicopter power-transmission and rotor systems, and some recommendations on testing procedure have been agreed with the Society of British Aircraft Constructors and the Ministry of Supply.

The routine approval of instruments and equipment will be considerably simplified by the publication of British Standard specifications for instruments and electrical equipment; some have already been issued, and others will be published in the near future. To attain higher standards of reliability, an increasing amount of work is being carried out on following up and analysing the behaviour of the equipment in service. On several civil aircraft prototypes, the electrical-system voltage has been raised to 110 volts to cater for the increased power requirements, which have increased about tenfold over the 6-kW 24-volt system of the immediate post-war civil aircraft; in conjunction with high-altitude operation, this has introduced many new problems. The use of electronic equipment is increasing rapidly, and the Board has persistently endeavoured to make the electronic-equipment manufacturers aware of the need for valves of a high standard of reliability. In radio, the increasing use of very high-frequency multi-channel equipment has led to the investigation of a number of major modifications. The Board has received an application for the approval of a radar-operated cloud and collision warning indicator installed in a York aircraft.

* *Air Registration Board, Fourteenth Annual Report, Year Ended 31st March*, 1951. Offices of the Board. Brettenham House, Strand, London, W.C.2.

LAUNCHES AND TRIAL TRIPS.

M.S. "Aguila."—Single-screw tug and water-carrying vessel, built by Philip & Son, Ltd., Dartmouth, for the Compañia Sud-Americana de Vapores, Valparaiso, Chile. Main dimensions: 110 ft. between perpendiculars by 25 ft. by 12 ft. 3 in.; gross tonnage, 234; capacity of fresh-water tanks, 160 tons; carries two towhooks, each with a working load of 10 tons. Four-cylinder Diesel engine, developing 680 b.h.p. at 260 r.p.m., constructed by British Polar Engines, Ltd., Glasgow. Speed, 10¼ knots. Trial trip, July 12.

M.S. "Tatry."—Single-screw oil tanker, built by Bartram and Sons, Ltd., Sunderland, for the Gdynia-America Shipping Lines, Ltd., Gdynia, Poland. First vessel of an order for two. Main dimensions: 445 ft. between perpendiculars by 60 ft. 6 in. by 34 ft. to upper deck; deadweight capacity, about 11,000 tons on a draught of 27 ft. 6 in. N.E.M.-Doxford four-cylinder opposed-piston airless-injection oil engine, developing 4,250 b.h.p. at 110 r.p.m. in service, constructed by the North Eastern Marine Engineering Co. (1938), Ltd. Sunderland. Speed on trials, 13¾ knots. Trial trip, July 16. (Ship requisitioned by British Government and renamed "Surf Patrol").

M.S. "Vanja."—Single-screw oil tanker, built by the Furness Shipbuilding Co., Ltd., Haverton Hill, County Durham, for Skibsaktieselskapet Nordheim, Oslo, Norway. Main dimensions: 560 ft. between perpendiculars by 80 ft. by 42 ft. 3 in. to upper deck; deadweight capacity, 24,700 tons on a summer draught of 32 ft. 3¼ in. Hawthorn-Doxford six-cylinder two-stroke single-acting opposed-piston oil engine, developing 6,600 b.h.p. at 115 r.p.m. in service, constructed by R. and W. Hawthorn, Leslie & Co., Ltd., Hebburn-on-Tyne. Service speed, about 14 knots. Trial trip, July 19.

S.S. "Normannia."—Twin-screw vessel to carry 1,400 passengers on the cross-channel service between Southampton and Havre, built and engined by William Denny and Brothers, Ltd., Dumbarton, for the Southern Region, British Railways, London, S.E.1. Main dimensions: 312 ft. overall by 48 ft. by 17 ft. 6 in. to main deck; gross tonnage, about 3,800. Two sets of geared steam turbines of Pametrada design and two Foster Wheeler oil-fired boilers. Service speed, 19½ knots. Launch, July 19.

M.S. "Patagonia."—Single-screw cargo vessel, with accommodation for twelve passengers, built by the Nakskov Shipyard, Ltd., Nakskov, Denmark, for the East Asiatic Co., Ltd., Copenhagen. Main dimensions: 445 ft. between perpendiculars by 61 ft. by 38 ft. 3 in. to shelter deck; deadweight capacity, 10,100 tons on a summer draught of 27 ft. 1 in.; cargo-carrying capacity, about 600,000 cub. ft. Six-cylinder two-stroke single-acting Diesel engine, developing 8,050 i.h.p. at 115 r.p.m., constructed by Burmeister & Wain, Copenhagen. Loaded speed, 16 knots. Trial trip, July 20.

S.S. "Van Oost."—Single-screw trawler, built by Cook, Welton and Gemmell, Ltd., Beverley, Yorkshire, for the Motorvisscherij, N.V., Ostend, Belgium. Third vessel of a series for these owners. Main dimensions: 170 ft. by 29 ft. by 15 ft. 3 in.; gross tonnage, 580; fishroom capacity, 12,000 cub. ft. Triple-expansion engines and one oil-burning boiler, to develop 900 i.h.p. at 125 r.p.m., constructed and installed by Charles D. Holmes & Co., Ltd., Hull. Speed, 12 knots. Launch, July 20.

Employment of Elderly Persons in Industry.—Dr. W. Hobson, Professor of Social and Industrial Medicine at Sheffield University, has urged that persons reaching pensionable age should be encouraged to remain at work, provided that the jobs they have are suitable for them. In his address to the annual provincial meeting of the Association of Industrial Medical Officers, at Sheffield, he stated that, in his opinion, the problem of finding suitable work was most difficult to solve in heavy industrial areas. Some firms had attempted to cope with it by setting up special workshops for the elderly, while other firms had tried redeployment policies. It was significant, he stated, that the proportion of elderly people to that of insured persons was increasing.