

ADMIRALTY TEST HOUSE FOR GAS TURBINES.

A NEW test house which has been constructed for the Admiralty at the National Gas Turbine Establishment, Farnborough, has been designed for carrying out trials of main-propulsion gas turbines of up to 10,000 shaft horse-power. The Heenan and Froude double-ended hydraulic dynamometer which absorbs the load can be used in either direction of rotation and will withstand, subject to certain limits of speed and power, an instantaneous reversal of torque. Within the short time (as little, perhaps, as 15 seconds) required for the system to slow down, stop, and speed up in the reverse direction, a change-over cock enables the weighing gear to recommence registering. The maximum permissible speed of the dynamometer is 1,100 r.p.m., but the full power can be absorbed at a speed as low as 575 r.p.m. The test house is also equipped with a 1,250-kW electrical load tank for dissipating the output of gas turbo-alternators. Space has been left for switchgear to facilitate a connection to the national electricity grid, if required at some time in the future. In the interior view of the test house illustrated in Fig. 1, there are shown two Metropolitan-Vickers Gatric gas turbines coupled to the dynamometer, and a W. H. Allen 1,000-kW gas-turbine generator.

The Admiralty test house has been designed for carrying out trials of gas turbines intended for main propulsion up to 10,000 s.h.p., but provision has been made for extension of the test bed in the future, for larger engines or for a greater number of small ones. Instrumentation is full, and both control and observation arrangements are centralised. Auxiliary machinery is provided to cater for gas-turbine sets which are not self-contained in this respect, and heavy fuel can be heated to the correct temperature for burning. The building, which is

shown in Fig. 2, on page 386, is of steel-framed concrete construction. It is nearly square in plan, 100 ft. by 94 ft., orientated so that the exhaust gases are discharged on the leeward corner of the prevailing wind and the inlet air taken from the opposite corner well above ground to reduce dust intake. The flat roof is 50 ft. above the ground. The main part of the building is the test bay shown in Fig. 1, which runs the full length (100 ft.), from floor to roof, and is about 40 ft. wide. It contains the test bed, and has a temporary wall at the south end so that it and the test bed can be extended if necessary. All walls and the roof are lined with slabs of compressed fibre to lessen noise. On the ground floor to the east side of the test bay are a fuel-oil and lubricating-oil store; a pump room, which is open on one side to the test bay and contains the fuel and lubricating-oil auxiliary machinery including heaters, coolers, etc.; and an electrical room, shown in Fig. 3, with switchgear, transformers, rectifiers, emergency Diesel generator and rotary converter. On the first floor to the east side of the test bay is a flat open roof supporting the exhaust duct and splitters, and also a hut over the pump room containing two gravity tanks, one for fuel oil and the other for lubricating oil. On the first floor to the west side of the test bay are the control room (Fig. 4) and three offices. The design of the plant was started in August, 1948, when Captain (E) W. K. Weston, O.B.E., R.N., was appointed to the Establishment. He has since been relieved by Captain (E) H. Farquhar Atkins, D.S.O., D.S.C., R.N. In May, 1951, work was commenced on the test bed. The construction of the building and installation of standing machinery were executed mainly by contract supervised by the Ministry of Works.

TEST BED.

The test bed was modelled on a larger one built at Pametrada. It consists of a mass of heavily-

reinforced concrete, 6 ft. deep, carrying four parallel lines of cast-iron girders. Each line consists of nine "I"-section girders, each 8 ft. long, set end to end with a $1\frac{1}{2}$ -in. space between. The top faces of the girders are 15 in. wide and their centre lines are set 3 ft. apart. The girders, in addition to being grouted in to half their depth, are bolted down by 2-in. bolts of considerable length which extend down into the concrete and are secured to the reinforcing. The whole structure, therefore, is of very solid construction and its great weight should prevent vibration troubles. It is sunk in the ground so that deck plates on either side, level with it, form a convenient floor for the test bay, graded to the approach road outside. The girders were carefully levelled, before being bolted down, to within 0.005 in. of the datum level and the average level of each girder is within 0.002 in. Slots are provided at frequent intervals along the flanges of the girders for engine holding-down bolts up to 2 $\frac{1}{2}$ -in. diameter. A 20-ton electric crane and a 1-ton hand crane serve the whole length of the test bed and the loading platform.

Air is drawn through a series of portable splitters to reduce noise and passes thence by way of a bank of dust filters (which remove particles down to 10 microns) to a Venturi nozzle consisting of throat, measuring section, and diffuser. It then continues through steel trunking of 5-ft. square section into and along a distributing shaft high up along the length of the test bay; take-off pieces, interchangeable in position with simple straight-through pieces, form the distributing shaft. Ducting shaped to suit the size and position of the intake to turbines on the test bed is led down from the take-off pieces. As far as possible, cascades, i.e., internal deflector plates, are fitted to right-angled bends to reduce eddy losses. The Venturi throat, with its measuring length and diffuser and the parts immediately preceding it (the air-inlet entry piece, which collects

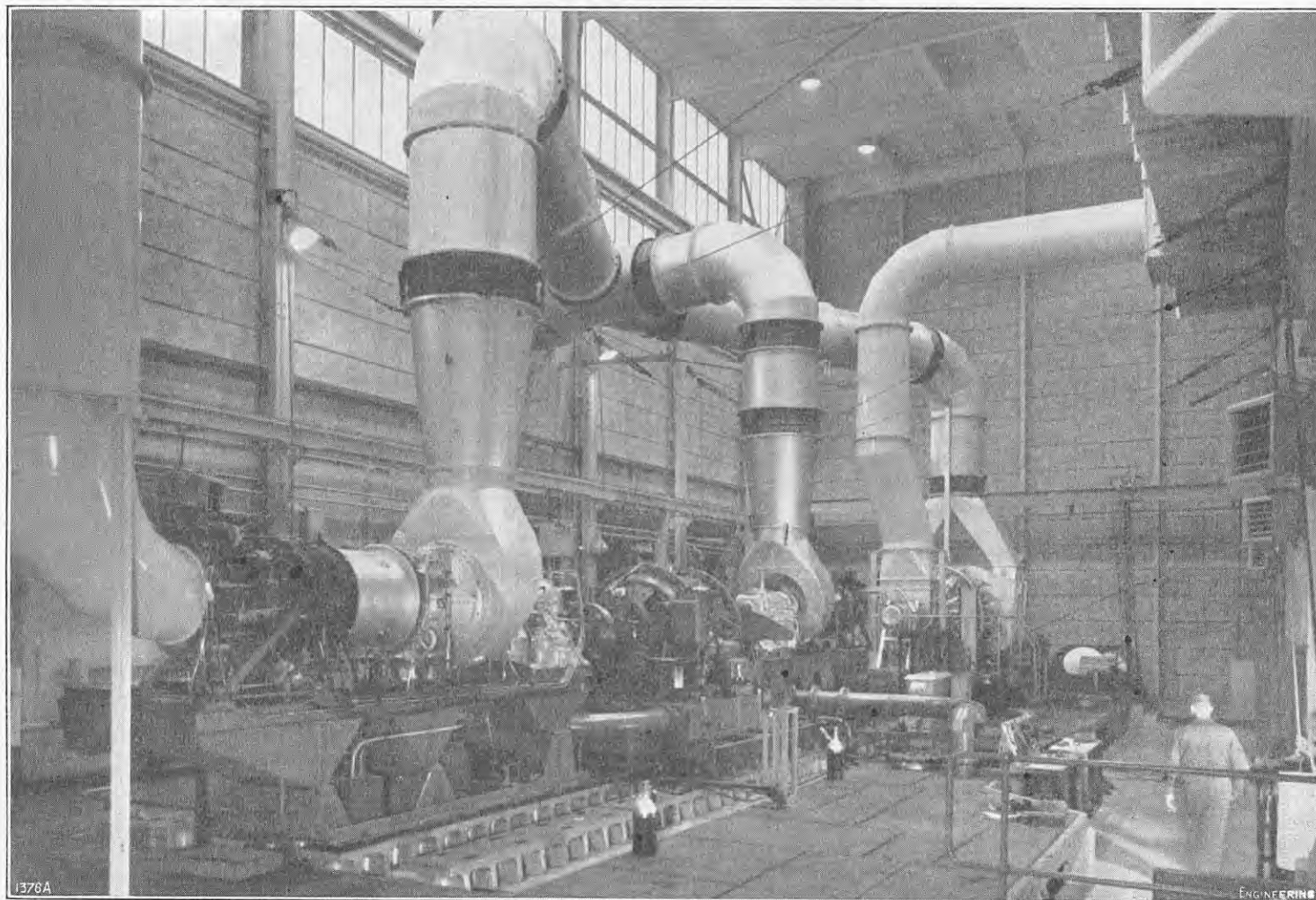


FIG. 1. TEST HOUSE, WITH THREE GAS TURBINES ON TEST.

the air which has passed through the filters, and a length 6 ft. in diameter containing a honeycomb section for straightening out the flow prior to entering the throat) are made of wood. All parts of the inlet trunking which are outside the test bay, both wood and steel, are supported on rubber strips to reduce noise. There are two interchangeable Venturi assemblies, one having a 36-in. throat for measuring mass flows between 150 and 50 lb. per second, and one with a 28-in. throat for smaller mass flows. Exhaust trunking from each turbine on the test bed is led up to a common duct, which takes the gases out of the test chamber to a diffuser and a set of splitters on the flat roof to the east of the test bay. Two water-injection pumps are incorporated in the system to assist in further silencing; they are fed from a pump which draws water from the dynamometer header tank, a maximum of 6,000 gallons per hour at 100 lb. per square inch being provided.

DYNAMOMETER AND WATER CIRCUIT.

The Heenan and Froude double-ended reversible water-brake dynamometer is mounted on a stool and is capable of being sited as required on the test bed. Remote control of the back-pressure valves, which regulate the load, is arranged from the control room, and a hydraulic weighing gear also enables the torque to be measured from the control room. A feature of the weighing gear is an oscillator to prevent inaccuracies in readings due to sluggishness in the transmitting and receiving pistons and in the long lengths of piping connecting them. The brake can be run with its axis inclined at any angle up to 11 deg. to the horizontal, to enable it to test engines which are installed at a rake. A 12,500-gallon header tank supplies water to the brake at a constant head of about 40 ft., and the brake drains to a hot sump through a 14-in. pipe. The water is then pumped to a cooling tower, and again from the cooling-tower pond to the header tank. An overflow from this tank to the hot sump enables the head to be kept constant despite varying requirements of the brake, and both pumps and "key" valves in the system are controlled from the control room. The pumps and cooling tower are designed to give a margin over the maximum requirements of the brake, which are 64,000 gallons per hour cooled from 140 deg. F. down to 100 deg. F., and the 6,000 gallons per hour for the water-injection pumps (which is, of course, supplied but not returned). Float-controlled make-up valves on this and all other cooling-tower ponds are designed to give ample compensation for evaporation and other likely losses.

For absorbing the output of alternators driven by gas turbines under test, arrangements have been made to provide a variable load for alternating current up to 440 volts and 1,250 kW by means of the load tank, situated in the open, with switch-gear in the electrical room. The load tank is divided into four equal portions, three of which have a common water level kept steady by float-controlled supply, and the fourth level varied by two pumps which are controlled from the control room. Current from the alternator leads to a main switch, controlled from the control room, and thence to four switches, one to each quarter of the tank, locally controlled but with indicators in the control room, which is connected, of course, by telephone. Thus it is possible for the control room to vary the load either in steps throughout the whole range or gradually through a chosen range.

FUEL SYSTEM.

Fuel stowed in two 10,000-gallon ready-use tanks (each designed to give a 10-hour run) is pumped by either of two electrically-driven rotary pumps, through strainers and filters, and by a cross-connected system, up to the discharge valve at the end of the system, to which is connected the suction

system of the turbine under test. Incorporated in the test-house system are a steam-worked heater, two Titan centrifugal separators in parallel, a 1,300-gallon overhead tank for centrifuged oil, and a second steam-worked heater, all of which can be by-passed when running on light oils. Additional by-pass arrangements are provided to enable turbines to be started up on light oil and switched over to heavy residual oil, hot-oil circulating pipes being included. The system is designed to supply up to 1,000 gallons per hour of clean fuel at about 20 lb. per square inch and at a suitable temperature to the suction side of the fuel pump of the engine being tested. Steam heating is provided to heat residual oils up to 120 deg. F. in the 10,000-gallon ready-use tanks, up to 180 deg. F. in the first heater for centrifuging, and up to 220 deg. F. in the second heater. Thermostatic control is provided on the heaters. Filling arrangements are provided to charge the ready-use tanks from a large tank farm. A Tecalameter, read in conjunction with specific-gravity readings taken from a sampling cock,

measures the flow. Dip-stick readings of the ready-use tanks are taken as a long-time check.

LUBRICATING-OIL SYSTEM.

A complete lubricating system charged with O.M. 100 oil is provided by the standing plant; it is capable of supplying about 15,000 gallons per hour up to a pressure of 36 lb. per square inch to the inlet of the distribution system of a gas turbine under test, and of receiving the drainage in a drain tank. In cases where the turbine has its ancillary supply pump, the oil can be supplied from a header giving a head up to about 16 ft. instead of through an electrically-driven pump which gives the 36 lb. per square inch referred to above, but the latter can be put into use at short notice if the turbine's pump (itself probably under test) were to fail. The oil which returns to the drain tank is drawn out through a strainer by an electrically-driven lobed booster pump, which delivers it through Clinsol filters at about 30 lb. per square inch to two water-cooled coolers and thence to the header tank,

GAS-TURBINE TEST HOUSE.



FIG. 2. EXTERIOR OF THE ADMIRALTY TEST HOUSE.

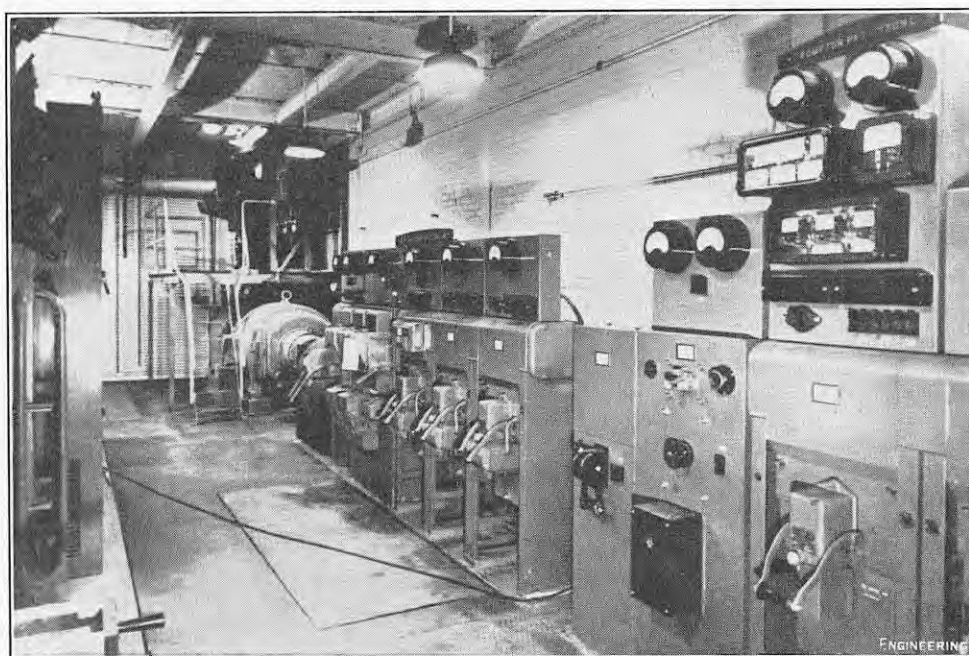


FIG. 3. ELECTRICAL ROOM.

GAS-TURBINE TEST HOUSE.

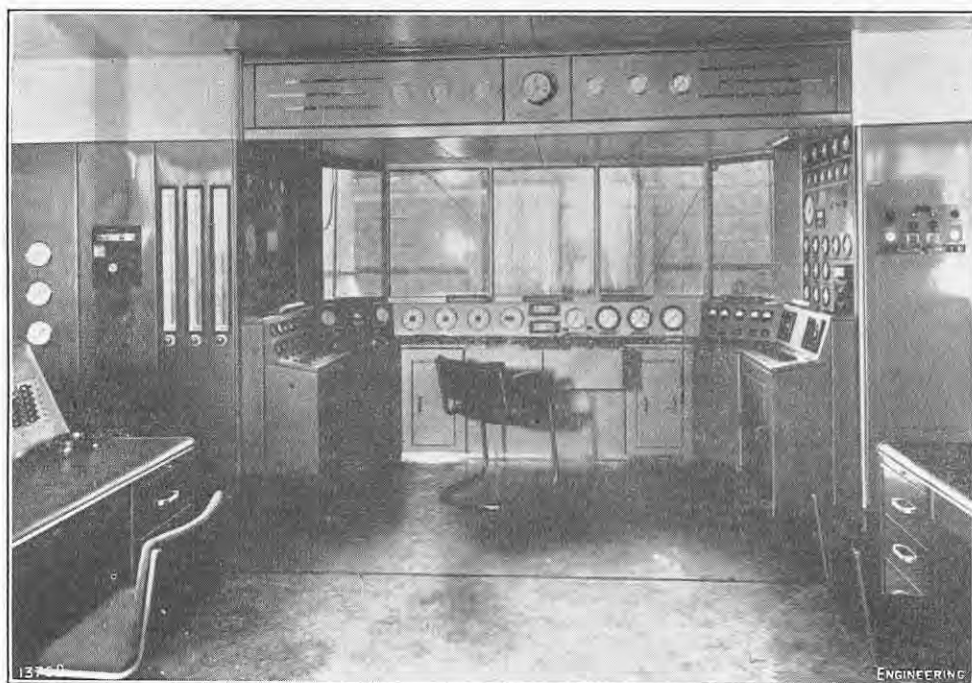


FIG. 4. CONTROL ROOM.

whence a downtake leads it through a Tecalometer and orifice plate in parallel either direct or through the 36 lb. per square inch pressure pump, also called the "through-flow" pump, to the turbine under test. In order to maintain a constant level in the header tank, a pre-adjusted weir in the tank allows oil to overflow back to the drain tank, the booster pump being run at a speed to deliver more oil than the turbine requires. An Alfa Laval centrifugal separator draws oil continuously from the drain tank and returns it there, or can similarly deal with the oil in the header tank.

To provide for a shut-down due to grid failure (which would stop the booster pump), a small emergency pump supplied with electric power by an emergency Diesel generator can lift enough oil from the drain tank to the header tank to keep the turbine bearings lubricated while the turbine is being turned by its turning motor (which, if it is a direct-current machine, can also be supplied from the emergency Diesel generator). The 36 lb. per square inch pressure pump can also be driven by this emergency Diesel generator to maintain supply to the bearings (as long as the oil in the header tank lasts) while the turbine is slowing down. When the turbine under test is self-contained as regards its lubricating-oil circuit, except for purifying, the centrifugal separator in the standing plant can be used through connections provided for flexible pipes. Temporary connections can be made to use the standing plant coolers if required, or to use the standing plant as a stand-by lubricating system. A 5,000-gallon storage tank provides the main reservoir from which the oil can be run down to the drain tank.

An 18-in. bore pipe from a pump which takes suction from a separate cooling tower forms a supply main, running along the east side of the test bed, to any intercoolers which may be part of the turbine under test. A similar return main is provided along the west side of the test bed and thence out of the building to a hot sump, from which it is pumped to the top of the cooling tower. Both supply and return mains consist of interchangeable lengths to suit any positions of the intercooler inlets and outlets along the test bed. Control of pumps and key valves is effected from the control room. A 6-in. pipe is led from the end of the supply main to two lubricating oil coolers, which are in series, and thence direct to the hot sump. The whole

system is designed to circulate 230,000 gallons per hour and cool it from 89 deg. F. down to 72 deg. F. The nearby cooling tower for the Parsons 10-MW gas-turbine alternator is cross-connected with the intercooler and dynamometer systems so that it is possible for any tower to be used for any of the three services.

ELECTRICAL EQUIPMENT AND CIRCUITS.

The main electrical supply is fed from the grid and distributed to neighbouring buildings at the usual 415 volts, three phase and 50 cycles. This is, in general, used for driving the standing plant and for lighting the building, but a large portion of it can be converted into either 440 volts, three phase and 60 cycles or 220 volts direct current, in order to run auxiliary machinery attached to gas-turbine plants which are intended for ships having either of these systems. In addition, a 50-kW supply of direct current at 220 volts is available from an emergency Diesel-driven generator to give limited lighting, lubrication and other services needed to prevent damage to a turbine on trial in case of failure of the main supply due to grid failure or other cause. The main supply is led to a 750-kW oil-enclosed switch on the 415-volt 50-cycle three-phase switchboard in the electrical room, and on this switchboard are mounted enclosed switches to supply the various services, as follows: a 300-kW motor-alternator set for conversion to 440 volts, three phase and 60 cycles; two 175-kW transformer rectifier sets for conversion to 220-volt direct current; three heaters in the lubricating-oil header tank; a heater on the lubricating-oil centrifuge; the overhead travelling crane in the test bay; various pumps, etc., in the pump room, i.e., two fuel-oil boost pumps, lubricating-oil boost pump, fuel-oil separators with ancillary pumps, lubricating-oil centrifuge, and exhaust-duct cooling-water pump; workshop machinery; lighting (two circuits, each single-phase); welding points and small power-plug points; and two 30-ampere switches in the test bay for driving lubricating or other temporary pumps which may happen to come with turbines on test.

The motor-alternator set mentioned above supplies current to the 440-volt three-phase 60-cycle switchboard (all in the electrical room), where it is distributed to any of the following which may be on the gas turbine under test: the starting motor

(up to 300 kW); turning motor (25 kW); two fuel-oil pressure pumps (each 25 kW); two lubricating-oil pumps (each 10 kW); and two miscellaneous pumps or fittings (each 25 kW). The two transformers and rectifiers supply a total of 350 kW at 220 volts to the direct-current switchboard (which is fitted with open knife-type switches) all in the electrical room, whence it is distributed to the same services as the 440-volt three-phase 60-cycle supply, and, in addition, to the lubricating-oil "through-flow" pump which is part of the standing plant in the pump room. The emergency Diesel generator is connected by a change-over switch to some of the items which are normally supplied by the transformers and rectifiers, i.e., the turning motor, one lubricating-oil pump (on the turbine), and the lubricating-oil through-flow pump. It also supplies a small emergency pump to lift a limited flow of lubricating oil from the drain tank to the header tank, and an emergency lighting circuit. The emergency Diesel generator is not intended to provide means to continue a trial during grid failure, but to provide means to supply sufficient lubricant while a gas turbine is slowing down after being shut off, and to turn it (and maintain an oil circulation) while it is subsequently cooling, as is necessary for some types. Oldham lamps, fitted with hold-off switches to close on a main current failure, are wired in to a 230-volt direct-current circuit throughout the building as secondary lighting. A small amount of 24-volt direct-current lighting is provided by separate transformers and rectifiers for instruments in the control room.

CONTROL AND INSTRUMENTATION.

Considerable thought and research have been put into the design and instrumentation of the control room. In deciding upon the number and type of instruments which should be provided, it was necessary to consider the great variety of engines, from small electrical generators to medium and large propulsion units, which may be sent for testing. Thus, in the first layout of the control room, instrumentation by the best-known methods has been provided for complete performance analysis of gas turbo-generators or alternators up to 1,250 kW, and propulsion units up to 10,000 s.h.p. In doing this, however, some assumptions as to likely cycle arrangements have been inevitable, but in general the most complicated cycles thought likely have been catered for. The following cycle for a propulsion unit is given as an example: three-stage compression with two intercoolers; two reheat chambers, a free power turbine and a heat exchanger.

The present engine test arrangements include the performance and endurance running of the 1,000-kW gas-turbine alternator built by W. H. Allen, Sons and Company, Limited, Bedford, and the acceptance trials of the Heenan and Froude 10,000-h.p. dynamometer, for which two Metropolitan-Vickers Gatric engines from motor torpedo boats are coupled one at each end of the brake. The instrument panels, of unit construction and interchangeable, were supplied finished with suitable "cut-outs" ready for the flush-mounting of the instruments. All the instruments and the extensive and intricate system of pressure-gauge piping and electrical wiring, running into several miles, have been installed entirely by the test-house staff. The Ministry of Works were responsible for the installation of the motorised valve and pump controls on the driving panel and the makers of the brake for the controls on its panel. Particular attention has been paid to the measurement of the mass flow through the air intake and to the means of obtaining the accurate temperature and pressure distribution throughout the whole of the aerodynamic cycle. Means are provided for the test-house staff, which is small, to deal with small fires and also to take immediate steps to start fighting a major fire pending the arrival of the establishment fire brigade, which is a standing force.

LITERATURE.

Strength and Testing of Materials, Parts I and II.

Selected Government Research Reports, Volume 6, collected by the Technical Information and Document Unit of the Department of Scientific and Industrial Research. H.M. Stationery Office, York House, Kingsway, London, W.C.2. [Price, each part, 55s. net.]

VOLUME 6 of this series of Selected Government Research Reports, *Strength and Testing of Materials*, has been published in two parts, containing, in all, 30 reports on research work carried out for the Ministries of Aircraft Production and of Supply, now combined as the Ministry of Supply. The 13 reports included in Part I are concerned with the theories of strength and deformation of engineering materials; the theories being those associated with indentation and hardness, with plastic as well as elastic deformations, the behaviour of tubes suffering internal pressure and of materials generally in compression, together with the phenomena of notch brittleness and metal extrusion. Part I also includes an outline of the general methods of solution of the axially-symmetric problems in elasticity and a report of a theory that has been proposed to account for the yielding and plastic flow of anisotropic metals. Seventeen reports concerned with testing methods, and giving the results of the tests, are presented in Part II. Outlines are given for methods of measuring "stress" (more correctly, strain) both mechanically and electronically, the latter method being supplemented by a nomogram for solving the equations that arise in the X-ray measurement of stress. A number of the reports deal with strain measurements on particular forms of specimens, for example, tubes and sheets, as well as on cylinders and spheres; and notes are also given on the strength of butt and spot welds in various metals.

These reports, some of which were written as long ago as 1940, are of a most advanced character, written by specialists for specialists. It is to be doubted, however, whether such a collection of authoritative reports can be of much value to many individuals, or to teams working in industry, and it might have been more satisfactory, and less expensive to the buyer, if the reports had been made available individually. The collected reports will, however, make valuable reference books for libraries, for they are concise and well illustrated, and each is concluded by a bibliography of equally advanced references. As is to be expected of reports emanating from Government research establishments, there is no restriction on the use of mathematics as a probing tool; indeed, in several of the reports, the probe has been sharpened to make use of the most abstruse mathematics and it is to be suspected that, on occasions, the assumptions have been adjusted knowingly so as to make the problem still amenable to mathematical treatment. Nevertheless, for those who are interested in the problems discussed in these pages, and who are prepared to analyse them, there is excellent material in these two volumes.

PHOTOGRAPHY IN THE OIL INDUSTRY.—An exhibition of photographs drawn from the library of the Shell Photographic Unit, containing over 20,000 pictures, opened last week at the gallery of Kodak, Ltd., 184, Regent-street, London, W.1, and will remain open until April 2. The excellent photographs shown illustrate all aspects of the oil industry from the preliminary survey work to the distribution and applications of the numerous petroleum products. Although most of the exhibits are of a pictorial nature, included among them are some notable examples of scientific photography produced in the research department of the organisation. The whole exhibition illustrates clearly what an important part photography plays in a large modern industrial organisation. The exhibition is open from 9.30 a.m. to 5 p.m. on Mondays to Fridays, and until 11.30 a.m. on Saturday. Admission is free and tickets are not required.

"NOMAD" COMPOUND DIESEL AERO-ENGINE.

D. NAPIER AND SON, LTD., LONDON.

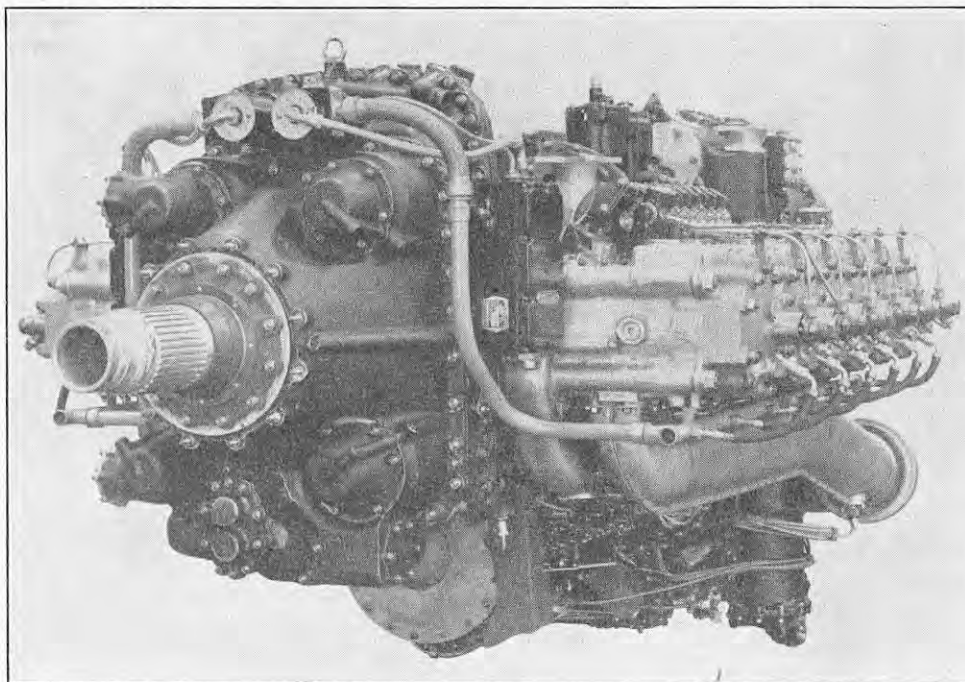


FIG. 1.

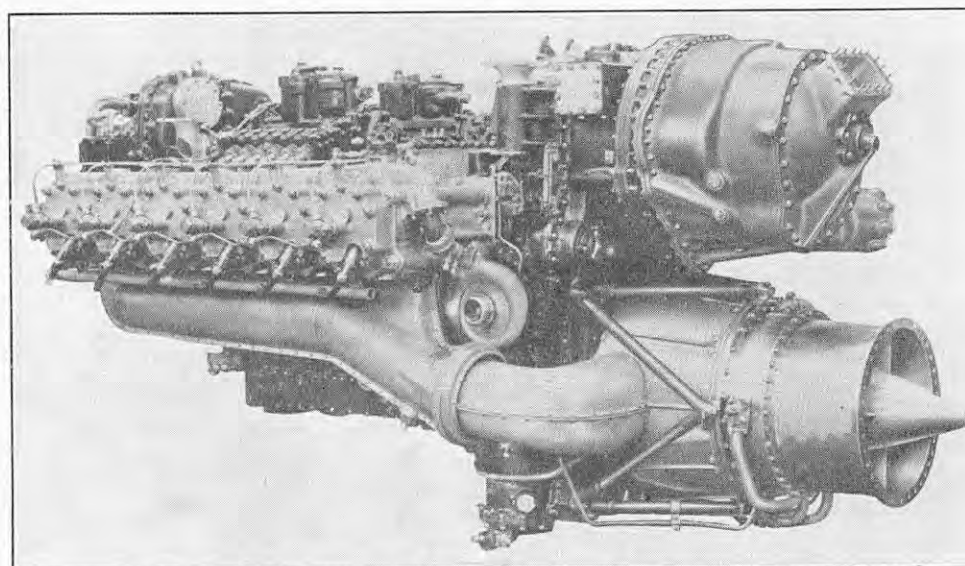


FIG. 2.

THE NAPIER "NOMAD" COMPOUND DIESEL ENGINE.

ALTHOUGH full technical details of the latest form of the Napier "Nomad" compound Diesel engine for aircraft are not yet available for publication, some interesting particulars of the engine were given by Mr. H. Sammons, C.B.E., M.I.Mech.E., F.R.Ae.S., managing director of D. Napier and Son, Limited, Acton, London, W.3, at a Press conference held at the Savoy Hotel, London, on Friday, March 13. From these the information given below has been extracted.

The Nomad consists of a simple, valveless, two-stroke compression-ignition engine, with 12 horizontally-opposed cylinders, the exhaust from which is passed through a multi-stage turbine mounted on the same shaft as an axial-flow compressor. The turbine-compressor set thus formed is coupled to the compression-ignition engine through gearing, and the power of both the engine and turbine are transmitted to a common, single-rotation propeller shaft by a reduction gear in the nose of the engine assembly. A single pilot's lever serves for the control.

Among the advantages claimed for the engine are that it has a low specific fuel consumption over a wide range of altitudes and speeds, the figure given being 0.33 lb. to 0.35 lb. per effective horse-power hour. It operates with equal efficiency on kerosene, Diesel fuel or wide-cut gasoline, and, compared with propeller-turbines and turbo-jet aero-engines, is considerably less sensitive to changes in atmospheric temperature. The engine, the weight of which is 3,580 lb., gives an effective horse-power of 3,135.

An idea of the appearance and general arrangement of the engine can be obtained from Figs. 1, 2 and 3, on this page and opposite. Fig. 1 shows the end of the propeller shaft and the casing in which the propeller reduction gears are housed. On the right, the ends of six of the cylinders of the compression-ignition engine can be seen and below there is the exhaust pipe leading from these cylinders to the turbine; there is, of course, a similar exhaust pipe on the other side of the engine. Fig. 2 illustrates the rear end of the engine, and the connection of one of the exhaust pipes to the turbine casing is clearly shown. Above the turbine in this illustration is the gearbox through which the power output of the turbine is delivered

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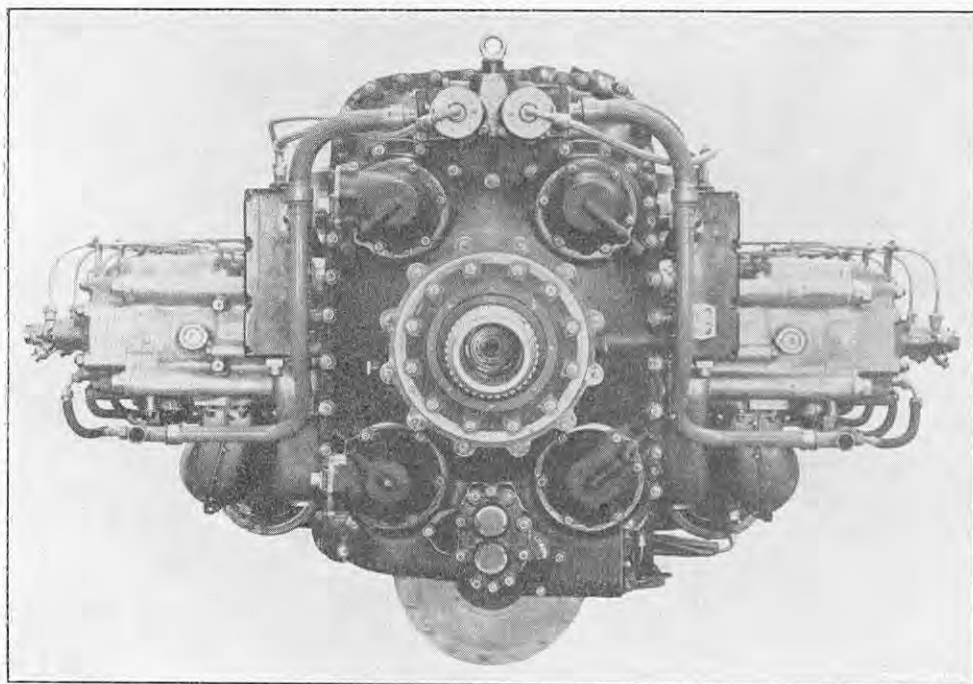


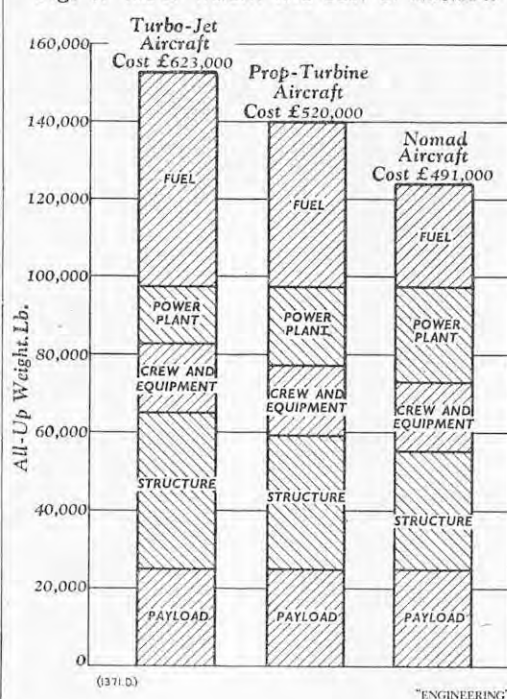
Fig. 3.

to the propeller. As previously mentioned, the axial-flow compressor, which supplies air to the engine cylinders, is on the same shaft as the turbine and is situated below the cylinders. The air intake is at the front end just behind and below the propeller reduction gear. The fuel-injection pumps can be distinguished in Figs. 1 and 2. The front end view, Fig. 3, shows the comparatively small frontal area of the power plant, which amounts to 19.25 sq. ft.

The diagram, Fig. 4, gives an interesting comparison of the all-up weight and cost of three hypothetical civil aircraft each designed to take the same pay-load of 25,000 lb. over a still-air sector distance of 2,860 statute miles with different methods of propulsion. The effect of the lower fuel consumption and the consequent reduction in structure weight are clearly brought out. The comparison is made between one aircraft powered by four turbo-jet engines, each of 10,000 lb. static thrust at sea level, another having four propeller turbines, each developing 3,780 effective horsepower for take-off, and the third equipped with four Nomad engines each developing 3,135 effective horsepower for take-off. For the comparison, the specific fuel consumption, in lb. per e.h.p. per hour at sea-level static take-off power, were taken as 2.24 for the turbo-jet, 0.624 for the propeller turbine and 0.36 for the Nomad engine. The overall length of the aircraft and the fuselage diameter are the same in each case, being 114 ft. and 12 ft., respectively; the overall length of the Nomad engine is 9 ft. 11 in. Other data for the turbo-jet, propeller-turbine and Nomad-engined aircraft respectively are wing span 123.5 ft., 140 ft., and 132 ft., and the corresponding wing areas are 2,185 sq. ft., 2,050 sq. ft., and 1,840 sq. ft. The all-up weights, as shown in the diagram, are 153,000 lb., 140,000 lb. and 123,500 lb. and the estimated costs are also indicated on the diagram.

In addition to the advantages of the Nomad engine for civil aircraft, already referred to, it may be pointed out that, owing to the low fuel consumption, a long range is obtainable, with a consequent elimination of, or reduction in the number of, intermediate stops; and also that a shorter runway can be used for a given landing weight in comparison

Fig. 4. ALL-UP WEIGHT AND COST OF AIRCRAFT.



with a turbo-jet type aircraft. The new engine will doubtless have numerous advantages from the military standpoint, but these were not dealt with at the conference.

ROYAL AERONAUTICAL SOCIETY GARDEN PARTY.—The annual garden party of the Royal Aeronautical Society will be held at Hatfield Aerodrome, Hertfordshire, on Sunday, June 14. Further particulars will be announced later.

EXHIBITION OF OLD MACHINE TOOLS AT BIRMINGHAM: ERRATUM.—In the article on this subject which appeared on page 289 of our issue of March 6, we regret that the references to Figs. 2 and 3 were inadvertently transposed. It will be evident from the text that the centre lathe of almost entirely wooden construction is shown in Fig. 3, not Fig. 2, and that the reference near the foot of the middle column should be to Fig. 2.

THE ENGINEERING OUTLOOK.

IX.—SHIPBUILDING AND MARINE ENGINEERING.

If prosperity could be measured solely by the volume of orders on hand, the fortunes of the shipbuilding industry have never been higher. The total tonnage on order at the beginning of 1953 amounted to about 6.75 million tons gross, valued at 670l. millions, compared with 6.25 million tons, valued at 550l. millions, at the beginning of 1952. Since launchings in 1952 amounted to 1.34 million tons, it would seem that shipbuilders have about five years' work on hand. In truth, however, orders have accumulated in the books largely because of the slow rate at which ships are being completed. Frustrated by the shortage of steel, shipbuilders have been working from 15 to 30 per cent. below capacity. Efficient planning of production has often been difficult, and, in consequence, building costs have risen. Inability to give prompt delivery has resulted in the loss of orders to foreign competitors, and British yards, which launched 57 per cent. of the world output in 1947 and 37 per cent. in 1951, launched a little under 30 per cent. in 1952. Fig. 1, on page 390, compares the trend of British and foreign output.

The volume of new orders booked in 1952 was only 1.2 million tons, substantially less than the tonnage completed and less than a third of the high total of 4 million tons booked in 1951. This fall is not wholly, or even mainly, due to increased foreign competition, though it seems that some foreign builders have done relatively better than British builders. The major cause is the fall in freight rates, for both tanker and dry-cargo tonnage, to less than a half of the level prevailing twelve months ago. Many of the vessels on the high seas, under British and foreign flags alike, are old and due for replacement, but owners will not place orders for new tonnage unless they can be reasonably sure of a profitable return on the very high outlay which is required for a new vessel. The present trend of freight rates can inspire little confidence. Shipowners in the United Kingdom, moreover, have the additional handicap of high taxation, which both prevents them from making adequate allowance for the depreciation of their fleets, and makes it difficult to set aside from current profits the reserves needed to purchase new ships.

Since the war, tankers have accounted for an increasing proportion of the output of the shipyards. The trend of total tonnage laid down, under construction, and completed in British yards is shown in Figs. 2, 3 and 4, and in Table I, on page 390. Figs. 5 and 6 and Table II, on the same page, illustrate the relative importance of tanker and other tonnage. The Tables are taken from Lloyd's Register's shipbuilding returns. In December, 1951, 56 per cent. of the tonnage under construction in the yards of the United Kingdom consisted of tankers; in December, 1952, the corresponding proportion was 57 per cent., and of the tonnage ordered but still to be laid down, 62 per cent. were tankers. The world tanker fleet is now about 32.4 million deadweight tons; 2.6 million tons more than a year ago, and more than twice as much as in 1939. The British tanker fleet, which now totals 7.2 million deadweight tons, is the largest in the world (180,000 tons larger than that of the United States) and is still growing rapidly. The Anglo-Iranian Oil Company placed orders in 1952 for seven tankers, each of 32,000 tons deadweight, at a total cost of 12l. millions. The company already had 21 tankers on order, aggregating 426,000 deadweight tons, all of which were due for delivery before the end of 1954. The British Tanker Company, the shipping subsidiary of the Anglo-Iranian Oil Company, in the middle of 1952 had a fleet of 155 tankers, of nearly 2 million tons, and had a further 2 million tons on charter. The largest ship of the year in the United Kingdom, the British Sailor, of 21,800 tons gross, was launched at Clydebank for the British Tanker Company. Orders for tankers placed by the Royal Dutch-Shell Group in 1952 were for 19 ships, valued at 20l. millions, and aggregated 383,000 tons deadweight, British shipbuilders received orders for ten of these, four of 31,000 tons and six of 18,000 tons. Under

the building programme begun in 1951, the Group already had on order 46 vessels, valued at 45½ millions and aggregating 900,000 tons deadweight.

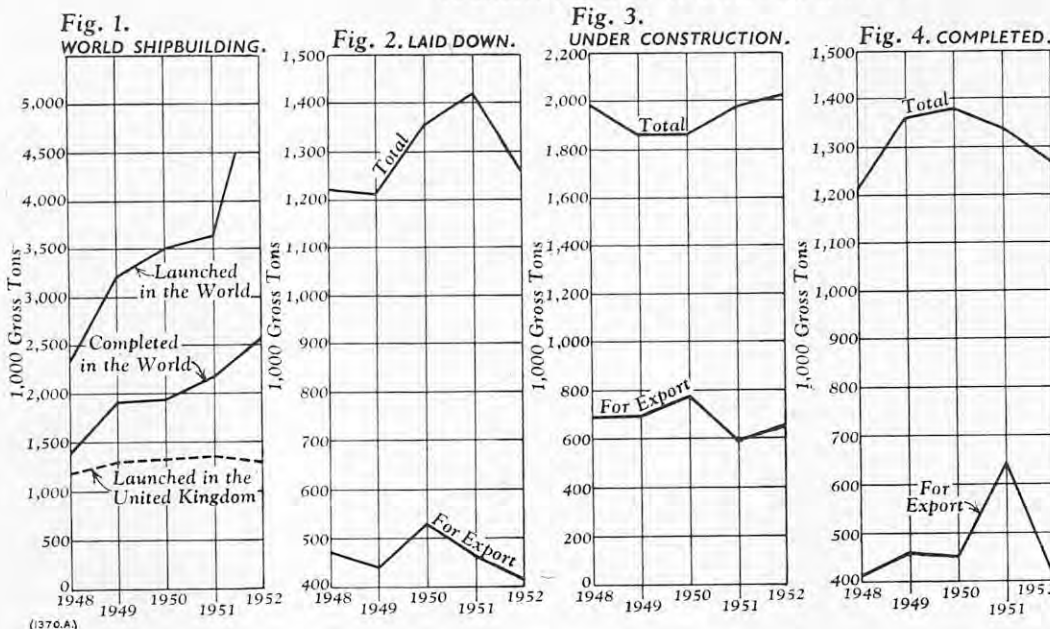
The world consumption of petroleum and petroleum products is growing, and the world tanker fleet must necessarily expand in proportion; but there are some ominous indications that the present rate of expansion of the tanker tonnage may be excessive. The Korean war resulted in a rapid rise in freight rates, but it was only temporary. The subsequent decline, which began as early as the second quarter of 1951, was abruptly arrested by the cessation of Persian oil supplies at the end of June in that year. This meant considerable re-routing of tankers and frequently involved longer voyages; and, by the beginning of 1952, freight rates had reached record heights, about 15 per cent. above the previous peaks. A reaction set in early in 1952, and, apart from seasonal and tem-

not the factors which at present are depressing freight rates are more than temporary. One of the most important is the decline in the demand for dry-cargo shipping, which has seriously reduced the consumption of bunker oil. This is due partly to the import restrictions which many countries have imposed in order to adjust their balance of payments, but in part, also, to reduced economic activity, which directly affects the demand for petroleum and its products for industrial power and transport. In Europe, the demand for petroleum has also been curtailed as a result of the improvement in coal supplies. The tanker building programmes which are now being undertaken were planned on the basis of certain assumptions about the trend of industrial activity; it now seems unlikely that the former rates of expansion will be resumed unless and until some fairly far-reaching action is taken on an international level. Mean-

DECLINE OF THE BRITISH TRAMP FLEET.

The total merchant fleet of the world (including the reserve fleet of the United States, of 11 million tons) amounted in July, 1952, to 90·2 million gross registered tons, an increase of 2·9 million tons compared with 1951. Only about half of this increase consisted of tankers, which now form about 21 per cent. of the total gross registered tonnage. The merchant fleet of the United Kingdom, in the year to July, 1952, increased by 73,000 gross tons, but this rise was more than accounted for by an increase of 300,000 gross tons in the British tanker fleet. The total British merchant fleet is now only 20·6 per cent. of the world total, compared with 21·1 per cent. in 1951, 27·1 per cent. in 1939, and 50·4 per cent. in 1905. This decline is of considerable strategic importance to a country so heavily dependent as Britain upon shipping for food and essential raw materials in time of war. It has been

FIGS. 2, 3 AND 4, UNITED KINGDOM :
MERCHANT VESSELS OF 100 GROSS TONS AND OVER.



FIGS. 5 AND 6, UNITED KINGDOM :
MERCHANT VESSELS OF 1,600 GROSS TONS AND OVER.

TABLE I.—UNITED KINGDOM : SHIPBUILDING ANALYSIS.

Year and Quarter.	Commenced.		Launched.		Completed.		Under Construction.		Preparing.*	
	No.	Tons.	No.	Tons.	No.	Tons.	No.	Tons.	No.	Tons.
1951—March ..	56	316,881	55	241,483	47	291,173	549	3,487,032	212	1,414,309
June ..	79	382,478	79	414,138	70	346,211	600	3,955,170	255	1,840,851
Sept. ..	75	423,602	51	242,446	53	268,638	645	4,261,346	277	1,989,706
Dec. ..	69	361,259	73	433,364	76	434,415	655	4,434,416	295	2,225,404
1952—March ..	56	324,831	62	327,141	55	267,511	680	4,664,324	324	2,393,703
June ..	57	205,641	62	309,018	68	405,600	664	4,607,864	321	2,531,623
Sept. ..	52	267,648	61	291,276	49	266,255	670	4,746,745	327	2,684,263
Dec. ..	63	389,800	66	373,177	66	324,438	642	4,752,880	306	2,606,478

* Plans approved or material ordered.

TABLE II.—UNITED KINGDOM : SHIPBUILDING ANALYSIS BY TYPES OF VESSEL.

Type of Vessel.	Commenced.		Launched.		Completed.		Under Construction.		Preparing.*	
	No.	Tons.	No.	Tons.	No.	Tons.	No.	Tons.	No.	Tons.
Passenger ..	1	20,000	2	13,000	4	42,716	22	294,650	7	79,450
Passenger/Cargo ..	17	124,450	16	111,052	12	94,163	160	1,127,882	94	679,050
Cargo Liner ..	6	39,170	6	36,227	4	25,781	65	377,654	36	207,430
Oil Tanker ..	16	199,200	18	194,066	13	140,360	221	2,816,934	118	1,602,070
Collier ..	2	2,770	3	5,469	3	5,558	16	40,108	3	8,340
Coaster† ..	8	6,796	10	9,036	12	9,334	48	37,001	18	12,700
Miscellaneous ..	13	7,414	11	4,327	18	6,526	110	58,651	30	17,438

* Plans approved or material ordered.

† Including oil tankers of less than 1,000 tons gross.

porary revivals, the course of freight rates has since been steadily downward. At the beginning of March, 1953, the current rate for carrying crude oil from the Persian Gulf to the United Kingdom was 12½ per cent. below the Ministry of Transport basis, whereas a year earlier it had been 310 per cent. above that level. There is now a grave danger that tankers will have to be laid up on a large scale during the summer months.

It is not easy, at this stage, to decide whether or

while, the shipyards of the world will continue to turn out about 2 million deadweight tons of tankers per annum, and this is likely to have a depressing effect on freight rates. Some of the new tonnage will be required, of course, to replace old and inefficient vessels; a recent analysis shows that 16 per cent. of the world tanker fleet is over 18 years old, and that 38·3 per cent. was built during the war, much of it of types which are inefficient by more recent standards.

concentrated, moreover, upon one class of tonnage, namely, dry-cargo tramps. In July, 1952, the British tramp fleet consisted of 443 vessels, of 2·38 million gross tons. This compares with 513 vessels of 2·79 million tons in July, 1951, and 587 vessels of 3·14 million tons in July, 1950. Moreover, the proportion of British tonnage at present unemployed is by no means negligible; at the end of 1952, 83 tramp ships, aggregating 290,000 tons gross, were laid up for reasons other than repair or overhaul, compared with 29 vessels of 44,889 tons at the end of 1951. It is not easy to-day for even up-to-date vessels to make a profit. The Chamber of Shipping index (1948 = 100) shows that freight rates reached a record of 203·8 in April, 1951. In February, 1952, they stood at 157·3, but thereafter the decline was rapid. By August, they were down to 79·2, and, though there has been a modest seasonal recovery, they had reached only 96·6 in January, 1953, which compares with 163·9 in January 1951. In consequence, a Liberty ship of about 11,000 tons deadweight, which was making a profit of from 500l. to 600l. a day at the beginning of 1952, was showing losses of 75l. to 100l. a day by the end of the year. Such vessels were fetching 600,000l. at the beginning of 1952, but cannot now find purchasers at less than half that price. The extent to which shipowners could influence freight rates by laying up tonnage, even if concerted action by all shipowners were possible, is limited. The continuance of low freight rates is likely, therefore, to lead to a further reduction in the tramp fleet, as economic tonnage goes out of service and is not replaced.

About one in seven of the dry-cargo vessels in the British mercantile marine is more than 25 years old and already overdue for replacement. The economic life of a ship is generally accepted to be about 20 years; since, however, ships ordered to-day cannot be delivered much before 1958, replacements for ships 15 years old should be ordered now, and shipping companies might, with profit, plan the replacement of ships that are only ten years old. About 43 per cent. of British shipping is more than ten years old, so that the shipyards should be assured of a continuity of work as far into the future as it is reasonable to look. Unless financial difficulties can be removed, however,

replacement is likely to fall far short of the rate desirable. Mr. John Boyd-Carpenter, Financial Secretary to the Treasury, stated in the House of Commons in December that "any limitations on the replacement of tonnage are physical rather than financial." This view has been strongly contested by shipowners, as well as by shipbuilders and representatives of the officers' and seamen's societies, who have all submitted evidence to the contrary to the Royal Commission on Taxation.

Undoubtedly, profits have been high in shipping, but the price of new ships has risen rapidly since the war, and taxation has been deducted from the industry's profits on a basis which takes no account of this increase. Mr. J. Ramsay Gebbie, managing director of William Doxford and Sons, and chairman of the Shipbuilding Research Association, went so far as to say that, unless there is a change in the methods of taxation, there will be no dry-cargo ships in the British mercantile marine in ten years' time. This, no doubt, is an exaggeration, but the serious consequences of the present taxation system need emphasising. As Mr. Gebbie pointed out, a cargo vessel which could be built for 80,000*l.* in the decade before the war now costs 600,000*l.* A shipowner with a fleet of ten vessels is unlikely to be able to find 6*l.* millions to replace them when the allowance made for depreciation on each vessel is only 80,000*l.* One source of finance for new vessels is the Ship Mortgage Finance Company, which was registered in March, 1951, and published its first accounts in June, 1952. At that time, the company had completed contracts to lend 1.44*l.* millions and was negotiating contracts to lend 1.86*l.* millions more. The company's lending powers are much greater than this, although not unlimited; their share capital amounts to 1*l.* million and their own borrowing powers amount to 10*l.* millions of debenture stock. Proposals for ship mortgages, on the other hand, amounted to 21*l.* million in the first year's trading. Applications for 24 of the proposed 70 ships had to be turned down, and applications for a further 26 were withdrawn. Advances are generally limited to first mortgages on half the value of the completed ship and to periods of five to six years. So far, foreign owners, principally Norwegian, appear to have taken more advantage of the services of the company than the British, but there have been requests from British owners, some for dry-cargo tonnage. Despite the weakening of freight rates, the company have reported that the flow of new applications is not unsatisfactory.

RIISING SHIPBUILDING COSTS.

Since the outbreak of war in Korea, shipbuilding costs have risen steeply. In the past two years, according to Mr. George Berrie, the chairman of Barclay, Curle and Company, they have increased by 25 per cent. Mr. Berrie, who was explaining the difference in costs of the Polartank, launched in December, 1952, and her sister tanker launched two years previously, said that, in the intervening period, the price of steel had risen by 40 per cent. and wage rates by 27 per cent. Since the number of man-hours spent in the building of the two ships was exactly the same, there was no falling off in efficiency. Because of the shortage of steel, however, it has not always been possible to maintain efficiency in the yards, and many shipbuilders consider that the adoption of the five-day week for winter as well as summer is likely to bring reduced productivity. At a meeting between shipbuilding employers and the trades unions, it was decided that the question of the five-day week should be left to local decision. By the end of December, however, all the shipyards, with the exception of those in the London area and some of the smaller ones, had accepted the five-day week for the winter as well as the summer months. Following the recommendations of a court of inquiry, most shipyards have been concentrating the 44-hours working week into five days in summer. The court decided, however, that, despite improvements in artificial lighting, the tempo of a shipyard slows down with the approach of dusk, and that the introduction of the five-day week in winter would result in a loss of production.

The main obstacle to efficiency is, however, the shortage of steel. The supply of plate, the main type of steel required by shipbuilders, is expected

to be 15 per cent. higher in 1953 than in 1952, and allocations to the shipbuilders have steadily increased since the third quarter of 1952. Allocations in the second quarter of 1953 are to be 6 per cent. higher than in the first quarter, when they were scheduled to be 8 per cent. higher than in the last quarter of 1952. Increased allocations do not, however, seem in all cases to have been translated into increased deliveries, and when deliveries have increased they have not always been of the desired sizes and types of steel. There have been anomalies as between different shipbuilding districts and individual shipbuilders. Despite the shortage, the Clyde yards succeeded in launching 19,700 tons more in 1952 than in 1951. Launchings on the Tyne and the Wear, on the other hand, were less than in 1951, by 42,200 and 26,400 tons, respectively. In a recent number of the *Burntisland and Hall Russell Shipyard Journal*, it is pointed out that "some of our shipyards, just now, present an appearance that recalls the most depressed periods in shipbuilding history." On the other hand, reports have been published of record individual and district outputs. This, in the opinion of the journal, is sufficient reason for scrapping the present allocation system and replacing it by one which, when the total steel available is insufficient for requirements, will allocate supplies to all shipyards in all districts on a "strictly proportional and impartial basis, regardless of claims of priority for this and that." No distribution scheme will seem fair to all parties, and recriminations are likely to end only when steel allocation becomes unnecessary.

The difficulties which have resulted from the steel shortage have been accentuated by modern methods of ship construction. Prefabrication methods have considerably reduced the time taken to build a ship; a modern welded vessel may take only about one-third to one-half of the time necessary to construct an older-type riveted vessel. Modern construction methods require, however, that the various plates and steel parts of different sizes shall be available in a definite order; a steel allocation system would have to work very smoothly indeed to ensure the correct sequence of deliveries. On the other hand, welding secures the most efficient use of steel, and, if corrugated bulkheads are also used, the saving in steel may be considerable. A tanker of 16,000 tons deadweight, with these features, can be constructed from 3,900 tons of steel as compared with 4,500 tons for a riveted vessel.

Not all British yards are equipped to take advantage of modern methods of construction, and in some it is physically impossible to alter the old layouts to make room for prefabrication facilities and larger cranes. Nevertheless, considerable re-organisation and re-equipment has taken place, and the construction methods employed in British shipyards, as well as the products which they turn out, are second to none in the world. The shipbuilders have at their disposal the services of the very active British Shipbuilding Research Association, and individual companies have not neglected their own research work. The United Kingdom is leading in the development of gas turbines for marine propulsion, and much of the credit for this must go to the Marine Research and Development Department of the Anglo-Saxon Petroleum Company. The tanker *Auris*, belonging to that company, the first merchant ship to be propelled by a gas turbine, has crossed the Atlantic on that power alone. In the *Auris*, Diesel engines are also fitted, but it has been recently announced, as recorded on page 307, *ante*, that an order has been placed with Cammell Laird and Company for a tanker to be propelled exclusively by gas turbines. The first British operational gas-turbine warship has already gone into service.

FALL IN BRITISH PASSENGER TONNAGE.

The British lead in large passenger ships has not been so well maintained. The liner *United States*, of 53,330 gross tons, deservedly gained much popular applause when she won the Blue Riband of the Atlantic. The operation costs of the vessel may not be so praiseworthy, however, since speed, which involves a heavy fuel consumption and the sacrifice of cargo and passenger space, is a very expensive factor in a passenger liner. Moreover,

the entry of the vessel into the Atlantic service raises the issue of fair competition, since 42 million dollars of the vessel's total cost of 70 million dollars was met by a State subsidy; the liner is also in the service of a company which receives an operating subsidy. At present, however, there is more than enough business for all the passenger vessels on the Atlantic route, including the new Italian liner *Andrea Doria*. The possibility of a similar vessel to the *United States* being built in the United Kingdom should not be overlooked. The *United States*, which can carry 12,000 troops, was built primarily for defence purposes, and as Mr. R. W. Johnson, the managing director of Messrs. Cammell, Laird and Company, stated in an interview reported in the *Journal of Commerce Annual Review*, "it is by no means certain that a British ship will not be built for a similar purpose."

The need for passenger ships in the British merchant marine is no less great than that for cargo vessels. British ships of 5,000 gross tons and over, and carrying upwards of 100 passengers, numbered 212, of 3.15 million gross tons, in 1939; this number has now been reduced by nearly one-half and the tonnage by nearly one-third. Foreign shipping lines, on the other hand, are building up their passenger tonnage. A sister ship to the *Andrea Doria* is under construction, and in the United States there are two new liners, *Independence* and *Constitution*, which will operate between New York and the Mediterranean. The French liners *Flandre* and *Antilles* will be ready for service this year. Two passenger liners are in construction in Scandinavia, and the Portuguese liner *Santa Maria*, of 21,780 gross tons, launched at Antwerp in 1952, was the second largest ship of the year. The Holland-America Line were reported in July to be about to order a new 37,000-ton liner for the Atlantic service. British companies, however, also have some passenger tonnage on order. Messrs. John Brown and Company are building two liners of about 20,000 tons for the Canadian run, on behalf of the Cunard Steamship Company. Canadian Pacific Steamships, Limited, are having two liners built, also for the Canadian service. One, to be built by the Fairfield Shipbuilding and Engineering Company, will be of 22,500 tons and will carry 150 first-class and 900 tourist passengers. The Shaw-Savill Line have recently announced that a liner of 20,000 tons, to carry 1,200 one-class passengers, has been ordered for the Australian service.

GROWTH OF FOREIGN COMPETITION.

The total shipping under construction in the United Kingdom fell from 2.2 million gross tons in December, 1951, to 2.15 million gross tons in December, 1952. The tonnage under construction abroad, however, rose from 5.5 millions to 6.1 millions. France was the only major shipbuilding country, other than the United Kingdom, which recorded a fall. The increases in all the other countries were fairly substantial, though steel has been far from plentiful abroad. The most striking increase is in Japan, from 295,000 tons in December, 1951, to 567,000 tons in December, 1952. Despite this, the outlook for the Japanese shipbuilding industry is not a happy one. Costs in Japanese shipyards are said to be 10 to 20 per cent. higher than the current international levels, due mainly to the fact that steel in Japan costs at least 50 per cent. more than in the European shipbuilding countries. Although, moreover, Japanese shipbuilders in the past two years have gained orders through being able to offer delivery more promptly than their competitors, these orders have been far from profitable, since they were accepted at 170 to 190 dols. per ton. To show a profit, the price should have been 200 dols. per ton.

The demand from Japanese shipowners has not been so large as was expected. The Shipping Rationalisation Council in Japan had urged that the Japanese ocean-going fleet should be increased, regardless of cost, from 2 million gross tons to a minimum of 3 million tons by 1957. This was to be achieved by building 300,000 tons per annum for four years, for which it was hoped that the Government would have provided 70 per cent. of the necessary finance, and the private banks the remainder. The Ministry of Transportation, however, cut down the programme for the first year to

250,000 tons, for which Government finance will be limited to 22,000 million yen (22½ millions). At present, the Japanese shipbuilding industry, which has an output capacity of 580,000 tons per annum, has work on hand for only a few months, and shipbuilders have been pressing the Government for immediate aid—some for direct subsidies; but it has been pointed out that the industry would also benefit from a reduction in the exchange rate. This would not affect the cost of imported raw materials, since the revenue of the shipping industry, about 90 per cent. of which is in foreign currency, could be devoted to their purchase. On the other hand, it would enable the shipbuilders to quote much lower prices.

The tonnage under construction in Germany, 515,000 gross tons at the end of 1952, was only slightly less than that in Japan. Further relaxation of Allied controls will enable the Germans to increase their shipbuilding capacity still more. The Howaldtswerke A.G. in Kiel, Bremer Vulkan, Schiffbau und Maschinenfabrik and Stulcken Sohn, Hamburg, are to be permitted to add substantially to their yards and equipment. In August, 1952, German shipyards had orders on hand for 2·16

The United States continues to be the second largest shipbuilding country in the world; at the end of 1952, there were 680,000 tons under construction, all but a negligible proportion on home account. At the time of the launching of the United States, the total work in hand in American shipyards amounted to 1·4 million tons gross, or nearly 2 million tons deadweight. Of this, about 1·25 million tons was accounted for by tankers, and a further 350,000 tons by ore carriers. Much of the remainder comprised Mariner-class cargo liners, 35 of which are to be built, with a total deadweight tonnage of 450,000. The first have already been launched and are expected to have a speed of 20 knots when fully loaded. The appearance of these highly efficient subsidised vessels on the world shipping routes may give rise to complaints of unfair competition, particularly if freight rates remain depressed. The volume of naval construction in the United States at present is considerable. The aircraft carrier Forrestal, which, with a gross tonnage of 60,000, will be able to accommodate more than 100 aircraft, succeeded the liner United States in the yard of the Newport News Company. A second aircraft carrier is to be built at the naval

STEAM TURBINE RESEARCH AND DEVELOPMENT.

(Continued from page 362.)

THE Conference on Steam Turbine Research and Development, held on March 6 at the Institution of Mechanical Engineers to receive and discuss seven papers presented by the Parsons and Marine Engineering Turbine Research and Development Association ("Pametrada"), was resumed in the afternoon to hear the remaining three papers. The chair was taken by Dr. R. W. Bailey, F.R.S., who called upon Mr. Basil J. Terrell, M.B.E., B.Sc. (Eng.), senior research engineer of Pametrada, to read his paper, "Some Reflections on the Thermal Distortion of Turbine Casings."

THERMAL DISTORTION OF TURBINE CASINGS.

Of the three causes of casing distortion, said Mr. Terrell—namely, thermal effect, pressure effect and external influences, which might act separately or together—the first was by far the most important and probably the least predictable. The magnitude of the stresses caused by differential temperature was determined by both the time-dependent temperature gradient and the degree of restraint on the body, and the stresses might become enormous. Heavy stresses could be induced when warming-through, because of the very high heat-transfer coefficient of condensing steam. The maximum stress occurred on the inner surface, and was compressive. During the process of warming-through, a wave of heat appeared to pass from end to end of the machine, the steam temperature reaching any given elementary annulus of the casing in the form of a steep-fronted wave on a graph of temperature plotted on a base of time. The maximum stress occurred in a remarkably short time after the wave of heat reached the given annulus—in actual cases cited, 22 seconds in a mild-steel casing 2 in. thick, and 38 seconds in a similar casing of austenitic stainless steel. Priming, when the turbine was hot and under pressure, caused very high thermal stresses. The design of casings for gas turbines presented special problems, as, in starting, hot gas was applied rather suddenly to a cold casing, so that the choice of casing material became an important factor. In the case of austenitic steel, with an elastic limit of about 8 tons per square inch, the maximum casing thickness appeared to be about 1 in.; but, with a high-grade heat-resisting stainless steel, a thickness of many inches might be adopted. If a casing could be heated equally on both sides, the thickness might be doubled for a given thermal stress. The practice of making turbine casings in halves, with a horizontal joint, caused a bending moment to be developed in the complete cylinder by the differential thermal stress, the casing either being a flattened section, like a longitudinal section through a lemon, or a "figure of eight," depending on whether the conditions were those of heating or cooling. In a turbine with radial-clearance blading, distortion of that type could not be tolerated, as it would set a minimum value to the permissible clearances. It was possible to design a flange sufficiently strong to hold the casing to a circular section, but the heavy flange introduced other problems. A heavy flange had a much greater thermal inertia than the casing, so that it heated more slowly; this not only tended to make the cylinder oval, but produced severe axial constraint in the plane of the flange, while the top and bottom of the casing expanded freely. As a result, plane cross-sections of the casing no longer remained plane, which was likely to affect the leakage seal at the periphery of impulse-turbine diaphragms and nozzle plates, as well as the axial running-clearance. In the design of casings, Mr. Terrell continued, it was important to avoid large openings or any lack of symmetry, which was a prolific cause of hogging and sagging. Much distortion trouble had been avoided by fitting the astern turbine in a separate casing. External strengthening ribs also caused bad distortion, because they heated more slowly than the casing; if strengthening ribs were necessary, it was better to fit them inside the casing. Finally, the author observed that a casing which was of good design from the

TABLE III.—UNITED KINGDOM : REGISTRATION OF SHIPS UNDER CONSTRUCTION.

	December 31, 1950.		December 31, 1951.		December 31, 1952.	
	No.	Tons.	No.	Tons.	No.	Tons.
British Dominions and Colonies ..	21	30,559	32	86,705	25	73,882
Argentina	5	70,000	1	12,000	—	—
Belgium	2	1,200	—	—	—	—
Brazil	7	35,968	7	35,968	4	1,368
Chile	—	—	—	—	1	6,750
Costa Rica	—	—	—	—	1	8,453
Denmark	2	9,623	—	—	—	—
France	5	40,250	2	16,150	1	425
Greece	—	—	—	—	2	17,200
Holland	4	25,550	1	6,050	—	—
Iceland	8	5,600	2	1,400	—	—
Liberia	5	74,940	4	64,250	6	86,048
Norway	38	391,618	23	248,430	33	279,719
Panama	1	13,070	6	67,140	8	83,780
Poland	3	18,400	—	—	—	—
Portugal	3	16,700	—	—	—	—
Sweden	3	27,400	3	22,608	2	13,128
United States	1	13,070	1	12,000	1	22,000
Other countries	10	20,630	23	122,218	12	79,090
Total for registration abroad	118	794,638	105	694,919	96	671,843
Total for registration in the United Kingdom	212	1,250,050	255	1,514,093	240	1,474,559
Total under construction	330	2,044,688	360	2,209,012	336	2,146,402

million gross tons of shipping, sufficient to keep them occupied until the end of 1955; but the flow of orders has slackened in recent months, and much of the success of the German yards in obtaining orders in competition with the British in the past few years seems to have been due mainly to their ability to offer quick delivery. Nevertheless, the Germans have been remarkably successful in booking foreign orders; the total tonnage under construction for export accounted for 41 per cent. of the total under construction at the end of 1952. This compares with 31 per cent. for British shipbuilders. (Table III, herewith, shows the tonnage under construction in the United Kingdom for various countries abroad.) In Germany, as in the United Kingdom, shortage of steel has been a problem, and in 1952 shipbuilders are reported to have been bidding for supplies of plate from Japan. The situation is likely to improve as supplies become available from the new rolling mills at Dortmund Hoerde. German steel, however, is still more expensive than the British, though the Germans have some advantage in lower wage rates. Most of the German shipping lines are concentrating on freighters, usually of about 10,000 gross tons. The German merchant fleet is still far below pre-war strength, though it increased by 367,000 tons, to 1·4 millions, in 1952. Public funds are being made available for new ships on a fairly liberal scale, but the shipping lines are required to find 20 per cent.

Shipbuilding in Sweden had a very successful year in 1952, the shipping under construction having increased by 36,000 tons to 348,000. Kockums Mekaniska Verkstads A/B, for the second year running, achieved the distinction of launching more tonnage than any other single yard in the world. Their output amounted to 132,000 tons, compared with 131,000 tons launched by Messrs. Harland and Wolff, Limited, of Belfast.

shipyard at Brooklyn, and altogether ten ships of this class are to be built. An atomic power plant is to be developed for the propulsion of the later vessels. The keel for one atomic-powered submarine has already been laid down, and a second is included in the programme for 1953, under which an outlay of 512 million dols. is envisaged. "Off-shore purchases" by the United States Government include contracts valued at 40 million dols. for a frigate, minesweepers etc., placed in Italy. Further orders for minesweepers, valued at 11 million dols., have been placed in the United Kingdom.

In the United Kingdom, the aircraft carrier Hermes of 18,300 tons, the last of four vessels in this class, was launched at Barrow-in-Furness on February 16, 1953. There are now no aircraft carriers on the stocks in British yards. Apart from conversion and modernisation work, the naval re-armament programme concerns only small vessels, mainly frigates and minesweepers. Contracts for a large hospital ship and two fleet tankers have been cancelled as a result of the decision to slow down the re-armament programme; but there has not been any large-scale cancellation, since it has been possible largely to make the reductions by cutting down or re-arranging follow-on orders.

FIRE PROTECTION ASSOCIATION.—The Fire Protection Association has issued recently a booklet on the subject of "The Prevention of Fires caused by the use of Cutting, Welding and Riveting Equipment and of Blow Lamps," which gives advice on the safe handling of oxy-acetylene and electric welding equipment, the use and maintenance of blow lamps, and the use and storage of pressure cylinders containing oxygen and acetylene gases. Copies of the booklet may be obtained from the Fire Protection Association, 84, Queen-street, London, E.C.4.

point of view of thermal distortion would probably be easy to cast soundly. It was suggested that the effect of hogging might be minimised by using a double casing, the internal casing being supported at the ends.

NATURAL RESONANCES IN MECHANICAL SYSTEMS.

The sixth of the seven papers in the programme, and the second to be presented at the afternoon session, was by Dr. O. P. T. Kantorowicz, leader of the Applied Physics Section in the Pametrada organisation, whose subject was "The Determination of Natural Resonances in Mechanical Systems."

The paper dealt with "some of the methods and conceptions used at Pametrada in the experimental exploration of turbine and gear vibrations." The first category of vibrations discussed was that of turbine discs, in which field the effective pioneer was Wilfred Campbell, in the United States. It was noted, in later experiments, that disc designs which had been free from vibration trouble 20 years ago were accompanied by failures of blades and shrouding when incorporated in turbines built a few years later. The reason was that the later turbines were running in steam of much greater density. The author then passed to a consideration of the radial-flow blade rings of Ljungström turbines, in which the main ring, carrying the blades, was linked to the adjacent rotor disc by a weak expansion strip of dumb-bell section. The ring and the strip appeared to vibrate independently, causing a noise described as a "disagreeable cracked jingle"; it was cured by tack-welding the strip to the ring in a few places. After a short section on resonance curves and a description of the test procedure now followed in investigating turbine vibrations, Dr. Kantorowicz turned to experiments on marine gears, in which, he observed, the mode of excitation was fundamentally different from that of a turbine wheel in that the exciting forces were pulsating. The wave-passage frequency, which could be calculated, was most noticeable at low frequencies and high rotational speeds. Simple diagrams in which the wave-passage frequencies, for forward and backward waves, were plotted against speed of rotation, were of considerable help in the analysis of noise and vibration records of complete gear installations. Development work was in progress, directed towards improving the experimental technique for the measurement of exciting frequency, exciting force, the number and position of nodes, and the extension (upward and downward) of the frequency range of excitation and observation. The determination of turbine-blade frequencies *in situ* was found difficult in the case of impulse turbines, because sustained excitation always set the whole wheel in motion and the blades then vibrated at the frequencies of the wheels. By the use of wave analysers, however, it was now easy to determine the frequencies of both impulse and reaction blades, by tapping gently at the blade tip and measuring the vibration near the blade root; but the mode of vibration was sometimes difficult to establish, particularly with twisted and tapered impulse blades. In conclusion, Dr. Kantorowicz dealt briefly with some experiments on turbine stators, in which the structure was vibrated by running the turbine up to speed and allowing it to "coast" down while the vibration was recorded with a Cambridge universal vibro-graph.

RESEARCH APPLIED TO TURBINE DEVELOPMENT.

The concluding paper of the Conference, like the opening paper, was presented by Dr. T. W. F. Brown, the Director of Research in the Pametrada establishment. It was entitled "The Application of Research to Marine Turbine Development," and was devoted mainly to various aspects of the work of Pametrada which were not covered, or were mentioned only incidentally, in the previous papers.

As a research station, Dr. Brown pointed out, Pametrada was "built round the design department," in which the tendering and design particulars for geared-turbine machinery were prepared for the member firms of the Association. The same

department suggested many of the researches most urgently required. The first design for a geared-turbine installation was produced in January, 1945, when the staff numbered only 15 [it is now 260], and it was still being used in 1953; but, in increasing measure, the complete machinery layout was being considered, the aim being to produce the most economical whole when running under the varied conditions of sea service. In addition to the activities covered by previous papers, studies were being made of fluid dynamics, lubrication, gas-turbine machinery, condensers, low-pressure water drainage from turbines, axial compressors, etc. In the detailed investigation of blade and nozzle efficiencies, the effect of partial admission, and of axial clearances, aerodynamic techniques were extensively used; wind-tunnel testing, for instance, provided detailed knowledge of the flow conditions in turbine machinery. The deflection of blades under aerodynamic loading and the amplitude of flutter were among the other matters being studied. There was a lack of systematic information on the performance of highly-loaded high-speed bearings, so a bearing tester had been constructed, in which the test bearing, which had a journal diameter of 6 in., could be loaded hydraulically to 1,000 lb. per square inch at journal speeds up to 290 ft. per second, the frictional torque being measured directly. A hydraulically-loaded thrust bearing was incorporated with it. Tests were being initiated on a pneumatic bearing with a view to reducing the mechanical losses; if steam were used as the lubricating fluid, such a bearing could be arranged inside the turbine casing, thus shortening the turbine and improving the critical-speed margin. The 3,500-h.p. marine gas-turbine set had been running for some years, and its behaviour under heating-up and load conditions had been studied; particulars of some of the tests were given. An experimental condenser had been installed, under an Admiralty contract, in which water speeds up to 20 ft. per second could be used. The plant also included a six-stage axial-flow compressor, absorbing 3,600 shaft horse-power at 7,000 r.p.m., with a mass flow of 57 lb. per second. Other researches dealt with fine-tooth and other mechanical couplings; tests of a blade-vibration rig consisting of a small impulse turbine in which the blades were stationary, while the nozzles rotated; and a gland-strip tester, in which glands of various designs could be rotated and a controlled contact made with rotor samples, the aim being to ascertain which type of gland was least likely to bend the rotor if rubbing occurred.

(To be continued.)

MACHINING AIRCRAFT STRESSED-SKIN STRUCTURES.

METHODS of machining aircraft box-spar flanges with integral stiffeners from solid forgings or extrusions, which are under development by Sir W. G. Armstrong Whitworth (Aircraft), Limited, Baginton, Coventry, were described in a lecture entitled "The Application of Integral Construction to Aircraft Design and its Effect on Production Methods," presented by Mr. E. D. Keen before the Royal Aeronautical Society on Thursday, February 12. In the first part of his paper, Mr. Keen analysed structural design trends and showed that the end loads in the box-spar flanges of a current straight-wing single-engine fighter aircraft wing were already approaching values where the riveted skin-and-stringer type of construction was becoming impractical, and the logical technique appeared to be the machined skin with integral stiffeners. This form of construction afforded, in addition to structural efficiency, a reduced assembly time and the maintenance of a smooth outer skin. With a swept-back twin-engine fighter of current design, the wing loads would be considerably heavier, and multiple-web construction, with thick-sheet top and bottom spar flanges and several stabilising webs, and a minimum number of ribs, was far superior to the box spar. He concluded that the development of both integral box-spar construction

for modern bomber and transport aircraft, and multiple-web construction for high-speed fighter aircraft were necessary.

Mr. Keen then described some experiments of the Armstrong Whitworth company in producing machined wings and tail surfaces. The researches, he emphasised, were costly and involved installing expensive machinery. The first experimental contract placed by the Ministry of Supply was for the production of three Meteor tailplanes with the box-spar flanges of integral construction. It was decided to try three different methods: (i) by machining from the solid to the required contours without any further forming process; (ii) by machining flat from a solid billet and subsequently stretch-forming to the required contour; and (iii), if the latter method proved to be successful, by splitting a tubular extrusion, available in this country complete with stiffeners, then flattening and stretch-forming to contour.

In the first method, the outside skin profile and the rough form of the stringers were machined on a Cincinnati Hydrotel copy miller. The final shape of the Z-section stringers was obtained by adapting the head of a planer miller. For the second method, a spar miller was used, giving a much higher cutting speed than the Hydrotel machine; it was proposed to stretch-form the flat machined flange span-wise in a Hufford machine. The flange was machined full width for stretching and afterwards tapered in plan form by removing the unwanted material. The skin had to be well supported, and suction beds were required for milling in the flat. When machining on the Hydrotel miller in the contoured shape, accurate form blocks were required; it was not yet determined whether these also required to be suction beds. The ball-ended cutter of the Hydrotel machine, however, had proved to be unsuitable. The finish obtained was composed of a series of ridges, the height of which was determined by the feed for each successive cut. A final smoothing down process was therefore required, and there seemed little alternative to hand finishing. To avoid this final processing, the Armstrong Whitworth company were developing a machine (Patent No. 12391/52), and had constructed a successful model of it. This machine had no electronic operating gear; a hydraulic servo ensured correct following on steeply sloping surfaces such as would occur near the leading edge.

The lecturer then discussed the application of machining techniques to a box-spar with thick sheet flanges of tapering thickness. The light-alloy billet could be initially flat-rolled to the approximate contour, and machined to the required thickness. On the inner portion of the wing, the web attachments would be made by tapping into the thick skin. On the outer portion, where the skin was thinner, ridges for attaching the webs would be machined integrally. The final contour on the outside, and the required spanwise and chordwise taper, could be produced by the Armstrong Whitworth skin miller, using suitable cam bars. If the plates could be produced nearly to the required thicknesses, leaving only a slight finishing cut to be taken by the milling machine, much time could be saved.

In this country the size of hot-rolled light-alloy plate was limited by the available heat-treatment plant and roller levelling machines to 14 ft. long by 4 ft. 6 in. wide. This meant that wasteful spanwise and chordwise joints would have to be introduced. Forged plates, such as were used for the experimental Meteor tailplanes, were limited to about 14 ft. long by 2 ft. wide. If forged plates with rough stringers formed on them could be produced, the amount of machining required would be greatly reduced. Present plant, however, limited the amount by which the forged billet could be reduced in thickness.

Many uses could be found for light-gauge sheet material in which stiffening ribs were formed during the manufacturing process, and to stimulate the interest of material manufacturers some investigations had been made. By using such material the number of parts in a Meteor tab could be reduced from 102 to 58, and the number of rivets from 830 to 260. To "break even" on a cost basis, in this case, the cost of the ribbed sheet could be 32 times that of plain sheet.

PRESIDENTIAL ADDRESS TO THE INSTITUTE OF METALS.*

By PROFESSOR F. C. THOMPSON, D.Met., M.Sc.

THE Institute came into existence at a time when the foundations of scientific metallography had been well and truly laid. The advances which have been made since then, in no inconsiderable degree, have been the result of the work of our own members, and much of this work is recorded in our *Journal*. The Institute may take a legitimate pride in the part which it has played in fostering knowledge in its own field of science. It seems worth while, therefore, to look back and spend a few minutes in considering the state that metallography had reached when the Institute came into existence in 1908. The metallographic techniques then available were the microscopic examination of metals and alloys, the construction and interpretation of thermal-equilibrium diagrams and their correlation with a wide range of chemical, physical, and mechanical properties. These techniques are still employed, though now enriched by others which have since been developed.

Although modern microscopic techniques, such as phase-contrast or the use of polarised light, had not then been applied to metallic systems, the results obtained by the older metallographer were of a high standard, being little, if at all, inferior to those obtained to-day. In no instance is the swing of the pendulum of scientific fashion more evident than in the return to favour of the microscope, with its new accessories, after a period of semi-eclipse.

In 1908, most of the methods now employed for the development of microstructures had already been introduced. Heat-tinting had been used with success by Martens, and methods for etching both at high temperature and in vacuum had been employed. A technique then common, but which has since tended to fade out, was the simultaneous polishing and etching, known as "polish-attack," but, in some forms of electrolytic preparation something not very different from this has again come to the front.

Work on the thermal-equilibrium diagrams of metals will always be connected with the names of Roozeboom and especially of Heycock and Neville, and it is of interest that in his recent book, *Thermodynamics of Alloys*, published by the Institute, J. Lumsden deliberately employed some of their data as being, for his purpose, the best even yet available. Nor was the early work by any means confined to alloy systems of low melting point, for Carpenter and Keelings' iron-carbon diagram was published in 1904.

The preparation of pure metals by electro-deposition was an already established technique, and work on the properties of iron, using electrolytic material, which even to-day would be regarded as of high purity, had been done by many people. It was also appreciated that the properties of such iron, as deposited, differed greatly from those of the same metal in the normal condition, and further that this difference might be due on the one hand to some unknown change of structure, or on the other to the occlusion of hydrogen, the effect of which gas on iron, and particularly on palladium, had been extensively studied. The sub-division of metallic alloys into eutectics, solid solutions, and inter-metallic compounds had long been understood, and the work of Matthiessen had correlated such metallographic structures with physical properties such as electrical conductivity.

The first attempt to elucidate the relationship between atomic volume and the mechanical properties of alloys seems to have been due to Roberts-Austen. His work, coupled with that of Arnold and Jefferson on gold, and of Arnold himself on iron, had demonstrated that, so long as the added element passed into solid solution, the relationship of the atomic volumes of the solvent and solute atoms was a potent factor in controlling the strength (or, in other words, the structure) of the alloy. Looking back on this work in the light of present

knowledge, it is clear, although the fact was then but dimly perceived, that the whole evidence required for an appreciation of the influence of the "size-factor" was already there. The Second Report to the Alloys Research Committee of the Institution of Mechanical Engineers, in 1893, concludes that: "In all probability, therefore, the introduction of free molecules of an added element must create a disturbance, the nature and magnitude of which will bear some relation to the volume of the disturbing atom."

With the aid of the recording pyrometer which he had designed, Roberts-Austen investigated, among other things, the surfusion of metals and alloys. He showed, for instance, that in those alloys of lead and tin which were slightly richer in lead than the eutectic, considerable surfusion could occur, a fact which was later to assume great significance in connection with the process of "modification."

Lacking modern resources such as X-ray methods of investigation, these earlier workers were at times compelled to rely on specially-devised techniques, some of which were of considerable ingenuity. As an example may be quoted the proof by Benedicks that the bars in the austenite-martensite structure were, in fact, magnetic. This he did by placing the polished and etched specimen between the poles of a powerful electromagnet in a bath of colloidal iron in acetone, the iron being attracted to the magnetic "needles" and thus producing a structure similar to that obtained by normal etching. It may be that, with the wider range of techniques at the disposal of the present-day worker, this spirit of ingenuity is now less evident, and, if this be so, metallography has suffered a serious loss.

Although Wilm had not yet published his pioneer work on age-hardening, there were already, if eyes had been available to see it, clear indications of some such effect. In particular may be mentioned the fact, already well known, that the electrical and magnetic characteristics of soft-iron transformer cores changed in the course of time.

The first experiments in powder metallurgy had been conducted long before the period with which we are here concerned, and with such experiments the name of Spring of the University of Liège must always be associated. Not only did he succeed in producing compacts even of brittle metals such as bismuth, but he showed that eutectics could be synthesized by pressure, producing the quaternary eutectic of bismuth, lead, tin, and cadmium with a melting point corresponding to that of the eutectic itself, although the most fusible of the constituents of which the powders were made did not commence to melt till a temperature some 130 deg. C. higher had been reached. When such compacts were heated, Tammann, among others, obtained the clearest evidence of diffusion, a fact of which some recent workers seem to have been unaware.

The metallography with which we are concerned was in the main linked with physical chemistry; it might almost be defined as the physical chemistry of the metallic state; and the re-orientation with the formation of a metallurgical-physical bond was still in the future. The revolution which resulted from the introduction of X-ray techniques, for instance, can perhaps be best appreciated by reading a text-book of metallography written before 1914, when Bragg worked out the structure of copper.

Passing on now to the metallographic effects of cold work, the general outlines of the mechanism of plastic deformation, both by twinning and slipping, were common knowledge. No account of the state of metallographic knowledge in 1908 regarding the deformation of metallic crystals would be complete without some mention of the work of Beilby. As a result of simple, but ingenious experimental techniques, fortified by a keen and inquiring mind, he had shown the effect of polish on a metallic surface and demonstrated that the surface layer was non-crystalline or amorphous. Later electron-diffraction experiments probably did no more than confirm what Beilby had already demonstrated.

That most articles made from metals and alloys were a seat of internal stresses had long been known, and methods were already available for their measurement, in which field it would appear that Kalakoutsky may claim priority. The originator of the suggestion that the mechanical properties

of metals could be improved by pre-stressing is uncertain, but the application of the process to gun tubes was suggested by Jacob in 1907, and probably to him the name "autofrettage" is due. Clearly, then, not only were the bad effects of internal stress only too well appreciated, but also the fact that these might, in suitable cases, be turned to good use, was not novel.

That such internal stresses were unstable even at ordinary temperatures was a matter of common knowledge. The "weathering" of castings before machining was frequently resorted to to minimise distortion during the machining operation, and I remember well a Sheffield firm that "weathered" their nickel-silver ingots for 12 months before cold-rolling, in the belief that the treatment diminished edge-cracking and similar difficulties.

The absorption of energy by a metal due to cold working had been inferred by Osmond and Werth from their calorimetric studies, in which they found that cold-forged steel when dissolved in copper ammonium chloride solution gives out more heat than does the same material in the annealed state. In the case of cold-worked copper, on the other hand, they were unable to find a corresponding difference; this is not surprising in view of the fact that the measured rise of temperature was only about 0.1 deg. C., while their experimental error was roughly one-third of this.

The excessive crystal growth which results from small amounts of strain followed by an appropriate annealing treatment had been observed by Stead in the case of iron. It is almost certain that a similar effect must have been equally well known, by those in the industry, to occur with non-ferrous metals and alloys; and single metallic crystals had been cleaved from such coarsely crystalline samples and their properties examined. It was left to Carpenter and Elam, however, to devise, on the basis of such knowledge, their strain-anneal technique for the routine production of single crystals.

I may perhaps be pardoned for mentioning the property now known as damping capacity, a tool increasingly useful in metallographic research. Although that designation was not used until the nineteen-thirties, the ability of a solid to dissipate mechanical vibrational energy had been appreciated for a long time. Weber, in 1837, described work on the elasticity of silk fibres, in which he stated that the decay of amplitude of a vibrating system is not due entirely to air friction, but is partly the result of mechanisms operating within the elastic parts of the system. He further stated that a relationship must exist between the logarithmic decrement and the elastic after-effect which is observed, for example, in galvanometer suspension wires.

In 1865, Lord Kelvin published results of the measurement of the viscosity of solid metals, derived from the fall of amplitude of a system in torsional vibration; he noted the high rate of decay for zinc, compared, for example, with that for copper, silver, and aluminium. Previous analysis of the thermo-elastic effect allowed him to state from fundamental considerations that here was a mechanism which must of necessity, under certain conditions, endow even a perfect isotropic crystal with what we now call damping capacity. Another important conclusion drawn from his experiments was that the variation of damping with frequency differed from that to be expected if the damping forces obeyed the same law as that which holds for a classical viscous fluid.

There is one field in which factual knowledge was almost as complete 50 years ago as to-day. This is the inter-relation between magnetic characteristics and mechanical deformation. The remarkable, and often extremely complex effects of both elastic and plastic deformation on magnetic properties had been examined by a large number of workers. During the last 40 years or so, explanations based on the "domain" theory of magnetism have clarified considerably our understanding of these phenomena, but much still waits to be done.

Such, then, was the broad state of metallographic knowledge when this Institute was formed. The foundations were built on rock and have withstood the storms of time. Is the superstructure equally sound?

* Delivered at the Annual General Meeting, London, on Tuesday, March 24, 1953. Abridged.

CUSTOMS PATROL LAUNCH.

JOHN I. THORNYCROFT & CO., LTD., LONDON.



CUSTOMS PATROL LAUNCH FOR CEYLON.

TRIALS of the patrol launch *Sunga Marutham*, which has been built at the Hampton-on-Thames yard of John I. Thornycroft and Company, Limited, Smith-square, London, S.W.1, have recently been held on the River Thames. The vessel, illustrated above, has been built for the Crown Agents for the Colonies on behalf of the Collector of Customs, Ceylon, and will be engaged in anti-smuggling duties among the islands off Ceylon. The launch is of hard-chine form with transom stern and cut-away keel, 58 ft. in length, 12 ft. 6 in. beam and a draught of 3 ft. 6 in. The propelling machinery comprises two Thornycroft-Rover "Meteorite," 8-cylinder Diesel engines, type RMD. MK. 100, fitted with reverse gears and a 2:1 reducing gear, driving twin screws and giving a maximum speed of 20 knots. A radar unit is carried in the chart room.

The hull and deck are constructed of double-skin teak on timbers of American elm and the deck is double-planked. An American-elm keel is used and the underwater part of the hull is protected by Muntz-metal sheathing. The frames are spaced 8 in. apart and the fastenings are of copper. The interior is finished in mahogany. In the forward part of the boat is the crew space, fitted with locker seats on each side, also two cot frames. Between the seats is a drop-leaf table and at the aft end of this compartment there is a locker and hanging space. The deck can be reached by a ladder through a sliding hatch. Behind the crew's quarters on the port side is the galley. It is fitted with stainless-steel sink, racks, shelves, and cupboards. A stairway from the galley leads to the chart room, the windows of which are level with the top deck. It is fitted with a hinged chart-table and flag-locker on the port side and on the starboard side is a type-12 radar unit with a 12-in. display, made by Decca Radar, Limited, 1-3, Brixton-road, London, S.W.9. Space is also provided for radio telephone equipment which is to be installed in Ceylon. The outside of the chart room is surrounded by kapok-type splinter-proof mattresses about 3 in. thick; these can be seen in the illustration. At the rear of the chart room is a sliding door for access to the engine room, and on the port side are steps leading up to the open bridge. The steering wheel is in a central position on the bridge.

The engine room, which is aft of the chart room, has two engines at the forward end. A seat for the mechanic is on the port side directly behind the engine and an instrument panel is mounted in front of him. On the starboard side is a Stuart Turner 1-kW Diesel generating set for charging the batteries, and also provided with an auxiliary dynamo for use with the radar equipment. The

main engines have air intakes trunked down to them from two apertures in the front planking of the bridge, and are cooled by a closed-circuit fresh-water system operating with internal heat exchangers. The exhaust is cooled by water injection, and led away through pipes of reinforced-rubber composition on each side to the transom. No soundproofing covers have been provided for the engines because the vessel will be operating in high temperatures and it is thought that this will aid in obtaining the maximum degree of cooling. This arrangement, however, results in a high noise level. The clutches of the reverse gear are operated by oil pressure and a small single lever controls both the ahead and astern motions and engine speed from the bridge. The continuous output of the engines is 215 brake horse-power at 2,100 r.p.m., giving a speed of 19 knots.

The Customs Officers' quarters are aft of the engine room. There are Dunlopillo settee berths on each side with lockers beneath, and a sideboard and wardrobe are built against the aft bulkhead. A toilet compartment is fitted on the port side at the forward end, and next to it is a sliding door to the engine room giving access to the chart room without going on deck. At the rear of this cabin are two hinged doors through which the deck can be reached by a step ladder or by an escape hatch. The aft peak of the vessel houses two fuel tanks of 200 gallons capacity and the twin rudder gear and steering gear. A 50-gallon fresh-water tank is located under the chart-room floor on the centre line. Both the masts hinge down and the radar mast is a stayed construction. Searchlights are carried fore and aft and the loud hailer is mounted on the chart-room roof.

STANDARD SPECIFICATIONS FOR RESISTORS.—The Radio Industry Council, 59, Russell-square, London, W.C.1, have issued Sections 1 and 2 of their specification No. RIC/121, which deals with rotary, variable wire-wound resistors and, for the time being, is intended for use internally within the industry. It is hoped, however, to submit it in due course to the British Standards Institution. The price of the two sections together is 5s., post free.

THE LATE MR. H. L. BOWEN.—We regret to record the death of Mr. H. L. Bowen, which occurred on Tuesday, March 17. He joined the Mullard Company as an outside technical representative in 1927 and two years later assisted in the formation of that firm's Technical Service Department. He was subsequently engaged principally on technical liaison work with Government departments and radio manufacturers. He also devoted considerable time to the work of the British Radio Valve Manufacturers Association and became chairman of its Technical Committee in 1949. At the time of his death he was on his way to the United States to represent the Association at the Joint Electron Tube Engineering Council Conference in Atlantic City.

FLOOD DAMAGE TO RAILWAYS IN THE EASTERN REGION.

THE flooding which occurred along the East Coast and in the Thames Estuary during the night of Saturday, January 31, 1953, has given the Engineering and Operating Departments of the Eastern Region of British Railways some extensive engineering work in the restoration of damaged plant and permanent way. No less than 145 miles of railway were flooded, and where the track had been overtopped by advancing flood waters the formation was eroded over considerable distances, as is shown in Figs. 1, 2 and 3, on page 400. In a few minutes, main lines, yards and installations were under anything up to 10 ft. of water, on which floated all kinds of debris. In the Shell sidings at Purfleet, 24 empty rail tankers floated away at random. Matters were further aggravated by the failure of signalling circuits and the fact that over 600 coaches and 100 locomotives were either caught by the floods or marooned.

Apart from track-relaying and the closing of breaches in embankments, which required millions of sandbags and the carriage of over 100,000 tons of material, axleboxes had to be washed out, dynamos dried out and numerous flooded water-supply pumping stations brought back into service. At Purfleet, large quantities of paper have had to be cleared, as shown in Fig. 4, on page 400. It was, however, generally found that where the track had merely been flooded and not subject to any scouring action, it was in tolerably good condition. Also, where actual breaching had not occurred and there had been only surface scouring action, the formation had become so consolidated over the years as to be fairly resistant to erosion. Considerable damage, however, was sustained by the 120-ton double track bridge-ramp of the Harwich-Zeebrugge train ferry terminal; this damage was caused by the ramp being forced upwards by the berthed ferry *Essex*, which was lifted on the flood some 7 ft., to which was added a swell of 4 ft. to 5 ft. The ramp became jammed and the lifting machinery suffered to the extent that the 15-ton bedplate casting supporting the 6-ton winding drum, gearing and electrical drive was completely fractured, as also was the larger of the two side pedestal castings of the main winding drum. All the machinery was dismantled (the 6-ton winding drum having to be man-handled in the confined space of the machinery house) and the main bed welded in position with reinforcing plates. The fractured pedestal was removed to and welded in the contractor's own works. The contractors were Messrs. R. and H. Green and Silley Weir, Limited, and the British Arc Welding Company, Limited, both of 130, Leadenhall-street, London, E.C.3. New 5-in. circumference wire ropes were supplied by British Wire Ropes, Limited, and delivered before the main repair work in the machinery house was completed. On completion of the work in the first week of March, the normal daily sailing of one of the three train ferries working this route was resumed. The three ferries, *Essex*, *Norfolk* and *Suffolk*, handle between them some 130,000 tons of perishable foodstuffs and freight a year—which indicates how necessary it was to reinstate this service as soon as possible. The cost of rehabilitating the lines, yards, installations, rolling stock, etc., of the Eastern Region cannot yet be stated, but it is expected to be nearly 250,000l.

ELECTRICITY SUPPLY STATISTICS.—During February, 1953, 5,300 million kilowatt-hours were sold by the British Electricity Authority to the Area Boards, an increase of 0.6 per cent. over the output in the corresponding month of last year. When corrected for weather and the number of working days, however, the increase was 5.9 per cent., the weather having been slightly warmer and the effective working days fewer than a year earlier. The amount of electricity sent out by the Area Boards during the same month was 5,300 million kilowatt-hours, an increase of 0.6 per cent., although the supplies in the "mainly industrial" areas showed a falling off of 0.9 per cent. and in the "mainly non-industrial" areas an increase of 2.8 per cent.

SLIDE-VALVE HYDRAULIC MOTOR FOR AIRCRAFT SYSTEMS.

BRITISH MESSIER, LTD., GLOUCESTER.

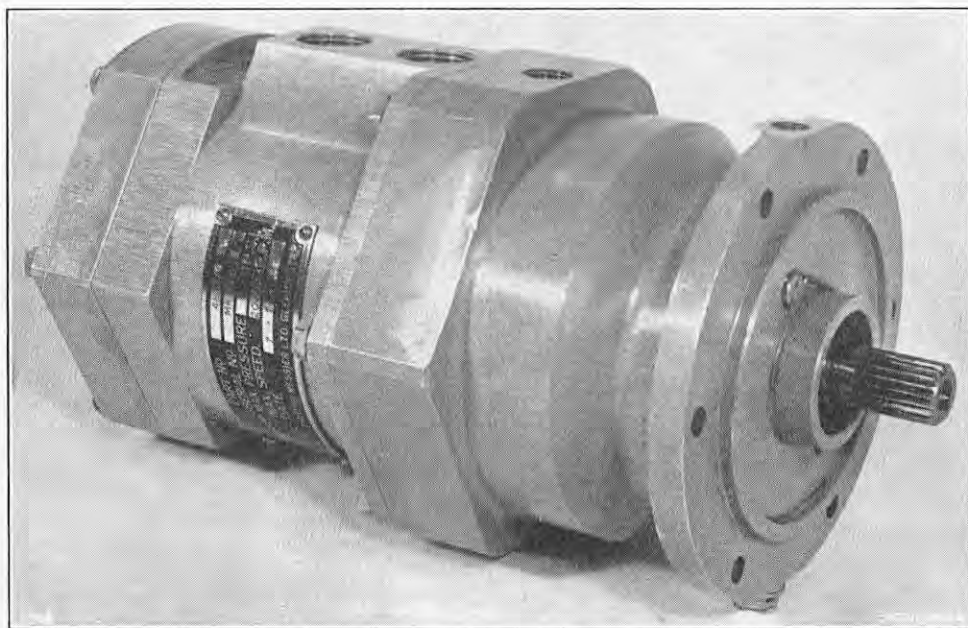
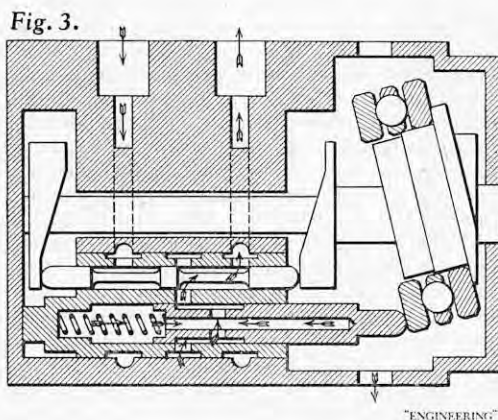
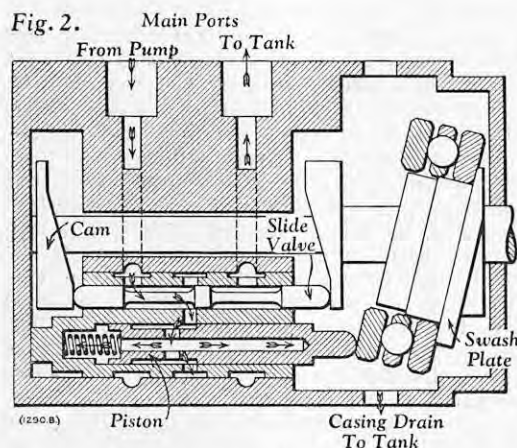


FIG. 1.



SLIDE-VALVE HYDRAULIC MOTOR FOR AIRCRAFT SYSTEMS.

A REVERSIBLE hydraulic motor for use in aircraft hydraulic systems has been developed recently by British Messier, Limited, Cheltenham-road East, Gloucester. It provides a rotary drive for operating Fowler flaps and similar mechanisms where a comparatively long travel is required, and for which the normal hydraulic jack that has hitherto been mainly used in British aircraft is not suitable. The manufacturers claim that the new motor, which weighs 14.3 lb., is lighter than an electric motor for the same duties; it is continuously rated at approximately 15.8 h.p. at 2,500 r.p.m., and it has a high ratio of torque to inertia, so that when the hydraulic connections to the motor are reversed, the rotation of the motor is reversed almost instantaneously. At the maximum system pressure, 4,000 lb. per square inch, the unit is capable of delivering a maximum torque of 400 lb.-in. over a speed range from 300 r.p.m. to 2,500 r.p.m., with a corresponding horse-power range of 1.9 h.p. to 15.8 h.p. The output torque is directly proportional to the input pressure, and the speed is directly proportional to the input flow.

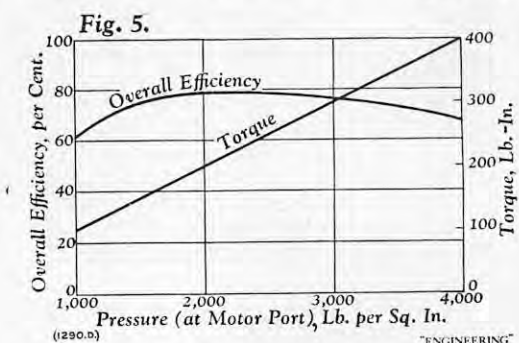
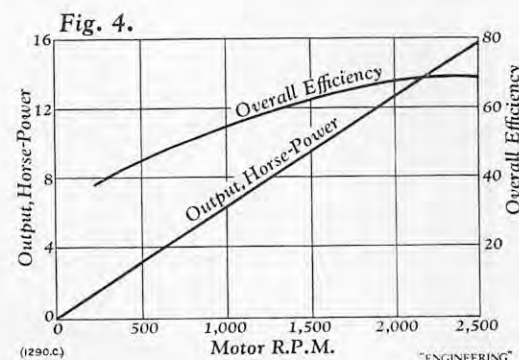
The motor is illustrated in Fig. 1, and diagrams illustrating the principle of operation are given in Figs. 2 and 3. The motor shaft carries a swashplate formed by a ball thrust race mounted at an angle. Five cylinder sub-assemblies are housed within the motor casing, each consisting of a single-acting piston and slide-valve assembly. The free ends of the pistons bear upon the swashplate, and cause it to rotate as oil is fed to each cylinder in sequence.

The admission and exit of oil to and from each cylinder are controlled by the motion of the slide valve, which, in turn, is actuated by a pair of timing cams on the motor shaft. As shown in Fig. 1, the motor is arranged for flange mounting. Each of the cylinders has a bore of 0.53 in. and a stroke of 0.672 in., giving a total swept volume per revolution of 0.741 cub. in.

Extensive static and endurance tests of the motor have been carried out. In a 52½-hour endurance test, the motor was coupled directly to a Messier type 4814 pump, which acted as a loading medium. The motor ports were fed through a reversing valve. At an inlet pressure of 2,400 lb. per square inch, the motor was reversed every 15 seconds, and completed 10,000 reversals without developing any fault. The unit was calibrated with a dynamometer before and after the test, and was found to have maintained its performance throughout.

In a test to determine the starting torque at low temperatures, the motor was refrigerated to a temperature of -60 deg. C. An inlet pressure of 86 lb. per square inch was required at this temperature to start the motor rotating. Leakage tests were carried out by locking the motor shaft to prevent rotation, and applying a pressure of 4,000 lb. per square inch at one port. The leakage from the other port was 710 cc. per minute. When the ports were reversed, the leakage was 600 cc. per minute. Both these figures were well within the permissible limit of leakage, 1,000 cc. per minute. In a low-pressure test, the main ports were sealed and the motor was totally submerged in oil. An air pressure of 20 lb. per square inch applied at the casing drain resulted in no leakage.

Performance curves for the motor, operating on D.T.D. 585 hydraulic fluid at a temperature of



45 deg. to 60 deg. C., are reproduced in Figs. 4 and 5. In Fig. 4, the overall efficiency and the output horse-power are plotted against motor-shaft speed for an inlet pressure of 4,000 lb. per square inch. In Fig. 5, the overall efficiency and torque are plotted against inlet pressure, for a shaft speed of 2,000 r.p.m., and an inlet flow of approximately 30 cub. in. per second.

A TEST PILOT'S VIEW OF HIGH-PERFORMANCE JET AIRCRAFT.

PROBLEMS encountered by test pilots of high-altitude high-speed aircraft were discussed in a lecture entitled "Some Aspects of High-Performance Jet Aircraft" given by Squadron Leader W. A. Waterton, G.M., A.F.C., at a meeting of the Royal Aeronautical Society, at Derby on Thursday, March 12. During his service with the Royal Air Force, Squadron Leader Waterton said, he had been engaged in tactical and comparative trials of German, American, Italian, and British aircraft. These trials had shown that superior speed, rate-of-climb, and rate-of-turn performance did not necessarily indicate the ability to out-maneuvre other aircraft if, for example, the latter had good acceleration, a steeper angle of climb, or superior lateral control. Stability and control, as well as performance, were essential to the pilot, and so were reasonable comfort, vision and security.

Longitudinal stability deteriorated with increasing altitude, low airspeed and high incidences near the stall (particularly with swept-back wings), greater variation of engine power, and in the transonic, and possibly supersonic, region. Conversely, large increases in stability could occur at very high airspeeds. Stability variations could also arise from aero-elastic distortion, from the up-float and down-float of controls, and from compressibility effects due to the local breakdown of airflow or to turbulent air conditions. The latter factor, he thought, might have been responsible for many high-speed aircraft hitting the ground through loss of control. Good damping was essential for achieving the steadiness of aim and flight path required for accurate sighting, gunnery, bombing, or photography. Unfortunately, damping fell off seriously with increasing altitude.

The behaviour of the controls varied widely over the speed, Mach number and altitude ranges. Hinge moments might increase by seven times or more at the high-speed end of the range, and hinge-moment characteristics might change in the tran-

THE "AIRCOMATIC" WELDING PROCESS FOR ALUMINIUM.



FIG. 1. WELDING GUN IN USE.



FIG. 2. REGULATOR FOR ELECTRODE WIRE AND WELDING GUN.

sonic region, giving rise to buffeting and to stick forces beyond the pilot's strength to control. Lack of self-centring, coupled with unequal responses over the range of control movements and the range of speed and altitude, could produce lack of sensitivity at low speeds and over-sensitivity at high speeds. At supersonic speeds, lack of effectiveness might be experienced. At high speeds and Mach numbers, undulating flight and flutter might arise from the deterioration of damping. The only solution to these problems appeared at present to be the use of irreversible fully-powered controls.

Many of the discrepancies between the results of wind-tunnel tests on scale models and full-scale flight tests, suggested the lecturer, were not true scale effects but arose because the full-scale aircraft was not truly representative of the smooth-surfaced model. Quite small leaks and surface irregularities could affect handling and performance very seriously. New types of aircraft structure, with heavier skins and less light-gauge internal members, should be developed to provide more accurate surfaces which would distort less under air loads and would allow more internal space.

Discussing aircraft configurations, Squadron Leader Waterton favoured a low wing loading for good turning and climbing capability at high altitude; it also gave a useful low-speed range and allowed the use of smaller aerodromes. The delta-wing layout had excellent high-speed characteristics in a compact, strong and stiff form, and the problems of handling delta-wing aircraft were no more severe than those encountered in more conventional high-speed aircraft.

At altitudes above 40,000 ft., vision presented a problem, as a result of the extreme brilliance of the sunlight in the absence of dust and water vapour, the lack of contrast, the lack of prominent reference points, and the reduced air-to-ground vision. Shifting the eye from the aircraft instruments to the horizon imposed a continuous strain on the eye muscles, and more easily-read instruments were required. At high speeds, the time available for sighting another aircraft before it passed out of range—or before encountering it head-on—was extremely short; and serious errors in track could result from slight deviations from course at high speed. For the fighter aeroplane, there was a strong case for the development of search and gun-laying radar.

Discussing the growing complexity of aircraft hydraulic and electric services, instruments, and engines, Squadron Leader Waterton made a plea for the use of more standardised ranges of components and equipment which, he thought, should lead to the production of cheaper aircraft. In particular, he asked for simplified and standardised warning lights to replace the various instrument indicators.

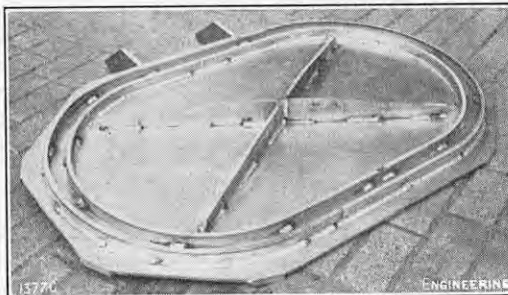


FIG. 3. WELDED HATCH COVER.

THE "AIRCOMATIC" WELDING PROCESS FOR ALUMINIUM.

Two main factors have had a retarding effect on the successful welding of aluminium; these are, firstly, the great affinity of the metal for oxygen when heated, and, secondly, its high heat conductivity. The first factor has necessitated the use of a flux to prevent or minimise the formation of oxide and its inclusion in the weld with disastrous effects on strength and durability. These fluxes, however, have a corroding effect on aluminium and care must be taken to ensure their final removal from the joint. Owing to the high heat conductivity of aluminium, the heat of welding spreads rapidly through the metal and affects a comparatively large area. This gives rise to difficulties, especially in the case of heat-treatable alloys. The introduction, some ten years ago, of a process incorporating an arc shielded with an inert gas did much to solve both problems. Argon is the inert gas used in this country and it prevents, of course, the oxidation of the liquid metal. Moreover, the increase in the welding speed that has become possible means that the heat input into the work is less, and, consequently, the parent metal is less affected. The process enables good clean welds of high strength to be produced by operators after a little practice.

An outcome of the development of the argon-arc welding technique is the "Aircomatic" process recently demonstrated in Glasgow by the British Aluminium Company, Limited, Norfolk House, St. James's-square, London, S.W.1. In this process an aluminium filler wire of suitable composition is automatically fed through the welding gun inside a protective argon envelope. Power is supplied by a direct-current arc, the electrode being positive. An important feature of the process is the utilisation of high current densities in the electrode, the minimum value being in the region of 50,000 amperes per square inch. Under these conditions

projected metal transfer is obtained, droplets of the filling-wire metal being transferred at a high velocity through the arc and deposited in the direction in which the welding gun is pointed. Fillet welding, as shown in Fig. 1, on this page, is thus facilitated, and all-position welding is made relatively simple. Another important feature of the process, when operated manually, is that the arc is self-adjusting. The rate of consumption of the electrode, or the "burn-off rate" of the aluminium filler wire, varies with the arc current and voltage in such a manner that, combined with the characteristics of the direct-current welding generation, the arc length is self-regulating. The regulating apparatus and the welding gun are shown in Fig. 2, above. By using the Aircomatic welding equipment, which is soon to be manufactured by the British Oxygen Company, Limited, and marketed under the name of Argonaut, the speed of the arc traverse is high, thus economising argon. For fillet and lap joints in an aluminium-5 per cent. magnesium alloy plate of from $\frac{1}{8}$ in. to $\frac{3}{4}$ in. in thickness, the speed is from 20 in. to 48 in. per minute. The strength of the welds is high, it being stated to be at least 75 per cent. of that of the parent metal or 85 per cent. of the annealed strength of the parent metal. In the welding of the small hatch cover shown in Fig. 3, in which only fillet welds are involved, the cost of the welding operation is apportioned as follows: argon shielding gas 40 per cent., electrode wire 25 per cent., labour 20 per cent., overhead expenses on a 10 per cent. cost-plus basis, 10 per cent., and electricity 5 per cent. The actual welding cost is quoted as approximately 2s. 6d. per foot run of a $\frac{1}{8}$ -in. single fillet.

COURSE ON WORK STUDY.—Following the success of the first course at the new Work Study School at the College of Aeronautics, Cranfield, Buckinghamshire, the British Institute of Management, 8, Hill-street, London, W.1, are organising a second course to run from April 13 to June 26. There are still a few vacancies on this course, since some firms have transferred their applications to the third course, which is to be held from October 5 to December 8.

THE CHEMICAL SOCIETY.—The Corday-Morgan medal and prize for 1952, consisting of a silver medal and a monetary prize of 150 guineas, is made annually to the chemist of either sex and of British nationality who, in the judgment of the Council of the Chemical Society, has published during the year in question the most meritorious contribution to experimental chemistry, and who has not, at the date of publication, attained the age of 36 years. Copies of the rules governing the award may be obtained from the general secretary of the Society, Burlington House, London, W.1. Applications or recommendations in respect of the award for the year 1952 must be received not later than December 31, 1953, and applications for the award for 1953 are due before the end of 1954.

NOTES FROM THE INDUSTRIAL CENTRES.

SCOTLAND.

RECORD BLAST-FURNACE OUTPUT.—A record output of 4,584 tons of pig iron was produced at the No. 2 blast furnace at Messrs. Colvilles' Clyde Iron Works, Tollcross, Glasgow, during the week ended 6 a.m. on Sunday, March 15. The furnace operates on the high top-pressure principle. A second record of 4,379 tons a week, during the four-weekly period ended on the same shift, was also set up. The previous record of 4,100 tons a week, over four weeks in 1946, was made using only high-grade foreign ore, whereas the latest record was achieved using about 25 per cent. native English ores. The coke consumed in the record for the week ended March 15 was 17.57 cwt. per ton, and for the four week's record, 17.39 cwt.

SHEET STEEL IN HOUSE BUILDING.—Recent developments in the provision of communal services for dwelling houses would surely indicate completely air-conditioned and air-heated houses, in which the steel industry, and particularly the sheet-steel industry, must play a leading part, said Mr. C. D. Rigg, director of Smith and McLean, Ltd., sheet-bar manufacturers, in the concluding lecture, on March 17, of a series of 15 on "The Future of the Steel Industry." The lectures have been sponsored by the Lanark County Council. If that vision were sound, he said, it would be a matter of early development to provide more continuous sheet-mills in this country. Future large developments in the steel industry would necessarily be confined to areas close to waterways on account of the prevailing large imports of iron ore.

SALVAGE OF S.S. "CLAN MACQUARRIE."—The Clan Line cargo steamer Clan Macquarie, which was aground at Borrie, on the west side of the Isle of Lewis, for six weeks and was refloated on March 16th, has arrived in the Clyde from Stornoway in the charge of the salvage vessels Salvada and Metinda, belonging to Metal Industries, Ltd. She proceeded to Faslane, in the Gareloch, for survey of damages and certain repairs before going into dry dock.

THE LATE MR. J. MCINTYRE.—A founder member of the West of Scotland Foremen Engineers' Association, Mr. J. McIntyre, of Dumbarton, died on March 15, at the age of 92. His working life was spent in marine-engine construction.

PUBLIC WORKS AT GRANGEMOUTH DOCKS.—The Docks and Inland Waterways Executive have approved a scheme to spend 30,000*l.* in laying new water mains through the Grangemouth dock area. Work is due to start immediately. Approval has also been given for the expenditure of 12,000*l.* for the renewal and improvement of existing roads.

A PRESTRESSED CONCRETE BRIDGE.—The final beam of the bridge under construction between Lewis and Great Bernera, across Loch Roag, was placed in position on March 21. Each of the nine 100-ft. prestressed concrete beams, of a hollow-trough design 4 ft. square in section, weighs 50 tons. With the main structure now in position concreting and asphaltting of the roadway is expected to be finished by the end of June.

CLEVELAND AND THE NORTHERN COUNTIES.

STEEL ALLOCATIONS TO SHIPBUILDERS.—At the annual staff dinner of Messrs. John Readhead & Sons, Ltd., the South Shields shipbuilders, Mr. G. H. R. Towers, the managing director, said that it was strange that, when the British steel output was higher than ever, shipyards could not obtain their proper allocations from the steelworks. The shipbuilder had the difficult task of explaining this to shipowners who saw delivery dates receding, while steel output increased.

COLLIERY SPOIL HEAPS AT BLYTH.—Blyth Town Council, Northumberland, are concerned at the number of colliery spoil heaps already existing in the area and have decided not to allow the tipping of refuse in the borough from the proposed new power station at Cambois. Increased tipping has been caused by further mechanisation and developments at local pits, especially the Bates Pit. It is possible that waste from the proposed power station may be tipped into the sea.

EXTENSION TO SHIPBUILDING BERTHS AT SUNDERLAND.—Messrs. William Doxford & Sons, Ltd., Sunderland, have begun work on extensions to two of

their building berths to permit the construction of ships of 20,000 tons deadweight carrying capacity. Each berth will be lengthened by 35 ft. to 550 ft. and the work will be completed about the end of this year.

IRON-ORE QUAY AT TYNE DOCK.—The new iron-ore discharging quay which is being erected at Tyne Dock, South Shields, by the Tyne Improvement Commission, is expected to be officially opened in July or August. The work was originally to have been completed last month, but there have been delays due to shortages of materials. The quay will accommodate ships up to 20,000 tons deadweight carrying capacity. It is being built by the Yorkshire Henebique Contracting Co., Ltd., the ore-handling plant by Simon Handling Engineers, Ltd., and the cranes by Stothert & Pitt, Ltd.

TRADING ESTATES IN THE NORTH-EAST.—North-Eastern Trading Estates, Ltd., have under consideration schemes for new factories and factory extensions for 30 firms on various trading estates in the North-East. These works will cost 1,200,000*l.* and result in employment for a further 3,300 men and women. Employment at factories owned by North-Eastern Trading Estates, Ltd., has recently reached a total of more than 44,000 men and women, the highest figure yet recorded.

FATAL ACCIDENT AT SLAG TIP.—Messrs. Dorman, Long & Co. Ltd., Middlesbrough, have issued a statement contradicting reports that two men killed at the firm's Cleveland Works, Grangetown, had been engulfed by molten slag. The statement said that a heavy fall had occurred on the south face of the slag tip. Certain men employed by contractors to move the slag at the foot of the tip escaped, but a wave of hot flue-dust spread away from the tip and suffocated the two men, who were working at nearby railway sidings. It was not molten slag, but hot flue-dust which caused the accident. The technical staff are carrying out an investigation.

LANCASHIRE AND SOUTH YORKSHIRE

AUTOMATIC SKIP-WINDING AT COLLIERY.—A 1,000,000*l.* scheme to mechanise and modernise the haulage system at Yorkshire Main Colliery is making good progress and when completed will release 200 haulage hands for other coal-getting duties. Four units so far have been converted to automatic skip-winding and a further nine units are to be converted. Coal is loaded into mine cars, hauled by Diesel locomotives, which take it directly to the pit bottom, where the cars are automatically tipped into a skip. Each skip carries seven-and-a-half tons of coal, and a conveyor belt takes the coal to the screens. Of the 17 locomotives in use, each hauls about 22 cars and a full train carries 80 tons of coal.

STEEL FOR BUILDING FLATS.—The Sheffield Housing Committee have provisionally decided to build 2,000 flats on a 250-acre site in the Norfolk-Park area, as a result of the recent allocation of 1,000 tons of steel for flat erection. The architectural design of the flats will be based on types seen by the committee on a recent visit to Sweden.

THE LATE MR. A. WHITAKER.—We regret to record the death of Mr. Arthur Whitaker, which occurred on Monday, March 16, at the age of 80. He had been a director of Ferranti, Ltd., Hollinwood, since 1905, and during the second World War acted as chairman and managing director while Sir Vincent de Ferranti was on military service.

THE MIDLANDS.

NORTH-EAST MEN IN LINCOLNSHIRE STEELWORKS.—A representative of Scunthorpe steelworks has been visiting North-East towns interviewing unemployed men with a view to giving them work at Scunthorpe. About 50 men are needed. A number of North-East men have already secured employment at Scunthorpe works in recent years. The men wanted include labourers, welders, electricians, maintenance fitters, boilermakers and also draughtsmen.

OIL PROSPECTING.—Routine drilling operations by the National Coal Board at Radcliffe-on-Trent, Nottinghamshire, have disclosed small quantities of oil. The D'Arcy Exploration Company have taken over the borehole, to investigate the oil occurrence and to deepen the drilling.

RETURN OF FAST EXPRESSES.—British Railways (London Midland Region) are to restore, on June 8,

two-hour express trains between Birmingham and London. Two-hour services between the two cities were withdrawn in 1939, on the outbreak of war, and in recent years there has been increasing pressure for their restoration. There will be five trains a day each way on the London Midland line between Euston and Birmingham (New Street), but the two-hour service is not to be restored on the Western Region line from Paddington to Birmingham (Snow Hill). The new service will operate until September 20, the end of the summer season, when the position will be reviewed.

VEHICLE PRODUCTION AT COVENTRY.—The Standard Motor Co., Ltd., have decided to increase the production of vehicles at their Coventry factories. Short time has been worked at the company's factories since last October, but when it was introduced, it was announced that there was a hope that it would soon be possible to return to normal working. It will now be necessary either to engage extra labour, or to work overtime. The latter scheme is favoured, as it is not possible to foresee what the position will be in a few months, and if extra men were engaged, it might be necessary to dismiss them again in June.

CO-OPERATION IN THE EXPORT TRADE.—The Board of Trade and the Ministry of Supply are jointly sponsoring a plan for encouraging co-operation among small firms engaged in export work. There are about 3,000 small and medium-sized engineering firms in the Midlands, each employing from 11 to 500 persons, and it has been suggested several times that, by pooling resources and marketing facilities, these firms could improve their export trade considerably. The two Government departments concerned are making their services available to assist firms wishing to form groups for marketing their products overseas. The Ministry of Supply have prepared lists of possible groups, and are ready to put interested firms in touch with others having similar problems and products.

CLOSING OF BRANCH RAILWAY LINE.—The branch railway line between Bretby, Burton-on-Trent and Swadlincote Junction is to be closed on April 8. The line, operated by the London Midland Region of British Railways, was opened 70 years ago to serve a colliery which has long since been closed, and there has been very little traffic for some years.

GLASS-SCREEN FOR CHAIN-MAKERS.—Following upon the recent investigation into the cause of eye-complaints in the chain trade by two eye-specialists, a special glass screen has been introduced for the use of the chain-makers. The new screen has been tried at Cradley Heath, and has proved successful. It is considered that it will be particularly suitable for workers engaged on the production of small chains.

THE LATE MR. F. H. REEVES.—The death has been announced, at the age of 76, of Mr. F. H. Reeves, founder of the Revo Electric Co., Ltd., Tipton, Staffordshire. Mr. Reeves became manager, at the age of 30, of a small firm then known as the Cable Accessories Company, which had been started in a derelict iron-works a year earlier, and built the business up until it became the Revo Company, which now employs 2,000 workers.

SOUTH-WEST ENGLAND AND SOUTH WALES.

HORIZON-MINING AT NANTGARW.—Officials of the South-Western Division of the National Coal Board have been defending their 5,000,000*l.* horizon-mining project at Nantgarw Colliery, near Cardiff, against hostile criticism and deny emphatically that it is a "white elephant," unlikely ever to be a success. Development work at the colliery is up to reasonable expectations, though difficulties have been encountered, both on the surface, owing to the delay in deliveries of equipment, and underground, owing to adverse geological conditions. In spite of these, however, the output of the colliery has improved steadily from a negligible quantity in January, 1952, to 300 tons a week by May last, and to 2,500 tons a week at present. The colliery is the first of the Coal Board's major projects planned on horizon-mining methods, and, at the outset, was intended to reach an output of 750,000 tons a year by 1956. The carbonisation plant at the colliery is working to full capacity and the results fully justify the expectations.

SATURDAY WORKING AT ABERDARE VALLEY PITS.—Three collieries, employing 2,400 men, the Tower, Tirherbert and Pandy collieries, in the Aberdare Valley, have decided to resume working the Saturday-morning shift after banning it for five months. These were some of the collieries that imposed the ban because of dissatisfaction at the progress of wage negotiations. Work on the shift was resumed on Saturday, March 21.

NOTICES OF MEETINGS.

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.

SOCIETY OF ENGINEERS.—Monday, March 30, 5.30 p.m. Geological Society's Apartments, Burlington House, Piccadilly, W.1. "Structural Failure and What We Learn From It," by Dr. R. Week.

INSTITUTION OF ELECTRICAL ENGINEERS.—Monday, March 30, 5.30 p.m., Victoria-embankment, W.C.2. Discussion on "Use and Abuse of Research," opened by Dr. S. Whitehead. *South Midland Centre*: Monday, March 30, 6 p.m., James Watt Memorial Institute, Birmingham. Discussion on "Electric Heating," opened by Mr. E. H. Cox. *North Midland Centre*: Tuesday, March 31, 6.30 p.m., The University, Leeds. "275-kV Developments on the British Grid System," by Mr. D. P. Sayers, Dr. J. S. Forrest and Mr. F. J. Lane. *London Students' Section*: Tuesday, March 31, 7 p.m., The Public Library, Chelmsford. "The Generation of High-Voltage Direct-Current Power for Transmission Systems," by Mr. J. R. Rickard. *Institution*: Thursday, April 9, 5.30 p.m., Victoria-embankment, W.C.2. "Special Effects for Television Studio Productions," by Mr. A. M. Spooner and Mr. T. Worswick. *South Midland Centre*: Thursday, March 9, 7 p.m., College of Technology, Birmingham. "The Devising of Examination Questions," by Professor G. W. Carter.

NORTH EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.—Monday, March 30, 6.15 p.m., Neville Hall, Newcastle-upon-Tyne. "The Preservation of Oil-Tanker Hulls," by Mr. John Lamb and Mr. E. V. Mathias.

ILLUMINATING ENGINEERING SOCIETY.—*Leeds Centre*: Monday, March 30, 6.15 p.m., Lighting Service Bureau, 24, Aire-street, Leeds, 1. Annual Meeting. "Lighting and Vision as Age Advances," by Mr. H. C. Weston. *Cardiff Centre*: Tuesday, March 31, 5.45 p.m., Offices of the South Wales Electricity Board, Cardiff. "Development of Lamps Other than Tungsten," by Mr. E. J. G. Beeson.

CHEMICAL ENGINEERING GROUP.—Tuesday, March 31, 5.30 p.m., Geological Society's Apartments, Burlington House, Piccadilly, W.1. Joint Meeting with the **INSTITUTION OF CHEMICAL ENGINEERS.** "The Production of Acetic Anhydride from Acetone," by Mr. W. G. Daroux.

INSTITUTION OF CIVIL ENGINEERS.—*Road Engineering Division*: Tuesday, March 31, 5.30 p.m., Great George-street, S.W.1. "Factors Affecting the Riding Quality of Machine-Laid Concrete Roads," by Mr. R. H. H. Kirkham. *Midlands Association*: Thursday, April 9, 6 p.m., James Watt Memorial Institute, Birmingham. Open Discussion Meeting. *Hull and East Riding Branch*: Friday, April 10, Electricity Showroom, Ferensway, Hull. 6.15 p.m., Annual Meeting. 6.30 p.m., Vernon Harcourt Lecture on "Practical Methods of Flood Protection," by Mr. W. E. Doran.

INSTITUTION OF HEATING AND VENTILATING ENGINEERS.—*Scottish Branch*: Tuesday, March 31, 6.30 p.m., Engineering Centre, 351, Sauchiehall-street, Glasgow, C.2. "Steam-Boiler Performance Testing and Insurance," by Mr. R. H. Brown. *East Midlands Branch*: Wednesday, April 1, 6.30 p.m., College of Technology, Leicester. Annual Meeting. Short papers by junior members. *Manchester Branch*: Friday, April 10, 6.30 p.m., Engineers' Club, Manchester. Annual Meeting and Chairman's Address.

SOCIETY OF INSTRUMENT TECHNOLOGY.—Tuesday, March 31, 7 p.m., Manson House, 26, Portland-place, W.1. "The Presentation of Control Theory and the Training of Control Engineers," by Dr. G. L. d'Ombrian.

INSTITUTION OF STRUCTURAL ENGINEERS.—*Northern Ireland Branch*: Tuesday, March 31, 6.45 p.m., College of Technology, Belfast. Annual Meeting. *Western Counties Branch*: Friday, April 10, 6 p.m., The University, Bristol. Annual Meeting.

INSTITUTE OF METALS.—*Oxford Section*: Tuesday, March 31, 7 p.m., Black Hall, St. Giles, Oxford. Annual Meeting. Various papers for discussion. *Birmingham Section*: Thursday, April 2, 6.30 p.m., James Watt Memorial Institute, Birmingham. Annual Meeting and Chairman's Address. *London Section*: Thursday, April 2, 6.30 p.m., 4, Grosvenor-gardens, Westminster, S.W.1. Annual Meeting.

ROYAL AERONAUTICAL SOCIETY.—Tuesday, March 31, 7 p.m., 4, Hamilton-place, W.1. Section Lecture. "Experimental Work on Boundary Layer Flow," by Mr. W. E. Gray.

SHEFFIELD METALLURGICAL ASSOCIATION.—Tuesday, March 31, 7 p.m., Grand Hotel, Sheffield. "Stainless-Steel Production," by Mr. P. Munro.

INSTITUTION OF PRODUCTION ENGINEERS.—*Luton Section*: Tuesday, March 31, 7.15 p.m., Town Hall, Luton. "Some Visits to American Factories Engaged in Jobbing Engineering," by Mr. G. P. E. Howard.

Nottingham Section: Wednesday, April 1, 7 p.m., Victoria Station Hotel, Milton-street, Nottingham. "Lighting for Production," by Mr. F. Jamieson. *Reading Section*: Thursday, April 2, 7.15 p.m., Great Western Hotel, Reading. "Fatigue of Metals," by Professor J. A. Pope. *Luton Graduate Section*: Tuesday, April 7, 7.30 p.m., Peahen Hotel, London-road, St. Albans. "Standardisation and the Utilisation of Materials," by Dr. E. L. Diamond. *Leicester Section*: Thursday, April 9, 7 p.m., Bell Hotel, Leicester. "Gear Finishing," by Mr. H. Pearson. *London Section*: Thursday, April 9, 7 p.m., The Royal Empire Society, Northumberland-avenue, W.C.2. "Building a Steam Turbine," by Mr. A. C. Annis. *Liverpool Graduate Section*: Friday, April 10, 7.30 p.m., Exchange Hotel, Tithebarn-street, Liverpool. Film Evening. *West Wales Section*: Friday, April 10, 7.30 p.m., Central Library, Alexandra-road, Swansea. "Advanced Science and the Production Engineer," by Professor Llewellyn Jones.

INSTITUTION OF ENGINEERING INSPECTION.—*South-Western Branch*: Tuesday, March 31, 7.30 p.m., Grand Hotel, Broad-street, Bristol. "Photo-Elastic Methods of Stress Analysis," by Mr. H. D. Haddon.

JUNIOR INSTITUTION OF ENGINEERS.—*Midland Section*: Wednesday, April 1, 7 p.m., James Watt Memorial Institute, Birmingham. Discussion on "Pressworking Machines, Methods and Problems." *Institution*: Friday, April 10, 7 p.m., Townsend House, Greycoat-place, S.W.1. "Developments in the Design of the Steam Locomotive," by Mr. D. M. Hunter.

INSTITUTE OF FUEL.—*North-Western Section*: Wednesday, April 1, 7 p.m., Central Library, Burnley. "Let There Be Light," by Mr. S. N. Duguid. *East Midland Section*: Thursday, April 9, 6.15 p.m., Gas Showrooms, Nottingham. "Investigations in Power Stations Concerned with Boiler Fouling and Corrosion," by Dr. H. E. Crossley. *South Wales Section*: Friday, April 10, 6 p.m., South Wales Institute of Engineers, Park-place, Cardiff. "Some Aspects of Domestic Heating," by Mr. E. Brooks.

INSTITUTE OF WELDING.—*Manchester Branch*: Wednesday, April 1, 7.15 p.m., College of Technology, Manchester. Annual Meeting. "Welding as Applied to Locomotive Construction and Maintenance," by Mr. G. Foster. *South London Branch*: Thursday, April 9, 6.30 p.m., Caxton Hall, Victoria-street, S.W.1. Annual Meeting. Debate on "Standardised Inspection Tests for Welded Work." *North-Eastern (Tyne-side) Branch*: Thursday, April 9, 7 p.m., Neville Hall, Newcastle-upon-Tyne. Annual Meeting. "Welding of Deck-Houses," by Mr. W. Muckle. *Birmingham Branch*: Friday, April 10, 7 p.m., James Watt Memorial Institute, Birmingham. Annual Meeting and Film Display.

INCORPORATED PLANT ENGINEERS.—*Southampton Branch*: Wednesday, April 1, 7.30 p.m., Polygon Hotel, Southampton. Open Meeting. *Peterborough Branch*: Thursday, April 2, 7.30 p.m., Offices of the Eastern Gas Board, Church-street, Peterborough. "Industrial Fire Protection," by Mr. W. H. Tuckey. *Edinburgh Branch*: Tuesday, April 7, 7 p.m., Heriot-Watt College, Edinburgh. "Elementary Industrial Electronics," by Mr. J. H. Jones. *East Midlands Branch*: Wednesday, April 8, 7 p.m., Welbeck Hotel, Nottingham. "Peak Steam Demands and Thermal Storage," by Dr. E. G. Ritchie. *Newcastle-upon-Tyne Branch*: Thursday, April 9, 7.30 p.m., Roadway House, Oxford-street, Newcastle-upon-Tyne. "Oil-Injection Method of Separating and Uniting Joints on Shaft Couplings," by Mr. C. S. Clarke.

LEEDS METALLURGICAL SOCIETY.—Thursday, April 2, 7.15 p.m., The University, Leeds. "Recent Advances in Electro-Deposition of Metals and Alloys," by Dr. J. W. Cuthbertson.

INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND.—Tuesday, April 7, 6.30 p.m., 39, Elmbank-crescent, Glasgow, C.2. Annual Meeting. "The Fatigue Strength of Marine Shafting. Part II.—Large-Scale Investigation of the Effect of Fillet Radius on the Torsional Fatigue Strength of Marine Shafting," by Mr. T. W. Bunyan and Dr. H. H. Attia.

INSTITUTION OF WORKS MANAGERS.—*Sheffield Branch*: Tuesday, April 7, 7.30 p.m., Grand Hotel, Sheffield. "The Bones of Industry," by Mr. A. Elson. *Tees-Side Branch*: Wednesday, April 8, 7.30 p.m., Vane Arms Hotel, Stockton-on-Tees. Annual Meeting.

INSTITUTE OF PETROLEUM.—Wednesday, April 8, 5.30 p.m., Manson House, 26, Portland-place, W.1. "The Present Status of the Art of Cracking," by Mr. W. C. Dickerman, Jr.

BRITISH INSTITUTION OF RADIO ENGINEERS.—*North-Eastern Section*: Wednesday, April 8, 6 p.m., Neville Hall, Newcastle-upon-Tyne. Annual Meeting and Demonstration of Stereophonic Reproduction. *London Section*: Wednesday, April 8, 6.30 p.m., London School of Hygiene and Tropical Medicine, Keppel-street, W.C.1. "Lens Aerials for Centimetric Wavelengths," by Lieut.-Col. J. P. A. Martindale. *Scottish Section*: Thursday, April 9, 7 p.m., 39, Elmbank-crescent, Glasgow, C.2. "Remote-Control Devices and Servo-Mechanisms," by Mr. A. E. W. Hibbitt.

PERSONAL.

H.R.H. THE DUKE OF EDINBURGH has graciously signified his willingness to become an honorary member of the Institute of Fuel, 18, Devonshire-street, Portland-place, London, W.1.

SIR JOHN COCKCROFT, C.B.E., M.A., D.Sc., F.R.S., director, Atomic Energy Research Establishment, Ministry of Supply, Harwell, is to have the honorary degree of D.Sc. conferred upon him by the University of Manchester on Founder's Day, May 20.

PROFESSOR R. J. SARJANT, O.B.E., D.Sc., A.R.C.Sc., D.I.C., F.Inst.F., M.I.Min.E., is retiring from the chair of Fuel Technology in the University of Sheffield. His successor is to be **MR. M. W. THRING, M.A. (Cantab.), F.Inst.F., F.Inst.P.**, an assistant director of research of the British Iron and Steel Research Association.

MR. LESLIE J. DAVIES has retired from the post of assistant managing director of Richard Thomas and Baldwins Ltd., on account of age. He is 66, but will remain on the board. The new assistant managing director is **MR. G. A. YOUNG**, general manager, Ebbw Vale section, who has also been elected a director of the Steel Company of Wales Ltd. **MR. C. G. GILBERTSON** has retired from the board of Richard Thomas and Baldwins Ltd., on the grounds of ill-health.

MR. J. P. BRETT has been appointed engineer in charge of the low-power television transmitting station of the British Broadcasting Corporation at Pontop Pike, near Newcastle. **MR. C. DUDDINGTON** has been appointed to the corresponding position at the similar station at Glencairn, near Belfast, Northern Ireland.

MR. WALTER TONKINSON, director and chief engineer of the Electric Construction Co. Ltd., Bushbury Engineering Works, Wolverhampton, is retiring on medical advice on March 31. He has served the company for 54 years.

MR. P. R. SCUTT has been appointed managing director of Tecalemit Ltd. He was first appointed to the board in August, 1948, and later was made director and general manager.

MR. L. J. RAY, M.I.Mech.E., manager, Gear Division, George Angus & Co. Ltd., Angus House, Newcastle-upon-Tyne, 1, retires on March 31. He joined the staff of the company in 1924.

MR. W. McFARLANE, O.B.E., B.Sc., M.I.E.E., is relinquishing his appointment as chief generation engineer (operation) of the South-West Scotland Division of the British Electricity Authority at the beginning of April.

The services of **MR. A. A. WADDELL**, of 137, Craiglea-drive, Edinburgh, have been lent by the United Kingdom Government to the Ceylon Government, through the Technical Co-operation Scheme of the Colombo Plan. Mr. Waddell will prepare the layout for a modern rice mill in connection with the Gal Oya Development Scheme in the Eastern Province of Ceylon. He will also set up the machinery, supervise its working for the first year, and train Ceylonese mechanics and foremen.

MR. E. ORLOFF, M.B.E., of the Continental Division of the Metropolitan-Vickers Electrical Export Co., Ltd., London office, retired on February 23.

MR. H. D. ROBERTS, who has been secretary of Air Control Installations Ltd., Ruislip, Middlesex, since the inception of the company in 1935, has been elected a director. He will continue to act as secretary.

MR. F. W. WHITEHOUSE retired on February 28 from the position of sales manager, in Birmingham, to McKechnie Brothers, Ltd., Birmingham, after 33 years of service with the company. Matters formerly dealt with by Mr. Whitehouse will now receive the attention of **MR. DONALD BYARD**.

MR. C. GODFREY, A.M.I.Mech.E., late of the Metropolitan-Vickers Electrical Co., Ltd., has been appointed chief engineer to Spiro Gills Ltd., Pulborough, Sussex.

MR. T. K. YOUNG, who has been responsible for the development of the sale of the products of Acheson Colloids Ltd., 18, Pall Mall, London, S.W.1, in Western England and South Wales, has retired after 32 years of service with the company. **MR. J. C. F. LANG** has succeeded Mr. Young and will operate from 103, Promenade, Cheltenham. **MR. P. H. BILLINGTON** has joined the company's staff to assist in the application of its products in industry.

WINSTON ELECTRONICS, LTD., 1, Park-road, Hampton Hill, Middlesex, have opened a new Transformer Division which is the result of an amalgamation between that firm and the **EDLIN ELECTRICAL CO.** **MR. J. W. BINSTED** has been made sales manager of the new Division.

DUNLOP SPECIAL PRODUCTS LTD. have moved from their New Bond-street address to new premises at Kingsbury Works, Kingsbury-road, London, N.W.9. (Telephone: COLindale 7033.)

FLOOD DAMAGE TO RAILWAYS IN THE EASTERN REGION.

(For Description, see Page 395.)



FIG. 1. BREACH IN MAIN-LINE FORMATION.

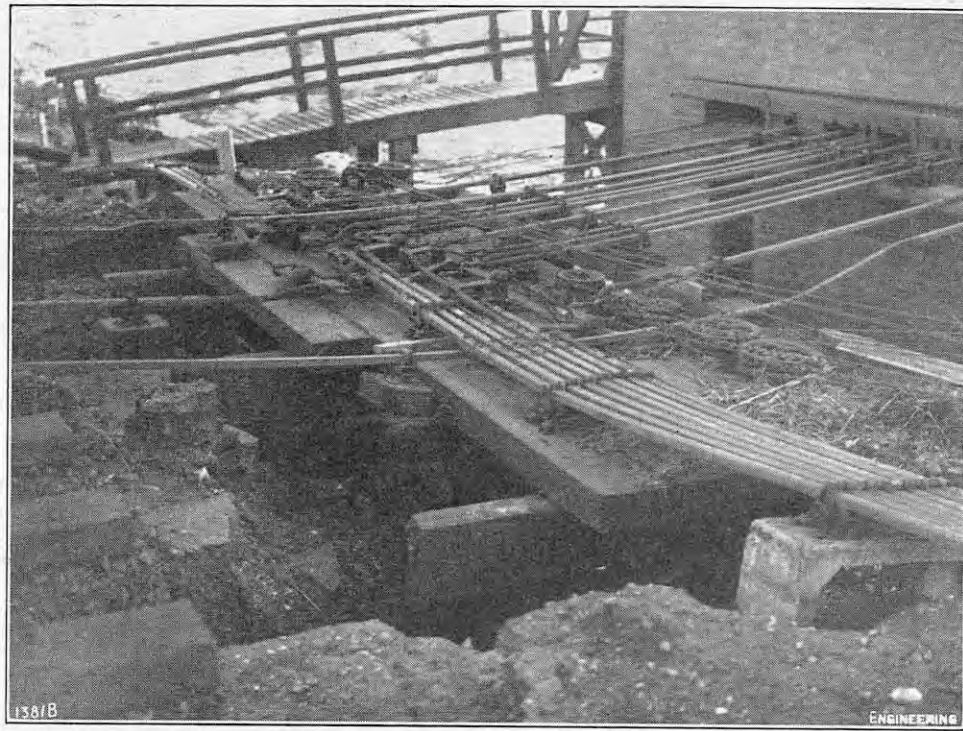


FIG. 2. SCOUR UNDER SIGNAL-BOX GROUND FRAME.



FIG. 3. PARKESTON-DOVERCOURT LINE.



FIG. 4. CLEARING WRECK FROM PURFLEET SIDINGS.

ENGINEERING

35 & 36, BEDFORD STREET, STRAND,
LONDON, W.C.2.

Registered at the General Post Office as a Newspaper.

We desire to call the attention of our readers to the fact that the above is the address of our Registered Offices, and that no connection exists between this Journal and any other publication bearing a similar title.

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For Canada	£5 5 0

Subscriptions for periods less than twelve months are based on the price of a single copy, namely, 2s. 3d. post free.

ADVERTISEMENT RATES.

Terms for displayed advertisements can be obtained on application to the Manager. The pages are 12 in. deep and 9 in. wide, divisible into four columns 2½ 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 10s. for the first four lines or under, and 2s. 6d. per line up to one inch. The line averages six words and when as advertisement measures an inch or more, the charge is 30s. per inch. If use is made of a box number the extra charge is 1s. 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 33½ 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 14 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.

CONTENTS.

	PAGE
Admiralty Test House for Gas Turbines (<i>Illus.</i>).....	385
Literature.—Strength and Testing of Materials, Parts I and II.....	388
The Napier "Nomad" Compound Diesel Engine (<i>Illus.</i>).....	388
The Engineering Outlook.—IX (<i>Illus.</i>).....	389
Steam Turbine Research and Development.....	392
Machining Aircraft Stressed-Skin Structures.....	393
Presidential Address to the Institute of Metals.....	394
Customs Patrol Launch for Ceylon (<i>Illus.</i>).....	395
Flood Damage to Railways in the Eastern Region	395
Slide-Valve Hydraulic Motor for Aircraft Systems (<i>Illus.</i>).....	396
A Test Pilot's View of High-Performance Jet Aircraft.....	396
The "Aircomatic" Welding Process for Aluminium (<i>Illus.</i>).....	397
Notes from the Industrial Centres.....	398
Notices of Meetings.....	399
Personal.....	399
Productivity in Action.....	401
Electricity Supply in the North of Scotland.....	402
Notes.....	403
Obituary.—Mr. Andrew Gray (with <i>Portrait</i>). Professor Dempster Smith, M.B.E.....	404
Count von Rumford, F.R.S. (1753-1814).....	405
The Institution of Naval Architects.....	405
The Institute of Metals.....	406
British Iron and Steel in 1952.....	407
Caliper Thread Gauges (<i>Illus.</i>).....	407
Forthcoming Exhibitions and Conferences.....	407
Labour Notes.....	408
Automatic Tippler for Railway Wagons (<i>Illus.</i>).....	409
Inspection Problems of Modern Jet Engines (<i>Illus.</i>).....	409
Titanium—A Survey (<i>Illus.</i>).....	413
Water-Cooled Lifting Magnet for Furnace Charging (<i>Illus.</i>).....	413
The National Institute of Agricultural Engineering (<i>Illus.</i>).....	414
Launches and Trial Trips.....	415
Notes on New Books.....	416
High-Temperature Tube Furnace for Laboratories (<i>Illus.</i>).....	416
Books Received.....	416
Contracts.....	416

ENGINEERING

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No. 4548.

PRODUCTIVITY IN ACTION

THE Anglo-American Council on Productivity was set up in 1948 "to promote economic well-being by a free exchange of knowledge in the realm of industrial organisation, method and technique and thereby to assist British industry to raise the level of its productivity." The Council was dissolved on June 30, 1952, a date coincident with the termination of the Marshall Aid plan, but under its auspices 47 teams from various British industries and 19 expert groups, comprising a total of 911 persons, visited the United States and spent a good deal of time examining industrial procedure in that country. As a result, 58 reports, of which 33 deal with engineering problems more or less directly, have been published; and another ten or so have still to appear. In summing up these activities in their final report the Council answered the natural question as to what practical benefit had resulted from all this work by pointing out the difficulty of discriminating clearly between action taken as the result of a productivity team's inspection and what had happened as a consequence of normal development. In other words, they found it difficult to make any accurate assessment in terms of quality, and almost impossible to do so in terms of quantity.

Nevertheless, these surveys have been useful in uncovering, and sometimes also in breaking down, potential barriers to progress. The decision, therefore, to form a new body—the British Productivity Council—to undertake the task of putting the lessons that have been learned into practice, is wise and timely. This new body, which may be said to have been formally inaugurated at a largely attended conference, held in London on Thursday, March 19,

is representative of both "management and workers, free of Government control and concerned only with the improvement of the economic position of the country." Its objectives are set out under 12 headings, which may be briefly summarised as being the improvement of productivity in every sector of the national economy by every possible means, and the enlistment of the services of every working member of the community for that purpose; for, it is argued, the British standard of living cannot be maintained, let alone improved, unless productive efficiency keeps pace with that of other nations or, put in another way, unless the real costs of production enable competitive prices to be quoted. This aim, it is considered, can only be achieved if all the industries and services "adopt the dynamic and progressive approach, which now exists only in some." Moreover, the changes which are essential for this purpose, "to be effective, must be based not on guesswork, emotion or practices that may be obsolete in the light of modern knowledge, but on an objective analysis of all the factors involved."

Full understanding and appropriate incentives of all kinds and at all levels are essential, the manifesto continues, if productivity is to be increased as rapidly as possible. Full understanding, however, implies that every individual must know what is expected of him, be able to take pride and interest in his work, and be assured of opportunity for advancement, based on merit and monetary reward. In this connection a special responsibility falls on the managers and supervisors, who, if real progress is to be made, must not only bring about advances on the technical side of production and distribution, but secure understanding and enthusiasm from their subordinates. A fearless and critical examination of methods of working and of organisation is therefore necessary as a short-term policy, to implement which all ranks must show themselves willing to accept changes for the common good. As regards the more distant future, higher productivity must be sought mainly in the continual improvement of methods of production, a policy which requires the application of the results obtained from research and the provision of fresh capital in adequate amounts. Finally, the Council consider that it is the duty of each individual to increase the effectiveness of his own work. Only if this is done can the present economic difficulties be overcome.

This is, of course, all quite impeccable, and there will be few, if any, to deny the truth of its underlying philosophy or that of the deductions which can be drawn from such a statement. Since, therefore, action rather than exhortation was postulated as being the keynote of future policy, in the speeches of the Chancellor of the Exchequer and others who participated in the conference, it may appear rather superfluous. Industry does not, or at least should not, need to be told that the problem to-day is to determine how much of the output overseas customers can be induced to buy in the face of increasing competition; or that it is a prime necessity that Britain's productive system should be modernised as rapidly and economically as possible. It is perhaps hardly necessary to add that priority should be given to productive industry rather than to what the Chancellor of the Exchequer called "milk bar" development, a term of which the implied meaning is perhaps clearer than its formal definition. It is equally clear that the issue to-day is not how much of the production can be spared for export, but how much of it can be sold abroad; and that, among the many reasons why exports should be increased, is the fact that import restrictions cannot be continued indefinitely, that the nation's substantial debts must be repaid and reserves re-established without undue delay. The trouble is how to set about the numerous and complicated tasks which are involved in these processes.

The position may, in fact, be likened to that of a skein of wool with which a kitten has been sporting. That its condition is chaotic is patent. It is equally obvious that before it can be usefully re-employed order must be restored. What is not so evident is exactly where the work of reconstitution is to start, or to continue. It is clear, however, that to perform the task determination, certainly patience, and perhaps ruthlessness will be required. The same applies when the aim is greater productivity; for while everyone agrees that it is essential, few seem to realise that, while the problem can be stated in simple terms, its solution is a most complicated matter. For instance, while many will agree with Sir Lincoln Evans that to achieve higher productivity the right attitude of mind must be acquired and the adoption of labour-saving techniques regarded not as a threat to employment, but as a path to a higher standard of living, it is not going to be easy to persuade the majority of the industrial population of that fact after it has been exposed to floods of dialectic in the contrary sense. Education in economic facts is, moreover, not only necessary for the rank and file. It is equally essential for supervisors, managers and the higher hierarchy. It is certainly necessary for central and local Government servants as well as for Members of Parliament and all those others who at present have so much say in trade. It is only if all play their part, even if that part means retirement from the stage to the wings, that rate of productivity which Sir Ewart Smith places between 1 and 2 per cent. per annum can be doubled, as has been done already in other countries.

In fact, the more closely we look into the overt and implied problems involved in this question of increased productivity, the more we are impressed with its complications and troubled by its difficulties. It is therefore with a real feeling of depression that we examine the proposals that are being put forward by the Council to deal with the immediate situation. As explained by Sir Norman Kipping at the conference, these include the establishment of 105 local productivity committees. These committees, who to begin with will be assisted by the joint committees attached to the regional boards of industry, will be centres for the exchange of views on how productivity can be increased, and will be assisted in this task by printed material, lecturers and perhaps films from the central body. A scheme has also been devised whereby teams of six, formed equally from the management or supervisors, the technical staff and the workshop, will be grouped into circuits and will visit factories for the mutual acquirement of knowledge and the exchange of information.

Little or no objection can be raised to such a policy (which should lead to useful results), with the important exceptions that it does not go anything like far enough and that it will be a long time before any harvest can be reaped from it. At best, it can be no more than a preliminary step towards the unravelment of the ultimate problem. In our view, before productivity can be increased by even that small amount, which has just been mentioned, the removal of all those restrictions which impose obstacles to output (using the term in its widest sense) is essential, for it is only in that way that we can place competitive prices upon our goods. It only needs a cursory examination to discover how numerous and how widespread these obstacles are. They range from Government regulations, through restrictive practices at more than one level, and, above all, to excessive and unnecessary expenditure of man-hours. Moreover, what has to be done must be done quickly. In spite of inspired pronouncements to the contrary, the position is little short of desperate; and if the present standards of living are not to be lowered, the remedies must be applied without delay, a task which will require hard thinking to organise and self-denial to apply.

ELECTRICITY SUPPLY IN THE NORTH OF SCOTLAND.

THE North of Scotland Hydro-Electric Board had, in 1952, 391.225 MW of hydro-electric plant, 130.625 MW of steam plant, and 37.821 MW of Diesel plant. The average cost per kilowatt-hour generated by water power was 0.42 pence, the corresponding costs for steam and Diesel stations being 0.81 and 1.95 pence. The average price paid by consumers was 1.498 pence per kilowatt-hour, so that all who were served by Diesel stations were supplied at a loss. As the Diesel plant supplied less than 5 per cent. of the total, this uneconomic operation was not of major importance in overall finance, but as a general proposition it is desirable that the public should pay the correct price for public services. The electricity-supply industry as a whole has the reputation of attempting to build up loads, particularly domestic loads, by uneconomic practices, and when such loads begin to take a position of major importance in the overall picture, financial embarrassment ensues and matters can only be rectified by increasing domestic charges to a point at which they bear a nearer relation to costs.

The undercharging of domestic consumers was frequently practised as a concomitant of competition with a gas company, and no doubt assisted in the development of electric cooking and heating, but as the demands of the latter service often occur at peak periods an unsatisfactory type of load curve resulted. The domestic consumer is well aware of appeals not to use his household appliances just at the time when he wants them. None of these remarks is relevant in the case of the undercharging of domestic and farm customers by the North of Scotland Hydro-Electric Board. That body was set up in 1943 to develop electric-power supply over an area which is nearly three-fourths of the whole of Scotland, but the conditions with which it had to deal were very different from those facing an authority operating in a populous area. One of the reasons, possibly the main reason, why the body was constituted was the absence of modern amenities in the north of Scotland with little opportunity for industrial employment and a consequent depopulation problem.

The duties of the Hydro-Electric Board are more extensive than those of a mere electricity-supply authority. Its activities have to be directed to the rehabilitation of remote areas in which, it is stated by the Consultative Council (which represents the consumers) that "depopulation . . . continues unabated." Many of these areas are potentially food-producing. It is for the purpose of serving these scattered districts, which are at present beyond the reach of a general transmission scheme, that no less than 28 different Diesel stations have been set up. They vary in capacity from 4,040 kW to 224 kW. As the transmission and distribution systems of the Board are gradually extended, some of these isolated plants will be shut down, but many, especially those on islands, will, no doubt, continue in permanent operation. Two very small stations, at Millport and Portree, were shut down during the year. Little information is given about the experimental work on wind-power generation. As a result of test runs with the 100-kW set at Costa Head in Orkney, a 250-kW set is being designed. It is evidently not at present expected that wind power will become of major importance.

The Board has shown great energy and initiative since its inception, but the fact that in 1952 its stations generated 1,237 million kWh owes much to the fact that it took over the pre-war Rannoch and Tummel installations of the Grampian Power Company and the steam stations at Dundee and Aberdeen. These latter stations generated 295 million kWh out of the total of 1,237. The fact that the cost per kilowatt-hour of steam generation was 0.81 pence compared with 0.42 pence for water-

power generation is partly explained by the high cost of coal, but allowance must also be made for the fact that the capital charges per unit of capacity on the Grampian Company's pre-war schemes are much less than those of post-war developments.

Both Aberdeen and Dundee are connected to the Highland grid and while it is not suggested that the steam stations may ultimately be shut down, it is recorded that they frequently go out of operation at week-ends, the whole load being carried by the hydro-electric plant. That there is no early intention of closing down these stations is shown by the fact that a new boiler is on order for Dundee, and that a 12-MW gas turbine is being installed. This will run on oil, but it is hoped that in the future similar plant may operate with peat. Surveys have shown that there are 170,000 acres of peat bog in the Highlands of Scotland, and the utilisation of this material for power production would be of great economic importance to the country. Much work has been done on this matter by Messrs. John Brown and Company, of Clydebank, and it is stated that a 500-kW gas turbine, operating with pulverised peat, has completed a 1,000-hour endurance test.

It is claimed that the electricity generated by the Board's water-power plants represents a saving of 600,000 tons of coal per year. This quantity, if exported at 4l. 5s. 0d. per ton, would bring in 2,500,000l. of foreign exchange. The hydro-electric plants in operation have a combined capacity of 391 MW and those under construction of 287 MW. Schemes in course of promotion and survey are estimated to have a capacity of 416 MW. As the total capacity of the existing steam stations is only 131 MW, it would appear that ultimately the country might rely entirely on water power except in remote districts and islands. The Board's report* contains notes on the evidence submitted to the Ridley Committee, which inquired into national fuel policy. In the course of this, it is stated that the potential water-power resources of the Highlands are ample to deal with all electricity demands in the area and to provide a margin for export to Central Scotland for many years to come.

It is pointed out that practically all the coal used in the Highland area, amounting to some 1,660,000 tons per annum, has to be transported by rail or sea over long distances. Aberdeen is 105 miles and Inverness 150 miles from the Fifeshire coal pits. Of the total consumption of 1,660,000 tons of coal, 35,000 tons are used by British Railways in transporting coal to the Highland area and 400,000 tons by "other users, including British Railways' use of coal for all other transport purposes." In view of these figures, it is somewhat rhetorically asked "Can the country afford not to electrify the railways?" In connection with this matter of coal consumption it is also pointed out that the campaign directed to the use of efficient solid-fuel ranges is contrary to the public interest as far as the Highlands is concerned. Solid fuel can be replaced by the product of local water power.

The average price per kilowatt-hour paid by consumers, already quoted as 1.498 pence, showed a rise of 0.087 pence compared with 1951. Rates naturally varied with the type of customer; the British Electricity Authority paid 1.1093 pence per kilowatt-hour for bulk supply. The highest charge was for public lighting, at 1.9881 pence per kilowatt-hour. Domestic consumers paid 1.4853 pence per kilowatt-hour and farms 1.3272 pence. The development of the remote countryside, which is one of the duties of the Board, requires that supplies should be furnished at as low a charge as possible, but consideration has naturally to be given to the fact that distribution in areas of sparse population is costly.

* North of Scotland Hydro-Electric Board Annual Report and Statement of Accounts 1st January 1952 to 31st December 1952. H.M. Stationery Office. [Price 2s. 6d. net.]

NOTES.

NEW FELLOWS OF THE ROYAL SOCIETY.

At a meeting on March 19, the Royal Society elected 25 new Fellows. They include Dr. J. S. Anderson, deputy chief scientific officer, Atomic Energy Research Establishment, Harwell, who has made contributions to inorganic chemistry, particularly in connection with the chemistry of the metal carbonyls, complex salts, and non-stoichiometric compounds; Dr. J. C. Burkill, lecturer on mathematics, University of Cambridge, who is well known for his researches in analysis, especially on the theory of integration and for his contributions to the theory of the trigonometrical series; Mr. S. C. Curran, senior lecturer, Department of Natural Philosophy, University of Glasgow, who has made contributions to electronic counting techniques and has conducted researches upon the emission of β and γ rays by atomic nuclei; Mr. A. G. Gaydon, Warren Research Fellow, Imperial College of Science and Technology, London, who has carried out investigations on the spectra of flames, which have gone far in elucidating the mechanism of flame reactions under varied conditions; Mr. A. A. Hall, M.A., F.R.Ae.S., director of the Royal Aircraft Establishment, Farnborough, who has made many contributions to the theory and design of aircraft and their equipment; Sir Claude Inglis, C.I.E., M.I.C.E., director, Hydraulics Research Station, Department of Scientific and Industrial Research, who has carried out pioneer work in the study of hydraulics by the use of scale models and has applied these techniques to hydraulic problems in India; Professor Willis Jackson, D.Sc., M.I.E.E., who occupies the Chair of Electrical Engineering, Imperial College of Science and Technology, and has made a study of the electrical behaviour of dielectrics and of the performance of transmission lines and wave-guides; Professor M. J. Lighthill, who occupies the Beyer Chair of Applied Mathematics, University of Manchester, and has conducted researches in fluid dynamics, especially on non-linear problems of compressible flow, on the supersonic boundary-layer theory and on the shock-wave theory; Dr. G. H. Mitchell, principal scientific officer, Geological Survey of Great Britain, who has made a study of palaeozoic stratigraphy; Mr. A. R. Powell, research manager, Messrs. Johnson, Matthey and Company, Limited, whose contributions to analytical chemistry and the chemistry and metallurgy of the rarer metals have led to important developments in methods for the extraction of platinum ores and the production of very pure metals; Mr. H. M. Powell, reader in chemical crystallography, University of Oxford, who has elucidated problems of chemical constitution by X-ray methods; and Mr. David Schoenberg, reader in physics, University of Cambridge, who has carried out researches in the field of low temperatures, especially upon superconductivity and the magnetic properties of metals.

COLD EXTRUSION OF STEEL.

The extrusion of steel while it is cold—described as “the newest and most revolutionary technique for the production of steel components”—is to be discussed in detail, for the first time in this country, at a conference to be held in May. The cold extrusion of lead, tin and aluminium has been practised on a large scale for many years, but it was only about 1935 that Liebergeld, in Germany, tried to adapt the process to steel. During the war, the Germans achieved a certain measure of success, and after the war the process was introduced into the United States where, with the aid of German technicians, the process has been applied. Details of the technique, however, are not adequately available and no information exists as yet on the requirements for success. The possibilities of the process are now engaging the attention of a number of organisations, as it appears that its adoption would lead to a considerable saving in steel and to the production of higher grade products. It is too early to prophesy what its effect will be upon manufacturing processes in general, but in response to the urgent demand of its members for fuller infor-

mation, the Sheet and Strip Metal Users' Technical Association has arranged a two-day conference on the subject, to be held on May 12 and 13, in the main hall of the Royal Empire Society, Northumberland-avenue, London, W.C.2. The problems associated with the cold extrusion of steel will be dealt with in a range of papers to be presented at this conference. Brigadier A. R. W. Low, Parliamentary Secretary to the Ministry of Supply, will open the conference. Full details and application forms for tickets are obtainable from the honorary secretary of the Association, at 49, Wellington-street, Strand, London, W.C.2.

THE INSTITUTION OF MECHANICAL ENGINEERS.

Two new photo-elastic techniques were described in two papers presented at a meeting of the Institution of Mechanical Engineers on Friday, March 20. Dr. J. H. Lambie and Dr. Salah E. A. Bayoumi described a room-temperature photo-elastic technique for three-dimensional problems—a technique which they developed to overcome some of the disadvantages of existing stress-freezing methods; it also has the advantage that many loadings may be applied to the same model, the fringe patterns being repeatable. The method arose from a “composite model” construction first suggested some years ago. A sheet of birefringent material, they explained, was cemented between pieces of an insensitive material having the same elastic constants. From the composite block a three-dimensional model could be cut, with the birefringent sheet as the plane under investigation. The insensitive material was Perspex (the British variety). “Catalin 800” was used for the birefringent layer because Young's modulus for the material could be raised to that of Perspex by subjecting it to an additional curing. The Catalin 800 sheet was annealed before curing, and, after curing, the highly-polymerised layers were removed. The sandwich was bonded with “Tensol,” employing a special technique described by the authors, and the model was then machined. To avoid scatter of light from curved surfaces of the model, it was immersed, during polariscope examination, in a fluid having substantially the same refractive index as Perspex. The authors described the application of the method to notched bars under tensile loading. They found that the results were of a high accuracy not attainable by the freezing method, though they recognised that the method yielded results which were related to only one plane in the model. They considered, also, that the search for a material possessing all the requisite qualities for an insensitive material should be continued. In the other paper, Mr. John D. C. Crisp examined the use of gelatin models in structural analysis. This material, he explained, allowed the construction of a model in which the body-force field was that of the self-weight of the gelatin itself. As an example, he described a model of an elastic untied bulkhead retaining a horizontal elastic fill which induced loading pressures on each face of the bulkhead. His paper dealt with the principles of similarity and with the technique.

A STEEL CASTINGS RESEARCH ASSOCIATION.

The latest addition to the list of research associations in this country is one which will deal with steel castings. The British Steel Castings Research Association, as it is termed, is to succeed the Research and Development Division of the British Steel Founders' Association and has inherited from it an active and established research organisation possessing a comprehensive programme of research and development work already in hand. The chairman of the new Association is Mr. F. N. Lloyd, B.A., and the other members of the Council are Mr. A. H. Catton, Dr. C. J. Dadsell, B.Sc.(Eng.), M.I.Mech.E., Dr. E. Gregory, M.Sc., M.I.E.E., Mr. J. Jackson, Mr. C. H. Kain, A.M.I.Mech.E., F.I.M., Brigadier A. Levesley, O.B.E., M.C., T.D., M.I.Mech.E., Mr. A. B. Lloyd, B.A., A.M.I.Mech.E., A.M.I.P.E., Mr. R. J. Richardson, Mr. Frank Rowe, B.Sc., and Mr. W. Scott, O.B.E., M.I.Mech.E. Mr. J. F. B. Jackson, B.Sc., A.R.I.C., F.I.M., who has been in charge of the Research and Development Division since its formation in 1949,

has been appointed director of the new Association. Mr. R. Barber, A.C.I.S., has been appointed secretary. The policy of the B.S.C.R.A., like that of the Division before it, while not neglecting fundamental research and the sponsoring of long-term projects, will be directed, in the main, to the translation of the results of research as rapidly as possible into industrial practice. The new Association will also aim at maintaining and further extending the cordial relations and contacts established during past years with kindred research organisations in Great Britain and the Commonwealth, and in Europe and the United States. Engineers and firms engaged in the design, manufacture and use of steel castings will also be interested to learn that the British Steel Founders' Association are holding a “Customer-Founder Convention” from April 15 to 17, at Park Lane House, 45, Park-lane, London, W.1. The Convention will be opened by the Rt. Hon. David Eccles, P.C., M.P., Minister of Works, at noon on the first day. Morning and afternoon sessions will be held on Thursday and Friday, April 16 and 17, at which papers will be read by makers and users of steel castings. Two exhibitions, one devoted to the metallurgy and design of steel castings and the other to their application, have also been arranged. Castings weighing from a few ounces to 5 cwt., and models of others of up to 150 tons in weight, will be on view. Further particulars of the Convention and also of the new British Steel Castings Research Association may be obtained on application to the secretary of the British Steel Founders' Association, Broomgrove Lodge, Broomgrove-road, Sheffield, 10.

THE MACHINE TOOL TRADES ASSOCIATION.

The President, Mr. Robert W. Asquith, occupied the chair at the annual dinner of the Machine Tool Trades Association, held at the Dorchester Hotel, Park-lane, London, W.1, on Tuesday, March 24. The principal guest was the Rt. Hon. Lord Piercy, C.B.E., chairman of the Industrial and Commercial Finance Corporation. In proposing the toast of “The Guests,” Mr. Asquith observed that, for a number of years, international commerce had been in a state of bad health; but, he asked, must we now consider this as normal? Had the time not arrived when, after so many nostrums had been tried in vain, faith-healing should be given a chance? As far back as 1945, the Machine Tool Trades Association had expressed the view that “the industry sees the need for the maximum export of machine tools”; yet, to take only one example, France was unable to buy from Britain the tools that French industry needed. In the same report—that of 1945—there had been a strong plea for freedom to import foreign machine tools into Britain—the British machine-tool manufacturers would welcome the importation and export of machine tools on equal terms; yet, at the present time, while European tools could be imported, American tools could not. Were the dollars more important, he asked, than allaying the very natural suspicion that import-licensing restrictions in Great Britain were really a form of protection for British industry? Lord Piercy, in his reply to the toast, did not comment directly on the President's challenging observations, but thought that the industry, which had been handicapped by various features of Government policy—notably, the restrictions on home investment—would welcome some relaxation in this respect. The first World War had shown, he said, that Britain had too few machine tools, and the second World War had confirmed this. Some inducement should be offered to British industrialists to undertake additional investment in productive plant. Moreover, the arrangements for writing off capital expenditure were much more liberal in other countries—for example, the United States and Sweden—than they were in Great Britain, and British industry suffered in consequence. If some easing of that situation could be achieved, it would be a good thing for British industry in general, and for the machine tools industry in particular. The only other toast—that of “The Machine Tool Trades Association”—was proposed by Sir James Helmore, K.C.M.G., Permanent Secretary of the

Ministry of Supply, and acknowledged by Sir Lionel Kearns, C.B.E., who said that, so far as the machine-tool industry was concerned, the Government were welcome to remove all import restrictions.

DEPARTMENTAL COMMITTEE TO INQUIRE INTO FLOODING.

During the debate in the House of Commons on Monday, March 23, on the Government's flood relief policy, Sir David Maxwell Fyfe, the Home Secretary, announced the names of some of the members of the Departmental Committee which is to inquire into the causes of the floods of January 31 last and the lessons to be learnt from the disaster. Lord Waverley (formerly Sir John Anderson), chairman of the Port of London Authority, is to act as chairman of the Committee and the members will be: Sir Donald Fergusson, formerly Permanent Secretary of the Ministry of Fuel and Power and of the Ministry of Agriculture and Fisheries; Sir Claude Inglis, Director of the Hydraulics Research Station of the Department of Scientific and Industrial Research; Mr. R. G. Leach, formerly Deputy Financial Secretary to the Ministry of Food; Sir Basil Neven-Spence; Professor J. Proudman, F.R.S., Professor of Oceanography at the University of Liverpool; Mr. A. S. Quartermain, Past-President of the Institution of Civil Engineers and formerly Chief Engineer of the Great Western Railway; Lord de Ramsey; Professor J. A. Steers, Professor of Geography in the University of Cambridge; Sir John Wrigley, lately Joint Deputy-Secretary of the Ministry of Housing and Local Government; and Mr. T. Yates. The Home Secretary indicated that the names of other members would be announced in due course and he accepted a suggestion that practising engineers should be invited to join the Committee. He also announced that the joint secretaries to the Committee could be contacted at the offices of the Port of London Authority, Trinity-square, London, E.C.3.

THE FIRST FACTORY EQUIPMENT EXHIBITION.

The first Factory Equipment Exhibition was officially opened at the Royal Horticultural Society's New Hall, London, S.W.1, on Monday, March 23, by Sir Miles Thomas, chairman of the British Overseas Airways Corporation, and was visited by the Duke of Edinburgh on the following day. Sir Miles spoke of the need for faster production and full utilisation of all resources and energy in industry, and said that factories and workshops must take advantage of the latest applications of scientific research in their particular field. He also paid tribute to the work of the Anglo-American Council on Productivity, which he asserted had contributed to the task of improving industrial efficiency. Exhibits include mechanical handling equipment, costing and accounting systems, safety equipment, and workers' welfare equipment. The exhibition is sponsored by *Factory Equipment News* and the *Factory Manager*, and the organisers are the London Press Exchange, Ltd. In a message to the organisers the Rt. Hon. Peter Thorneycroft, M.P., President of the Board of Trade, says, "It is a particular example of the general truth that the maintenance and improvement of our standard of living depends in the last resort upon our industrial efficiency. We cannot rival some of our competitors in size of population and resources; we must compensate in skilful employment of men and materials, and in producing goods of superlative quality. The Factory Equipment Exhibition sets out to demonstrate this fundamental principle. I commend it to you, and wish it every success."

DISCHARGE OF WATER FROM STEEL PIPES.—Stewarts and Lloyds, Ltd., Brook House, Upper Brook-street, London, W.1, have produced a pocket-size table on a small sheet of plastic material which gives data relating to the discharge of water from steel pipes. The figures given are based on formulae devised by Dr. J. S. Blair, of their Research Department, and published in a paper presented by him to the Institution of Mechanical Engineers in 1951. The table gives the discharge from pipes at various slopes, dealing particularly with galvanised screwed and socketed steel tubes, and with standard bitumen-lined welded-steel pipes.

OBITUARY.

MR. ANDREW GRAY.

WE regret to record the death of Mr. Andrew Gray, which occurred at Brentford, Middlesex, on Sunday, March 22, in his eightieth year. He was well known among an earlier generation of telecommunication engineers, as he had been associated with Marconi from the days of that pioneer's first experiments in wireless telegraphy.

Andrew Gray was born in Glasgow and received his education in that city, graduating in the University and also obtaining a diploma in electrical engineering at the Glasgow and West of Scotland Technical College, where he worked under Professor Andrew Jamieson. After a short time as assistant to Professor Jamieson, he joined the staff of the West India and Panama Telegraph Company at the age of 22, and served with them successively as assistant electrician, chief electrician and telegraph engineer, being responsible in the latter position for the working efficiency of some 7,000 miles of cable.



THE LATE MR. ANDREW GRAY.

In 1899 he began his long association with the Marconi Company as personal assistant to its founder, and was engaged initially on making tests at the stations at Poole and Alum Bay, which had been built for signalling between the mainland and the Isle of Wight. He was also connected with work on a number of other short-distance transmitters, among which were the installations on the East Goodwin Lightship and the South Foreland Lighthouse, and with experiments on coupling between aerial and detector circuits. A year later Gray introduced the Marconi system into the Hawaiian Islands, where he also organised the training of the native operators of the Inter-Island Telegraph Company of Honolulu.

In 1900 Marconi took out his famous "four sevens" patent for tuned or syntonistic telegraphy and established a transmitting station at Poldhu in Cornwall, from which a year later he succeeded in transmitting and receiving radio signals across the Atlantic. This episode provided a great incentive to this form of communication, and Gray, being the only man with cable and telegraph experience in Marconi's employment, was appointed to organise the operation of the ship-to-shore wireless communication system of the Marconi International Marine

Communication Company. This operation was based on general telegraphic practice, and the regulations Gray introduced for its safe working formed the basis of those subsequently promulgated by the first International Radio Convention.

Gray's formal position in the Marconi Company at this time was chief of the staff, in which position he was also responsible for the training of young engineers in the parent company and of the telegraph operators in the marine company, as well as for the designing, testing and installation of both ship and shore stations and much development and patent work for both concerns. In 1906 the marine company took over their own telegraph operating work, but Gray continued to supervise the design and installation of wireless apparatus on merchant ships. He was appointed chief engineer to the parent company in 1910, becoming joint general manager in 1923 and technical general manager five years later. He retired in 1932, when Marconi said that he had "contributed to and kept pace with the vast expansion of wireless communications throughout the world."

Gray had been a Member of the Institution of Electrical Engineers and an associate member of the Institution of Civil Engineers. He had taken out a number of patents, one being for the Gray tubular steel mast, which was constructed in sections for easy transport and superseded the early wooden mast for supporting aërials.

PROFESSOR DEMPSTER SMITH, M.B.E.

WE also announce with regret the death on March 21 of Professor Dempster Smith, M.B.E., M.Sc. (Tech.), Hon.M.I.Mech.E., whose work at Manchester on the mechanics of cutting tools justly earned him wide recognition. Apart from a short period during the first World War, when he was works manager to Messrs. Mirrlees, Bickerton and Day, Limited, Stockport, he was associated with the Manchester College of Technology for 36 years, from 1903 to 1939, and for the last 13 years of this period he was Professor of Mechanical Engineering in both the University and the College.

Dempster Smith was born on February 6, 1874, and was educated at the English School, Perth, and the Glasgow and West of Scotland Technical College. His apprenticeship was served at the locomotive firm of Messrs. Sharp, Stewart and Company, Glasgow, and with them, also, he gained his early experience as a draughtsman. In 1898, he went to Sir W. G. Armstrong, Whitworth and Company for two years as a designer, and followed this with two years as chief designer to Messrs. Hulse and Company, Manchester. In 1903, he was appointed mechanical engineering demonstrator at the College of Technology, and four years later he became the lecturer in machine design. In this post, which he occupied until 1917, Smith prepared his first paper for the Institution of Mechanical Engineers—"Experiments upon the Forces Acting on Twist Drills when Operating on Cast-Iron and Steel," which was presented, jointly with R. Poliakoff, in 1909. After a period of two years with Messrs. Mirrlees, Bickerton and Day, he was re-appointed as a lecturer at the College in 1919. He was part author of a paper to the "Mechanicals" on orifice flow in 1923, but meanwhile his work on cutting tools was expanding. He had been experimenter and reporter to the Tool Steel Committee of the Manchester Association of Engineers in 1914 and 1915, and was a member of the Cutting Tool Research Committee of the Institution of Mechanical Engineers. For that committee he prepared, with A. Leigh, a paper on experiments with lathe tools with fine cuts (1925), and, with A. Nield, a report on the heat conductivity and hardness of carbon and high-speed steel.

Dempster Smith was also the author of a number of books on tools and contributed articles to the technical Press. He became an associate member of the Institution of Mechanical Engineers in 1907 and a member in 1913. From 1918 to 1921, he was honorary secretary of the North Western Branch, and in 1941, when he was a member of Council, he was elected an honorary life member.

COUNT VON RUMFORD, F.R.S. (1753-1814).

By ENGINEER CAPTAIN EDGAR C. SMITH,
O.B.E., R.N. (Ret.).

(Concluded from page 375.)

IN 1792, Rumford heard of the death of his wife and in 1793 he wrote to a friend asking about the possibility of his returning to America. He then fell sick, went to Italy in search of health, and was away from Bavaria for over a year. Soon after his return, in 1795, the people of Munich erected a monument to him in the English garden that he had created. Towards the end of the year he left for London, only, however, to be robbed of his papers as he was being driven across St. Paul's Churchyard. Taking up his residence in Pall Mall, he renewed his friendship with Banks and other men of science and also became known to a small group of benevolent men who, in the next year, founded the Society for Bettering the Conditions of the Poor. Among the supporters of this society was Mr. (afterwards Sir) Thomas Bernard (1750-1818), son of Sir Francis Bernard (1711?-1779), who had been Governor of Massachusetts during 1760-69. Bernard, who had been educated at Harvard, had become treasurer and resident governor of the Foundling Hospital, in which he promptly installed kitchens and fireplaces according to Rumford's plans. There was much collaboration between the two men, but Bernard's work for the Royal Institution is often overlooked. To the year 1796 also belongs Rumford's visit to Dublin, from which he returned full of honour, and his gifts of 1,000*l.* each to the Royal Society and the American Academy of Arts and Sciences for founding the Rumford Medals.

While in London, he had been joined by his daughter, and together they left for Munich where, the Elector having taken refuge in Saxony, Rumford was head of a council of regency and commander of the Bavarian troops. As such, he was able to preserve the neutrality of the city when it was threatened by the French. It was then proposed that he should come to England as Bavarian Minister and he returned to London with this in mind. His British citizenship, however, made this impossible and he then again thought of returning to his native land and of settling near Cambridge. His daughter, a Countess now, did return home, but Rumford had committed himself too deeply with his scheme for "A Public Institution for diffusing the knowledge and facilitating the general introduction of useful mechanical inventions and improvements and for teaching by courses of philosophical lectures and experiments the application of science to the common purposes of life." His long memorandum is to be found in Dr. Bence-Jones's book *The History of the Royal Institution* (1871). There was little delay in launching the Institution. The inaugural meeting took place in the Soho house of Sir Joseph Banks on March 7, 1799, the managers first meeting there two days later. On June 5, the managers for the first time met in the house in Albemarle-street. The presidency was accepted by the Earl of Winchelsea, and the King became the patron and allowed the new establishment to be called the Royal Institution.

"The history of the life of Count Rumford in 1799, 1800, 1801 to May, 1802," said Bence-Jones, "is the history of the Royal Institution." Passing his time mainly in the building itself or at his house, 45, Brompton-row, Rumford handled its affairs as he had those of Munich and took little counsel of others. Dr. Thomas Garnett began lecturing in February, 1800; 1801 saw the appointment of Dr. Thomas Young as professor of natural philosophy; and in April, 1801, the youthful Humphry Davy, then 22, made his first appearance in the lecture room. Davy's advent perhaps saved the Institution from an early death. Nobly and elaborately planned, with lecture room, reading rooms, laboratory, workshops, repository, restaurant and kitchen, with its own architect, printer, craftsmen, house-keeper and servants, its finances were founded on the shifting sands of public support, and in these it

was nearly engulfed. Its income, 6,379*l.* in 1799, rose to 11,047*l.* in 1800, then sank to 3,474*l.* in 1801, and to 2,999*l.* in 1802. From this precarious position it was rescued mainly by the efforts of Bernard. On April 26, 1802, Rumford attended a meeting of the managers for the last time, and on May 3 he made his last report, concluding with the sentence, "All the different subjects mentioned in this report remain for future discussion among the managers." So he abdicated his dictatorship, and on May 9 he left England, never to return. As in all his undertakings, he had given unstintingly of his time and energy, but London paid him no such tributes as Dublin and Edinburgh had done. Thomas Webster (1773-1844), the future geologist, who also, in 1799-1802, was the architect to the Institution, but who severed his connection with it in 1802, afterwards wrote "Count Rumford left England about the same time, certainly neither rewarded nor thanked in proportion to the good he had done." The Royal Society had awarded him its Copley Medal in 1792 and in 1802 it sent him the first Rumford Medals, but London has not followed the example of Munich.

It is generally true that biographies of men of science seldom appeal to the ordinary reader, but there is plenty of interest in the biography of Rumford and in his self-revealing letters. When he left England for the Continent in 1802, he was drawn thither partly by his obligations to the Elector Maximilian, who always treated him with the greatest consideration, partly by his desire for a better climate, but also by his admiration for Madame Lavoisier, the widow of the great chemist. He had first visited Paris in 1801, had been present at the meeting of the National Institute when Volta explained the Voltaic pile, had been entertained by Napoleon, then First Consul, and, like Banks, Cavendish, Maskelyne, Herschel, Priestley and Jefferson, had been made a foreign associate of the Institute. When he returned in 1802, he was therefore no stranger, but his position became a rather curious one, for he was a retainer of a ruler of a foreign State, a citizen of an enemy country, but an American by birth. Taking no part in public affairs, he was left unmolested. Yet his life did not altogether flow smoothly. He married Madame Lavoisier, but by January 2, 1804, he felt impelled to write to his daughter that "experience only serves to confirm me in my belief that in character and natural propensities Madame de Rumford and myself are totally unlike, and never ought to have thought of marrying . . . I call her a female dragon." On April 12, 1808, the unhappy Rumford wrote, "I have the misfortune to be married to one of the most imperious, tyrannical, unfeeling women that ever existed . . ." To solace himself in his domestic troubles, he took to his laboratory and during those unhappy years sent to the National Institute papers on a differential thermometer, radiation, conduction, solar heat, the maximum density of water, and other subjects. The inevitable separation took place "amicably" on June 30, 1809, and Rumford betook himself to a pleasant villa in Auteuil, where he realised "as never before the sweets of quiet liberty and independence." In the following year, he was again in Munich. He then returned to Auteuil, where, in December, 1811, he was joined by his daughter. She had found him in excellent health, but when overtaken by a nervous fever in August, 1814, he had not the strength to fight it and died after three days' illness. He was buried in the cemetery at Auteuil. During the Commune of 1871, the tomb was destroyed by a shell, but five years later it was restored by the American Academy of Arts and Sciences, of Boston, and Harvard University, by whom it is now maintained.

DECONTROL OF BOLT AND NUT PRICES.—The Minister of Supply, Mr. Duncan Sandys, has issued an Order terminating, with effect from March 23, the statutory control of maximum prices for steel bolts, nuts, screws and rivets. The industry has undertaken to maintain prices at reasonable levels and to make available, to the Ministry of Supply, as and when required, information concerning their costs of production and other matters affecting prices. Copies of the Order, the Bolts, Nuts, etc., Prices (Revocation) Order, 1953, S.I. 1953 No. 478, may be obtained (price 2*d.*) from H.M. Stationery Office.

THE INSTITUTION OF NAVAL ARCHITECTS.

THE 1953 Spring Meeting of the Institution of Naval Architects opened on the morning of Wednesday, March 25, with the holding of the annual general meeting. Once again, by courtesy of the Honourable Company of Master Mariners, the Institution was able to use, as a place of meeting, the Honourable Company's headquarters ship, the Wellington, moored in the Thames at the Temple Stairs. The chair was taken by the President, Viscount Runciman of Doxford, O.B.E., D.F.C., who announced formally to the members the death, on the previous evening, of Her Majesty Queen Mary. The members stood in silence in tribute to Her late Majesty. The proceedings then began with the presentation of the annual report and accounts for 1952; a summary of the report is given below.

ANNUAL REPORT FOR 1952.

In addition to items mentioned in the President's address and elsewhere, the Council's annual report showed that the membership at December 31, 1952, stood at a total of 3,602, comprising nine honorary members, 1,257 members, 1,296 associate-members, 723 associates and 317 students; this represented an increase of 90 since the previous year, mainly in the category of associate-members. The Council have elected Mr. J. L. Adam, C.B.E., and Dr. S. F. Dorey, C.B.E., F.R.S., to be honorary vice-presidents of the Institution, in recognition of their long and valuable services. The report also mentions the election (previously recorded in our columns) of General Giuseppe Rota, D.Ing., as an honorary member of the Institution. During the year, awards were made of 69 Higher and 84 Ordinary National Certificates in Naval Architecture. After some 30 years co-operation in the Engineering Joint Council, the Institution of Naval Architects, together with the Institutions of Civil, Mechanical, and Electrical Engineers, is withdrawing from the Joint Council, which together they formed in 1922, as it is felt "that this body no longer fulfils the purpose for which it was originally set up." The report concludes with summaries of the research work in which the Institution is interested. This work is being carried on by the Ship Division at the National Physical Laboratory, as well as by the British Shipbuilding Research Association, by Pametrada, and by the British Welding Research Association.

COUNCIL ELECTION.

The results of the ballot for the election of Vice-Presidents and members of the Council were as follows: Vice-Presidents, Mr. R. W. L. Gawn, O.B.E., R.C.N.C., Mr. Norman M. Hunter and Sir Robin Rowell, C.B.E., A.F.C.; and Members of Council, Mr. K. C. Barnaby, O.B.E., B.Sc., Mr. John Brown, B.Sc., Dr. T. W. F. Brown, Professor L. C. Burrill, M.Sc., Ph.D., Mr. W. T. Butterwick, C.B.E., Mr. A. C. Hardy, B.Sc., Mr. S. A. Hodges, M.B.E., Mr. J. Hodgson, Mr. J. L. Kent, C.B.E., Mr. R. B. Shephard, C.B.E., B.Sc., and Mr. R. C. Thompson, C.B.E., B.A. The associates elected to the Council were Sir Ronald T. Garrett, Instructor Rear-Admiral Sir Arthur E. Hall, K.B.E., C.B., and Vice-Admiral Sir Cecil P. Talbot, K.C.B., K.B.E., D.S.O. Sir Arthur Hall was re-elected treasurer, and Messrs. Ball, Baker and Company were re-appointed as auditors.

The President then presented Institution Premiums to Mr. W. H. Dickie, for his paper on "High-powered Single-Screw Cargo Liners," delivered at the Spring Meeting in 1952, and to Mr. A. J. Williams, R.C.N.C., for his paper entitled "An Investigation into the Motion of Ships at Sea," delivered at the Autumn Meeting in Italy; and, having done so, proceeded to deliver his address.

THE PRESIDENT'S ADDRESS.

"The practice has grown up," said Lord Runciman, "of confining what the President has to say at this meeting to more or less domestic matters, and to address the larger audience in the evening on subjects of more general import. I shall, therefore,

refer now to the progress of our Institution during the last 12 months.

"I cannot refrain from recording our pleasure that Her Majesty the Queen has graciously continued the Royal Patronage which the Institution has enjoyed since the days of King Edward VII. That is an event which must give us all the very greatest satisfaction. Another much more recent event, which again we received by no means without satisfaction, is that, within the last few days, Viscount Weir of Eastwood has generously presented to this Institution a sum of no less than 10,000*l.*, free of all conditions. That is the sort of benefaction which we have not the good fortune to receive very often, and I am sure that, in addition to the letters which have already gone to Lord Weir, this meeting would like to express in, perhaps, a formal manner its extreme appreciation of his generosity. We know that he has extended similar generosity to other bodies comparable with ours in the general field of activity which we cover, so that he really has come out as a patron of these arts and sciences in no small way. Your Council and the House Committee will, of course, consider in due course what is the proper use to make of this generous gift. You have already heard that there will be a special meeting to deal with the new by-laws and regulations on May 13.

"Arising from the very successful autumn meeting that we had in Italy in 1952, we are indebted to our Vice-President, Mr. E. L. Champness, for having provided a gavel which we have sent to the Italian Institute as a memento of that occasion. I understand that it is now in the hands of the British Consul in Genoa, who is to present it to Dr. Della Ragione. This year we have an autumn meeting arranged to be held in Holland, from September 14 to 19.

"We have heard about the joint branches of this Institution and the Institute of Marine Engineers, and I think this meeting would like to record its pleasure and satisfaction on the progress which has taken place. It is interesting to reflect that, in any such joint undertaking, the Marine Engineers are bound to come out best numerically, since there are many more marine engineers in the world than there are naval architects. I think, therefore, that the membership of their Institute will always be larger than ours. That raises certain problems where joint branches are concerned, but quite clearly, as has been shown in the past and will be shown more abundantly in the future, those problems are by no means insoluble, and I look forward to many years' fruitful collaboration between the two bodies in their joint branches.

"You will be aware that the steamer *Normannia* has been chartered to enable members of the Institution to see the Naval Review this year. The Council have considered closely whether it would be practicable to remain late enough to see the illuminations, but were reluctantly forced to the conclusion that it would not be. It was not found practicable on the occasion of the 1937 Naval Review, and I am afraid that, if we were tempted to do it, the party would arrive very hungry and cold at Waterloo Station between 4.30 and 5 o'clock on the following morning. It has been decided, therefore, that the ship will leave the Review area earlier in the day, to bring the party back to London at a reasonable hour.

"It is a remarkable and satisfactory fact that, since the end of the war, the membership of the Institution has increased by more than 1,000. I am sure it will be agreed that this has been achieved without any lowering of the quality of our membership, and we may look on it as a very welcome accession of strength and a most encouraging sign. The necessity to raise the subscription has been mentioned already by the treasurer. The proposed increase, however, is by no means large, and the meeting might like to know that, even with this proposed increase, the subscription will be only double what it was 90 years ago. I repeat that, as an Institution, I think we can feel pleased with the work that has been accomplished and, on the basis of that pleasure, no doubt we shall resolve to extend our work and make it even better in the future."

(To be continued.)

THE INSTITUTE OF METALS.

THE forty-fifth annual general meeting of the Institute of Metals was opened on the evening of Monday, March 23, in the lecture theatre of the Royal Institution, London, when Sir Christopher Hinton, M.A., M.I.C.E., M.I.Mech.E., Deputy Controller of Atomic Energy (Production), Ministry of Supply, delivered the forty-third annual "May" Lecture. As pointed out by the President, Dr. C. J. Smithells, M.C., the old name of the lecture had been retained although this was now delivered in March. The lecture dealt with "The Present and Future Metallurgical Requirements of the Chemical Engineer." Sir Christopher stated that the experience of the 1914-18 war had given rise, on the return of peace, to a great expansion in the demands of the chemical-plant designer and this period had also witnessed the development of amalgamations of small firms into large "combines." Until approximately 1925 the chemical engineer had used available materials, such as cast-iron, "blue" bricks, and timber lined with lead, but, from that date onwards he had begun to demand, and specify, materials which would best suit the processes he had in view. Moreover, in the late "nineteen-twenties" the American oil industry was growing rapidly and it did not hesitate to specify its metallurgical requirements. The discovery of stainless steel by Brearley in 1913 had heralded a new era, although the "cutlery" stainless steels were not very suitable for chemical plant applications. When, after the 1914-18 war, however, the austenitic stainless steels had been developed, these materials had gone a long way to meet the needs of the chemical engineer. Moreover, the growth in importance of nickel and the nickel alloys as heat-resisting materials had coincided with the coming to the fore of the stainless steels.

The chemical engineer had made good use of the new alloys; they provided more elegant and more economical solutions to his problems than the older materials. It was often the case, however, that the method of fabrication of a new alloy or other material lagged behind its production, and those in charge of fabrication processes should begin work at once on a new material when it became available. Glass and rubber linings for tanks and other plant had found many applications in recent years but the first-named material imposed a limit to the size of the equipment in which it was used, while rubber linings could not be employed above a certain limiting temperature. The future, therefore, would seem to depend largely on the development of metals and alloys and, at present, the chemical engineer was interested in the manufacture of pure materials and in the production of such metals as beryllium and zirconium. In conclusion, Sir Christopher put in a plea for moderation in the use of expensive materials; it was all too easy for the chemical engineer to acquire the "stainless-steel habit" and specify high-grade materials when cheaper materials would be satisfactory for certain components.

On the three subsequent days of the meeting March 24, 25 and 26, business and technical sessions were held at the Park Lane Hotel, Piccadilly.

REPORT OF COUNCIL.

On the morning of Tuesday, March 24, Dr. C. J. Smithells, M.C., the retiring President, again occupied the chair, and the first matter on the agenda was the report of Council for the year ended December 31, 1952. This showed that the number of members on the active list of the Institute was 3,948 at the end of 1952, compared with 3,727 on December 31, 1951, and 3,579 on December 31, 1950. The Council reported, with regret, the death of Sir William Griffiths, a past-president, and of 18 other members. These included Professor L. C. F. de Brouckère, Colonel W. C. Devereux, Dr. H. D. H. Drane, Mr. G. H. Field, Dr. F. Johnson, Sir James Lithgow, Mr. E. J. Overton and Dr. G. Vanzetti. A total of 81 papers and lectures had been published in the Institute's *Journal* during 1952, as compared with 57 in 1951 and 61 in 1950. The Joint Committee for National Certificates in

Metallurgy had approved five new schemes during 1952. Last year, there were 30 Ordinary Certificate courses and 18 Higher Certificate courses in operation. Six other centres provided first-year or first-year and second-year courses. Final examinations for the Ordinary Certificate were held at 28 technical colleges, and for the Higher Certificate, at 16 colleges. The Council recorded their warm appreciation of the continuing generous contributions to the Industrial Donations Fund. Without this financial support, the Institute's work would have had to be severely restricted. With its aid, however, the Council had been able to expedite the publication of acceptable scientific and technical papers and to consider the provision of new services for science and industry.

HONORARY TREASURER'S REPORT.

The report prepared by the honorary treasurer, Mr. E. H. Jones, showed that the income for the financial year ended June 30, 1952, was 31,742*l.*, and the expenditure 38,659*l.*, thus giving an excess of expenditure over income for the year of 6,917*l.*, as compared with a deficiency of 2,406*l.* in the previous financial year. The excess of expenditure had been met by transfer from the Industrial Donations Fund. Apart from the Capper Pass and Mond Nickel Fellowship funds, the total resources and current surplus, including the Endowment Fund and the Industrial Donations Fund, amounted to 51,095*l.*, against 46,155*l.* in the previous year.

The honorary treasurer's report was presented to the meeting by Mr. E. A. Bolton, a member of the Finance and General Purposes Committee of the Institute, in the absence of Mr. Jones in the United States.

ELECTION OF OFFICERS AND ANNOUNCEMENTS.

The officers nominated by the Council at the autumn meeting held in Oxford on September 15, 1952, were declared to be duly elected for the year 1953-54. They were: as President, Professor F. C. Thompson; as vice-presidents, Major C. J. P. Ball, D.S.O., M.C., and Professor G. V. Raynor; and as members of the Council, Mr. W. A. Baker, Mr. J. C. Colquhoun, M.B.E., Mr. E. R. Gadd, and the Hon. John Grimston, M.P. The members were also reminded that, last autumn, the Council had elected Dr. S. F. Dorey, C.B.E., F.R.S., Chief Engineer-Surveyor, Lloyd's Register of Shipping, to serve as senior vice-president for the year 1953-54 and that he would be the Council's nominee for the Presidency in 1954-55. Among other announcements, it was intimated that by invitation of the Councils of the Manchester Metallurgical Society and the Liverpool Metallurgical Society, the 1953 Autumn Meeting of the Institute would be held in Southport from September 21 to 25, and that by invitation of the Swiss Association of Machinery Manufacturers and the Swiss Association for Testing Materials, the 1954 Autumn Meeting would be held at Zürich.

INDUCTION OF NEW PRESIDENT.

After a vote of thanks to the retiring officers had been carried with acclamation, Dr. Smithells inducted his successor, Professor F. C. Thompson, into the chair. In doing so, Dr. Smithells said that Professor Thompson had been a member of the Institute for 36 years. He had first been elected to the Council in 1924, and had served the Institute on several of its committees and in many other ways. He was the author of 12 papers published in the *Journal* and had often taken a distinguished part in discussions or had acted as a *rapporteur* in symposia. For the past 32 years, he had served as Professor of Metallurgy at the University of Manchester and had won a high reputation as a teacher.

The new President's first duty was to call on Dr. L. B. Pfeil, F.R.S., to propose a vote of thanks to Dr. Smithells for his services as President during the year 1952-53. This was seconded by Professor H. O'Neill. Professor Thompson then delivered his presidential address, in which he made a survey of the state of metallographic knowledge when the Institute of Metals had been formed in 1908. We reproduce the address, in abridged form, on page 394 of the present issue.

AWARDS OF MEDALS.

The secretary then announced that the Institute of Metals Platinum Medal for 1953 had been awarded to Professor Georg Masing, of the Institut für allgemeine Metallkunde, University of Göttingen, in recognition of his contributions in the field of metallography. Unfortunately, however, Professor Masing had been unavoidably prevented from coming to the meeting to receive it at the hands of the President, and the Medal would be presented to him at a future meeting of the Institute. The secretary then announced that the Rosenhain Medal for 1953 had been awarded to Dr. Charles Eric Ransley, of the Research Laboratories of the British Aluminium Company, Limited, Gerrard's Cross, in recognition of his experimental and theoretical work on gas-metal equilibria. The President handed the Medal to Dr. Ransley and following this, the W. H. A. Robertson Medal and a premium of 50 guineas to Mr. John Francis Waight, engineer, West Midlands Gas Board, who had been awarded it for his paper, "Gas Equipment for the Thermal Treatment of Non-Ferrous Metals and Alloys." Finally, Professor Thompson handed to the recipients the two awards, each of 10 guineas, made by the Council for essays submitted in connection with the Institute's annual students' essay prize competition. The awards had been made to Mr. R. D. Stacey, of the University of Birmingham, author of "Some Experimental Evidence for Dislocations," and to Mr. G. Thomas, B.Sc., of the University of Cambridge, author of "Martensitic Transformations on Non-Ferrous Metals and Alloys."

The meeting was then adjourned until 2.30 p.m.
(To be continued.)

BRITISH IRON AND STEEL IN 1952.

THE two outstanding developments of 1952 in the iron and steel industry of this country were the introduction of the new Iron and Steel Bill and the steadily increasing production of both pig iron and steel in the latter part of the year. As already recorded in our columns, the production of steel ingots and castings reached 16,418,000 tons in 1952, the highest ever attained in a single year, while the output of pig iron totalled 10,728,000 tons, against 9,669,000 tons in 1951 and 9,633,000 tons in 1950. It is stated in the annual report for 1952 of the British Iron and Steel Federation, Steel House, Tothill-street, London, S.W.1, that, provided enough raw materials are available, it is expected that 17½ million ingot tons of steel can be produced in 1953. The improved position is, at all events, partly due to the success of the drive for scrap which, during 1952, resulted in the receipt, by steel-makers, of 300,000 tons more "home-bought" scrap than had been the case in 1951. Moreover, steelmakers themselves contributed some 268,000 tons of "internal" scrap over and above their normal arisings during the year. This included material recovered from slag heaps. Other encouraging features were the launching of two special iron-ore carrying ships, and the coming into production of the new Conakry orefield in French Guinea, West Africa, it being stated that a total of 500,000 tons of ore will be available to Great Britain during 1953. In co-operation with established ship-owners the construction of eight 8,000-ton and, later, seven 12,000- to 14,000-ton vessels has been arranged. The first two of these ships, now launched, will be in service early this year. During 1952, many investigations undertaken by the British Iron and Steel Research Association reached a stage at which definite recommendations could be made, while several new developments are now ready for application either on a full scale or in pilot plants. Methods of dealing with Sierra Leone ore concentrates and of agglomerating fine imported ores have been ascertained, and means of increasing the productivity of blast furnaces and open-hearth furnaces recommended. Processes for the pre-treatment of molten iron, and research on open-hearth furnace design and operation are among other subjects dealt with. Attention is also drawn, in the report, to new work in the field of accident prevention and to the extension which has taken place in training facilities by residential courses for managers and foremen.

CALIPER THREAD GAUGES.

A CALIPER thread gauge embodying a number of innovations designed to ensure the maintenance of accuracy during a long working life, has been developed by Tolimit Gauges, Limited, 16, Peterborough-road, London, S.W.6. The gauges are made in a duplicated series, designated types A and B. Type A, which is shown in the accompanying illustration, has fully-threaded gauging anvils and is intended for checking clean threads, plated threads or threads which are formed in soft, easily damaged material. For checking threads that have not been cleaned, the makers have introduced the second series, type B, in which the gauging anvils are fluted so that the dirt and swarf are cleared from the work-piece. The gauges are made for an extensive range of standard threads up to an overall diameter of 8 in., but larger gauges can be made.



The crescent-shaped frame of the gauge is made in a good-quality cast iron. Tests made on a sample frame from a ½-in. B.S.F. gauge showed that a 5-lb. pull was required normal to the axes of the anvils in order to separate the jaws by 0.0001 in., and that the relative displacement caused by opposing loads applied parallel to the axes amounted to 0.00005 in. per lb. applied.

The limits permitted for male threads are given in B.S. 84-1940, and for the three classes, "close," "medium" and "free," the high limits for each of the major, effective and minor diameters of any given thread are identical, the difference in class being dependent upon the dimension and tolerance specified for the lower limit. Due to the equality of the high limits, irrespective of fit, the "go" anvils are unaltered by the purpose of the work-piece and they are fixed, therefore, into the outer jaws of the frame. The fixed axial position of these anvils detects drunkenness that floating anvils would accept. The "not go" anvils, which have to be changed according to the class of fit of the bolt being examined, are permitted an axial float, as the tolerances allowed for the low dimensions are much wider. Three positively indexed gauging stations are available to each anvil, to be used successively as the gauge wears; regrinding is therefore not necessary and the difficulty of resetting a worn gauge is eliminated. Indexing the gauge anvil involves no more than slackening a holding stud and turning the anvil on its mounting pin. In order to adapt the gauge to check another class of fit it is necessary to change one of the flattened mounting pins of the "not go" gauge, replacing the same gauge anvil on the appropriate pin, which is marked with the class of fit for which it is intended. Similarly, the gauge can be adapted also for a plating allowance by use of another appropriate-sized mounting pin. It is not necessary to make use of a plug-type gauge when adjusting the anvils for an alternative class of fit. The gauges are made to comply with the limits laid down in B.S. 919-1952, "Limits of Tolerance for Thread Caliper Gauges."

FORTHCOMING EXHIBITIONS AND CONFERENCES.

THIS list appears in the last issue of each month. Organisers are invited to send to the Editor particulars of forthcoming events.

PHYSICAL SOCIETY'S EXHIBITION.—Monday, April 13, to Friday, April 17, at the Royal College of Science main building, Imperial Institute-road, and the Huxley Building, Exhibition-road, South Kensington, London, S.W.7. Organised by the Physical Society, 1, Lowther-gardens, London, S.W.7. (Telephone: KENsington 0048.) See also page 250, *ante*.

RADIO COMPONENTS SHOW.—Tuesday, April 14, to Thursday, April 16, at Grosvenor House, Park-lane, London, W.1. Organised by the Radio and Electronic Component Manufacturers' Federation, 22, Surrey-street, Strand, London, W.C.2. (Telephone: TEMple Bar 6740.)

FIFTH EMPIRE MINING AND METALLURGICAL CONGRESS.—To be opened on Tuesday, April 21, at Melbourne. Closes in New Zealand in mid-June. Sessions will be held at centres in Australia and New Zealand. Apply to Miss B. E. Jacka, Australian Institute of Mining and Metallurgy, 399, Little Collins-street, Melbourne, C.I.

LIÈGE INTERNATIONAL FAIR.—Saturday, April 25, to Sunday, May 10, at Liège. Apply to the manager, Foire Internationale de Liège, 17, Boulevard d'Avroy, Liège, Belgium.

HANOVER FAIR.—Heavy Industries Fair: Sunday, April 26, to Tuesday, May 5, at Hanover, Germany. Agents: Schenkers, Ltd., 27, Chancery-lane, London, W.C.2. (Telephone: HOLborn 5595.)

BRITISH INDUSTRIES FAIR.—Monday, April 27, to Friday, May 8, at Earl's Court, London, S.W.5, and Olympia, London, W.14; and Castle Bromwich, Birmingham. Particulars obtainable from the director, British Industries Fair, Board of Trade, Lacon House, Theobald's-road, London, W.C.1. (Telephone: CHANCERY 4411); or the general manager, British Industries Fair, 95, New-street, Birmingham, 2. (Telephone: MIDland 5021.)

ROYAL SANITARY INSTITUTE HEALTH CONGRESS.—Tuesday, April 28, to Friday, May 1, at Hastings. Particulars obtainable from the secretary, Royal Sanitary Institute, 90, Buckingham Palace-road, London, S.W.1. (Telephone: SLOane 5134.)

GLASS INDUSTRIES EXHIBITION.—Monday, May 11, to Saturday, May 16, in the New Horticultural Hall, London, S.W.1. *Exhibition postponed indefinitely.*

CONFERENCE ON COLD EXTRUSION OF STEEL.—See page 403.

CONFERENCE ON BRITTLE FRACTURE IN STEEL.—Friday, May 15, at 39, Elmbank-crescent, Glasgow, C.2. Organised by the West of Scotland Iron and Steel Institute. Programmes and particulars obtainable from the secretary of the Institute, at the above address.

ROYAL ULSTER AGRICULTURAL SHOW.—Wednesday, May 27, to Saturday, May 30, at Balmoral Showgrounds, Belfast. Organised by the Royal Ulster Agricultural Society, The King's Hall, Balmoral, Belfast.

BATH AND WEST AGRICULTURAL SHOW.—Wednesday, June 3, to Saturday, June 6, at Bath. Organised by the Bath and West and Southern Counties Society, 3, Pierrepont-street, Bath. (Telephone: Bath 3010.)

BRITISH PLASTICS EXHIBITION.—Monday, June 8, to Thursday, June 18, at Olympia, London, W.14. Organised by British Plastics, Dorset House, Stamford-street, London, S.E.1. (Telephone: WATERloo 3333.) See also our issue of October 10, 1952, page 462.

BRITISH ELECTRICAL POWER CONVENTION EXHIBITION.—Monday, June 8, to Friday, June 12, at Torquay. Arranged by the British Electrical Development Association, 2, Savoy-hill, London, W.C.2. (Telephone: TEMple Bar 9434.) See also page 115, *ante*.

THREE COUNTIES AGRICULTURAL SHOW.—Tuesday, June 9, to Thursday, June 11, at The Racecourse, Hereford. For further particulars, apply to the Three Counties Agricultural Society, Berrington House, 2, St. Nicholas-street, Hereford. (Telephone: Hereford 3969.)

BUSINESS EFFICIENCY EXHIBITION.—Tuesday, June 16, to Friday, June 26, at Olympia, London, W.14. Organised by the Office Appliance and Business Equipment Trades Association, 11-13, Dowgate-hill, Cannon-street, London, E.C.4. (Telephone: CENTral 7771-2.)

SAFETY AND FACTORY EFFICIENCY EXHIBITION.—Friday, June 19, to Friday, June 26, at Bingley Hall, Birmingham. Sponsored by the Birmingham Industrial Safety Group, 15, Old Town Close, Birmingham, 30. Further particulars obtainable from the exhibition secretary, Mr. A. G. Cogswell, Dunlop Rubber Co., Ltd., Fort Dunlop, Birmingham, 24. (Telephone: Erdington 2121.)

ROYAL HIGHLAND SHOW.—Tuesday, June 23, to Friday, June 26, at Alloa. Organised by the Royal

Highland and Agricultural Society of Scotland, 8, Eglinton-crescent, Edinburgh, 12. (Telephone: Central 6106.)

SECOND BRITISH INSTRUMENT INDUSTRIES' EXHIBITION.—Tuesday, June 30, to Saturday, July 11, at Olympia, London, W.14. Apply to F. W. Bridges & Sons, Ltd., Grand Buildings, Trafalgar-square, London, W.C.2. (Telephone: WHITEhall 0568.)

ROYAL AGRICULTURAL SHOW.—Tuesday, July 7, to Friday, July 10, at Stanley Park, Blackpool. Organised by the Royal Agricultural Society of England, 16, Bedford-square, London, W.C.1. (Telephone: MUSEum 5905.)

INDUSTRIAL CO-PARTNERSHIP ASSOCIATION, SUMMER CONFERENCE.—Friday, July 10, to Monday, July 13, at Somerville College, Oxford. Apply to the secretary of the Association, 36, Victoria-street, London, S.W.1. (Telephone: ABBey 3342.)

GREAT YORKSHIRE AGRICULTURAL SHOW.—Tuesday, July 14, to Thursday, July 16, at Harrogate. Apply to the Yorkshire Agricultural Society, Cliftonfield, Shipton-road, York. (Telephone: York 3102.)

SUMMER SCHOOL ON THE SOLID STATE AND HETEROGENEOUS CATALYSIS.—Wednesday, July 15, to Wednesday, July 22, at The University, Bristol. Applications to be made to the director of the Department of Adult Education, The University, Bristol 8. (Telephone: Bristol 25071.) See also page 194, *ante*.

SEVENTH INTERNATIONAL CONGRESS OF RADIOLOGY.—Sunday, July 19, to Saturday, July 25, at Copenhagen. Further particulars obtainable from the secretary-general, Professor Flemming Nørgaard, Kommunehospitalet, Copenhagen, Denmark.

ROYAL WELSH SHOW.—Wednesday, July 22, to Saturday, July 25, at Cardiff. Arranged by the Royal Welsh Agricultural Society, Queen's-road, Aberystwyth. (Telephone: Aberystwyth 7551.)

SECOND INTERNATIONAL CONGRESS ON RHEOLOGY.—Sunday, July 26, to Friday, July 31, at St. Hilda's College, Oxford. Organised by the British Rheological Society, 140, Battersea Park-road, London, S.W.11, with the support of the Joint Commission on Rheology of the International Council of Scientific Unions. Applications to be made to Dr. G. W. Scott Blair, The University, Reading. (Telephone: Reading 4422.) See also page 250, *ante*.

THIRD INTERNATIONAL CONFERENCE ON SOIL MECHANICS AND FOUNDATION ENGINEERING.—Sunday, August 16, to Tuesday, August 25, at Zürich and Lausanne. Apply to the secretary, Société Internationale de Mécanique des Sols et des Travaux de Fondations, Gloriastrasse 37, Zürich 44.

RADIO AND TELEVISION EXHIBITION.—Saturday, August 29, to Sunday, September 6, at Düsseldorf. Agents: John E. Buck and Co., 47, Brewer-street, London, W.1. (Telephone: GERard 7576.)

NATIONAL RADIO SHOW.—Tuesday, September 1, to Saturday, September 12, at Earl's Court, London, S.W.5. Applications to the organisers, Radio Industries Council, 59, Russell-square, London, W.C.1. (Telephone: MUSEum 6901.)

BRITISH ASSOCIATION.—Wednesday, September 2, to Wednesday, September 9, at Liverpool. Applications to be made to the joint local secretaries: Mr. T. Alker, Municipal Buildings, Dale-street, Liverpool, 2. (Telephone: Central 8433); and Mr. S. Dumbell, O.B.E., University of Liverpool, Brownlow Hill, Liverpool, 3. (Telephone: Royal 6022.) See also page 214, *ante*.

19TH ENGINEERING, MARINE AND WELDING EXHIBITION AND CHEMICAL PLANT EXHIBITION.—Thursday, September 3, to Thursday, September 17, at Olympia, London, W.14. Apply to F. W. Bridges & Sons, Ltd., Grand Buildings, Trafalgar-square, London, W.C.2. (Telephone: WHITEhall 0568.)

AMERICAN CHEMICAL SOCIETY: 124TH NATIONAL MEETING.—Sunday, September 6, to Friday, September 11, at Chicago, Illinois. Apply to the secretary, American Chemical Society, 1155, 16th-street, Washington 6, D.C., U.S.A.

FOURTH ANGLO-AMERICAN AERONAUTICAL CONFERENCE.—Monday, September 14, to Thursday, September 17, in London. Communications to the secretary, Royal Aeronautical Society, 4, Hamilton-place, London, W.1. (Telephone: GROsvenor 3515.)

PUBLIC LIGHTING CONFERENCE AND EXHIBITION.—Tuesday, September 15, to Friday, September 18, at Liverpool. Arranged by the Association of Public Lighting Engineers, 22, Surrey-street, London, W.C.2. (Telephone: TEMple Bar 9607.)

FIFTH INTERNATIONAL MECHANICAL ENGINEERING CONGRESS.—Friday, October 9, to Thursday, October 15, at Turin. Organised by the Associazione Industriali Metallurgici Meccanici Affini, Via Massena 20, Turin. Applications to be sent to the director, British Engineers' Association, 32, Victoria-street, London, S.W.1. (Telephone: ABBey 2141.) See also page 250, *ante*.

LABOUR NOTES.

WARNINGS of the dangers that could overtake the trade unions and co-operative societies, owing to slackness among their individual members, were given by Mr. C. R. Attlee, M.P., in the course of a speech at Weston-super-Mare on Saturday last. He said that besides the threats of mass attack, by which people were vanquished by totalitarianism, there were the risks of a sapping of strength, and of a betrayal, from within the movements themselves. Trade unions could become vulnerable to small sections simply because the average member did not attend meetings and otherwise do his duty. Co-operative societies could also be vulnerable. It was possible for groups to get into these bodies and take over control, not because they were wanted by the rest of the members, but because these members had been too slack. The failure of the individual citizen to do his duty as a whole could betray democracy.

"Go-slow" was roundly condemned by the chairman of the Trades Union Congress General Council, Mr. Tom O'Brien, in an address to members of the Fabian Society, at a meeting in Manchester last Saturday. The idea that workpeople generally could take things easily, because the country had a Government they did not like, could only lead to national suicide. If such a policy were to be carried out, chaos and bankruptcy would become so rife, he considered, that no future Labour Government could redeem the national fortunes. The conception of the welfare state could be destroyed by the workpeople just as easily as it could by hard-bitten right-wing elements. It might be better all round if political leaders laid greater stress on the many important matters on which Britons were united, rather than on those on which they differed.

The strike of steelworks employees engaged at the Redcar iron and steel works of Messrs. Dorman, Long and Company, Limited, at Middlesbrough, came to an end on Monday last, after a secret ballot at the week-end had disclosed that a majority of the strikers were in favour of an immediate return to work. The stoppage began on Sunday, March 8, and, a few days later, it was reported that over 400 of the firm's skilled men were involved. The strike arose owing to an alteration in the weekly production quota above which a bonus was paid to the firm's employees. This basic-output figure was revised on March 5 by a joint committee comprising representatives of the unions concerned and of employees in the North-East Coast area. The employees claimed that the agreement, which was based on a compromise, had been signed without their consent and that the new figure, 3,800 tons, would mean a reduction of 15s. a week each in their earnings.

Efforts are to be made to obtain improved efficiency in coal mining by the encouragement of a more general understanding of the difficulties confronting the industry, in accordance with the joint campaign recently instituted by the National Coal Board and the National Union of Mineworkers. In the Yorkshire coalfield, men and managements at all the area's 115 collieries are being asked to assist in the formation and functioning of efficiency committees. This decision was announced at a meeting of two thousand miners and representatives of colliery managements at Barnsley on Sunday. Previously, it had been intended to set up committees only at inefficient collieries in the area. The new proposals are that a sub-committee of the North-Eastern divisional consultative committee shall visit pits which have difficult problems to solve and that every pit in the coalfield shall be encouraged to form its own efficiency committee. Generally, such colliery committees will consist of the mine's agent, manager and under-managers, and officials of the local branch of the N.U.M.

The chairman of the North-Eastern Divisional Coal Board, Major-General Sir Noel G. Holmes, K.B.E., informed the meeting at Barnsley, the seventh to be held in British coalfields since the

campaign started, that the idea of having efficiency committees was introduced into one of that Division's areas some two years previously, and that the committee then appointed succeeded in transforming two very troublesome pits into two of the best in the Division. Some men, however, were against such committees. Before they could be formed, it was necessary to secure the consent of both the pit management and the branch officials of the N.U.M. He felt sure that local managements would do everything they could to aid the formation of committees at their collieries. A committee would be required to visit every part underground at least once a month to ensure that the miners at the pit concerned were working together as a team. With the agreement of the men and the union, a committee could make recommendations for overcoming difficulties, but the mine manager was the man ultimately responsible. If there was anything in a committee's suggestions, of which he did not approve, it would be his duty to get into touch with his superior and explain what he did not like.

The chairman of the National Coal Board, Sir Hubert Houldsworth, told the meeting that efficiency committees would foster a greater knowledge and understanding on both sides of the difficulties confronting the industry. The adverse financial position could no longer be corrected by increasing the price of coal. It was necessary that everyone should concentrate on putting more into the industry by securing all-round efficiency. He appealed for the working of more shifts on Saturdays, particularly during the summer months.

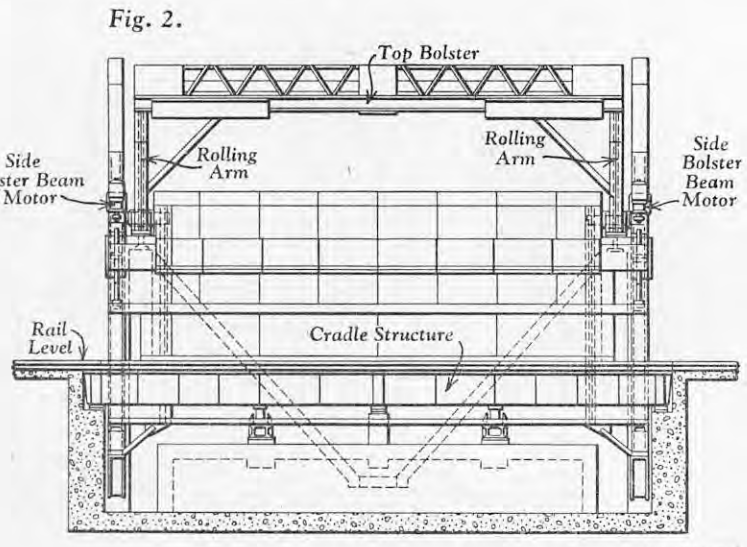
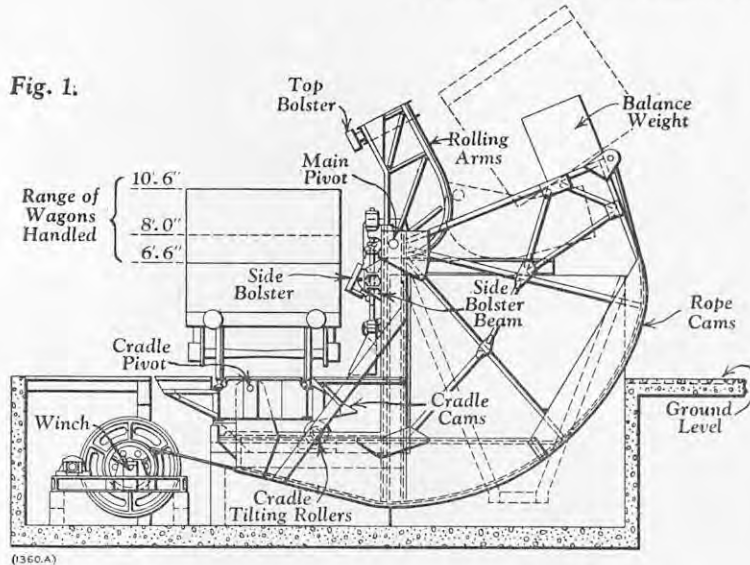
Engineering and foundry employees engaged at works in West Wales have been unsuccessful in their negotiations with their employers on their claim for a "substantial increase" in their wages. It was decided at a meeting of the Welsh Engineers' and Founders' Conciliation Board, held in Swansea on March 20, that the claim should be submitted to voluntary arbitration. Both sides are represented on the Board. More than seven thousand employees are involved in the claim, which was originally put forward in November last year.

Further small reductions in the number of vehicle builders on strike at the Longbridge works of the Austin Motor Company, Limited, were reported on Tuesday and Wednesday, following an ultimatum to the strikers issued by the company on Monday. This statement reminded the men that the stoppage was entering on its sixth week, so that everyone had had time "to think and draw his own conclusions." During that period, hardship and inconvenience had been caused to thousands of people who had been thrown out of work. The management had no intention of giving way to the strikers, and there could be no compromise. If a general return to work did not take place during the week, any person still on strike on Friday (to-day) would be regarded as having left the company's employment. If the return was insufficient to ensure a reasonable output of complete vehicles, production schedules would have to be reduced after Easter, which meant that employees in many departments which had been kept open would no longer be required.

It was announced during last week-end that the strike had caused a loss in output of 15,000 vehicles and that the company had suspended indefinitely its production bonus scheme, under which awards averaging 1,500% a week were granted. At a mass meeting of the strikers last Monday, at which some 800 were present, it was resolved to continue the stoppage, and, later in the week, it was announced that a further mass meeting would be held yesterday, to hear the result of the appeal by the strikers' union, the National Union of Vehicle Builders, to the T.U.C. General Council to intervene. The union had suggested that the dispute should be submitted to a Ministry of Labour court of inquiry, and had declared that it would abide by the decision of such a court. At its meeting on Wednesday, the General Council decided to advise the union to end the strike immediately, so that the men's grievances could be investigated.

AUTOMATIC TIPPLER FOR RAILWAY WAGONS.

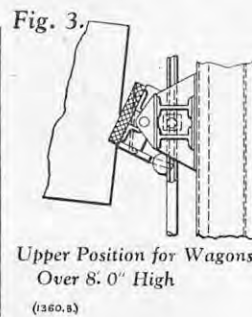
FRASER AND CHALMERS ENGINEERING WORKS, LONDON.



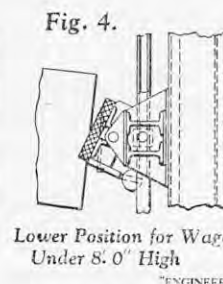
AUTOMATIC TIPPLER FOR RAILWAY WAGONS.

A FULLY automatic tippler which has been designed to Railway Clearing House standards to handle railway wagons up to the standard Ministry of Transport pattern of 24½ tons capacity has recently been completed by the Fraser and Chalmers Engineering Works of the General Electric Company, Limited, Kingsway, London, W.C.2. An interesting feature of its construction is that there is no clamping or binding mechanism, thus reducing the time necessary to perform a cycle of operations. A further feature is the provision of an adjustable side bolster beam, which can be moved vertically through a distance of 1 ft. and thus enables a range of wagons from 6 ft. 6 in. to 10 ft. 6 in. high above rail level to be handled in the machine. The present railway regulations, which give two different heights for the side bolster beam, depending on the range of wagons being handled, are thus complied with. Besides accommodating all normal hopper wagons, the tippler will take those of widths from 7 ft. 6 in. to 8 ft. 8 in., with lengths over the headstocks from 15 ft. to 21 ft. 6 in., and with wheelbases from 8 ft. 6 in. to 13 ft.

The wagon rests on a cradle, which is lifted, during tipping, by two lattice-construction cradle arms. One of these cradle arms is shown in the end view, Fig. 1; each incorporates a peripheral "cam" to take a winch rope. In the first stages of a tipping operation the cradle arms rotate about the pivot pins near the top left (Fig. 1); these pins pass through two rolling arms (Figs. 1 and 2) as well as through the cradle arms. At a later stage of tipping the whole of the cradle, cradle arms and rolling arms are rocked by the action of the rolling arms on horizontal rolling paths. The cradle arms, together with the rolling paths, driving gear, and adjustable bolster mechanism, consist of built-up lattice girders, which are braced together in the vertical and horizontal planes. The vertical girder has double beams at each end, between which are the pivot pins. These pins are supported at both ends and form the connection between the cradle arms and rolling arms structures. There is also a horizontal double beam, the ends of which rests on the vertical beams mentioned above. This beam, which is shown in its upper and lower positions in Figs. 3 and 4, respectively, carries the self-aligning side bolster cushions against which the side of the wagon rests during the tipping operation. This assembly can be moved vertically so that wagons of different heights can be accommodated and is raised or lowered by two screws, which are operated through gearing by electric motors on the cradle arms structure, as shown in Fig. 1. Plates attached to the cradle arms are provided behind this beam assembly, so that the contents of wagons of any height within the capacity of the tippler are dis-



Upper Position for Wagons
Over 8' 0" High
(1360.A)



Lower Position for Wagon
Under 8' 0" High
"ENGINEER"

charged to the hopper without spillage occurring. A pair of arms, which pivot on the pins already mentioned, are connected by a girder, attached to which are top bolster cushions for securing the top of the wagon while it is being tipped. The assembly rests upon, and during the final stage of tipping moves along, a pair of roller pulleys.

In its normal position the cradle rests upon solid foundations so that the tippler and its ropes are not stressed by through traffic. The pins by which the cradle is pivoted to its arms are slightly eccentric, so that the wagon is brought against the side bolster cushions at an early stage in the tipping operation. This tilt is controlled by two cam faces, which are attached to the cradle on the hopper side and rest on the tilting rollers, which are carried by the foundations. The side bolster cushions are also pivoted and are arranged so that they are aligned automatically to the sides of wagons of varying widths and slope. The lower ends of the rolling arms are bored to fit the pins, which are attached to the cradle arms, while their faces rest upon and move along the rolling paths, the relative positions of the two being ensured by registration ropes. A top bolster, supporting the girder to which the rubber-covered self-aligning top cushions are attached, is placed between the two rolling arms. There is no direct connection between the cradle arms and the foundation, so that the girders of the cradle arms are free to rise as the rolling arms move forward. Counterweights are mounted on the top of the rope cams close to the points where the hoist rope is attached and bring the cable arm structure into a condition just short of balance, thus reducing the amount of work necessary for tipping.

The drums of the hoisting gear are driven by an electric motor through a hydraulic coupling and worm and spur gearing, a solenoid brake being provided to prevent "run back" in case of current failure. During both hoisting and lowering the motors are controlled by push-buttons, and overwinding in the fully tipped position is prevented by an automatic cut-out. A cut-out is also provided to stop automatic lowering when the tippler is at rest on the foundations. In addition, the side bolster is controlled by push-buttons, thus enabling it to be placed in either the raised or lowered

position, depending on the height of wagon being handled.

As regards operation, a loaded wagon is first run on to the cradle and its brakes applied, the height of the side bolster beam being simultaneously adjusted. The hoisting gear is then started and, as the cradle arms rise, both cradle and wagon are inclined toward the hopper, the motion being controlled by the cradle pivots and cams actuating the tilting rollers, until the side of the wagon comes into contact with the cushions of the side bolster. As hoisting continues the wagon cradle and cradle arm revolve as one unit about the trunnion pins, until the top of the wagon meets the cushions of the top bolster. The final unit thus formed next revolves and moves along the rolling path.

INSPECTION PROBLEMS OF MODERN JET ENGINES.*

By C. GARSIDE.

(Concluded from page 347.)

PANTOGRAPH INSTRUMENTS.

AN important contribution towards the solution of blade profile inspection has been made by two types of projection pantometers that are based on optical principles, and the use of a pair of tracer-points that are traversed over the surface of the blade. The first of these instruments, shown in Fig. 9, on page 410, and made by Optical Measuring Tools, Limited, Slough, incorporates a fairly large screen, to which can be attached a master reference drawing showing the required blade sections on translucent material. One stylus is used at a time for traversing the convex or concave surfaces of the blade, and an image of the stylus is projected on to the screen at a magnification of $\times 10$ by way of a graticule mounted below the objective. When projected, this appears as three circles; the centre one is nominal, the outer one equals the plus limit, and the inner circle the minus limit. This tolerance graticule is connected to the traversing mechanism so that, as the stylus follows the blade contour, the three concentric circles follow the blade outline on the screen. Inaccuracies in the blade profile are clearly indicated by the relationship of the graticule image to the outline of the master profile. The blade is held in an inverted position by the root, which is clamped in a holding-fixture (to be seen in Fig. 10, on page 410), that can be rotated. This fixture, in turn, is carried on an arm that can be raised or lowered on a column. Adjacent to the

* Paper presented at a meeting of the Institution of Engineers and Shipbuilders in Scotland, held in Glasgow on February 24, 1953. Abridged.

INSPECTING GAS-TURBINE BLADES.

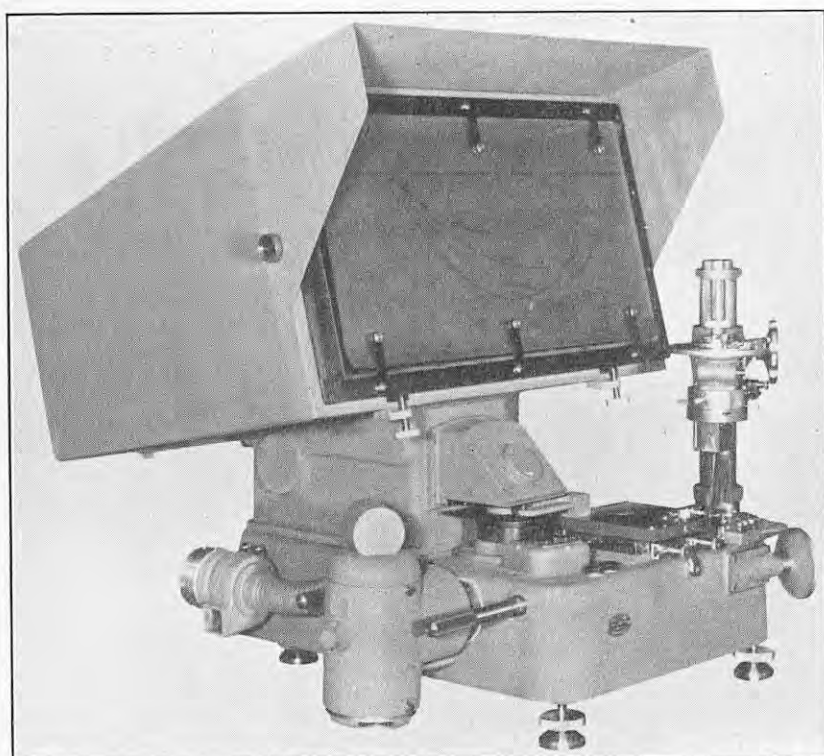


FIG. 9. PROJECTION PANTOMETER.



FIG. 10. BLADE-HOLDING FIXTURE AND SUPPORTING COLUMN.

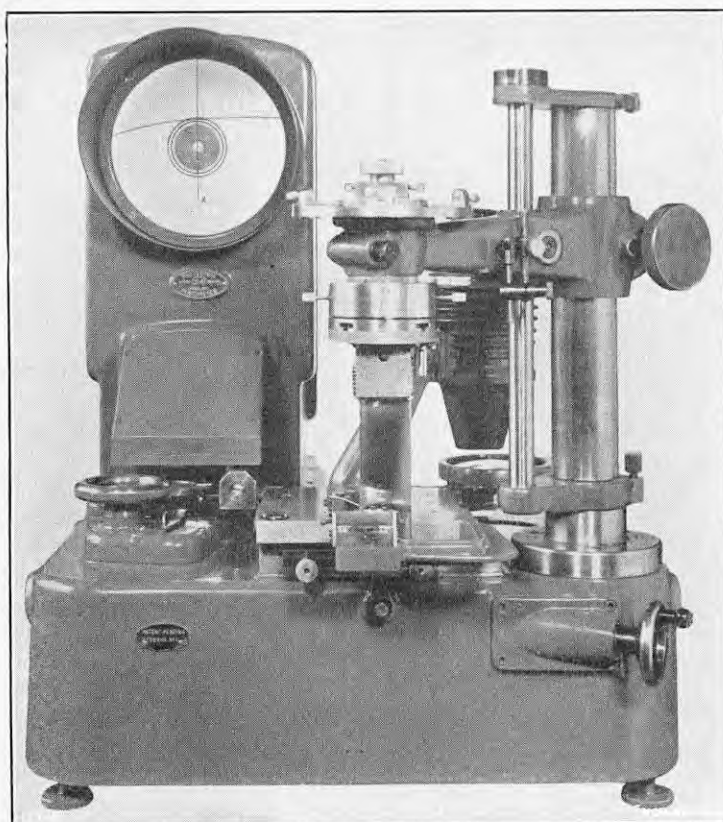


FIG. 11. STANDARD PROJECTION PANTOMETER.

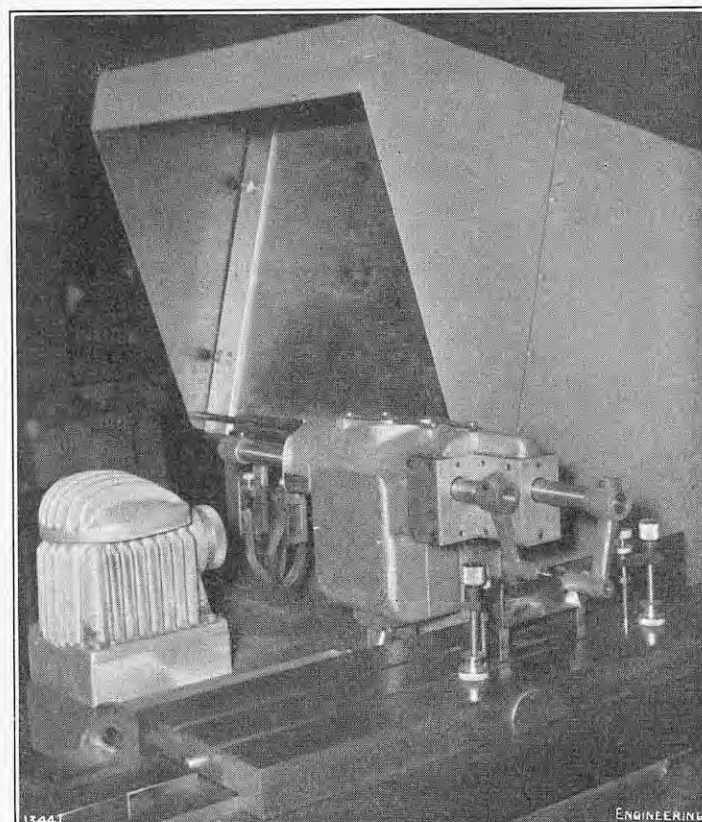


FIG. 12. BLADE PROFILE PROJECTOR.

foot of the column is a small co-ordinate table consisting of a ball-mounted carriage and a slide, the carriage having a C-shaped frame that carries two ball-ended tracer points, one corresponding to each side of the blade. The left-hand side of the carriage carries the tolerance graticule, which is illuminated from below. Setting lines are included in the master reference drawing and a setting piece is used, having a datum face related to the blade.

The second instrument (Fig. 11) is basically the same, with the exception that the screen becomes the tolerance graticule and the master reference profiles are engraved on glass plate at unit size and take up a similar position in the traversing mechanism as did the tolerance graticule on the

former instrument. This revised ingenious optical system has overcome the disadvantage of a confined optical field and now enables larger blades to be examined at an increased magnification of $\times 30$. The circular tolerance graticule on the screen remains stationary and the line of the blade profile is traversed past it. As the outline is traversed past the spot, it is seen to rise and fall in relation to the spot by an amount proportional to actual errors in the blade. Owing to the increased magnification, only a small outline is seen on the screen, depending on the size of the blade, and errors are read very accurately. Both instruments have their particular uses; the former is a little slower in use, but allows easier interpretation of

the whole profile and, consequently, is more suited to development and investigation work.

Another pantograph type of instrument using optical projection is the Hilger and Watts projector shown in Fig. 12. On this instrument, both sides of the blade are traced simultaneously. The blade is mounted on a robust carriage with a longitudinal traverse. A stylus contacts each side of the blade section with a very light spring pressure. The stylus mounts are attached directly to a pair of frames on which a pair of photo-plates of the sections to be examined are mounted. One plate contains all the convex sections and is attached to the stylus traversing the convex side of the blade, while the other plate contains all the concave

INSPECTING GAS-TURBINE BLADES.

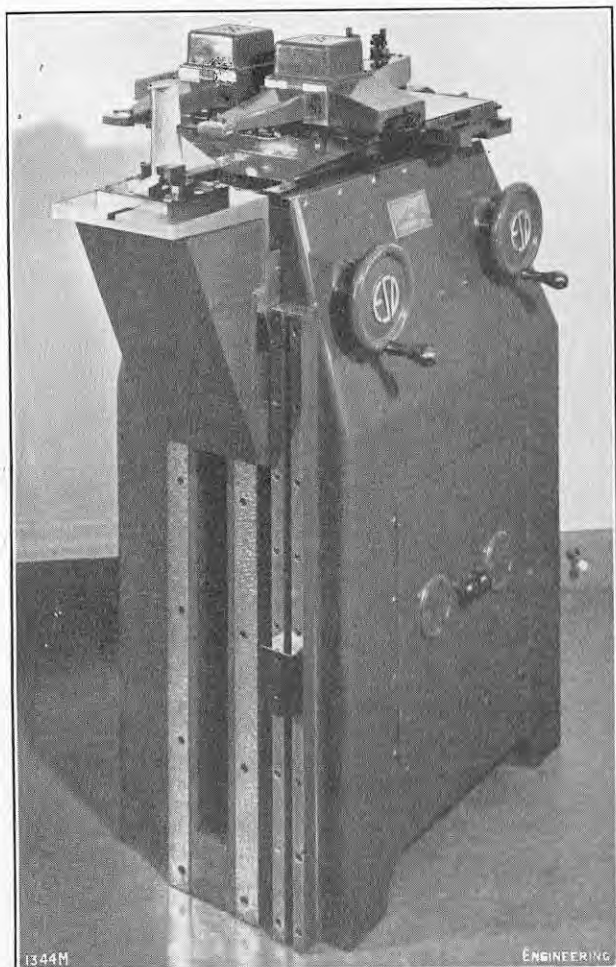


FIG. 13. "PANTOSCRIBER" BLADE CHECKER.

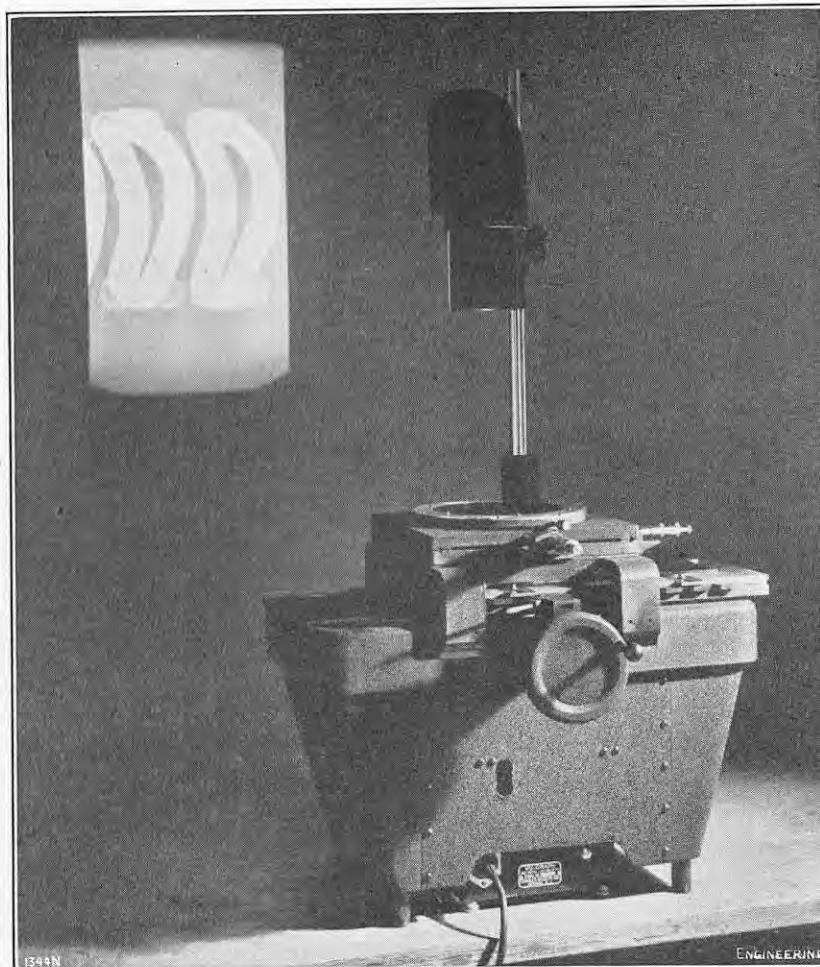
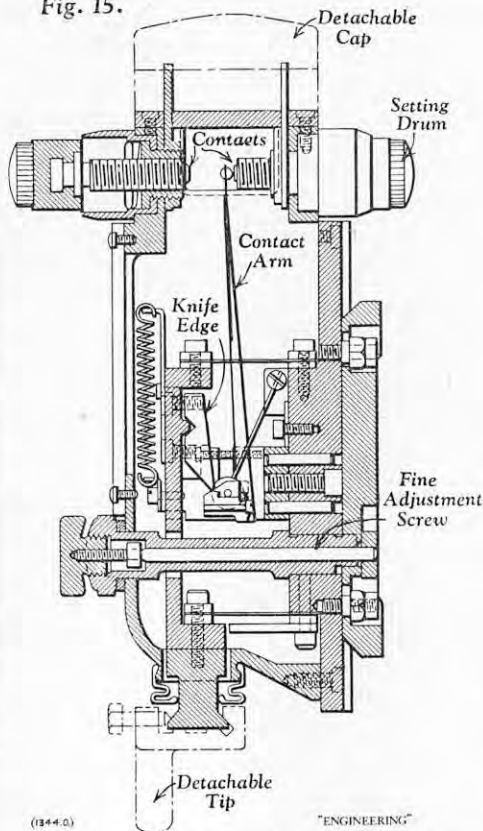


FIG. 14. "DELINEASCOPE," SHOWING PROJECTED BLADE FORM.

sections and is attached to the stylus traversing the concave side of the blade. Both frames have free horizontal movement and are carried on a carriage having vertical movement. On the screen a circle is drawn at 20 times the diameter of the stylus ball point. The tolerance can be indicated by circles larger or smaller than the nominal. The traversing action of the tracers is transmitted to the frames, which are situated in the focal plane of the objective, and on the screen the illuminated image of the blade outline is seen passing through the tolerance spot.

A pantograph instrument known as the Pantoscriber is made by the Universal Engraving Colourplate Co., New York. There are several different models, each capable of inspecting a variety of blades, dies, master patterns, etc. A description of the blade checker (Fig. 13) will indicate the general principle adopted. The blade is mounted vertically on a work stage that can be rotated for angular measurements. Two tracer arms that have a pre-loaded ball-bearing movement carry stylus rollers that contact both sides of the blade profile simultaneously, and on the opposite end of the tracer arms is an attachment carrying scribing cutter heads. This attachment is motor-driven and the cutters rotate in circles that are exactly the same radius as the tracer rollers. A glass plate is mounted below the cutters and this plate is coated with a thin film of suitably coloured emulsion. As the rollers move across the blade form, the motor-driven scribing cutters duplicate the movements, and in so doing cut or scribe the film from the surface of the glass plate. The rollers and scribing cutters are positioned so that the tracer rollers and scribing cutter of one arm are ahead of the corresponding unit of the other arm. This enables the tracer to travel as far as possible round the leading and trailing edges. It is a simple matter to index the blade to a new station and repeat the process. Some other Pantoscriber models have two or three tracer arms for simultaneous checking of two or three blade sections. The glass plate, when scribed, can be removed and projected

Fig. 15.



against a master reference drawing or attached to a master graticule of unit size and projected on to a screen or wall by a "Delineascope" or lantern (Fig. 14).

ELECTRICAL RECORDING INSTRUMENTS.

Since about 1938, a number of gauging heads which operate on the electrical contact and transmitter principle have been designed and marketed

in Germany, the United States and this country. The workpiece to be gauged is passed under a measuring contact of the head, which has been set previously to high and low limits of acceptance by master setting-pieces, and the resulting comparison is indicated by signal lights, namely, yellow oversize, green correct, red undersize. Mechanism of this type (Fig. 15, on this page) has been adapted to multiple measuring machines covering a large variety of applications. The principle of this head is that the measuring contact (which is detachable) is flexibly supported from the body of the instrument on a pair of horizontal steel strips. Downward movement of the contact is conveyed by a knife-edge to a pivot carrying a vertical arm, the tip of which is situated between a pair of opposing electrical contacts, their distance apart being adjusted by two micrometer screws to suit the tolerance on the work-piece. When the work-piece is within the tolerance, the tip of the arm will not touch either contact, but if it is outside limits it will touch either the left-hand or right-hand (undersize or oversize) and transmit the result through a relay system to the signal lights. By a system of bell-crank levers, floating carriages and these electrical gauging heads (Fig. 16, on page 412), a machine has been developed capable of checking as many as 28 blade dimensions simultaneously. The fixture carrying the blade in its root fixing is traversed into the measuring position automatically by the use of an electric motor drive. The various gauging tips are made to contact the blade form by a pneumatic system, and a special cam enables a dwell to take place during measuring. The relay system of lights has been so arranged that one green light covers all the 28 dimensions. This facilitates rapid inspection and the remaining signal lights only require sighting when the blade is outside the limits. A further attraction is the addition of a bell alarm system which only rings when the green light does not indicate. This again reduces the human element as regards the possibility of failing to sight a rejected blade.

The instrument is capable of measuring all the

INSPECTING GAS-TURBINE BLADES.

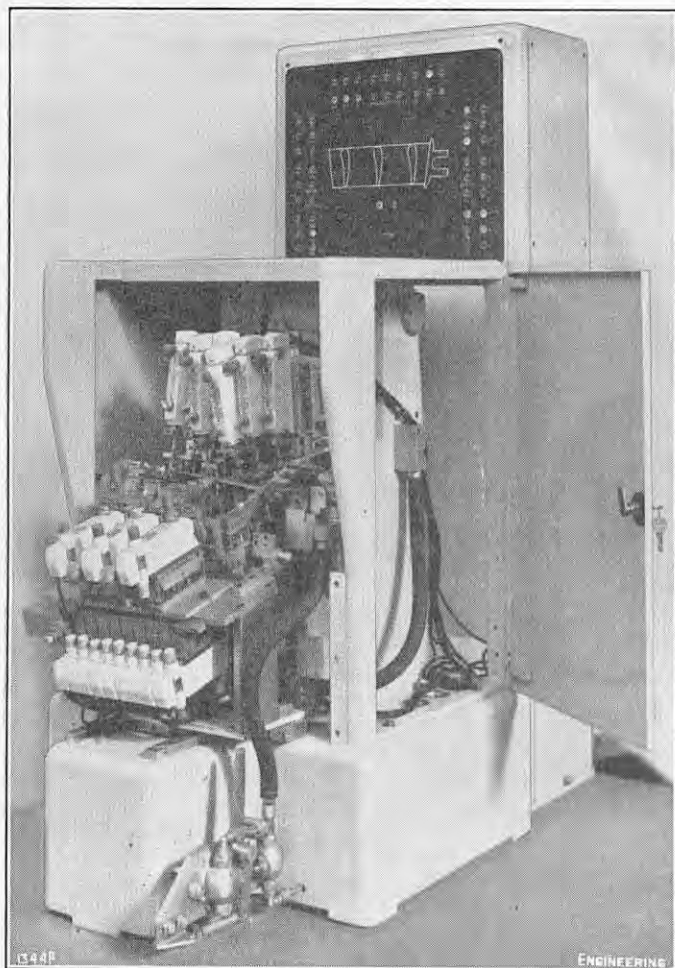


FIG. 16. "SIGMA" SIGNAL-LIGHT INSPECTION MACHINE.

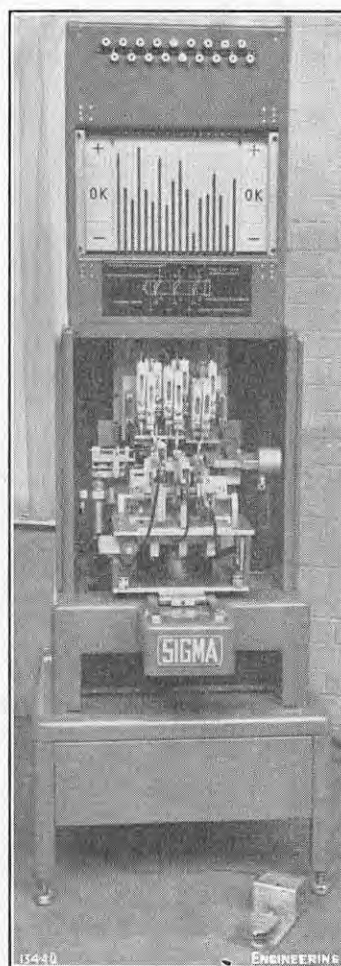


FIG. 17. SEMI-AUTOMATIC MULTI-INSPECTION MACHINE.

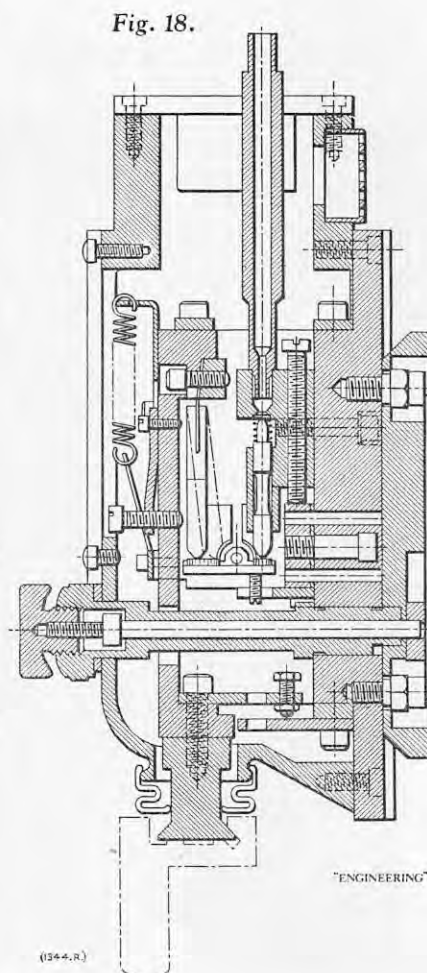


Fig. 18.

blade features and characteristics already mentioned at a rate of approximately 400 per hour. These measurements are taken at selected points on the blade and are relative to the root datum. The obvious difficulty with a machine of this type is to design the lever system so that true geometry is maintained and each feature is measured independent of its neighbour and in correct relationship to the required datum. The main disadvantage of this machine in its application to blade inspection is the necessity of manufacturing very accurate setting masters, one for all the plus limits and one for all the minus limits. This is made all the more difficult by the large number of blades per engine, mainly of varying sizes, and the involved and costly machining necessary to produce accurately these master blades from solid steel. They must include all the limits that the drawing allows, as it is not possible to adjust the gauging heads to allow for deviations. The problems outlined are confined mainly to blades, as masters are relatively simple to make for the average component. In view of the difficulty in manufacturing master setting blades, consideration was given to the use of dial indicators instead of signal lights, where, of course, a normal production blade with known errors could be used for setting purposes, and the dial indicators adjusted to these known sizes. Here, again, the difficulty in reading 28 dial indicators rapidly was a serious problem in the sense that it reduced production inspection considerably. The resultant loss in output did not offset the costly manufacture of setting masters.

PNEUMATIC RECORDING INSTRUMENTS.

Air gauging as a means of measurement is not new and many well-known manufacturers of air-gauging equipment must be familiar to engineers. In one such instrument, the measuring units, bell-crank lever system and floating carriages are identical with those previously described on the electrical recording instrument. The only difference in appearance is a manometer tube indicator in place

of the signal-light relay panel. The instrument, shown in Fig. 17, herewith, is again on the comparator principle and has a new design of pneumatic gauging head, shown in section in Fig. 18, herewith, identical with the one shown in Fig. 10. Each head consists of a frame, flexibly mounted by means of lath springs, and a secondary frame, free to move in an endwise direction. Movements of the contact point are conveyed by a knife-edge resting on a sapphire, which is inserted in a rocking lever pivoted at its centre and operating a needle valve in a jet. The needle valve incorporates a non-ferrous compression spring surrounding the stem. The pressure exerted by this spring tends to hold the air valve in the open position and maintains the end of the stem in contact with a second sapphire at the opposite end of the rocking lever.

In this way, the direction of travel of the valve and the gauging member are reversed and direct relationship between the valve area and gauging member movement is obtained. By adjustment of the ratio of the rocking lever, the sensitivity of the gauge head can be varied to suit different blade tolerances. The variations in air pressure due to the movement of the needle valve are conveyed to manometer tubes, mounted vertically and containing coloured liquid which rises and falls accordingly. The manometer tubes are fitted side by side on a panel at the front of the machine, and are covered with a transparent plate upon which is engraved two horizontal lines to indicate the parameter of the blade tolerance. The panel is removable and can be replaced with other suitable panels, toleranced as desired. To facilitate checking, an enlarged diagram of the blade profile is engraved on a plate and fitted below the manometer panel. Each manometer tube has a number which corresponds with a number on the diagram. The tubes are engraved with their representative tolerance boundaries and, by using a production blade of known dimensions, and correcting for deviations from nominal size with the zero adjusting screw at the top of each tube, the necessity for master setting

blades is obviated. In addition, the results of the combined measurements of blades can be seen very rapidly and no action is necessary, provided that the columns of coloured liquid fall within the parameter lines. Should the coloured liquid in any tube stay outside the lines, the dimension concerned can be ascertained at once and the amount of deviation from limit be read. It is necessary to provide means of controlling the air supply and this has been effectively applied by using a primary reducing valve, followed by a piston-type governor which is capable of balancing the system to very fine limits. Any variations in shop pressure over a fairly wide range can be catered for.

Future development trends would seem to be machine control, with the inspection media incorporated in machine tools; the greater use of automatic gauging equipment, with its associated economies in labour; optical projection—the ability to measure accurately several blade sections simultaneously; and a greater interest by production planning departments in inspection problems on mass-produced parts.

THE REVERSING OF ELECTRIC FORK TRUCKS.—Conveyancer Fork Trucks Ltd., Liverpool-road, Warrington, have developed an "anti-plugging" system which is to be fitted on all their current production models and is also suitable for fitting to the firm's trucks at present in service. It is designed to prevent the driver from using the forward reverse control as a brake, this practice being termed "plugging the motor." The driver does this by selecting reverse while the truck is moving forward, lifting his foot from the speed control and applying it again to give full power to the motor, to stop the truck and proceed in a reverse direction. It is said that this more than doubles the current consumptions, and frequently damages the transmission gear. With the new system it is claimed that "plugging" is impossible because the truck must be almost stationary before the electrical circuit can be re-connected for reverse drive, although reverse may have been selected; even then it can only be achieved by depressing the brake pedal, which means that the controls must be applied in the correct order.

TITANIUM—A SURVEY.*

By P. L. TEED, A.R.S.M., F.R.Ae.S.

(Concluded from page 342.)

ADDITIONAL PROPERTIES.

Surface Rubbing.—Titanium and the present titanium alloys have deplorable rubbing properties. The metal is inclined to pick up any other on which it is rubbing. This cold-welding tendency debars the use of the alloy for shafts unless they have a sleeve to provide a rubbing surface in the journals, or unless ball or roller races are fitted. A titanium piston is extremely unlikely to be successful for the present. It is even doubtful if a titanium-alloy nut can be used satisfactorily in connection with a bolt of similar composition.

Titanium and its alloys, however, can be given a hard surface by anodising. If such a coating will

improve, but considerably reduces, their fatigue limit. It is possible, however, that an improvement may be obtained by a modification of the peening technique. This view is based on the behaviour of magnesium (also a hexagonal metal), since, when shot-peening was first applied to its alloys, their fatigue resistance was lowered thereby. Now, however, by a modification of the method, a system of peening has been demonstrated that does in fact raise their fatigue resistance.

Impact Resistance.—So far, the influence on titanium alloys of trace elements, grain size and heat treatment, all very potent in relation to the impact resistance of the ordinary engineering materials, have received insufficient study. It is known that, like the ferritic steels, these alloys are extremely sensitive to temperature. At 300 deg. to 400 deg. C., an Izod impact value of 100 ft.-lb. or more can be obtained. At such a temperature the fracture would be ductile, but at a lower one,

success in reducing the temperature sensitivity of his creations has been somewhat limited; except for short-term uses, a temperature of about 350 deg. C. constitutes the upper limit of their employment.

Some creep figures are available, but creep results are difficult to reproduce. Grain size and very slight variations in chemical composition have considerable influence on the creep rate of alloys to the same specification. In Fig. 6, the superior resistance to creep of two titanium alloys to that of the commercially-pure metal is shown. Once again the temperature sensitivity of the three materials is emphasised. In Fig. 7, relative specific creep rates of three materials used for axial-compressor blades are shown. While at all temperatures within the range of the experiment the titanium alloy containing 2.7 per cent. chromium and 1.3 per cent. iron is very superior to the other two, the downward slope of its specific

TENSILE PROPERTIES AT ELEVATED TEMPERATURES OF ARC-MELTED COMMERCIAL-PURITY TITANIUM.

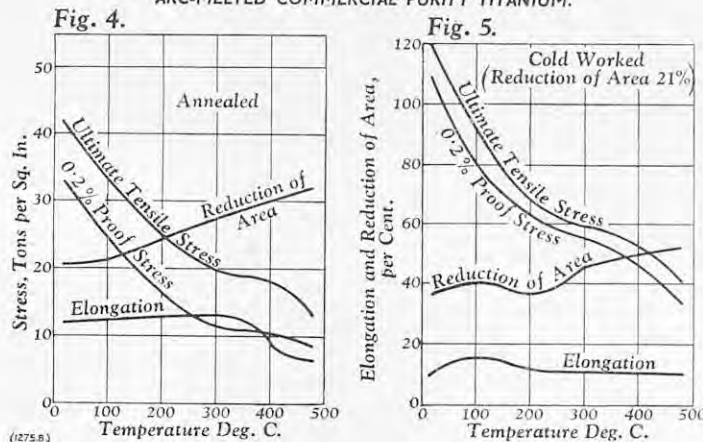


Fig. 6. INFLUENCE OF TEMPERATURE ON CREEP OF TITANIUM AND TITANIUM ALLOYS.

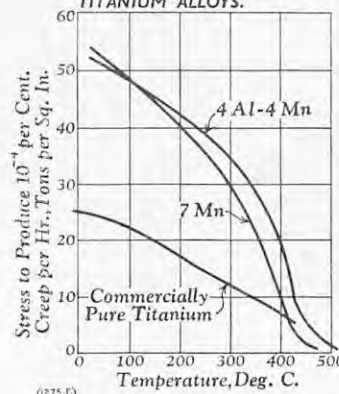
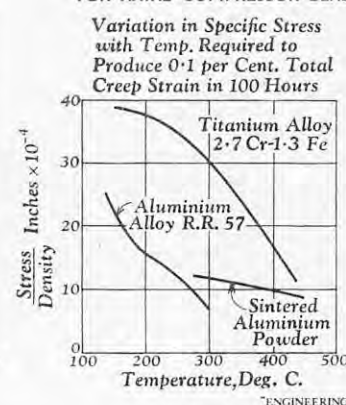


Fig. 7. COMPARISON OF MATERIALS FOR AXIAL COMPRESSOR BLADES.



not stop galling, or has too ephemeral an existence, then gas case-hardening, produced by heating either in oxygen or nitrogen, can be employed. Failing this, a hard surface can be produced by carburising. Such experiments are in hand. Under conditions in which contact corrosion is unlikely to arise, a flash coat of copper may be obtained by dipping in a copper-cyanide bath. This may prevent "pick-up." Finally, a chemical treatment, giving rise to an adherent film, can be used satisfactorily in conjunction with molybdenum disulphide, subsequently used as a solid lubricant.

Fatigue.—Unlike practically all the metals of the non-ferrous group, titanium has a true fatigue limit. Results obtained with highly-polished test-pieces show considerable scatter, but it is undoubtedly true to say that the ratio of the fatigue resistance of the metal and of its alloys to their respective tensile strengths exceeds, and sometimes greatly exceeds, one half. Thus the fatigue resistance of this group, in the form of the unrealistic test-pieces already mentioned, is better than that of alloy steels. When, however, notched fatigue test-pieces are used, this is no longer the case. Using test-pieces with and without a severe notch, it has been found that whereas the notched to unnotched endurance ratio for alloy steel specimens was 15 per cent., for identical titanium ones made of the 2.7-Cr, 1.3-Fe, 0.25-O₂ alloy, the figure was only one-fifth this amount. In other tests, with a less severe notch (stress concentration factor 2.7), employing the commercially pure alloy, the 10⁷-cycle endurance was shown to be only 50 per cent. of that of the unnotched specimens. These disturbing results have received confirmation from other experiments, but the position is not entirely without hope. It seems possible that, by control of the initial grain size and by close attention to metallographic structure, better resistance may be obtainable when titanium alloys are subjected to tri-axial cyclic stresses. Nevertheless, at present, it has to be admitted that the notched fatigue endurance of such strong titanium alloys as have been tested is poor.

It has been stated that shot-peening does not

which would certainly be above room temperature, it would be wholly brittle. This change in the type of fracture is accompanied by a sharp decrease in impact resistance, but at room temperature, it is probable that the strong titanium alloys, when their chemical compositions and methods of manufacture have become standardised, will possess notched-bar impact values better than those of the current strong wrought-aluminium alloys used in airframe structures, and probably comparable with those of the stronger alloy steels.

Welding.—Reference has been made to the absorption of oxygen and nitrogen when titanium is at a temperature above about 800 deg. C. When its gas content rises, so does its strength, but its ductility decreases. It is because of this that the inert gas type of welding gives the best results. If, however, a weld as strong and as ductile as the parent metal is required, contact of oxygen and nitrogen with the molten and neighbouring hot titanium must be prevented. The standard welding torch does this on the working face, but when welding sheet or plate, an inert gas atmosphere must be provided over the hot area on the reverse side of the job.

Roughly speaking, all titanium alloys can be argon or heli-arc welded, but in those which have a two-phase structure, although the tensile strength will be satisfactory, the ductility will be generally extremely low. It may be increased in some cases by subsequent heat treatment. One investigator contends (at present exceptionally) that welds made in two-phase titanium alloys by flash welding possess good ductility. This technique is particularly adapted to repetition work and might well find aircraft-engine applications. Should there be a demand for a weldable sheet with a 0.2 per cent. proof stress of 40 tons per square inch, a tensile strength of about 60 tons per square inch, combined with an elongation of not less than 15 per cent., this is a metallurgical possibility.

Properties at Elevated Temperatures.—The influence of temperature on the mechanical properties of commercially-pure titanium is indicated in Figs. 4 and 5. Both annealed and cold-worked, it is embarrassingly temperature conscious. In alloys of titanium, the metallurgist has succeeded in raising stress levels to a gratifying degree, but his

creep curve is impressive. On the basis of a considerable body of evidence available, the upper limit of temperature above which neither titanium nor its alloys can be usefully employed is, contrary to earlier expectations, of modest height.

WATER-COOLED LIFTING MAGNET FOR FURNACE CHARGING.

A WATER-COOLED magnet has recently been installed by the Wotton-Kramer Electric Tool and Hoist Works of the General Electric Company, Limited, Kingsway, London, W.C.2, in the factory of Tubes, Limited, Birmingham, for charging billets into a rotary-hearth furnace. The magnet weighs about 15 cwt. and is capable of handling billets from 3½ in. to 4 in. in diameter and up to 5 ft. long. Billets of the same diameter, but of different lengths, can be dealt with simultaneously. It is supplied, with direct-current at 220 volts through a selenium metal rectifier from the 400/440 three-phase mains.

It is claimed that this arrangement has the advantage over the usual method of charging rotary-hearth furnaces by a machine with a mechanically-controlled extension arm that the billets can be charged with their ends touching, thus giving a better hearth loading. It also enables more than one billet to be picked up at a time, so that the furnace can be charged less frequently, with a resulting reduction in wear and tear and in heat losses. As the magnet has to be inserted into the furnace, it has been designed to withstand temperatures of about 1,000 deg. C. by providing water jackets along each side as well as on the extension arm of the charging machine.

PORTABLE ELECTROMAGNET FOR OPTICAL WORK.—The British Thomson-Houston Co., Ltd., Aldwych, London, W.C.2, have recently developed a portable electromagnet weighing only 13 lb. to enable small metal particles to be removed from the eye with a minimum of danger to the tissues. Many of the instruments at present in use for this purpose weigh over 100 lb. and this large reduction has been achieved by paying special attention to shape and by increasing the input power. The magnet, which has been designed in collaboration with the staff of the Moorfields Eye Hospital, is to be manufactured by the Newton Victor Company.

* Paper presented to the Royal Aeronautical Society in London on Thursday, January 29, 1953. Abridged.

THE NATIONAL INSTITUTE OF AGRICULTURAL ENGINEERING.*

By W. H. CASHMORE, B.A., M.I.B.A.E.

THE Institute of Agricultural Engineering was set up in 1924 as a department of the University of Oxford. Its programme consisted mainly of investigations into agricultural processes such as grass drying, land drainage, etc. Tests for manufacturers did not form part of the programme until 1930, when the World Tractor Trials were carried out under the auspices of the Royal Agricultural Society of England. In 1932, the Institute was re-named the Institute for Research in Agricultural Engineering; apart from further tests of farm tractors, its main function was to foster the mechanisation of agriculture. As part of this programme, the Institute introduced new machines from overseas, such as the pick-up baler, and one of the first two combine harvesters to be brought into this country. Investigations were carried out with such machines to ascertain the best way of using them under British conditions. Where modifications or additional equipment were found necessary, development was carried out, as, for example, of grain driers, which made possible the efficient use of combines. Research work included wheel efficiency, fertiliser distribution and the mechanisation of sugar-beet harvesting. In 1942, the Institute moved to Askham Bryan, Yorkshire, to form the nucleus of the National Institute of Agricultural Engineering as a branch of the Ministry of Agriculture and Fisheries, under the direction of the Machinery Development Board. A testing scheme was built up to include not only tractors, but the full range of agricultural machinery. In addition, machinery instructors were trained and then posted to County Committees.

In 1947, the N.I.A.E. began its move to permanent quarters at Wrest Park, Silsoe, Bedfordshire. It became a State-aided Institute under the control of the Agricultural Research Council, and administered by the British Society for Research in Agricultural Machinery. Before the move to Bedfordshire, a horticultural engineering department was added, and the Scottish Machinery Testing Station was set up at Howden, Midlothian. During the war years, Britain's tractor population rose from 55,000 to 250,000. At the end of the war, the emphasis was still on increased production, and this had to be achieved with a reduced labour force and a depleted horse population. British farmers were requiring about 50,000,000 l. worth of machinery annually, most of which had to be produced in this country. In addition, British manufacturers were expected to export a similar amount in a keen world market, and some of this machinery had to be developed to meet special conditions. To help in coping with these demands, the N.I.A.E. programme of work was altered; the testing scheme was changed to a service for manufacturers, and investigations, experimental work, research and development were commenced to provide the data needed by design engineers and to improve farm technique. The total staff was increased to approximately 300, including about 100 scientific or experimental officers, and workshops and laboratories were set up and equipped.

The new terms of reference were, in general, "To assist the mechanisation of agriculture and horticulture." A long-term programme was agreed with the Agricultural Research Council, but with sufficient flexibility to allow additions and modifications to be made. Requests for items to be included in the programme are received from various sources, such as advisory committees of the Ministry of Agriculture, working parties and trade research associations, on all of which the N.I.A.E. is represented. There is close contact with research at the universities, and some of their pilot investigations may be continued in the N.I.A.E. programme. More recently, inquiries have been received from various parts of the Dominions and Colonies.

* Paper read before the Institution of British Agricultural Engineers in London on February 24, 1953. Abridged.

AGRICULTURAL ENGINEERING INVESTIGATIONS.

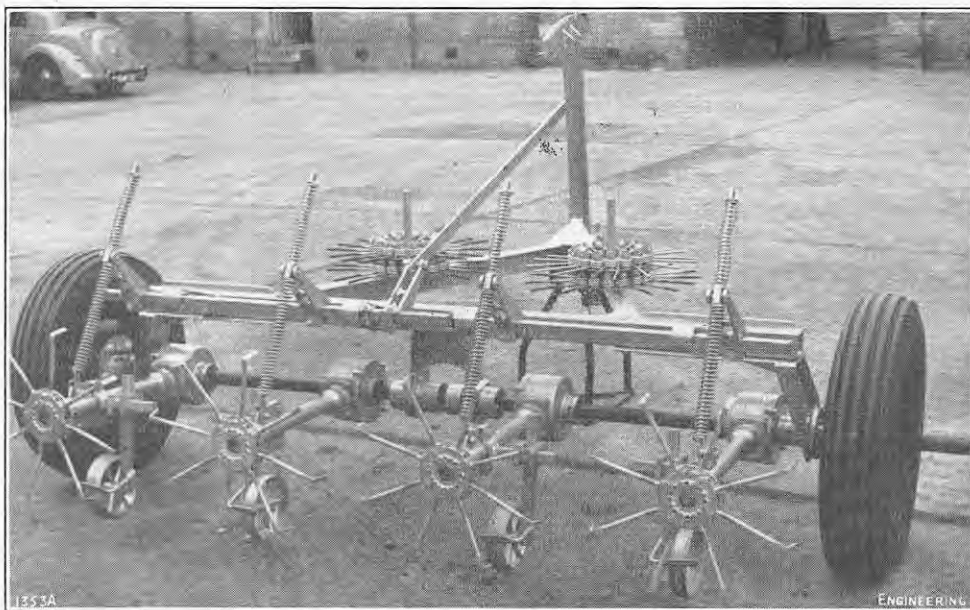


FIG. 1. GREAT WESTERN TYPE GAPPER, BUILT AT THE N.I.A.E.

The testing staff is separate from that engaged on development and research. Up to 80 tests a year on tractors and implements are carried out at the request of manufacturers. In addition, records of trials of machines, purchased by the Institute, are made to obtain information for internal use; often these are imported machines of types new to this country. It is the policy of the Institute to evolve, as opportunity offers, standard tests for each class of implement; so far, such tests cover tractors, grass and grain driers, hammer mills and fertiliser distributors, and advanced testing techniques are available for ploughs, potato planters, complete potato harvesters, and sugar-beet harvesters. Many of the tests for manufacturers are on prototypes or component parts. The test report enables the entrant's development staff to note progress, and it also contains a number of suggestions for improvement, many of which are incorporated in the final design. In special cases, developmental tests are carried out during which modifications are made in the N.I.A.E. workshop between trial runs in the field. Many manufacturers dispense with a testing department and rely entirely on the N.I.A.E., but even those having a testing department often request an independent test by the N.I.A.E. to confirm their own results, or to use the published report commercially to support the claims made for their machines. In some cases, overseas countries insist on a N.I.A.E. report before importing British agricultural tractors or implements.

Standard tests for machines closely associated with soil have not been developed because of the difficulty of assessing soil conditions reliably. Laboratory methods have proved unsatisfactory, but it is hoped that field work being done by the soil-physics section will make it possible in future to specify soil properties.

The testing staff carry out investigations and experimental work to provide the background for further schemes of test. They also assist organisations, such as the Royal Agricultural Society and the Sugar Beet Research and Education Committee, in drawing up schemes and measuring the performance of machines working in national trials and competitions.

Before development work is proceeded with, investigations into the problem are carried out. These are carefully planned on statistical lines, detailed measurements being made of as many variables as possible. The data obtained relate the performance to detail of design, and provide basic information on which a manufacturer can build the machine. Should the prototype be submitted for test, the testing department can use this basic information in drawing up a scheme of tests. The development of a machine may start

as a "lash-up" in the blacksmith's shop, and be modified and rebuilt as work in the field progresses. The alternative is to design the machine in the drawing office initially. The choice is mainly dependent on the problem. When it is thought desirable, designs are patented and handled by the National Research Development Corporation.

In the course of development, machines are built in the workshop, and brought to a standard which enables a full test to be carried out; an example is the Great Western type gapper shown in Fig. 1, herewith. No attempt is made to carry the design to the stage of a manufacturer's production model. The Institute is always ready to discuss a development scheme with an interested manufacturer. There is often close co-operation before an investigation is concluded, and also, ideas for component parts as well as experimental data can assist manufacturers in their own development. In this way, the benefits of N.I.A.E. work reach the farmer in the shortest possible time. The Institute designs and builds a good deal of special test equipment, varying from simple devices to complicated recording gear in self-contained mobile vehicles, such as the single-wheel tester illustrated in Fig. 2, opposite. It is hoped that the more simple gear will be used in the Dominions, Colonies and countries where British machines are employed, so that their performance can be linked up with the standard test at the N.I.A.E. Some manufacturers are using N.I.A.E. test equipment for their own testing, but, in the case of the more elaborate and costly devices, the N.I.A.E. is able to make it available to manufacturers for special trials. Experimental machines are designed and built by the N.I.A.E., to meet the requirements of other research stations, and when the experimental work carried out there reaches a stage at which the manufacture of a new or modified machine is justified, the N.I.A.E. can advise on the details and general design, using the experience gained during the trial runs with the experimental unit.

Inquiries from manufacturers are dealt with directly, and, when occasion arises, conferences are arranged at Wrest Park so that manufacturers can be kept informed of progress and the possible importance of any line of investigation. The Institute is prepared to give opinions on agricultural engineering inventions, but if an invention needs a considerable amount of development work, the inventor is usually dissatisfied. For obvious reasons, the Institute cannot undertake development work for an inventor unless the idea shows considerable promise and is closely allied to some part of the Institute's programme. The most satisfactory way of illustrating how this policy is put into practice is to choose a number of examples from the work at present in hand.

AGRICULTURAL ENGINEERING INVESTIGATIONS.



FIG. 2. SINGLE-WHEEL TESTER.

EXAMPLES OF WORK IN HAND.

The work with haymaking machinery is a typical example of N.I.A.E. investigations and was included in the programme because it is one of the main divisions of grass conservation, and one which is most wasteful. The losses are primarily due to unfavourable weather, and haymaking machines, and methods of using them, aim at reducing the chances of loss in a bad season. Before the experiment could start it was necessary to consider ways and means of making measurements; for instance, to enable the moisture estimations to be taken on the spot, a modified Brown Duvel method was evolved, and a semi-automatic chopper was designed and built to process the material before estimating.

An early part of the work was an investigation into dry-matter loss during the "making" process in the field. Experiments showed that this loss may vary from over 20 per cent. in an immature crop cut in May, to over 4 per cent. in a fibrous crop cut in July. A loss of 10 per cent. is quite general over the first 50 hours of drying, and about 5 per cent. is lost in the first 24 hours. These losses occur with gentle hand treatment, and the harmful effects of faulty methods or harsh treatment by machinery would give greater losses. Another part of the investigation was an attempt to correlate loss of moisture from the swath with climatic conditions, so that the results obtained from the main investigation could be interpreted for a range of seasons and for different parts of Britain. Unfortunately, no precise agreement has yet been found, one reason being the difficulty of obtaining a representative sample, and another, the variation in the rate of drying between the leaf and stem.

The possible effects of new types of equipment have to be taken into account, and the investigation covers a pick-up roller crusher of Canadian design, a flail type of cracker designed and built in Britain, and a swath aerator from New Zealand. Work with stem crushers and bruisers indicates that the design of machine has little influence on the results. When compared with uncrushed material, and material under various orthodox subsequent treatments, there is little difference in light crops. In heavier crops, there is no significance in loss of water at the end of the first day, but advantages occur later under some conditions.

Haymaking by means of pick-up balers is rapidly increasing in favour, and the field plot, with various treatments in the "making" stage, were baled at moisture contents ranging from 20 to 30 per cent., and bale densities from 10 lb. to 13 lb. per cubic foot. From some of the plots, hay was chopped to lengths of about 5 in. with a pick-up cutter-chopper and stored in small experimental Sisalkraft silos, at moisture contents ranging from 20 to 26 per cent. Temperatures were recorded, and the chopped hay stored for some months before examination for quality. This was only a pilot experiment with the object of finding one machine for collecting hay

dried in the field, and green material for silage. The investigation will have to continue for several seasons because, until more is known about the relationship between various mechanisms on the loss of dry matter, the rate of drying in the field and the subsequent feeding value, it is not possible to decide which machines are worthy of further attention, or whether new designs are advisable. At the present time, an extensive test of a hay-making machine can do little more than indicate the machine's durability. It is certainly difficult to see how new machines can be designed for a particular set of conditions without the basic information.

Another investigation, into American type down-the-row root thinners, commenced on a machine imported from the United States. The investigation into a scheme of test for this type of machine has now developed into an investigation into the spring mechanisation of root crops. The work began on the beet crop and has included close measurements on a number of small plots, linking up performance, measured as the saving in singling time, with such factors as rubbed or natural seed, high or low seed rates. Other measurements include the plant population at varying stages, and the final yield.

Preliminary results indicate the possibility of an appreciable saving of labour without an associated loss of plant population, or regularity in the rows, but considerable skill and field experience with a fair range of adjustments on the machine seem to be essential. Because of the importance of the matter and the fact that manufacture may be arranged in this country, it is hoped that a member of the staff who has worked on this scheme will visit the United States, where these machines have made a phenomenal rise in popularity. The investigation will be extended to other crops, and already it has been tried on a small scale on turnips, parsnips, kale and lettuce. An experimental down-the-row-thinner is being built in the N.I.A.E. workshop, so that the Scottish Testing Station can experiment on root crops grown on the ridge.

(To be continued.)

MINE-ROOF BAR CARRIER.—A recent invention of Mr. H. Hyde, manager of the Lodge Colliery in the Coal Board's East Midlands Division, greatly facilitates the placing in underground workings of roof-supporting bars and their supporting props. The device is essentially an elongated screw-jack, with a loose fitting U-shaped head. To use the device it is simply held vertically with its serrated base resting on the floor, when the head is screwed upwards until the horns of the U-piece contact the roof. The roof supporting bar to be fitted is then passed between the roof and the base of the U-piece, against which it is temporarily wedged to a sliding fit, with the carrier supporting the bar approximately at its centre. Permanent props are then fixed in position at each end and the carrier withdrawn.

LAUNCHES AND TRIAL TRIPS.

H.M.S. "EDDYCLIFF."—Single-screw vessel for carrying oil in bulk, built by the Blythwood Shipbuilding Co., Ltd., Scotstoun, Glasgow, for the Naval Stores Department, Admiralty, London, S.W.1. Main dimensions: 270 ft. between perpendiculars by 44 ft. by 18 ft. 6 in.; deadweight capacity, 2,000 tons on a draught of about 17 ft. 2 in. Triple-expansion steam engine, developing 1,750 i.h.p. at 227 r.p.m., constructed by Lobnitz and Co., Ltd., Renfrew. Service speed, 12 knots. Trial trip, February 10.

M.S. "BRITISH FLAG."—Single-screw oil tanker, built and engined by R. and W. Hawthorn, Leslie & Co., Ltd., Hebburn-on-Tyne, County Durham, for the British Tanker Co., Ltd., London, E.C.2. Main dimensions: 547 ft. overall by 69 ft. 6 in. by 37 ft. 6 in. to upper deck; deadweight capacity, about 16,200 tons. Hawthorn-Doxford six-cylinder combined-stroke opposed-piston oil engine, developing 6,400 b.h.p. at 115 r.p.m. Launch, February 12.

S.S. "BINNA."—Single-screw cargo vessel, built and engined by Hall, Russell & Co., Ltd., Aberdeen, for Fred. Olsen & Co., Oslo, Norway. Built with strengthening against ice, for use as a timber carrier in the Baltic. Main dimensions: 265 ft. between perpendiculars by 44 ft. by 19 ft. 3 in. to main deck; deadweight capacity, 2,500 tons on a summer draught of 16 ft. 10 in. Hall Russell-Fredriksstad double-compound four-cylinder steam motor and two oil-fired cylindrical boilers. Trial trip, February 14.

M.S. "ALVA STAR."—Single-screw oil tanker, built by Sir James Laing & Sons, Ltd., Sunderland, for the Alva Steamship Co., Ltd. (Managers: Navigation and Coal Trade Co., Ltd.), London, E.C.3. Main dimensions: 512 ft. between perpendiculars by 72 ft. 6 in. by 41 ft. 2 in.; deadweight capacity, 18,000 tons on a draught of 30 ft. 6 in. Six-cylinder opposed-piston oil engine, constructed by William Doxford & Sons, Ltd., Sunderland. Speed, 15 knots. Launch, February 16.

M.S. "NORDELITE."—Single-screw trawler, built by the Goole Shipbuilding and Repairing Co., Ltd., Goole, for the St. Andrew's Steam Fishing Co., Ltd., Hull. Main dimensions: 105 ft. by 23 ft. 6 in. by 11 ft. 6 in. Diesel engine of 450 b.h.p. at 310 r.p.m., supplied by Crossley Brothers, Ltd., Openshaw, Manchester. Launch, February 16.

M.S. "HAYLING."—Single-screw collier, built by S. P. Austin & Son, Ltd., Sunderland, for Stephenson Clarke, Ltd., London, E.C.3. Second vessel of two. Main dimensions: 249 ft. by 38 ft. 9 in. by 18 ft. 4½ in.; deadweight capacity, about 2,400 tons on a mean summer draught of 17 ft. Clark-Sulzer eight-cylinder vertical two-stroke single-acting trunk-piston oil engine, developing 1,150 b.h.p. at 225 r.p.m., constructed by George Clark (1938), Ltd., Sunderland. Trial speed, 11½ knots. Trial trip, February 18.

M.S. "NICOLAS."—Single-screw oil tanker, built by the Blythwood Shipbuilding Co., Ltd., Scotstoun, Glasgow, for the Parana Compania de Vapores, S.A., Panama City (Managers: Lyras Brothers, Ltd., London, E.C.3). Main dimensions: 530 ft. between perpendiculars by 72 ft. 9 in. by 38 ft. 8 in.; deadweight capacity, about 18,500 tons. Harland and Wolff-B. and W. six-cylinder two-stroke opposed-piston Diesel engine, developing 7,500 b.h.p., supplied by John G. Kincaid & Co., Ltd., Greenock. Launch, February 18.

M.S. "BEAVERBANK."—Single-screw cargo vessel, built and engined by Harland and Wolff, Ltd., Belfast, for the Andrew Weir Shipping and Trading Co., Ltd., London, E.C.3. First vessel of a series of six. Main dimensions: 425 ft. between perpendiculars by 59 ft. by 38 ft. 3 in. to shelter deck; gross tonnage, 5,800. Harland-B. and W. six-cylinder single-acting two-stroke crosshead Diesel engine. Trial trip, February 25.

M.S. "DIPLOMAT."—Single-screw cargo vessel, built and engined by William Doxford and Sons, Ltd., Sunderland, for the Charente Steam Ship Co., Ltd. (Managers: Thos. and Jas. Harrison, Ltd.), Liverpool. Main dimensions: 460 ft. overall by 59 ft. 6 in. by 37 ft. 8 in.; deadweight capacity, 9,770 tons on a draught of about 26 ft. 6 in. Doxford four-cylinder opposed-piston oil engine, developing 3,300 b.h.p. at 108 r.p.m. Service speed, about 14 knots. Trial trip, March 9.

S.S. "NORTHERN CROWN."—Single-screw trawler, built by Cochrane and Sons, Ltd., Selby, Yorkshire, for Northern Trawlers, Ltd., Grimsby. Main dimensions: 180 ft. between perpendiculars by 32 ft. by 16 ft. 6 in.; gross tonnage, 750. Triple-expansion engine, developing 1,150 i.h.p., and one coal-burning boiler, constructed by Amos and Smith, Ltd., Hull. Launch, March 17.

M.S. "KING ARTHUR."—Single-screw cargo vessel, built and engined by Harland and Wolff, Ltd., Belfast, for the King Line, Ltd., London, E.C.3. Last vessel of an order for three. Main dimensions: 466 ft. 5 in. overall by 59 ft. by 39 ft. 9 in. to shelter deck; gross tonnage, 5,883. Harland-B. and W. six-cylinder single-acting four-stroke Diesel engine. Trial trip, March 19.

NOTES ON NEW BOOKS.

Mining Machinery.

By THOMAS BRYSON, A.R.T.C., M.I.M.S. Third edition. Sir Isaac Pitman and Sons, Limited, Pitman House, Parker-street, Kingsway, London, W.C.2. [Price 35s. net.]

WRITTEN primarily as an elementary text-book for candidates for the Colliery Undermanager's Certificate of Competency, this book has served a very useful purpose during recent years, when so many changes have been taking place in the mining industry and when few up-to-date books on mining technique have been published. The subject-matter covers the generation, transmission and utilisation of power at collieries, and this third edition has been enlarged by the introduction of chapters on coal-face machinery and mechanical stowing, while the original brief reference to locomotive transport has been considerably amplified. In a new edition, it might have been expected that the author would pay a little more attention to the relative importance of modern tendencies; for example, the increasing use of large-capacity mine cars warrants considerably more space than a single page in relation to the four-page description of the Logan slab cutter-loader. At the end of each chapter there is a list of reference books and technical papers relating to the subject under consideration, and a number of exercise questions taken from former examinations set by the Ministry of Fuel and Power. While the majority of the questions are of a descriptive nature, the value of the many numerical problems would have been increased considerably if answers had been appended to these questions to enable the students to verify the accuracy of their calculations. However, such criticism is only of minor importance, and this 500-page text-book, amply and clearly illustrated, will continue to serve a useful purpose by giving a good introduction to the subject of mining machinery.

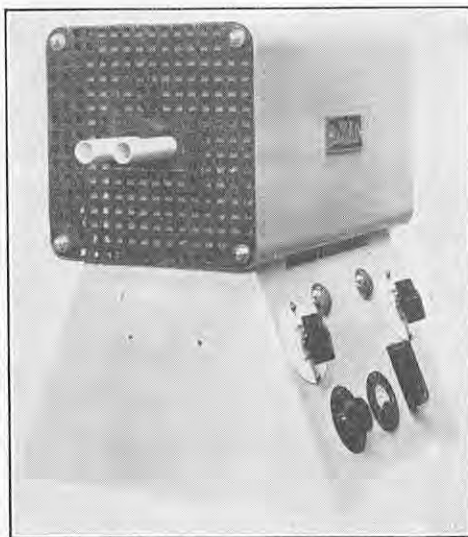
Fuels and Combustion.

By PROFESSOR MARION L. SMITH and PROFESSOR KARL W. STINSON. McGraw-Hill Book Company, Incorporated, 330, West 42nd-street, New York 36, U.S.A. [Price 6.50 dols.]; and McGraw-Hill Publishing Company, Limited, 95, Farringdon-street, London, E.C.4. [Price 55s. 6d.]

ALTHOUGH most text-books on boilers and heat engines include a chapter or two on combustion, it may be convenient to many students to have a fairly comprehensive review of the whole subject in a separate volume. The aim of the present authors, who are in the Mechanical Engineering Faculty of the Ohio State University, has been to co-ordinate the important facts concerning solid, liquid and gaseous fuels, and to present the modern theories of combustion reactions in a manner suited to engineering students who have no very extensive knowledge of chemistry. An introductory chapter describing briefly the various natural, derived, and synthetic fuels available for industry is followed by an explanation of the ordinary chemical and physical facts pertaining to combustion. The reader is thus prepared for one of the longest and most interesting chapters, which deals with the process of combustion, and summarises modern knowledge regarding the mechanism of the molecular reactions involved. The physical characteristics of fuels, and the various tests by which these are determined are next considered, leading on to chapters on the equipment used for burning gas, oil and coal. The last chapter of the book deals with combustion in internal-combustion engines and ends with a few pages on gas turbines and rockets. Though the book is mainly of a theoretical character, the authors have employed for all calculations the units most familiar to British and American engineers, the metric system being completely ignored, even for temperatures. Numerous questions (without answers) are appended to each chapter for the student to test his knowledge, and a list of references to appropriate sources of further information which the authors give should prove useful as a guide to more detailed and specialised works.

HIGH-TEMPERATURE
TUBE FURNACE FOR
LABORATORIES.

To meet the demand for tube muffles which are capable of operating up to temperatures of 1,400 deg. C., for carbon and sulphur determinations of high-alloy steels, Wild-Barfield Electric Furnaces, Limited, Watford By-Pass, Watford, Hertfordshire, have produced a new design of furnace, which is shown in the accompanying illustration. As will be seen, the furnace, which is rated at 1.75 kW, is arranged for bench operation and is self-contained with built-in temperature-control equipment and pilot lights. It is designed to take two standard combustion tubes with an outside diameter of 1½ in. The heating chamber is 4 in. square and 6 in. long and is provided with insulated vestibules at each end to ensure the greatest practicable uniformity of



temperature. In fact, uniformity within ± 10 deg. at 1,390 deg. C. can be obtained over a length of 4 in., which is ample for normal carbon and sulphur determinations. There is also a ventilated compartment at each end in which the connections to the heating elements are housed. The elements themselves are silicon-carbide rods, the life of which is increased by using the firm's system of control. In addition, a tapped transformer is fitted in the base, together with a tap-changing switch, ageing control switch and pilot lights, all of which are accessible on one face of the plinth.

BEWDLEY BRIDGE TOLL-HOUSE.—The appeal which the Bewdley Civic Society are making for funds to repair the toll-house at Bewdley Bridge over the Severn, in Worcestershire, is making progress, but a considerable sum is still needed to complete the required 1,500l. The toll-house was designed by Thomas Telford, the first President of the Institution of Civil Engineers, when he designed the bridge about 1800 and has not been used for the collection of tolls since 1834. It had been condemned as a dangerous structure because of serious cracks in the walls, partly the result of vibration from heavy road traffic and partly caused by erosion of the river banks by floods. Local efforts have raised about 600l., the Inland Waterways Association have subscribed 100l., the Royal Society of Arts 60l., and the Worcestershire County Council are prepared to give 300l. if the Society undertake the repair and maintenance of the toll house. Contributions may be sent to Mr. C. L. Mackaness, The Hawthorn Bush, Bewdley, or to the Midland Bank, Bewdley. Cheques should be crossed "Toll-house Fund."

FLASH LAMP FOR SURGICAL WORK.—The British Thomson-Houston Co., Ltd., Aldwych, London, W.C.2, have recently introduced a xenon-filled flash lamp which gives a light of great brilliance for very short periods and enables colour photographs of the retina of the eye to be obtained. The lamp consists of a cylinder of hard glass into each end of which an electrode is sealed, so as to form an air gap of a few millimetres. At a pressure of about one atmosphere, and when operating at 150 watts, the light source is 4 mm. to 5 mm. long by 2.5 mm. wide, and has a maximum brightness of 6,000 candlepower per square inch.

BOOKS RECEIVED.

Ministry of Transport. Railway Accidents. Report on the Collision which Occurred on 16th August, 1952, at Eterby Junction in the London Midland Region, British Railways. H.M. Stationery Office, Kingsway, London, W.C.2. [Price 2s. net.]

Basic Rates of Capital Allowances (Annual) for Plant Machinery and Other Assets in Common Use in the Engineering Industry. Engineering Industries Association, 9, Seymour-street, London, W.1. [Price 3s. 6d.]

Ajustements. By PIERRE AUSSANT. Gauthier-Villars, 55, Quai des Grands-Augustins, Paris (6e). [Price 325 francs.]

Détermination Rapide des Ressorts. By PIERRE AUSSANT. Gauthier-Villars, Quai des Grands-Augustins, Paris (6e). [Price 450 francs.]

Spectrographic Analysis of Low-Alloy Steels. A Report of the British Iron and Steel Research Association. The Iron and Steel Institute, 4, Grosvenor-gardens, London, S.W.1. [Price 7s. 6d. to members of the Institute, 15s. to non-members.]

Physical Similarity and Dimensional Analysis. By PROFESSOR W. J. DUNCAN. Edward Arnold and Company, 41, Maddox-street, London, W.1. [Price 30s. net.]

The Road and the Vehicle. By B. G. MANTON. Edward Arnold and Company, 41, Maddox-street, London, W.1. [Price 30s. net.]

Stahlbau-Tagung München, 1952. Abhandlungen aus dem Stahlbau, No. 12. Walter Dorn G.m.b.H., Bremen-Horn, Germany. [Price 9 D.M.]

CONTRACTS.

During January, contracts were placed by the British Electricity Authority for equipment for power stations, transforming stations and transmission lines, amounting in the aggregate to 7,418,676l. The principal contracts placed were: for Marchwood power station, near Southampton, four 550,000 lb. per hour boilers, with JOHN THOMPSON WATER TUBE BOILERS, LTD., and 3,300-volt switchgear and accessories, with the ENGLISH ELECTRIC CO. LTD.; for Goldington power station, Bedford, coal-handling plant, with INTERNATIONAL COMBUSTION LTD.; for Tilbury power station, high-pressure piping equipment, with JOHN THOMPSON WATER TUBE BOILERS LTD.; for Meaford power station, Stone, Staffordshire, a 60,000-kW turbo-generator, with the BRITISH THOMSON-HOUSTON CO. LTD., condensing and feed-heating plant for a 60,000-kW turbo-generator, with HICK, HARGREAVES & CO. LTD., 3,300-volt and 415-volt switchgear and accessories, with A. REYROLLE & CO. LTD., and 2,500-MVA and 132-kV switchgear, with the GENERAL ELECTRIC CO. LTD.; for Uskmouth power station, Newport, main and auxiliary cables and connections, with the PIRELLI-GENERAL CABLE WORKS LTD.; for Bold power station, St. Helens, two 30,000-kW turbo-generator sets with the METROPOLITAN-VICKERS ELECTRICAL CO. LTD.; for Ince power station, near Ellesmere Port, high-pressure pipework and valves, with BABCOCK AND WILCOX LTD.; for Keadby power station, Scunthorpe, 3,300-volt switchgear, with the ENGLISH ELECTRIC CO. LTD.; for Stella North power station, near Newcastle-upon-Tyne, an ash-handling transporter, with STRACHEN AND HENSHAW LTD.; for Stella South power station, 3,300- and 415-volt switchgear and accessories, with A. REYROLLE & CO. LTD., and an ash-handling transporter, with STRACHEN AND HENSHAW LTD.; for Chadderton power station, Oldham, coal-handling plant superstructure, with FRED. MITCHELL & SON, LTD.; for Humcoast power station, Accrington, structural steelwork, with SIMON-CARVES, LTD.; and for Clyde's Mill power station, Glasgow, condensing, feed-heating, evaporating plant, with the MIRRELES WATSON CO. LTD.

Sterling Metals, Ltd., Coventry, have placed an order, through the VAUGHAN CRANE CO., LTD., Manchester, for one of the radio-control systems developed by HEENAN AND FROUDE, LTD., Worcester, for the remote control of overhead cranes. The equipment will be used in a magnesium foundry at Nuneaton for the emergency and remote control of a furnace crane in the event of the failure of a ladle.

DORMAN, LONG & CO., LTD., Britannia Works, Middlesbrough, are to reconstruct portions of the superstructures of bridges carrying suburban railway lines over Warburton-road, and over Exmouth-place, between Cambridge Heath and London Fields, on the Eastern Region of British Railways.

THE NATIONAL GAS AND OIL ENGINE CO. LTD., Ashton-under-Lyne, have completed the shipment of a Diesel-alternator unit to be installed at Stanger, on the North Coast (Zululand) Railway, five miles from Durban. The equipment comprised one of the firm's R4AU6-type, six-cylinder, pressure-charged Diesel engines, developing 450 continuous b.h.p., at 600 r.p.m., coupled to a 400/440-volt three-phase 50-cycle alternator supplied by the BRUSH ELECTRICAL ENGINEERING CO. LTD.