

THE TROSTRE TIN-PLATE WORKS OF THE STEEL COMPANY OF WALES.

GENERAL descriptions of the Trostre tin-plate works of the Steel Company of Wales, near Llanelli, have been published already in *ENGINEERING*, on page 629 of volume 173 (1952), and on page 382, *ante*. We are now able to give more detailed information about the various installations, with special reference to the electrical equipment.

The electric power required for operating the works is obtained at 132 kV from the mains of the South Wales Area Board, being first stepped down to 33 kV and then to 11 kV, at which voltage a considerable proportion of the plant is supplied. Three 12.5-MVA and two 10-MVA Johnson and Phillips transformers are used for this purpose and are housed in semi-open bays, which form part of the substations. They are delta/star connected and are equipped with oil-immersed natural cooling, the necessary surface area for this purpose being provided by separate banks of

the works itself is housed in separate control and motor rooms or in cellars. The cables forming the 415-volt and the 240-volt systems were manufactured by Johnson and Phillips, Limited, Charlton, London, S.E.7, and are aluminium-sheathed. In one of the 60-ft. bays and in five of the 120-ft. bays in the factory, the lighting fittings are mounted at a height of 45 ft. and contain one tungsten and two mercury-vapour lamps to give good colour blending. These fittings, of which 314 are in use, were designed by the British Thomson-Houston Company, Limited, Aldwych, London, W.C.2.

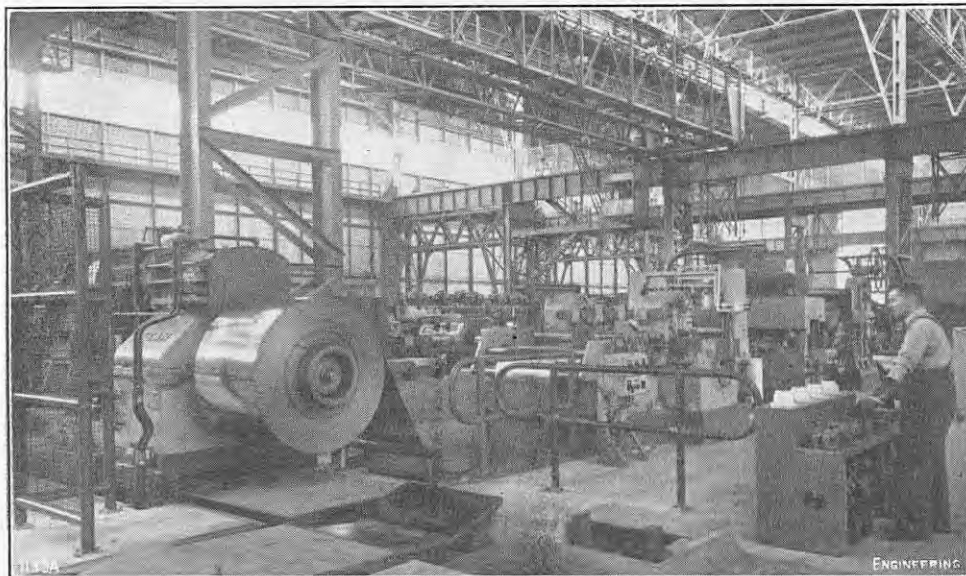


FIG. 1. ENTRY END OF COIL PREPARATORY LINE.

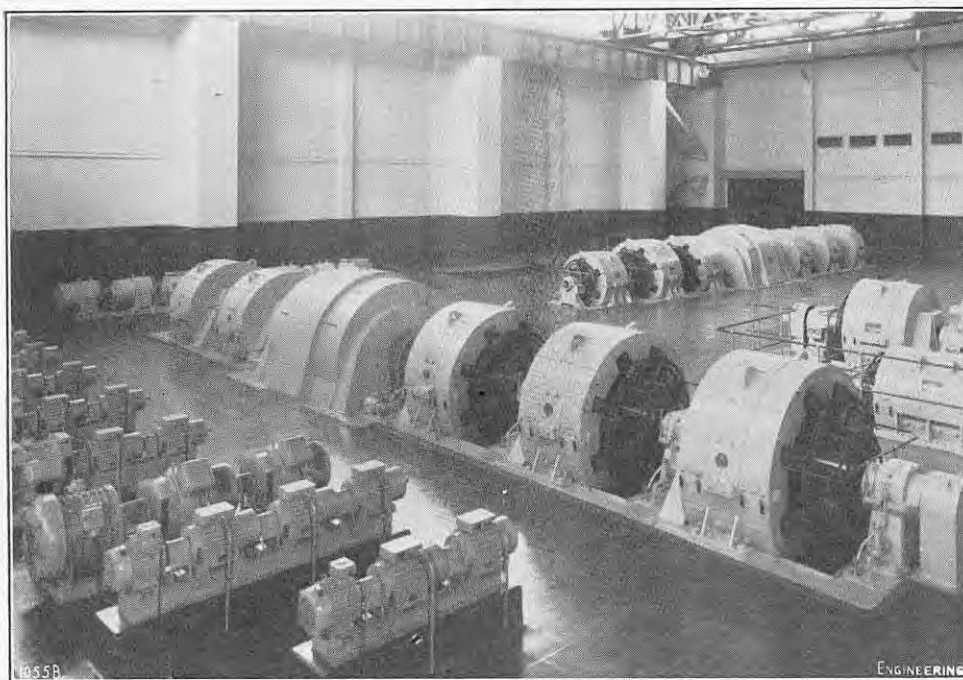


FIG. 2. MOTOR-GENERATORS AND AUXILIARIES FOR REDUCTION MILL.

The raw material used at Trostre consists of hot-rolled steel coils of various qualities, which are brought by rail from the Abbey Works at Port Talbot. These are first treated in a continuous pickling line and are then drawn through a five-stand cold-reduction mill where the strip is reduced to the required gauge. After re-coiling, all traces of oil are removed and the coils are then passed through annealing furnaces. The annealed strip is next cold-rolled to the required temper in one of two mills from which it is taken either to hot dip or to electrolytic tinning plant. Finally, the strip is coated with an emulsion of cotton-seed oil to provide the necessary lubrication during fabrication and is sheared into plates of the required width.

cooling tubes. The main 11-kV boards are connected through cast-in-concrete reactors, so that a supply will be available in case of emergency. The high-tension cables employed for connection purposes were manufactured by British Insulated Callender's Cables, Limited, Norfolk-street, London, W.C.2, and the switchgear by A. Reyrolle and Company, Limited, Hebburn, Co. Durham.

Some of the motors, however, are operated at 3.3 kV, and a number of the smaller power units and the lighting are fed through 11,000/415-volt Bryce transformers, the controlling switchboards being interconnected in groups of four through contactors, two transformers feeding each group. Generally speaking, the electrical equipment in

PICKLING LINE.

The pickling line, which handles strip up to 38 in. wide and 0.093 in. thick at a maximum speed of 650 ft. per minute, is in three sections. In the first or preparatory section, which is illustrated in Fig. 1, herewith, and Fig. 4, on page 650, the strip passes in turn through an uncoiler, processor, up-cut shear, stitcher and stitcher pinch rolls. As the pickling operation is continuous, the trailing end of one coil is attached to the leading end of the following coil, either by stitching or welding. The machine employed for the latter purpose is illustrated in Fig. 3, page 650. The second section comprises entry pinch rolls, acid and water tanks, drier table and follower pinch rolls, while the last section consists of an up-cut shear, side trimmer and coiler, from which the coils pass into a storage area. All this plant was supplied by the United Engineering Company, Limited, 2, Mansfield-street, London, W.1. Power for operating this portion of the plant is obtained from a six-machine motor-generator. This consists of a 1,250-h.p. 11-kV synchronous motor running at 1,000 r.p.m., which is coupled to three direct-current generators with outputs of 350/455 kW, 125/162 kW and 175/255 kW, respectively, at 300 volts. There are also two exciters on the same shaft one with an output of 20 kW for the motors on the pickling line and the other for the main synchronous motor. The set as a whole is self-ventilated and is arranged for reactor starting, while the generators are controlled on the Ward-Leonard system, which is operated from desks and cabinets placed in convenient positions along the line, as shown in Fig. 5, on page 651. The motor-generator and its control equipment is housed in a forced-ventilated room. Generally speaking, the motors driving the machines in the pickling line are totally-enclosed and fan-cooled. An internal fan circulates the warm air within the machine through one set of ducts, while cool air is forced through other ducts and over the surface of a diaphragm by an external fan. A dancer roll and regulator, which varies the shunt field of the pinch-roll motor, are provided immediately after the entry section at a point where the strip passes into a loop, so that its height in the pickling tank is controlled, while the tension between the mandrel and the processor is adjustable by cascade exciter control. The electrical equipment in this section of the mill was manufactured by the General Electric Company, Limited, Magnet House, Kingsway, London, W.C.2.

COLD-REDUCTION MILL.

The 30,000-lb. coils from the storage area at the end of the pickling line pass to a five-stand cold-reduction mill. The work rolls on this mill are 21 in. in diameter by 48 in. long and the back-up rolls 53 in. in diameter and 47 in. long; the mill has been designed to run at a maximum speed of 4,500 ft. per minute. Power is supplied from two motor-generator sets, one of which is illustrated in Fig. 2. These sets consist of a 11,580-h.p., 11-kV three-phase synchronous motor, which is supplied from a 10-MVA 33/11-kV transformer. One of these motors is coupled to five 1,600-kW, 1,600-volt direct-current generators and one 720-kW generator; these generators are, in turn, connected to the armatures of the motors driving the stands or the

reels. The first stand is operated by a 1,750-h.p. motor running at 90/230 r.p.m., to give a mill speed of 495/1,260 ft. per minute, while the second and third are each driven by two motors of the same output, one pair running at 125/273 r.p.m., to give a mill speed of 688/1,500 ft. per minute, and the other at 200/400 r.p.m., the mill speed being 1,100/2,200 ft. per minute. The last generator in this group supplies the two motors driving the reel, the combined capacity of which is 900 h.p. at 210/990 r.p.m. The motor of the second set drives the direct-current generators from which the two motors on the fourth and the three motors on the fifth stands are supplied, the respective outputs of the latter being 4,000 h.p. at 350/562 r.p.m. and 5,500 h.p. at 500/818 r.p.m. All these machines, as well as the extensive control equipment described below, were manufactured by the British Thomson-Houston Company, Limited, Rugby.

As will be seen from these figures, the relative speeds of the stand motors are adjustable over a considerable range, thus enabling a variety of rolling schedules to be dealt with. This relationship must be maintained under widely varying conditions of mill speed and load. At the same time, the strip between the stands must be subject to reasonable tension; and acceleration and retardation must be as rapid as possible to prevent the strip running "off gauge" at low speeds. To fulfil these requirements, motors with two or three armatures have been used, as this has enabled the accelerating currents and the differences in inertia between the stands to be kept as low as practicable. The stand motors have drum-type armature spiders, the inertia of which is also low and the ratio of core length to diameter has been made greater than usual. The keys of the armature of the reel motor, the diameter of which is relatively small, have been welded directly to the shaft. Speed control of the mill as a whole is effected by varying the armature voltage, and the relative speeds of the stands are adjusted by a combination of armature and field control. All the motors are of the compensated compound-wound type with commutating poles and off-set pole-face windings to give extra stability. They are capable of running on $1\frac{1}{2}$ times full load for two hours and of withstanding frequent working peaks of twice full load with a cut-out peak of 2.4 times full load. Speed indication is provided by overhung tacho-generators, which are mounted on the pedestals at the non-driving ends and also supply the overspeed protection relays. Each stand motor drives the bottom work roll directly and the top work roll through a pinion stand; the reel mandrel is driven directly.

The synchronous motors are self-cooled and the generators and mill motors are ventilated by tubular air coolers, which were manufactured by Heenan and Froude, Limited, Worcester, and operate on the closed-circuit system. Cool air is drawn in by Matthews and Yates fans over each armature from a plenum in the basement and enters the machines at the driving end. It leaves at the commutator end and discharges into common ducting, whence it is returned to the coolers. All the commutators are open, so as to facilitate access to the brush gear and to prevent the dust from them from fouling the circulating air. The small quantity of air lost in this way is replaced by a separate make-up fan and is drawn in through Matthews and Yates filters. The other electrical machines are provided with separate motor-driven fans.

CONTROL ARRANGEMENTS.

Reactor starting is normally used on the main motor-generator sets, but in emergency direct on-line starting can be employed, a special design of squirrel-cage starting winding being incorporated in the motors for that purpose. The armatures of the multi-armature motors are connected in series to ensure load sharing, the connections being

TROSTRE TIN-PLATE WORKS.

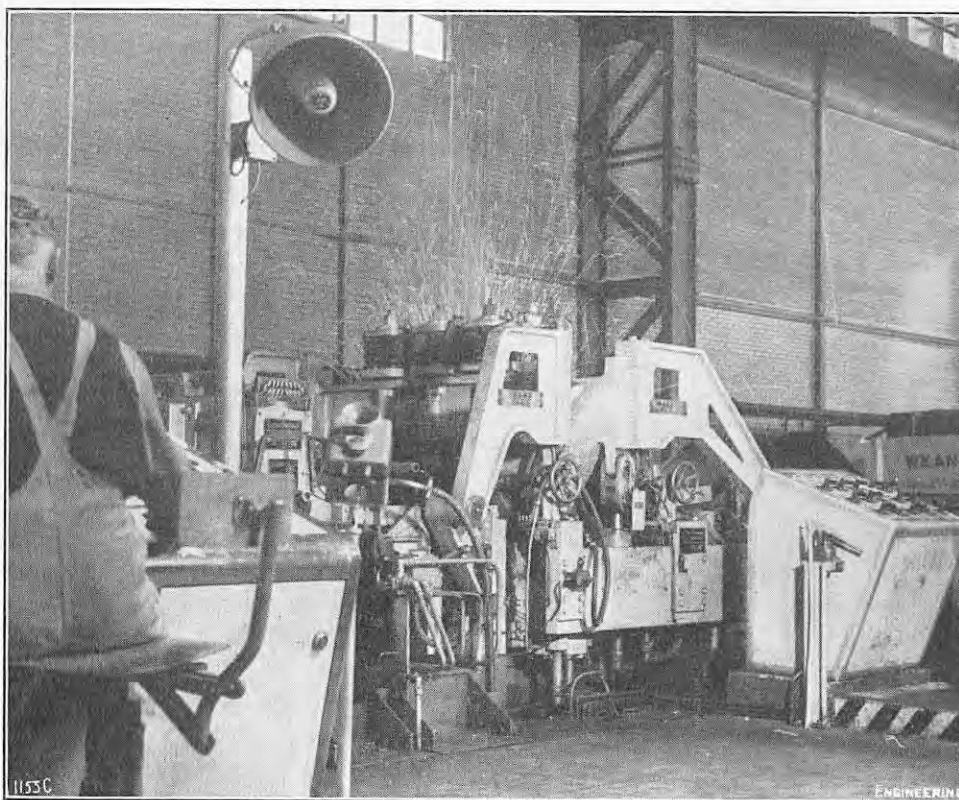


FIG. 3. WELDER ON PICKLING LINE.

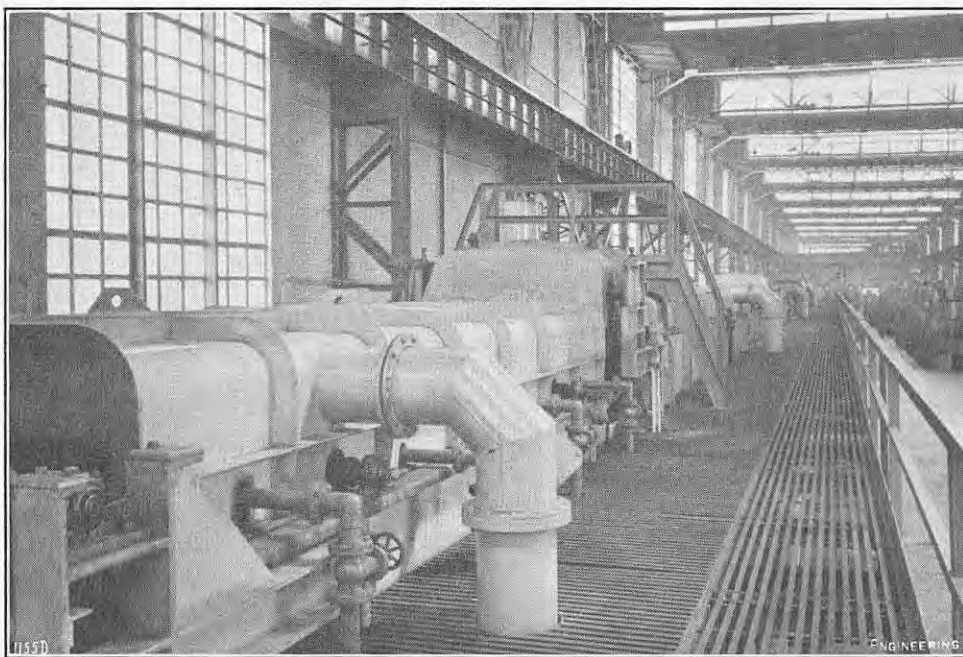


FIG. 4. CONTINUOUS PICKLING LINE.

arranged so that the voltage across any part of the circuit does not exceed that required by one armature, even under fault conditions. The speed of the mill as a whole is raised by increasing the voltage of all the generators in unison, an operation which is effected by exciting the fields from the same generator exciter. A "mill reference" voltage is then set up by a master pilot exciter, the fields of both main and master pilot exciters, and hence their voltages, being controlled by a master rheostat. The master pilot exciter also supplies "stand reference" voltages to the individual motors, and these too vary with the master pilot exciter voltage. The voltages of the generators supplying the individual stand motors are controlled by an Amplidyne regulating exciter, which is connected in series with their fields. The "stand reference" voltage and generator voltage are

compared through a field winding on this regulating exciter, any difference between them being corrected.

The voltage of the master pilot exciter, and hence the speed of the mill, depends on the position of the master rheostat arm. This arm is driven by a motor, which is supplied from a second Amplidyne, the voltage of which is limited to a pre-set value, so as to ensure constant acceleration and retardation. The voltage of any individual generator can be varied by modifying the reference voltage, this operation being effected by adjusting a dial on the stand speed rheostat, a second dial being used to vary the field current of the corresponding stand motor. These rheostats, which are motor-driven, give coarse speed control, while fine control is obtained by operating small manual rheostats, which are connected in series with the field of a motor-driven exciter. On the last stand, however,

TROSTRE TIN-PLATE WORKS.

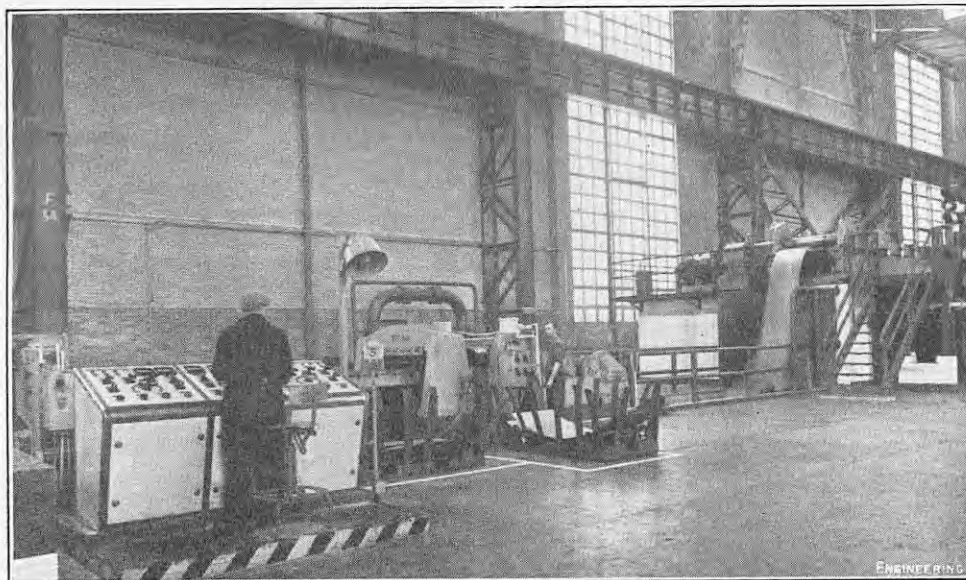


FIG. 5. CONTROL DESK ON PICKLING LINE.

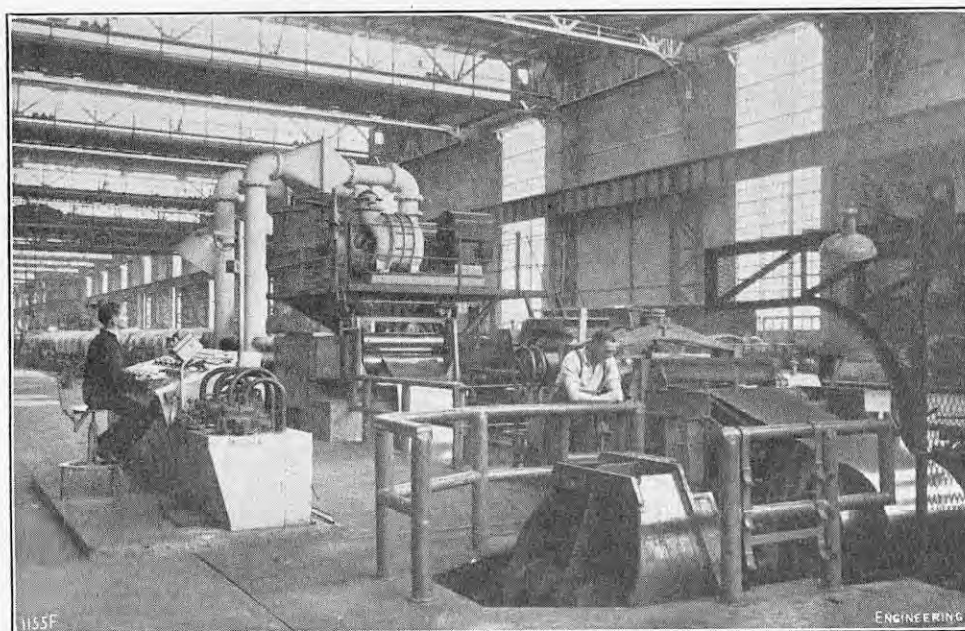


FIG. 6. DELIVERY END OF CLEANING LINE.

only a single rheostat with a large number of steps is provided and this is operated by a servo-Selsyn system.

In order to maintain the stand speed relationship when the load current varies, an Amplidyne, the armature voltage of which is proportional to that current, is provided for the purpose of increasing the stand reference voltage and thus the stand generator voltage. To reduce the quantity of "off-gauge" strip produced at threading speeds, and during acceleration and retardation, the voltages of the generators on the last two stands are progressively increased and those of the generators on the first two stands reduced as the speed of the mill approaches zero. The extra stand voltage is produced in the correct direction by a field winding on the Amplidyne mentioned in the preceding paragraph.

Arrangements are also provided whereby a definite tension is maintained on the strip as it passes from the last stand of the mill into the reel, so as to produce a satisfactory "build up" of the coil from a diameter of 20 in. to one of about 72 in. and also to help maintain the gauge constant. To do this, a voltage proportional to the delivery speed of the last stand is applied to a regulating system on

the reel generator, so that the voltage of the latter corresponds to the reel reference voltage. The fields of the reel motor are supplied from a constant voltage source through a regulating Amplidyne, one field of which is connected in a comparison circuit. The reference value of the current that is to be controlled is set by a rheostat, which is supplied from the constant-voltage source, while the actual current is determined by the voltage across a resistance in series with the armatures on the motors driving the reels. This voltage is amplified by another Amplidyne, and when the output voltage of the latter is greater than the reference voltage a current is generated in the comparison circuit and excites the field of the regulating Amplidyne. This current also strengthens the fields of the motors driving the reel, so that the speed of the latter is decreased to that necessary to provide the set current.

Other devices on this part of the mill enable the operators to control the speed of the motor driving the reel so that the first few turns of the strip can be correctly wrapped on to the mandrel and so that a light tension is maintained upon it when the reel is at rest. Each regulating system is stabilised to prevent hunting, and to give good transient

response, by including a transformer feed-back from appropriate parts of the circuits to the Amplidyne fields.

COIL CLEANING AND ANNEALING.

After leaving the cold rolling mill the strip is passed through one of two electrolytic cleaning lines where all traces of oil are removed prior to annealing. Each of these lines has been designed to handle coils up to 38 in. wide and 72 in. in diameter and weighing 30,000 lb. The coils are first mounted on the mandrel of a pay-off reel, from which strip is drawn through a caustic dip washer tank, 22-ft. long, where most of the oil is removed, and then through a scrubber. Next it enters the main electrolytic tank, in which the remainder of the oil is removed, a second scrubber, a hot-water rinse tank, wringer rolls and hot-air driers. At the exit, there is a looping pit in which the strips are sheared and wound into coils 54 in. in diameter weighing an average of 15,000 lb. These coils are then ready for annealing.

The electrical equipment for driving this part of the mill was manufactured by the Metropolitan-Vickers Electrical Company, Limited, Manchester, 17, and consists first of a 40-kW drag generator, which is coupled to a pay-off reel. The deflector, submerger, wringer and scrubber rolls which follow are each operated by a 5-h.p. direct-current motor, while the master pinch rolls are driven by a 125-h.p. motor of the same type. At the delivery end, illustrated in Fig. 6, herewith, the tension rolls are coupled to a 100-kW drag generator and the coiling reel is driven by two 75-h.p. direct-current motors in tandem. All these motors and drag generators are supplied from a 250-kW direct-current generator, the voltage of which can be adjusted to give any line speed up to the maximum of 2,000 ft. per minute. Automatic speed regulation of the individual units is effected by booster generators, which are connected in series with the motors, the correct tension being maintained by Metadyne regulators. Photo-electric apparatus, which operates in conjunction with electronic and magnetic amplifiers, holds the loop at a constant depth in the looping pit between the different sections of the plant.

ANNEALING SECTION.

The annealing plant, to which the coils are next conveyed, consists of five portable-cover furnaces and twelve bases which were constructed by the Salem Engineering Company, Limited, Milford, near Derby. The interiors of these furnaces, one of which is shown in Fig. 7, on Plate LI, are 22 ft. long by 12 ft. 8 in. wide and they are directly fired by 30 atomised-oil burners. The bases, which are 24 ft. 6 in. long by 17 ft. 6 in. wide, are designed to accommodate eight stacks of four coils, with a maximum diameter of 54 in. and a total weight of 214 tons. The coils are loaded to a height of 132 in.; they are separated from each other by ribbed convector plates and the stack is covered by a stainless-steel cylinder. Below each stack is a fan by which inert gas is circulated. The temperature in each inner cover and in the cover furnace is controlled by thermocouples; the pressure is also automatically controlled.

TEMPER MILLS.

After it has been annealed, the strip is cold-rolled in two two-stand temper mills, the work rolls of each of which are 18 in. in diameter and 48 in. wide, the back-up rolls being 53 in. in diameter and 47 in. long. One of these mills is illustrated in Fig. 8, Plate LI. As at this stage the strip is soft, great care is necessary to prevent breakage, wrinkling or buckling. For this reason, two pairs of separately-driven tension rolls have been installed, the rolls in which are arranged so that the increase in tension depends upon the friction between them and the strip. The strip is fed into these rolls

from a pay-off reel and is then re-wound on to a second reel. After rolling and re-coiling such strip as is not passed to stock is taken to "cut out" or preparatory lines. In the first of these, that portion of the output which is to be hot-dipped is side-trimmed and cut to size, while that which is to be electrolytically tinned is also side-trimmed and re-coiled. Any lengths that are off-gauge are removed at this stage.

Each stand of the two temper mills is driven by a 1,000-h.p. motor, which, like the motors driving the tension rolls, is supplied from a 2,000-kW motor-generator. This machine is designed for reactor starting and is equipped with closed-circuit air cooling. The uncoiler and reeler motors are supplied from a second motor-generator, which consists of a 500-h.p. synchronous motor and two 250-kW generators, all three machines being of the self-ventilated protected type. Excitation is obtained from a third motor-generator, consisting of a 120-h.p. squirrel-cage motor driving four exciters. Two of these machines supply the 2,000-kW and 500-kW motor-generators, while the third provides constant-voltage excitation and the fourth the main control excitation. A booster set is also installed for the stand and tension-roll motors.

TEMPER MILL CONTROL.

The main control gear on this part of the plant is of the contactor type and is mounted on flat back boards housed in cabinets fixed on the mill stands. The equipment is designed so that the mills can be accelerated from rest to full speed in from 12 to 20 seconds and stopped from full speed in from 5 to 20 seconds. Generally speaking, speed control is effected by varying the voltage of the generators of the motor-generator sets, a cascade exciter being employed for this purpose. One of the field windings of this exciter is energised by a reference voltage, the value of which is determined by a motor-driven potentiometer. The rate of rise of the reference voltage, as shown by the speed of the potentiometer, provides an acceleration signal, which is used to maintain the speeds of the tension roll and the main-stand motors in the correct relationship. The desired speed is selected by pressing "thread" or "run" buttons, and a "hold" button is provided to maintain the mill speed at any intermediate value. As particularly accurate speed control is necessary, the cascade exciters operate in conjunction with electronic amplifiers.

As the strip passes from the uncoiler to the entry tension rolls and from the delivery tension rolls to the coiler its tension is maintained constant by varying the generator excitation, so that the armature current of the driving motor always has a pre-selected value. The excitation of the motor, and consequently its torque, are however, altered automatically in proportion to the diameter of the reel. While the speed is changing, constant tension on the strip is maintained by altering the motor torque, taking into account the rate of change in speed and the change in the inertia of the reels. The stalled tension can be maintained if the strip is in the mill when it stops. The whole of the electrical equipment in this part of the mill was manufactured by the General Electric Company, Limited, Magnet House, Kingsway, London, W.C.2. One of the contactor boards installed for control purposes is illustrated in Fig. 10, Plate LI.

ELECTROLYTIC TINNING.

Before entering the electrolytic-tinning plant, which is illustrated in Fig. 9, on Plate LI, the off-gauge lengths at the ends of the coils are cut off and the sides are trimmed. The leading edge of one coil is also welded to the trailing edge of that preceding it. The maximum speed of the two preparatory lines in this part of the plant is 1,800 ft. per minute and the machines are installed

between two looping pits. Each electrolytic-tinning unit consists of two Ferrostal acid lines, designed to handle 30,000 lb. coils and to deposit tin coatings of $\frac{1}{2}$ lb. per basis box at a speed of 800 ft. per minute. At the entry end continuous operation is rendered possible by the installation of two uncoilers and by the provision of a looping pit with a depth of 70 ft. The position of the loop in the pit is controlled by a photo-electric cell.

The strip first passes through a cleaning zone, where it is electrolytically de-greased, rinsed with cold water, electrolytically pickled with sulphuric acid, sprayed with water and brushed. It next passes through five plating tanks and a drag-out tank, where it is washed and the electrolyte recovered for further use. It then enters a "flow-melt" unit, where the tin is caused to flow on the surface of the sheet, thus improving the quality of the deposit and giving a bright appearance to its surface. Subsequently, the sheet is treated in an electrochemical chromic-acid bath to prevent discoloration when lacquering and during storage. Finally, it is wiped with a fine emulsion of cottonseed oil to assist fabrication. After leaving the line the strip is passed through pin-hole and "off-gauge" detectors and is sheared into plates of the required width. Classification by visual inspection follows and the plates are then automatically counted and spaced ready for packing and stocking.

PLATING EQUIPMENT.

The current for plating purposes is obtained at 16 volts from a rectifier installation, manufactured by the Electric Construction Company, Limited, Wolverhampton. This supplies a current of 6,000 amperes for alkali cleaning and one of the same value for pickling. A current of 60,000 amperes is required for plating, while the tin-recovery plant, which is common to both lines, takes 3,000 amperes. There are ten plating circuits in a line, each of which is supplied from a bank consisting of one transformer and six rectifiers. The positives of these rectifiers are connected to the plating anodes and their negatives to the rolls over which the strip is passed. The current in each of the ten circuits is adjusted to give the best conditions for plating by altering the input voltage to the transformer by means of an oil-immersed induction regulator, so that the output voltage varies between 16 volts and 1.6 volts. Four of these regulators, which are mechanically coupled and work in parallel, are provided for the plating supply. The aggregate output of the rectifiers is kept proportional to the speed of the strip by automatically controlling the motor driving the pinch rolls, so that the deposit of tin per square foot remains constant. The currents supplying the alkali-cleaning and pickling tanks are supplied from a transformer and six rectifiers, the output of the latter being controlled by varying the alternating-current input by means of an induction regulator. A separate transformer and three rectifiers, which are similarly controlled, supply the tin-recovery plant. The tops of the transformer and rectifier tanks are provided with copper coils through which cold water is continuously circulated. Any failure of this circulation, excessive oil temperature or overloads are indicated by alarm lamps, while if the overload exceeds a certain value the main circuit-breaker is tripped. The alternating-current supply to the transformers is controlled by contactors, which operate in conjunction with the main circuit-breaker, so that the complete plating supply is shut off if a fault occurs on any section of the plant. When the main circuit-breaker is re-closed, however, the contactor of the faulty section remains open until the reason for its operation has been discovered. Interlocks are provided to ensure the correct sequence of operation of the cleaning, pickling and plating sections. All the auxiliaries and contactors

are supplied with direct-current at 230 volts from a special rectifier.

CRANES.

To ensure the efficient transfer of the coils through the works, numerous cranes have been installed. Six of these, two of which are installed in the mill bay, two in the annealing bay and one in the roll shop, were constructed by Sir William Arrol and Company, Limited, Glasgow, and have a span of 112 ft. They are designed to lift 50 tons on the main hoist and 10 tons on the auxiliary hoist. The same company also supplied a 45-ton electrically propelled roll-transfer bogie, while other cranes were supplied by Joseph Booth and Brothers, Rodley, near Leeds. Electric trucks are used for handling the rolls and other items of equipment, the necessary batteries being charged at a central station.

Steam for processing purposes and high-pressure hot water for heating purposes is supplied at 150 lb. per square inch, by ten "Super Economic" boilers constructed by Danks of Netherton, Limited, Netherton. These boilers are fired by mechanical stokers and work in conjunction with a separately-fired superheater.

Acid for the pickling lines is stored in plant supplied by L. A. Mitchell, Limited, Manchester. The plant is designed to hold sulphuric acid of 98 per cent. concentration in four 12,000-gallon tanks. A fifth tank of the same capacity is used to store acid for the tinning lines. These tanks are filled from rail wagons and discharge by gravity into the supply lines.

LITERATURE.

Carnegie Institution of Washington. Annual Report of the Director of the Department of Terrestrial Magnetism for the Year 1950-1951.

The Director, Department of Terrestrial Magnetism, 5241, Broad Branch-road, Washington 15, D.C., U.S.A. [Gratis.]

IN spite of an increasing number of calls upon members of the staff of the Department of Terrestrial Magnetism to participate in National Defence projects, this year's report by the Director, Dr. M. A. Tuve, records continued progress in all branches of the Department's research programme. Experiments employing three independent high-speed ionospheric recorders operating simultaneously have revealed local and temporary ionospheric surges having velocities, predominantly earthward, ranging from 100 km. to 400 km. per hour. This surprising result will necessitate a revision in the hitherto accepted concept of a comparatively quiescent ionosphere. Dr. J. A. Ratcliffe, of the Cavendish Laboratory, spent several months with the Department in 1951, during which time he developed a quick method for analysing existing ionospheric records of the equivalent height of reflection of a pulse as a function of the pulse frequency, to obtain an estimate of the total ionisation in the overhead ion bank. This was found to follow generally the variation in intensity of ultraviolet light from the sun, thus confirming that the latter is one of the main ionising agencies in the high atmosphere. Preparations were made to test whether the sun's corona contributes to this ionisation during the annular eclipse of September 1, 1951, and some time was devoted to investigations on radio-wave propagation.

Studies of the earth's crust were made, using a multiple seismometer array extending over 1 km. In the Atlantic coastal region a velocity discontinuity was located at a depth of 30 km. to 50 km.; and it was found that interference effects between waves arriving simultaneously over different paths are liable to be erroneously attributed to reflections at intermediate layers. A tripartite station for microseisms was set up and, from records taken during five minutes of every hour between February

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(For Description, see Page 649.)



FIG. 7. ANNEALING FURNACE.



FIG. 8. TEMPER MILL.

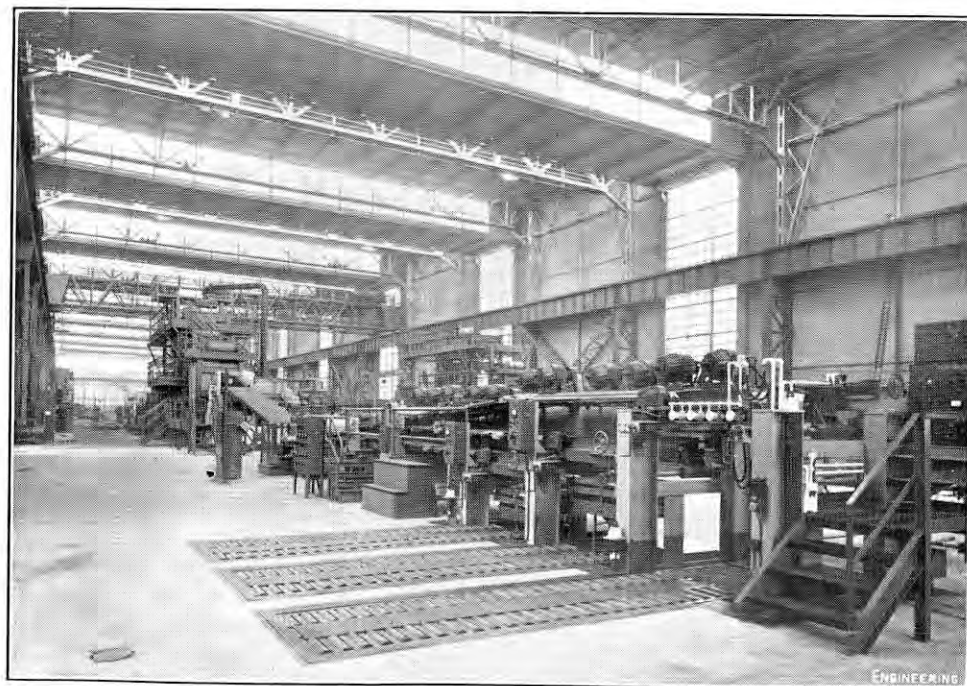


FIG. 9. EXIT END OF ELECTROLYTIC TINNING LINE.

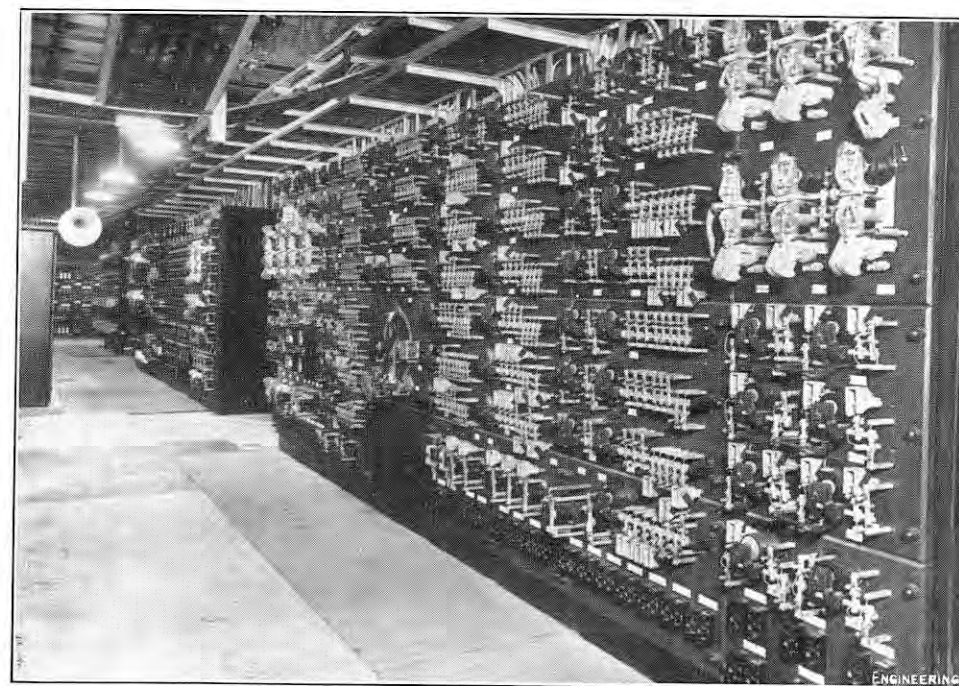


FIG. 10. CONTACTOR CONTROL BOARD.

and April, it was concluded that directions of microseisms cannot be dependably inferred from local observations. A new attack on the problem of determining the ages of minerals was begun in collaboration with the Geophysical Laboratory, and preliminary results, using the "isotope dilution" technique for the chemical estimation of Rb, Ca and Sr, appear promising. Further work on the magnetisation of rocks makes it seem likely that, since Permian times, the earth's field has not exceeded 10 oersted.

Laboratory work in nuclear physics was continued with investigations on proton-proton and neutron-proton scattering, and a preliminary survey of various experimental methods for determining spin-orbital angular momentum interactions in nuclei was undertaken. The Biophysics Group extended its investigations into the function of nucleic acid and its relation to protein synthesis, using a nutrient medium supplied with particular tracer-labelled compounds which were selected as being specific compounds that might be formed in intermediate stages of the synthesis. This work is beginning to throw light on some of the physical and chemical mechanisms whereby the components of a protein are reproduced. During the course of the year cyclotron-produced isotopes were supplied to a number of different laboratories, both in and outside the United States, and two volumes of magnetic results, obtained at Huancayo and Watheroo between 1945 and 1947, were published.

Electricity Meters and Instrument Transformers.

By S. JAMES, M.I.E.E. Chapman and Hall, Limited, 37, Essex-street, London, W.C.2. [Price 50s. net.]

BRIEFLY stated, this book is concerned with the design of electricity meters. Its range extends from direct-current and single-phase domestic meters, through prepayment meters, polyphase kilowatt-hour meters, reactive meters, kilovolt-ampere meters and maximum-demand indicators to summation metering, with chapters on current and voltage transformers. It is pointed out in the preface that many books on its subject have been written by engineers connected with the electricity-supply industry, whose interests are mainly centred on questions of performance and testing. Mr. James, however, is actively engaged in the production of meters, and deals, in illuminating detail, with the design of the whole range of instruments with which he is concerned. Performance, which is a function of design, is not neglected, but testing is not dealt with; it is to be treated in a companion volume.

Although the author is connected with a meter-manufacturing firm, his book is not restricted to their particular products or interests. It is a technical treatise covering the whole field, and full information is given about the design features of the meters made by other firms. Throughout, sketches and drawings of detail mechanisms amplify the descriptive matter. At the outset, the book surveys the legal requirements with which meters have to conform, this matter being followed by a chapter on direct-current meters, which are still in demand in connection with storage batteries and for some other services. The whole field of direct-current meters is reviewed from the early electrolytic meters to the latest practice. Single-phase meters occupy more space, and there is an informative chapter on their theory and performance.

From the point of view of the engineer who is not a meter specialist, it is possible that Mr. James's chapter dealing with prepayment meters will be of the greatest interest. It is stated that meters of this type have been used more extensively in Great Britain than in any other country. The control of a coin mechanism by an electricity meter raises interesting problems, both mechanical and electrical and the various ingenious arrangements which have been devised are of more than specialist interest. The design of polyphase meters raises more

complicated electrical problems than that of the single-phase type and, where they are considered, the book takes on a more mathematical nature; but, as the author points out, to follow his treatment the reader requires only a knowledge of trigonometry and vector representation. It is not possible here to refer in detail to the full treatment of polyphase meters, reactive meters and maximum-demand indicators which is given, but mention may be made of the chapter on summation metering. Summation metering has been employed in connection with large-scale power generation and transmission to distribution centres, to measure and record the maximum demand and to determine the charges from power delivered in bulk. It is not a question of merely determining the total consumption of a number of circuits; what is required is a record of maximum demands in terms of times which may not coincide in the various circuits. This book is an important and original contribution to its subject.

The Nile: A General Account of the River and the Utilization of its Waters.

By H. E. HURST, C.M.G., M.A., D.Sc., F.Inst.P. Constable and Company, Limited, 10, Orange-street, London, W.C.2. [Price 30s. net.]

THE growth of most nations is intimately linked with their facilities for transport by water, and many have been mainly dependent for that transport on rivers; but probably no single river has been so important in this respect as the Nile, and, certainly, no one is more competent to write a book upon that river than is Dr. Hurst, who joined the Survey of Egypt some 46 years ago, served for 27 years as Director-General of the Physical Department in the Egyptian Ministry of Public Works, and is still scientific consultant to that Ministry. Having explored the river to its several sources, travelled repeatedly over its 4,000 miles of waterway, and watched the development of most of the successive projects for its regulation and for the exploitation of its water-power resources, he has been able not only to take a long and broad view of all that it means and has meant to the territories through which it flows, but also to assess dispassionately and scientifically the great works that have been carried out along its course. He was the principal author of the report (Vol. VII of *The Nile Basin*) on *The Future Conservation of the Nile*, published by the Ministry of Public Works in 1946, the year of his retirement from the post of Director-General, which he had held since 1919.

The book opens with a general survey of the Nile basin, the study of which is greatly aided by the two excellent maps, inserted as end papers. This section contains also a succinct summary of the principal features of the adjacent country, the activities of the people (where there is any settled population) and the available sites for barrages, etc. A chapter follows on Egypt in general, and another on the development of irrigation in Egypt from the earliest times to the present day. Thereafter, the main river, the Blue Nile, the White Nile and the upper White Nile are treated in turn, and the course of the river is then followed to the Great Lakes, the Victoria Nile and Lake Victoria. To the topographical chapters succeed studies of the climate, vegetation and history of the basin, a chapter on its modern exploration, and a detailed survey of its hydrology. This leads naturally to a record of the major projects for the regulation of the river, as already carried out; and the book concludes with sections on the proposals for further developments in the storage and utilisation of the water.

Such a brief outline of the contents of the book can only indicate its scope in a very general way, and conveys no impression either of its wealth of authoritative detail or of its eminent readability. As the author observes in his introduction, there are few modern books on the subject, despite the fact that, "of all the rivers in the world the Nile

probably interests the greatest number of people" and "the lives of twenty million people . . . depend upon it entirely." A vast amount of data has been published from time to time in technical reports by the Egyptian Ministry of Public Works; but these volumes are not readily available to the casual inquirer and, in any case, their proper appreciation requires a considerable background of technical knowledge. Those who have that knowledge will be able to derive all the more satisfaction from Dr. Hurst's book, but it has been written primarily for those who are less well equipped. They will find it of absorbing interest, not only as a description but as an aid to the understanding of much in the current evolution of the peoples whose history, and future, depend so vitally upon it.

Fluid Flow in Pipes.

By CLIFFORD H. MCCLAIN. The Industrial Press, 148, Lafayette-street, New York 13, N.Y., U.S.A. [Price 3 dols.]; and Bailey Brothers and Swinfen, Limited, 26-27, Hatton-garden, London, E.C.1. [Price 25s. 6d.]

THERE is such a multitude of books on the subject of fluid flow that a new book, to be worth while, should present something new, or at least a new method of approach to the subject. Unfortunately, this short book fails to do either. The first chapter deals with "Dimensions of Fluid Properties," but, rather than simplifying this not very difficult subject, does so in such a way as to make it completely confusing. The author seems to like formulae for their own sake and, in fact, indulges in various totally unnecessary re-arrangements of algebraic equations; for example, " $^{\circ}\text{K} = ^{\circ}\text{C} + 273$ " and " $^{\circ}\text{C} = ^{\circ}\text{K} - 273$." The use of the "slug" does nothing to clarify the subject to the British reader.

The general approach is naive and frequently obscure. This is particularly true of the author's treatment of extremely low temperatures on pages 10 and 11. There is also a curious inconsistency in the figures used; for example, having pointed out, correctly, that the Centigrade degree is $9/5$ ths of the Fahrenheit degree, he then says that the Kelvin degree is 0.555 of the Rankine degree. Even his definition of specific gravity (on page 21) is wrong; and, although he lists the various units in the English system, there is no indication of any difference between the American gallon and the Imperial gallon.

The second chapter deals with "Viscosity of Fluids," and the general treatment is on the same lines, a great deal of space being taken to say what is adequately covered in much shorter form in most standard text-books. The third chapter, on the "Effect of Piping on Fluid Flow," presents the conventional so-called rational formulae based on Reynolds Number; but much of it is mere padding, such as " $D = \text{diameter of pipe in feet} = d/12$ ($d = \text{diameter of pipe in inches}$)," and the various re-arrangements of Reynolds Number are merely confusing. There are also some rather peculiar statements, such as "The relationship $(64/R_n)$. . . is a straight line function," that "The location of the critical region cannot be expressed as a function of Reynolds No.," and then, a few lines lower down, "The critical region lies between $R_n = 1,200$ and $4,000$." Pigott's friction charts and Moody's charts are both shown, but, in the discussion of Moody's charts, no mention is made of Nikuradse. The last chapter deals with "Design Practice," by which the author appears to mean the application of empirical and other formulae for evaluation of fluid flow; but here again, no new figures are given, and hardly any experimental data.

The book is not free from misprints. Simple spelling mistakes, though there is no excuse for them, do not lead to errors, but the index 1.5 instead of the correct value 1.25, which appears twice on page 110, is a more serious matter. There are other, somewhat similar, errors elsewhere; and there is no index.

ELECTRIFICATION OF THE PARIS-LYONS RAILWAY.

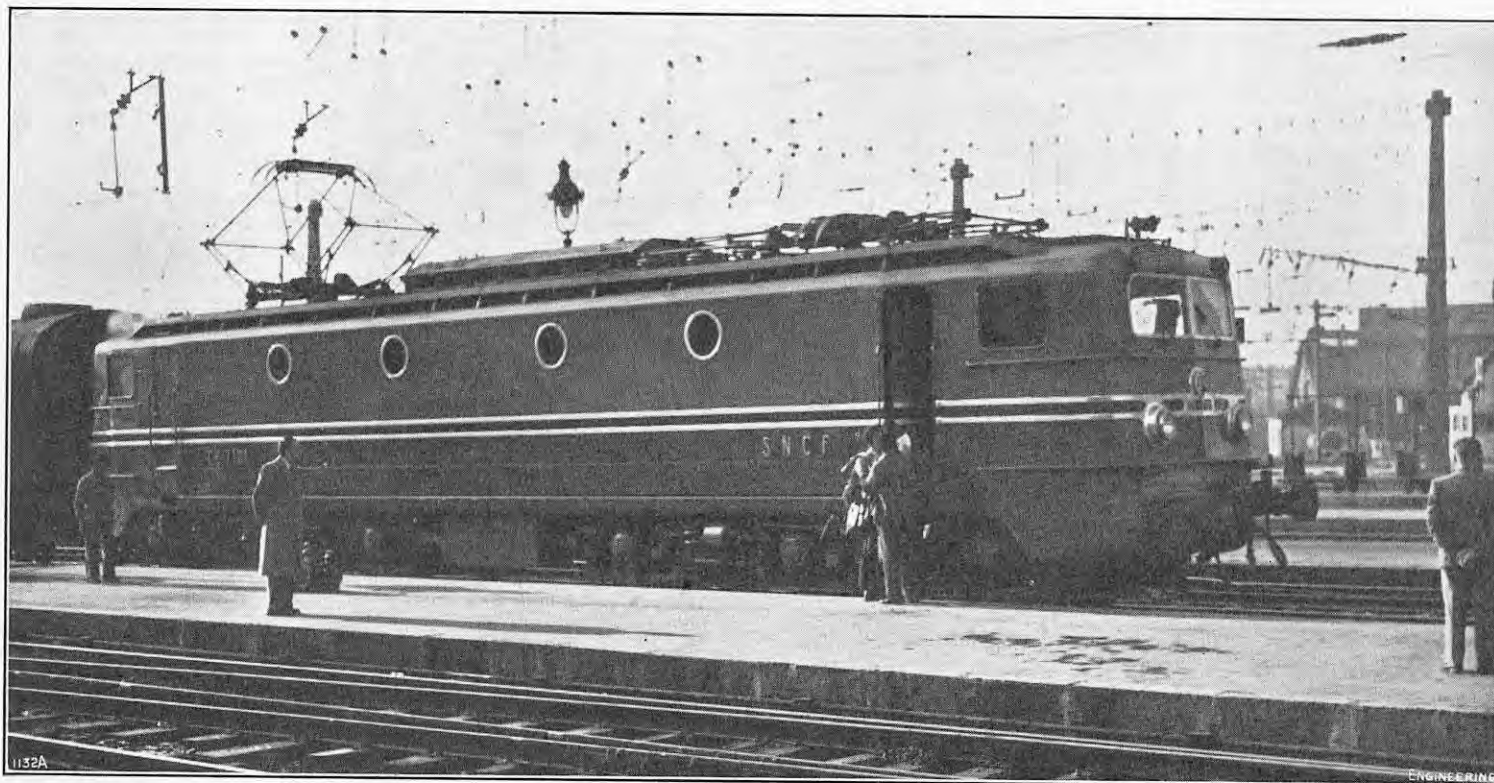


FIG. 1. 4,350-H.P. Co-Co ELECTRIC LOCOMOTIVE IN LYON-PERRACHE STATION.

ELECTRIFICATION OF THE PARIS-LYONS RAILWAY.

ELECTRIC traction was first introduced on the French main-line railways in 1900, when the lines between Paris (Les Invalides) and Versailles, and between Paris (Austerlitz) and Paris (Quai d'Orsay), were converted on the 650-volt and 600-volt direct-current systems. A year later, the line between St. Gervais and Chamonix was also changed to direct-current working, and between 1908 and 1913 sections of the Midi Railway in the Pyrenees were equipped on the single-phase system at 12 kV and 16 $\frac{2}{3}$ cycles, and another short section was operated at 850 volts direct-current. After the 1914-18 war it was decided to make the 1,500-volt direct-current system standard. Considerable lengths of the Midi and Paris-Orleans railways were then converted, as well as the section of the P.L.M. railway between Culoz and Modane, on the Italian frontier, and that of the State (Ouest) line between Paris and Le Mans. The position in 1944 was that 497 miles of line were being operated electrically and a considerable further mileage was being equipped.

It may be recalled that, at that date, all important French railway centres had been destroyed as the result of hostilities and that 2,600 bridges, 17 tunnels, 115 main passenger stations and 24 key marshalling yards were out of action for the same reason. The necessary restoration work has, however, by now been energetically carried out to completion, while, in addition, the important trunk line of the former P.L.M. Railway between Paris and Lyons has been converted to electric traction. As a result, 2,672 miles of French main-line railways are now being operated in this way, representing one-tenth of the total mileage and carrying one-third of the traffic. In addition, some 125 miles of suburban and mountain railways are operated on the same system at 600 to 800 volts.

The main line from Paris to Lyons, a distance of 318 miles, was opened in 1856, at which period the time taken to travel between the two cities was 26 hours. The route followed is shown on the map reproduced in Fig. 3, on the next page. From Paris to Les Laumes, a distance of 160 miles, the

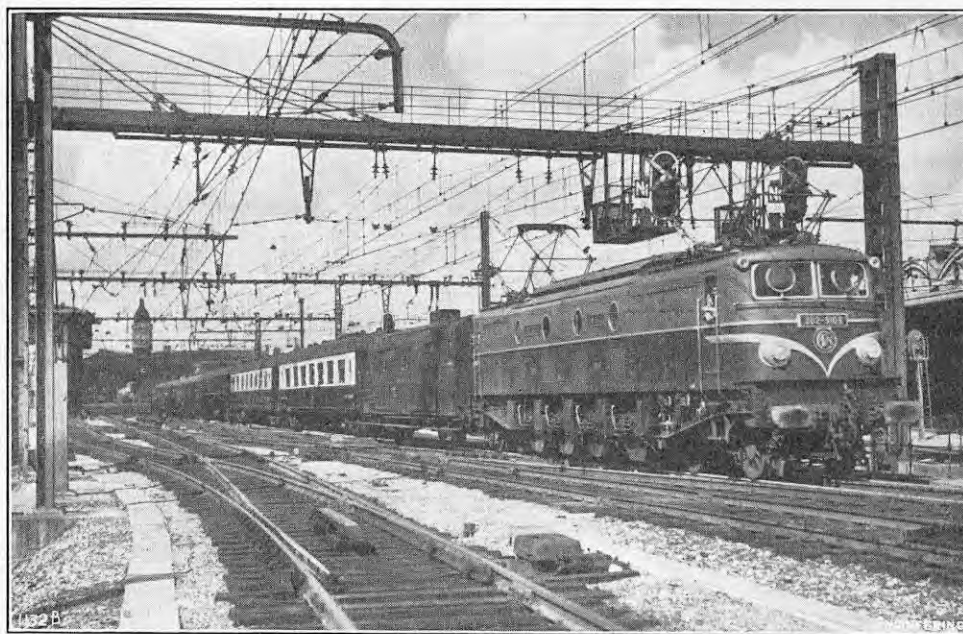


FIG. 2. "LE MISTRAL" LEAVING GARE DE LYON, PARIS.

gradients do not exceed 1 in 200, but thence to Alésia the line rises over the Seuil de Bourgogne on a gradient of 1 in 125 to the summit at Blaisy-Bas, 1,328 ft. above sea level. This section includes a tunnel 2 $\frac{1}{2}$ miles long at Blaisy, as well as several shorter tunnels and seven long viaducts. From Blaisy the line descends to Dijon, 196 miles from Paris and from thence to Lyons, another 122 miles, it follows undulating but not difficult country.

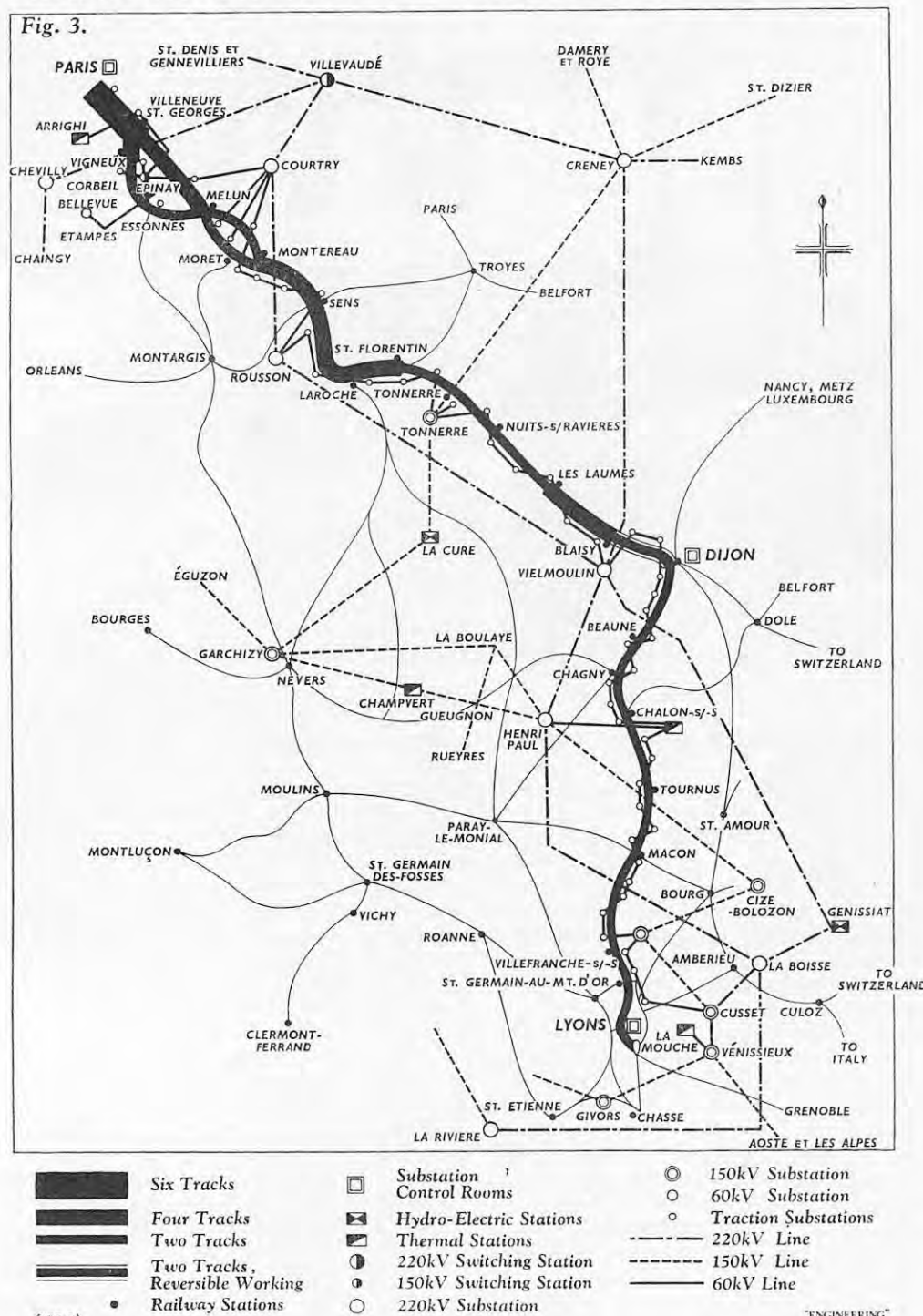
In 1925, as a result of the increase in the traffic on this important section of the French Railways, it was decided to quadruple the line between Paris and Blaisy, the widening thence to Dijon being prevented by the prohibitive cost. This work had been partly completed when war broke out in 1939, so that, at that time, there were six tracks from Paris to Villeneuve-St. Georges (8.9 miles) and four tracks thence to Melun (27.4 miles) via Brunoy and Combs-la-Ville. There was also a double-track loop from Villeneuve to Melun via

Juvisy, a connection being made at the latter place with the line to Orléans. Further connections were made with the line from Chasse, south of Lyons, via Nevers at Corbeil and Moret-les-Sablons. From Melun to Montereau there were two alternative double-track routes, one via Fontainebleau and the other via Héricy, the latter being 1.2 miles longer. From Montereau to Dijon there were also four tracks, except for the section of 52 $\frac{1}{4}$ miles between Saint Florentin and Les Laumes, and the 16-miles section between Blaisy and Dijon. Between Dijon and St. Germain-au-Mont-D'Or, at a distance of 306 miles from Paris, there were only two tracks, but thence to Lyons (12 miles) there were four tracks, one pair running into the Perrache station and the other into the Brotteaux station in that city.

In spite of the improved facilities provided by these widenings, the increase in traffic still gave rise to congestion and delays. It was decided, therefore,

ELECTRIFICATION OF PARIS-LYONS RAILWAY.

Fig. 3.



to convert the Paris-Lyons section to electric traction, especially as this would enable native water power, rather than imported oil, to be used as fuel, and some 620,000 tons of coal per annum to be saved. The actual work of electrification was started in 1946 and, although delays occurred, owing to lack of copper and lead and, to a lesser degree, of steel and cement, electric working was inaugurated on the line between Laroche and Dijon in March, 1950, and between Paris and Laroche in the same year. In January, 1952, electric working was extended from Dijon to Chalon-sur-Saône and, in June, from Chalon to Lyons. Electric traction is also being carried beyond Lyons to Chasse, a development which will enable perishable goods which were formerly hauled from the south via Moulins and Nevers to be transported over the main line. In all, 388 route miles have been electrified and work is now in progress on the conversion of the Mâcon-Ambérieu-Lyons triangle. This conversion will enable the expresses from Paris to Italy via the Mont Cenis tunnel, as well as to Geneva and resorts in the French Alps, to be routed via Mâcon and to rejoin the existing route at Bourg.

POWER SUPPLY.

The power required for operating the Paris-Lyons line is obtained principally from the hydro-electric stations of Électricité de France, the positions of which are shown in Fig. 3, nearly one-quarter of the whole consumption being drawn from the Génissiat station on the Rhône. As will also be seen from the map, some power is still obtained from thermal stations. Transmission is effected either at 220 kV or 150 kV to eight primary substations distributed along the route, where the voltage is stepped down to 60 kV. From these substations, one of which is illustrated in Fig. 5, Plate LII, feeders, each with a total cross-section of $\frac{3}{8}$ sq. in., are run to the traction substations. These feeders are usually in duplicate and are carried on separate lattice-steel towers 80 ft. high. The cross-arms of these towers were designed so that they sustain the greater part of the torque which is set up as the conductors expand or contract. Special anchor blocks were designed which reduced the concrete required for this purpose from 2,250 to 790 cub. ft. per mile. An earth wire is also carried on each group of towers.

These 60-kV lines are connected to 52 traction substations, which are spaced at intervals of about 10 miles on the Paris-Dijon section and at about half that distance between Dijon and Lyons, as shown in Fig. 3. A typical substation—that at Flogny—is illustrated in Fig. 7 on Plate LII. Each of the substations between Paris and Dijon is equipped with two 4,000-kW transformer/rectifier groups, one of which usually acts as reserve, although both are in circuit during peak periods. The substations on certain busy and steeply-graded sections, however, are equipped with three such groups, one of which is in reserve. The longer distances between the substations on the Paris-Dijon section was determined by the desire to limit the number of 1,500-volt connections which would otherwise have been needed where there were four tracks. On the Dijon-Lyons section the substations are equipped with one 4,000-kW transformer/rectifier group, but the shorter intervals between them will allow the service to be maintained from those on each side of any in which a fault may occur. As a further precaution, mobile transformer/rectifier units, mounted on railway wagons, are available for despatch to places where extra power is required.

TRACTION SUBSTATIONS.

The construction and equipment of the traction substations are simple. Most of the buildings are of rough ashlar, the walls being of sufficient strength to withstand bomb blast. All the equipment is interchangeable and the transformers, rectifiers, circuit-breakers and other apparatus are mounted on rollers so that they can easily be removed for repairs. Their removal has been further facilitated by raising the floors 2 ft. above the level of the branch railway track, thus enabling the faulty unit to be loaded on to a railway wagon by a travelling hoist and taken to a central repair depot at Oullins, near Lyons, which has been specially equipped to deal with this work. Considerable space has been saved by this arrangement and also by controlling each piece of apparatus by local switches, instead of from a central board.

All the substations are unattended and, for operating purposes, are arranged in three groups, which are controlled from Paris, Dijon and Lyons, respectively. All the control operations and metering indications are transmitted over four pairs of telephone cables, which link the substations in each group, different frequencies between 420 and 2,460 cycles being used to actuate the individual sets of apparatus. The controller carries out all necessary operations at a substation, with the exception of the replacement of automatic equipment, from a semi-circular panel about 100 ft. long; the positions of the various switches, the readings of the instruments and the occurrence of faults and breakdowns are shown on an illuminated diagram. As in the case of the substations, the control buildings have been constructed in a uniform style and contain not only the control rooms, but also the administrative offices.

OVERHEAD COLLECTING SYSTEM.

Direct current at 1,500 volts is supplied from the traction substations to an overhead collecting system, the construction of which can be seen in Fig. 2, opposite, and Fig. 4, on page 656, and Fig. 8, on Plate LII. It consists of main and auxiliary bronze catenaries from which twin copper contact wires are suspended, the tension of the latter being automatically adjusted within certain temperature limits. The system is similar to that used on other electrified lines in France, except that the cross-section of the conductors is $\frac{1}{4}$ sq. in. instead of $\frac{3}{8}$ sq. in. and it is designed for higher speeds. On double-track sections, the overhead system for each track is carried on separate uprights, as will be seen in Fig. 11, on Plate LIII. Over the four-track and six-track sections, gantries, which

also carry the signals, have been erected, as shown in Figs. 2 and 4. Most of the standards and gantries are of lattice-steel construction, but on the double-track sections between Dijon and Lyons some 1,600 tons of steel were saved by the use of reinforced concrete. A typical construction of this kind is illustrated in Fig. 11, Plate LIII. Both uprights and gantries are generally supported on concrete foundations, but special fixtures were designed to carry them over 41 long bridges, as shown in Fig. 4. Special arrangements had also to be made in 20 tunnels to prevent deterioration of the insulation from moisture.

The erection of this overhead system presented more than the usual difficulties. Owing to the density of the traffic, occupation of the permanent way could only be obtained for a maximum of two hours at a time, at the end of which the tracks had to be left in such a condition that express trains could be safely operated over them. Careful planning was therefore necessary, since in many cases the uprights could not be erected until telephone wires had been moved, nor the contact wires laid out until the signalling had been modified. The latter operation in turn necessitated a re-arrangement of the tracks. Work was facilitated, however, by the use of ten concreting trains, with which an average of 1,060 cub. ft. per hour could be placed. Specially equipped trains were also used for stringing the contact and communication wires, and for erecting the uprights.

LOCOMOTIVES.

At present, the traffic on the Paris-Lyons electrified line is being dealt with by three classes of locomotive, two of which are being utilised on express passenger trains and the other on mixed duties. One of the former classes is of the 2-Do-2 type and is generally similar to those used for some years on the railways in western and south-western France, although it embodies a number of improvements. One of the type is shown in Fig. 2, on page 654. It is 59 ft. 3 in. long over the buffers and has a total wheelbase of 48 ft. 2 in., a driving wheelbase of 20 ft. 3 in. and a bogie wheelbase of 7 ft. 10½ in. The diameter of the driving wheels is 5 ft. 9 in. The weight without ballast is 144 metric tons and the adhesive weight 82 metric tons. Ballast may be added to bring the total weight up to 150 metric tons, giving an adhesive weight of 92 metric tons, or 23 metric tons per driving axle. The longitudinal members of the underframe are of welded steel and are connected by riveted cross-members. The frame is completed by two shorter members, which are placed externally and carry the large gearwheels which drive the axles. These axles are borne in internal axleboxes of the Athermos type. The steel bogie frames are constructed with a welded bolster and are supported on the axleboxes by laminated and spiral springs. The body is of riveted, bolted or welded sheet steel and incorporates a driving cab at each end. Intermediate compartments house the traction motors, control gear, starting resistances and auxiliary machinery. Access to these compartments is obtainable from two corridors (which connect the cabs) through bolted doors with Plexiglass panels.

Each locomotive carries four 1,500-volt motors with compensating windings, which are connected to the overhead line through a high-speed circuit-breaker. These motors are mounted rigidly on the frame and carry pinions which engage with the large gearwheels mentioned above. The gearwheels are connected to the driving axles through flexible couplings of the Buchli link type, so that the axles themselves are free to move vertically or laterally relative to the frame. Starting and speed control is effected by a master controller in each cab. Movement of this master controller energises a solenoid which admits air to the appro-

priate servo-motor, so that the latter operates the starting contactors. The circuit of this solenoid is made and broken by cam-operated contacts which are mounted on a shaft coupled to the controller handle through differential gearing. Each cam continues to rotate until it reaches its working position, when the contacts are broken and the shaft stops. The controller can be moved over several notches at once, in which case a second set of valves is opened and the speed at which the cam shaft rotates is accelerated. This arrangement has led to a simplification of the electrical circuits, since the setting of the cams ensures that the contactors are operated in the correct sequence. It has also enabled the number of interlocks to be reduced.

A high degree of flexibility in control has been obtained by the use of series, series-parallel and parallel connection of the motors, combined with field weakening, so that 24 economical running speeds are available, compared with 15 on the earlier locomotives of this type. The employment of compensated windings for this purpose has reduced sparking and has enabled a minimum field of 29.5 per cent. of the full value to be used. Under these conditions the speed ratio, compared to that with full field, is 2.2. The number of notches has been further increased by the provision of an auxiliary, or vernier, controller, which first connects a resistance in parallel with each section of the main resistance and then cuts it out in seven steps, thus providing a total of 294 starting notches. A complete rotation of the handle of this vernier controller advances the main controller by one notch. This arrangement enables the power to be built up very gradually during the early stages of acceleration, so that wheel spin is prevented.

The auxiliary equipment on these locomotives consists of two compressors, each with an output of 70 cub. ft. per minute; four blowers for cooling the traction motors, the output of each of which is 5,300 cub. ft. per minute; and two blowers for cooling the starting resistance, with outputs of 18,000 cub. ft. of air per minute. The starting resistances are designed on generous lines, so that it will be possible for the locomotives to be used on mixed-traffic duties; operation under these conditions will be assisted by the flexibility of the control arrangements. The locomotives have been designed for hauling passenger trains weighing

840 tons, on level track, at a speed of 80 m.p.h.

Although these 2-Do-2 locomotives are capable of satisfactorily hauling the heaviest passenger trains at speeds up to 88 m.p.h., they are to be replaced by a number of the Co-Co type, one of which is shown in the Perrache station at Lyons in Fig. 1. Eventually, 60 of this type will be used on the Paris-Lyons line. These locomotives, although rated at 4,350 h.p. instead of 4,880 h.p., have the advantage that all the axles are equipped with motors and that the entire weight of 106 metric tons is therefore available for adhesion. The length over the buffers is 61 ft. 9 in. and the wheel diameter is 4 ft. 1 in. The traction motors, which are of the balanced type, are suspended from the bogie frames and drive the axles through hollow shafts and a system of connecting rods fitted with Silentbloes. The axleboxes are also connected to the frame by articulated rods and Silentbloes, and rubber shock-absorbers are incorporated in the suspension. Each bogie is connected to the frame by two vertical links which swing in opposite directions on curves and operate in conjunction with springs, so that a restoring effort proportional to the amount of displacement is exercised. In designing these locomotives, special attention was paid to the simplification of maintenance. Most of the apparatus is similar to that used on those of other types, but it is grouped in self-contained units, so that dismantling and re-erection are facilitated and the wiring and pipe work are simplified. In spite of their lower horse-power, tests show that these locomotives should be capable of hauling the heaviest trains satisfactorily. They have the further advantages of not requiring so much current and of causing less track wear. They are 40 metric tons lighter and 20 per cent. cheaper than those of the 2-Do-2 type.

The third type of locomotive, upon which trials are now being conducted, is of the Bo-Bo type. It is illustrated in Fig. 10, and is intended for dealing with mixed traffic. The weight is 90.5 tons and it has two four-wheel bogies, each axle being driven by a nose-suspended motor with a continuous rating of 600 h.p., so that the total output is 2,400 h.p.; the one-hour rating is 2,800 h.p. On some of the units now being built, the connection between the bogies and under-frame consists of a modified linkage, while the transmission system

ELECTRIFICATION OF PARIS-LYONS RAILWAY.



FIG. 4. TRAINS ON "REVERSIBLE WORKING" LINES.

ELECTRIFICATION OF PARIS-LYONS RAILWAY.

(For Description, see Page 654.)

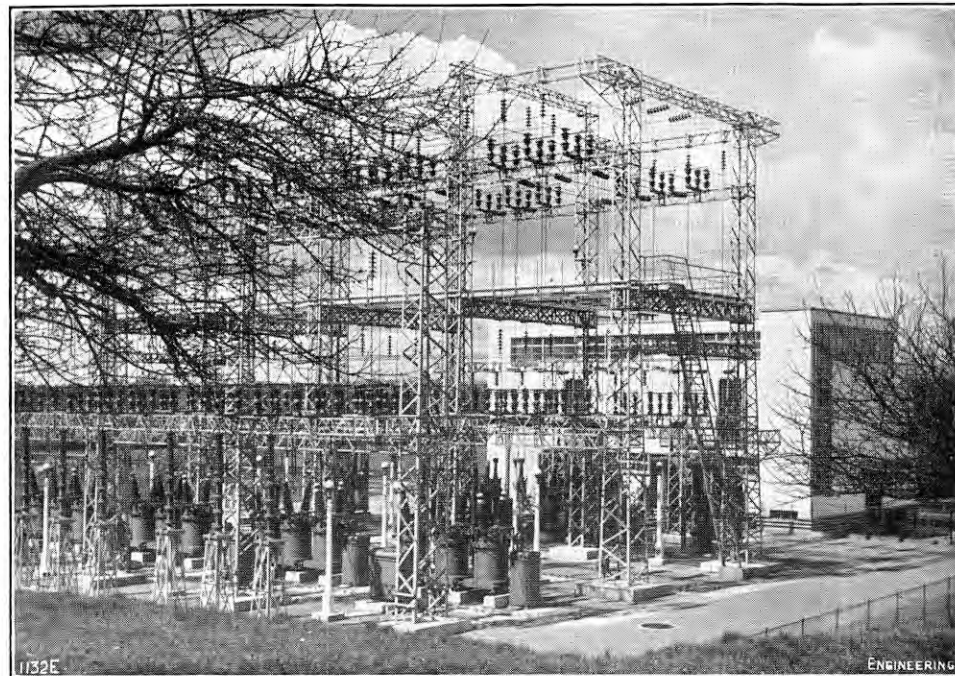


FIG. 5. TYPICAL MAIN SUBSTATION.



FIG. 6. PERRIGNY SIGNAL BOX.

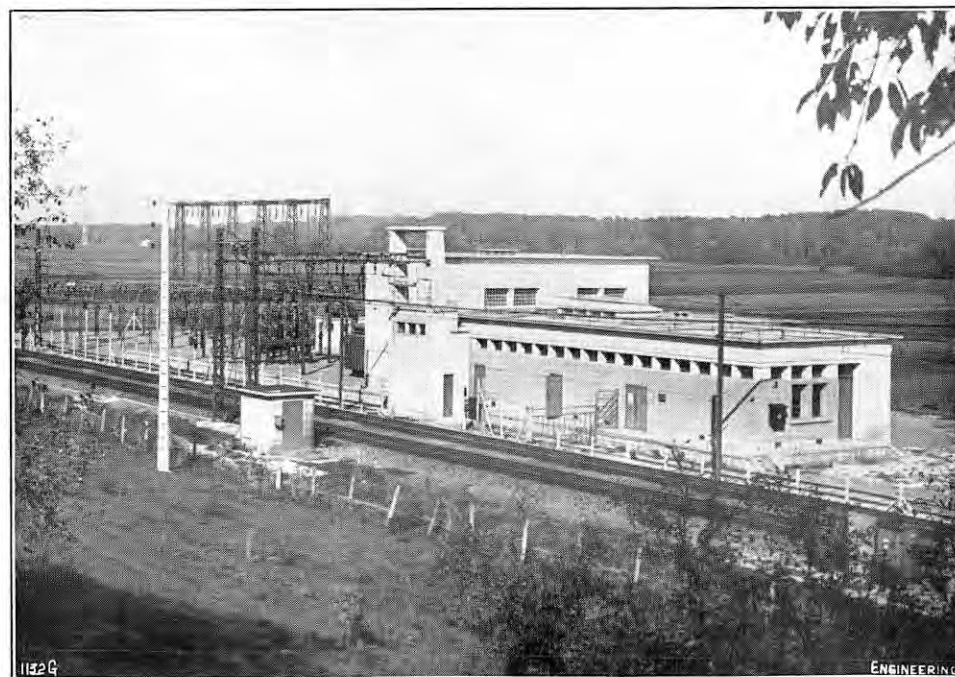


FIG. 7. TRACTION SUBSTATION AT FLOGNY.

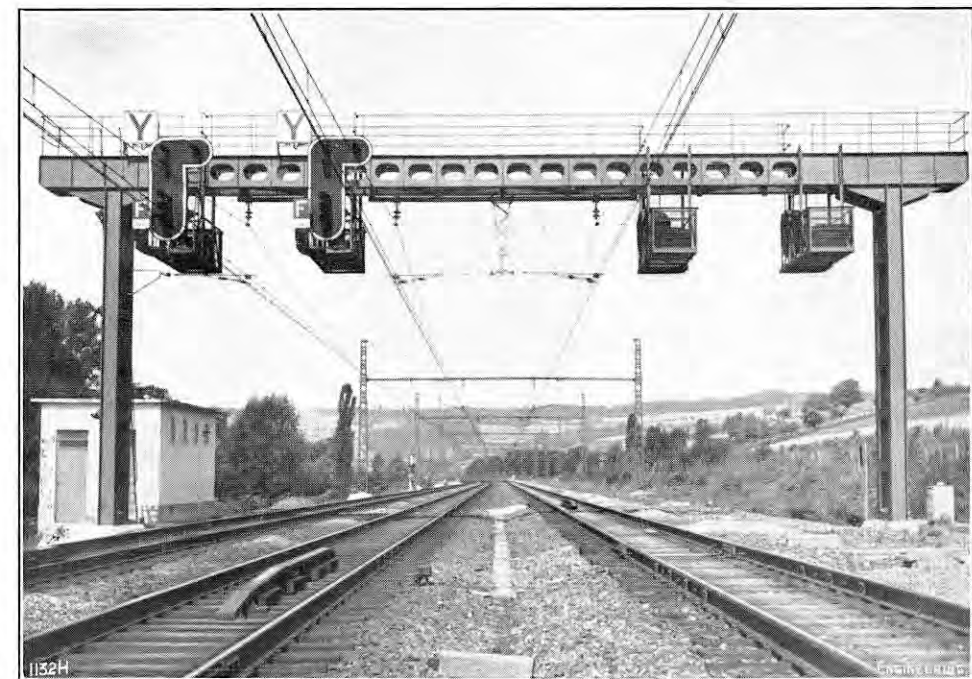


FIG. 8. GANTRY CARRYING CATENARIES AND SIGNALS.

ELECTRIFICATION OF PARIS-LYONS RAILWAY.

(For Description, see Page 654.)



FIG. 9. RECONSTRUCTED APPROACH TO GARE DE LYON, PARIS.

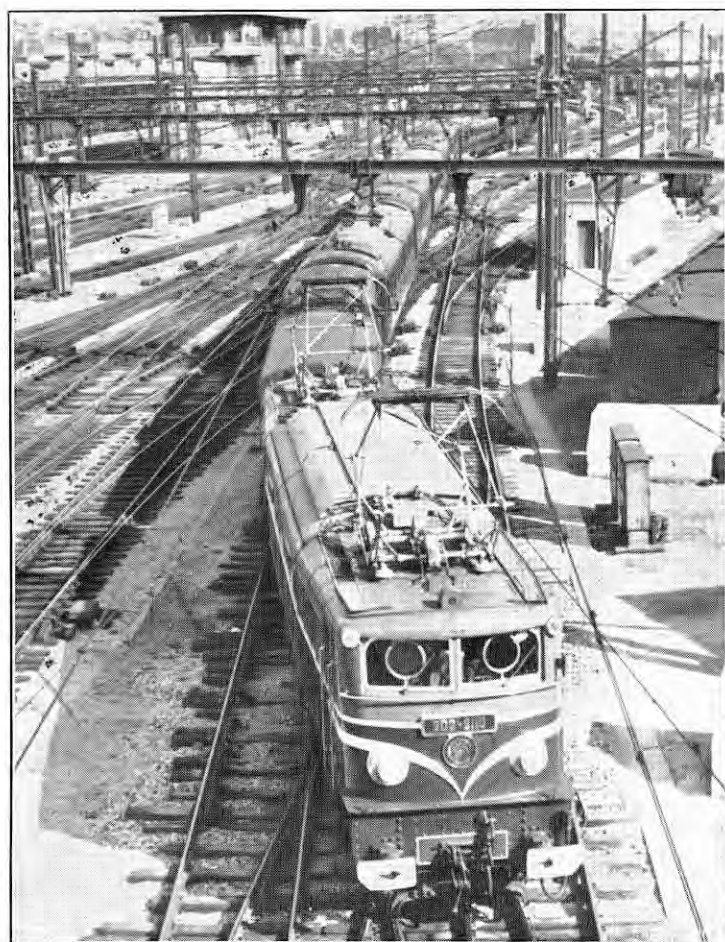


FIG. 10. TRAIN ENTERING GARE DE LYON.

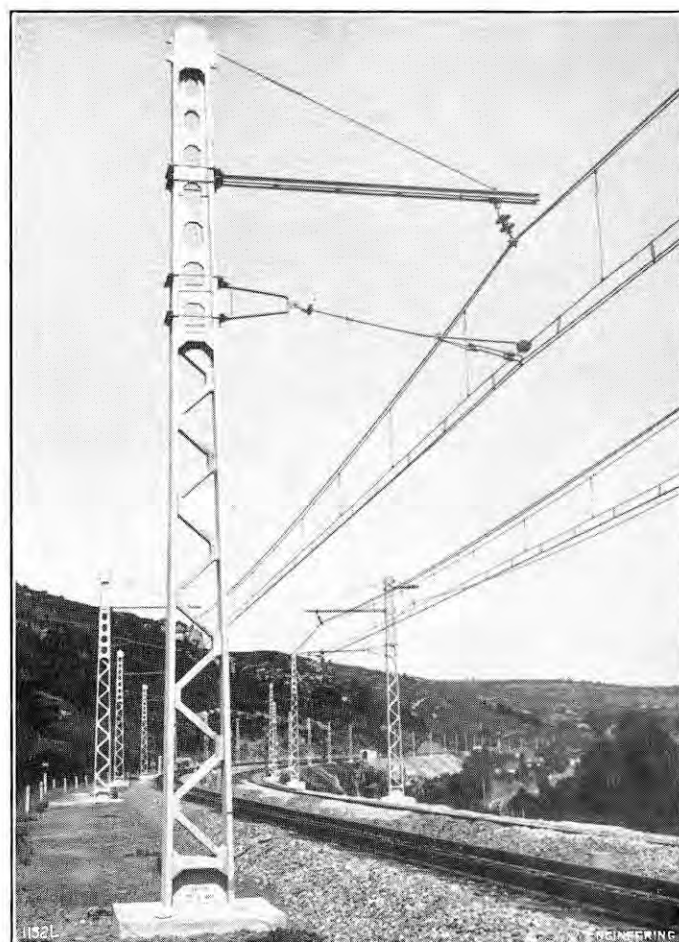


FIG. 11. REINFORCED CONCRETE UPRIGHT.

ELECTRIFICATION OF PARIS-LYONS RAILWAY.

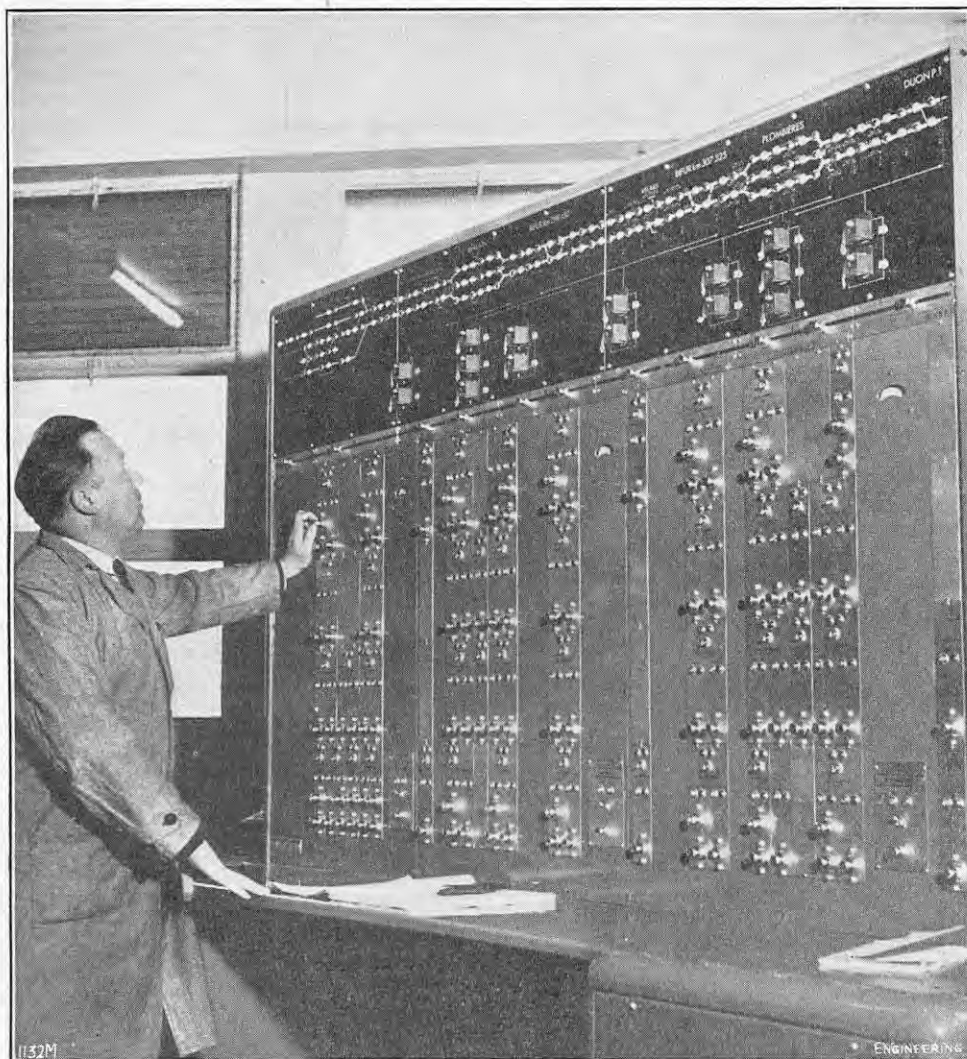


FIG. 12. TRAFFIC CONTROL PANELS AT DIJON.

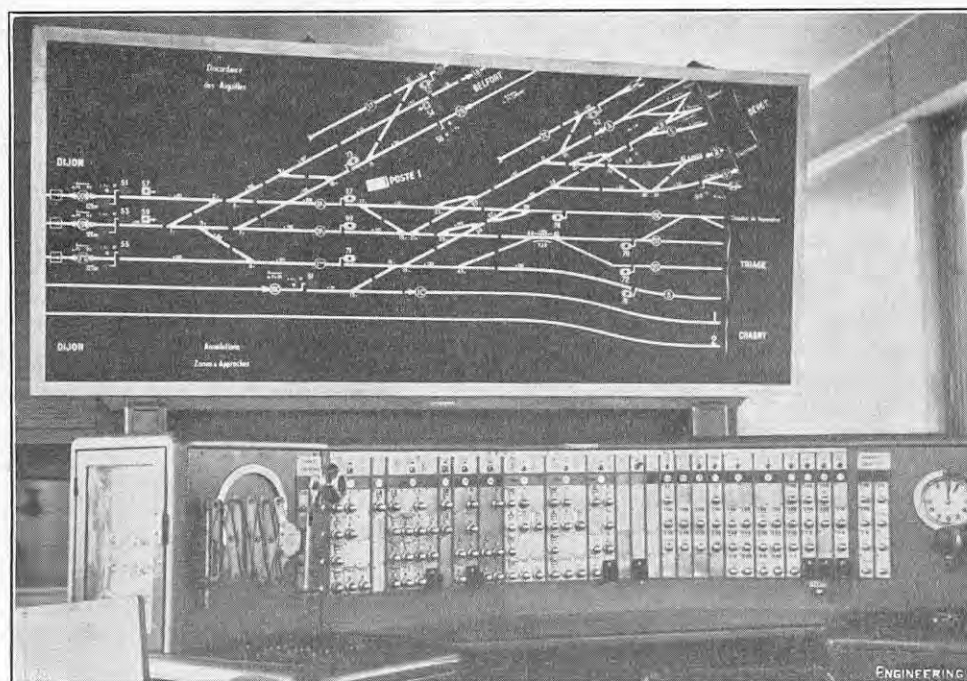


FIG. 13. INTERIOR OF DIJON-PERRIGNY SIGNAL BOX NO. 1.

consists of a short cardan shaft, which surrounds the axle and is connected through universal joints to the final gearwheel at one end and the driving axle at the other. These locomotives also differ from others of the same type in that extra stages of field weakening are incorporated, thus giving a wider range of economical speeds. Series compensating windings are used to counteract the

effect of armature reaction. At its weakest, the field has only 23 per cent. of the value at full field and the corresponding speed ratio is 2.28. Operating speeds of from $27\frac{1}{2}$ m.p.h. to $63\frac{1}{2}$ m.p.h. are obtainable, which is unusual for such light locomotives, and they are capable of hauling a load of 1,400 metric tons at a speed of 35 m.p.h. on a gradient of 5 in 1,000.

SIGNALLING.

The electrification of the Paris-Lyons line has been accompanied by the substitution of colour light for semaphore signalling, although this change would probably have been necessary in any event because of the increase in traffic. In addition, the double-track section from Blaisy-Bas to Dijon, as well as the cross-river bridges at Lyons, has been signalled so that trains can be run in either direction on either track; the trains shown in Fig. 4, opposite, are both running in the same direction, i.e., towards the observer. This arrangement greatly facilitates the handling of the traffic at busy periods. Manual block-working has been replaced by automatic equipment on the sections between Melun and Montereau, and Melun and Corbeil; and a number of signals have been re-sited and others added to enable trains running at 88 m.p.h. to operate on a three-minute headway. Direct-current track circuits have been replaced by circuits operating on alternating current, 22 new mechanical and 25 new electrically-operated boxes have been built, and 29 mechanical and nine electrical boxes converted. In some of the electrical boxes mechanical interlocking is employed, but, as a rule, electric interlocking is used, thus enabling the lengths they control to be extended. One of the new signal boxes is illustrated in Fig. 6, on Plate LII, and its interior is shown in Fig. 13, herewith.

On the "reversible" sections the tracks are equipped with two automatic blocks, one for each direction of working, and the points and signals are operated from the central traffic control post at Dijon. At this post, the interior of which is shown in Fig. 12, a single dispatcher can set up the route required by means of push buttons and with the assistance of an illuminated diagram. Control signals are then transmitted by coded impulses over two wires only and when the train has passed the route is automatically "broken down." A direction interlock prevents two trains entering the same block section in opposite directions. A particular route can be preselected, although it is partly occupied. This section is then registered and the route established when the occupied section becomes free. When reversible working is not required, the dispatcher can convert both tracks to normal directional running under automatic block control. As a result of the installation of this system, the number of point and switch controls has been reduced from 39 to 19 and the operating staff by 35 per cent.

At Montereau, three mechanical signal boxes have been replaced by a new electrical box from which the points and signals are operated directly or through a satellite box. Two other small mechanical boxes are also to be replaced by a satellite when the tracks east of the station have been re-arranged. Operation in the new box is effected by 306 push-buttons, which enable 350 routes, serving three traffic zones, to be set up. A similar box of simpler design has been erected at Lyons-Perrache to replace three older boxes.

Some alteration of the communication circuits on the Paris-Lyons section has also been necessary, as both the Post Office and railway telephone lines were frequently too near the track to leave space for the overhead contact line. In addition, they would also have been subject to disturbance from the rectifier harmonics. As to re-site the overhead lines would have meant the requisition of land, and more channels were required for control purposes, all the circuits were concentrated in four underground cables, two of which contain 24 voice-frequency channels. A third cable is provided for other railway services, and the fourth is used for medium-distance postal work. The voice-frequency cables have repeater stations at intervals of about $12\frac{1}{2}$ miles. On the other circuits, these stations are placed about 37 miles apart.

CIVIL ENGINEERING WORKS.

The introduction of electric traction on the Paris-Lyons railway made it necessary to carry out considerable structural alterations in order to facilitate the handling of the increased traffic. Of these the most important has been the re-arrangement of the six tracks outside the Gare de Lyon in Paris, so that all empty stock movements to and from the station can be made without fouling the suburban lines. For this purpose, a new track has been constructed to carry empty trains from the main-line arrival platforms, and the existing down tracks have been re-arranged with two depot tracks between the down main and down suburban lines, thus enabling empty trains to be worked into the station without crossing other lines. This re-arrangement has also necessitated the construction of a flyover across the two up lines and the down suburban line. This flyover, the construction of which was complicated by the presence of a road under-bridge, is in three sections: a tubular bridge of reinforced concrete, which carries the down suburban line across the street; a reinforced-concrete skew bridge over the street and part of the down suburban line, on which the depot tracks are laid; and a second skew bridge, which carries the depot tracks over the rest of the down suburban line and links up with the existing flyover across the two up lines. A view of the re-arrangement taken from the roof of the station appears in Fig. 9, Plate LIII.

The tubular concrete bridge is 85 ft. 4 in. long and is of rectangular section, 15 ft. 3 in. wide and 17 ft. 11 in. high. The first skew bridge is irregular in shape and is carried on two non-parallel girders, which vary in height to facilitate drainage. The other bridge is virtually an extension of the tubular bridge. To avoid interference with the traffic, this work was carried out in stages between May, 1947, and September, 1948. Other alterations at the Gare de Lyon included the lengthening of the main-line platforms from 328 to 459 yards.

At Dijon, the tracks have been re-arranged so that the down main line enters the station on a flyover, which crosses the lines from Dôle, Nancy and the Perrigny locomotive depot, while at Mâcon a similar flyover carries the Paris-Lyons down line over the track to Bourg. At Lyons, the lines to Bourg and Ambérieu are dealt with in the same way. Other flyovers have been constructed at Vigneux and St. Germain-au-Mont d'Or to facilitate the working of traffic into and out of marshalling yards. The yard at the latter place has also been extended, work which involved considerable road diversion and earth works as well as the construction of a reinforced-concrete suspension bridge.

A great deal of work was also necessary as a result of the alteration of the loading gauge to accommodate the overhead system. The track, in fact, had to be lowered under 95 bridges and in 20 tunnels, the total length involved being 63 miles. The roadway on 41 road bridges and 16 footbridges was raised, while 18 road bridges were re-built and five footbridges were demolished. At St. Florentin, a reinforced-concrete arch with a 170-ft. span and weighing 1,500 metric tons was raised 1 ft. 4½ in. Considerable re-alignment of tracks and easing of curves were necessary to enable speed restrictions to be removed and a maximum speed of 87 m.p.h. adopted. Between St. Clair and Guillotière, south of Lyons-Perrache, the track is being quadrupled, and the addition of a track at Mâcon, making a total of five, is necessitating considerable excavation of an embankment. The platforms at all the principal stations have been lengthened to accommodate trains of 14 coaches and two vans, weighing up to 850 metric tons. In numerous places the permanent way has been strengthened, and about 125 miles of new rails have been laid on the main line.

As a result of the electrification it has been possible

to reduce the time of the fastest trains between Paris and Dijon from 3 hours 46 minutes to 2 hours 32 minutes, an average speed of 77 m.p.h., and between Paris and Lyons from 6 hours 7 minutes to 4 hours 15 minutes, an average speed of 75 m.p.h. To ensure convenient hours of arrival and for other reasons, the trains between Paris and Dijon in both directions are run in groups, especially at night, the headway being often as little as 2 minutes. The peak of this traffic occurs about 2 a.m., thus improving the load curve and load factor of the electricity supply authority. In fact, about two-thirds of the power required for traction is taken between 8 p.m. and 8 a.m. It has also been possible to increase the weight and number of the trains and to maintain the service with 225 electric as against 600 steam locomotives. The effect on the fuel position has been to reduce the consumption of coal by the French railways from 13.4 per cent. of the total in 1938 to 8.7 per cent. in 1951, while during the same period the consumption of electricity has increased from 700 million to 1,700 million kWh, or from 3.3 per cent. to 4.7 per cent. of the total.

THE INSTITUTION OF NAVAL ARCHITECTS' AUTUMN MEETING.

(Continued from page 638.)

THE fourth paper of the five presented at Genoa during the joint meeting in Italy of the Institution of Naval Architects and the Associazione di Tecnica Navale was by Dr. Ing. Giovanni Villa and dealt with the measurement of vibrations in ships and the use of electrical and electronic apparatus for that purpose, with particular reference to recent work in Italy. The title, in full, was "Il Contributo dell' Elettrotecnica e dell' Elettrotecnica nella Determinazione degli Elementi Caratteristici delle Vibrazioni di Scafo, con particolare riguardo alle Ricerche eseguite in Italia." Dr. Villa spoke in Italian.

MEASUREMENT OF VIBRATIONS IN SHIPS.

In his paper, the author described a number of pieces of apparatus for vibration-measurement, some being commercially produced and some designed and made in the experimental laboratories at the Fiat motor works. They included a mechanical detector, consisting of a mass on the end of a spring, suspended in a frame; a combination of mechanical and electrical methods, to measure the velocity of displacement, and, by integration, displacement; a quartz detector, also combining mechanical and electrical means, used to measure acceleration at one point, and displacement, by double integration; and a mechanical vibrator, used to measure the frequency of vibration. By means of a portable quartz recorder, he measured the characteristics of the vibration at a number of points in succession; and by means of a mechanical and electrical detector, developed at the Fiat works, used in conjunction with the necessary amplifiers, oscillographs, photographic recorders, etc., he was able to measure the vibration of a ship at a number of points simultaneously and so to deduce the "elastic line," i.e., the curve of amplitude of vibration, plotted against distance along the deck from bow or stern. He also investigated the effect of changing the balance of the main engines, and of transferring ballast. Arising from this work, the author developed a complete new series of electronic instruments, with which readings could be taken simultaneously at six (or, if desired, 12) widely separated points in the hull, and recorded together on a single strip of paper. Finally, he discussed the relationships between the various tests and measurements made, the oscillograms recorded, and the theoretical and practical fundamentals disclosed; and outlined the improvements that might be expected, as a result of the knowledge gained, in the "habitability" of ships.

DISCUSSION.

Professor L. C. Burrill, who opened the discussion, regretted that, as he had not seen the paper until

that morning, his remarks could only be of a general nature; but later he hoped to go into the details of the instruments exhibited. It was of particular interest to those experimenters in England who had been engaged in studying the problems of ship vibration, and had developed instruments for measuring and recording vibrations at sea, to have an opportunity to see the parallel developments which had been taking place in Italy. Recent developments in the field of electronics had provided powerful means for recording vibrations; the cathode-ray tube had given research workers a new eye, and the various recording instruments, of which the Brush pen recorder was an extremely useful example, allowed them to make faithful records of the actual vibrations experienced, which could be analysed later and studied at leisure. To measure was to know, and the instruments described by Dr. Villa provided means whereby the exact circumstances obtaining in any ship could be determined with precision. At King's College, Newcastle-on-Tyne, they had been interested in developing such measuring instruments for about six years, and could now undertake the measurement of vibrations ranging from 50 to 60 cycles per minute up to 1,200 to 1,500 cycles per minute with instruments very similar to those described by Dr. Villa. In Newcastle, too, they preferred direct recording on paper, and had used the Brush instruments for that purpose; but they had developed various separate and special pick-ups for each range of vibration, i.e., main hull frequencies, propeller-blade impulse frequencies, and sundry panel frequencies. The instruments were self-contained and could be taken on to any ship; they were independent of the ship's mains.

Another problem was that of noise frequencies, and for that purpose the harmonic sound analyser was particularly useful. It had enabled them, for instance, to analyse the noises made by "singing" propellers at sea and thus to compare them with the natural blade frequencies in water. The British Shipbuilding Research Association had been pursuing vigorously the study of the vibration of ships' hulls by means of a vibration exciter built by the research department of Lloyd's Register of Shipping and already extremely valuable results had been published. The question of the degree of balance required in the main engines and auxiliaries was also important in that connection and was being closely studied. At King's College, he had been pursuing, on behalf of the British Shipbuilding Research Association, a long series of tests with long prismatic aluminium bars, vibrated in their natural modes by electronic means and immersed to different draughts in water. Similar work was being carried out elsewhere in order to resolve the problem of entrained water, both for vertical and horizontal vibrations. In brief, it was found that the entrained water for vertical vibrations followed closely the calculated values, using Lewis's work, but the horizontal entrained water was much less than had been expected. There were some people who liked to pretend that vibration did not occur in their ships; but for his own part, said Professor Burrill, in conclusion, he had always held the view that it was only by facing problems squarely and publishing the results of tests freely, that the full benefit could be obtained from their collective experience.

Dr. Ing. Sergio Marsich, speaking in Italian, desired to emphasise, to all who were interested in the subject of the paper, the importance of presenting the observed results in such a form as to be easily catalogued and compared; because records of hull vibrations were generally measured for the purpose of obtaining data for the prediction of vibrations, in the early stages of a new design. For that purpose, the essential particulars were the length, L , of the ship, the breadth, B , the depth, D , the draught, d , the displacement, A , and the observed number of vibrations per minute. By means of those data, it was possible to obtain quickly the non-dimensional symbols

$$\left(\frac{N}{\rho} \right) = \frac{NL}{\sqrt{\frac{E}{\rho}}}, \text{ for the characteristic frequency; and}$$

$u = \sqrt{\frac{BD^3}{\Delta L}}$, for the index of rigidity, where E was

the modulus of elasticity, ρ the density of the water (salt or fresh), and Δ was the volume of the hull. By means of the symbols N and u , the desired comparison could be easily made; moreover, the approximate value of the frequency could be predicted, just as, when the value of $\frac{V}{\sqrt{L}}$ was known

for a given ship, the approximate values of (C) and C were known. When, on the records, the deflections of the neutral axis were given, it would be very useful to be able to identify the disturbing forces and to plot the deflections to scale; because, in conditions of resonance, the greatest deflections might be presumed to be proportional to the forces that caused them.

Dr. G. Fusini said that the information that Dr. Villa had given in his paper was the result of a great deal of study, especially in correlation with the work on longitudinal strength, dealt with in the paper by Mr. Turnbull [see pages 465 and 498, *ante*.—Ed., E.J.]. He thought that the instruments were natural and practical tools for ship-builders, who were concerned with both the construction and the propulsion of ships, and also for the classification societies, who would find the records valuable in framing future rules.

Dr. Villa, in reply to the discussion, thanked Professor Burrill particularly for the information he had given about developments in England in the field of the paper. He had followed them with great interest, and was glad to have the information given, some of which was new to him. Naval architects and engineers, in designing their ships and engines, were always trying to achieve higher speeds, and the measurement of the resultant vibrations was an important matter for the future.

(To be continued.)

TRACK-TESTING VEHICLE ON LOAN TO BRITISH RAILWAYS.—Arrangements have now been made for a Matisa-Mauzin track-testing vehicle (which was described on page 225 of our issue of August 22, 1952) to be lent to British Railways by the French National Railways. It is expected to arrive shortly by the Zeebrugge-Harwich ferry.

INCREASE IN FEES FOR MARINE SURVEYS.—The fees charged by the Ministry of Transport for marine surveys and for some other shipping services have been increased. The new fees will apply to all surveys for which application is made on or after November 19. The fees charged by Classification Societies for load-line surveys will also be increased from that date. The publication, *List of Fees and Expenses payable in Connection with Marine Surveys and other Mercantile Marine Services*, is now being reprinted and should be on sale from H.M. Stationery Office in a few weeks.

THE "CLEARCALL" RADIO COMMUNICATION SYSTEM.—The "Clearcall" ground-to-cab system of the British Thomson-Houston Co., Ltd., Rugby, has recently been installed in the melting shop of a large steel works to test its performance under the noisy conditions set up by a bank of eight open-hearth furnaces with their associated chargers and cranes. The equipment consists of microphone transmitters, placed near the furnace control panels, and loudspeakers on the crane. The output from the microphone is fed through a modulator to the crane feeder conductors, whence it is picked up by the cab collector arms, demodulated and reproduced in a horn loudspeaker in the cab. It has been found that there is no trouble from "static," nor fluctuation in volume.

STRESS-RELIEVING PLANT.—A new plant for stress-relieving iron castings is being installed at the Farington foundry of Leyland Motors, Ltd., which, when completed, will ensure an increased flow of cylinder blocks and heads to the company's engine factory. The new plant will consist of two large gas-fired furnaces which will be capable of dealing with 45 tons of iron castings during a 24-hour period; this is more than double the output of the existing coal-fired furnaces. The new furnaces are being supplied by Gibbons Brothers Ltd., and are designed so that the castings will be loaded into the ovens and removed mechanically. Normally, the furnaces will operate at a temperature of approximately 550 deg. C., but provision is being made for the operating temperature to be increased to 950 deg. C. so that they may be employed for annealing steel castings should the occasion arise.

THE BRITISH SCIENTIFIC INSTRUMENT RESEARCH ASSOCIATION.

For the first time in their history, the oldest of the co-operative research associations, the British Scientific Instrument Research Association (B.S.I.R.A.), recently held two "open days," on November 5 and 6, at their well-equipped laboratories at "Sira," Southill, Elmstead Woods, Chislehurst, Kent, to which guests from industry, Government departments, and the technical Press were invited to see some of the investigations and development work in progress. The British Scientific Instrument Research Association came into being in 1918 with a membership of nine firms, and was established at 26, Russell-square, London, W.C.1, where all the work of the Association was carried out until the move to the new laboratories, at "Sira," in 1947. During the first 20 years, there was no great expansion of membership, and activity was concentrated mainly on optical and electrical investigations. Some notable work was carried out during this period, among which may be mentioned the design of the $f/0.36$ object glass for the 100-in. reflecting telescope at Mount Wilson, California, and the development of photographic methods for producing gratings, which contributed greatly to the rapid production of precision optical measuring instruments during the recent war.

The membership of the Association increased rapidly when the rearmament programme was introduced in the late 1930's, and the expansion has continued, until to-day 120 firms, representing all sections of the instrument industry, are members of B.S.I.R.A. By the end of the war it was clear that the Russell-square premises were inadequate, and in 1946 the Association purchased, with the assistance of the Department of Scientific and Industrial Research, the present site at Elmstead Woods. This consists of a spacious house set in pleasant and extensive grounds. The laboratories are divided into seven departments—physics, chemistry, electrical instruments, electronic instruments, mechanical instruments, optical instruments, and photographic and optical processes. The information department and library are housed in a separate building in the grounds of "Sira"; and the computing section of the optical department and the offices of the Association are still in London, at 20, Queen Anne-street, W.1.

MECHANICAL DEPARTMENT.

In addition to its research laboratory, the mechanical department includes a drawing office and workshops, comprising a well-equipped machine shop and a sheet-metal shop, which serve the needs of the whole research staff. One of the principal investigations being carried out in the mechanical laboratory is an investigation of the effect, on the spherical grinding of glass with bonded diamond tools, of varying the work speed, the tool speed, the pressure on the work, and the rate of flow and type of cutting fluid. Fig. 1, on page 664, shows the experimental grinding rig.

An important investigation in progress is the determination of the flow characteristics and metering accuracy of sharp-edged orifices in pipes of diameter less than 2 in., where the surface roughness may be a significant factor. The exhibit illustrating this research was a 1-in. diameter pipe with a knurled bore, giving a reproducible degree of roughness, a standard orifice being inserted between two flanges. The process for knurling the pipe interiors has been developed in the machine shop from a process originated by the National Physical Laboratory; the pipe is mounted in an ordinary lathe, and a knurling tool is fed through the bore, the travelling motion being provided, through a linkage, by a falling weight. The latter can be varied as necessary to adjust the feed speed.

Also on view in the mechanical laboratory was an application of pneumatic gauging to measuring spherical surfaces, for the production-checking of lenses, in which the instrument is held to the surface of the lens by suction. Another pneumatic-gauging instrument was shown for comparing the thickness of a lens with a standard micrometer.

Methods of providing a small controlled air flow, for applications such as dust sampling, were also demonstrated. One such example was capable of controlling air flows from 2 cc. to 50 cc. per minute, and another could control down to $\frac{1}{2}$ cc. per minute.

ELECTRONICS DEPARTMENT.

The work on electronics is divided between two laboratories—the electronics laboratory and the electron-physics laboratory. The latter is concerned with investigating and improving the behaviour of oxide-coated cathodes, and is therefore equipped with apparatus for making electron tubes, as shown in Fig. 2 on page 664. On view in this laboratory was an emission-measuring set, using single square-wave pulses of short duration, and a disappearing-filament optical micro-pyrometer for examining cathode structures.

An example of the work of the electronics laboratory, of general engineering interest, is an instrument under development for the continuous thickness-gauging of non-ferrous metals, illustrated in Fig. 3 on page 664. It employs a differential transformer operating with a frequency of the exciting alternating current such that the material being gauged is completely penetrated. The presence of the material unbalances the detector, the amount of unbalance depending on the thickness. It is also sensitive to variations of distance of the detecting head, and means are therefore provided for maintaining the head at a constant distance from the object being gauged.

One of the main lines of investigation of the electronics department is voltage stabilisation, and several exhibits of this work were on view. One example is an alternating-voltage mains stabiliser with form-factor correction enabling the rectified mean and root-mean-square voltages to be stabilised simultaneously. The unit has a power output of 150 watts with the output voltage stable to within ± 0.2 per cent. for changes in line voltage of $\pm 12\frac{1}{2}$ per cent., frequency changes of ± 4 per cent., and load changes over a range of 3 to 1. Reduced input-voltage range or reduced output-power range improves the power-handling capacity and increases the efficiency; thus, with input variations limited to ± 5 per cent., the unit can handle 400 watts, and if the load is constant the output can be increased to 600 watts.

Among the other exhibits in the electronics laboratory should be mentioned an experimental direct-coupled thermionic-valve amplifier developed in the course of an investigation on direct-current thermionic-valve amplifier circuits. The unit on view is noteworthy for its frequency range and its low drift. It has the following characteristics: bandwidth, 20 kilocycles per second; input resistance, up to 100,000 ohms; total noise level, expressed as equivalent input, 30 microvolts; long-term random zero variations, over a continuous-run of 17 days, about 50 microvolts per hour for over 50 per cent. of the time; long-term zero drift over 17 days' continuous run, about 10 microvolts per hour. The instrument provides a 1 cm. deflection on its oscilloscope for a 500-microvolt input.

ELECTRICAL DEPARTMENT.

The two main activities of the electrical department are the development of transducers and magnetic amplifiers, and the investigation of the properties of temperature-sensitive magnetic materials. Such materials are used as compensators in electrical instruments, and in temperature-sensitive relays. Induction-temperature characteristics at varying field strength and in different directions of the material have been studied, and so also have the effects of bending, cutting, and chilling down to -85 deg. C. Some examples of the results for several materials were on view. It has been found that by using combinations of two different materials in parallel, it is possible to increase the temperature range and the linearity of the characteristic obtained.

As an example of work on transducers, a constant direct-current source was on view, in which the inherent properties of a transducer are employed to produce a sensibly constant output current over a range of input alternating voltage. With this instrument, output currents between

0.2 and 1 ampere can be obtained with a stability of 0.1 per cent. for a 10-per cent. change in mains input. With a 6.3-volt output the unit is suitable as a heater supply to several thermionic valves.

A two-stage magnetic amplifier, suitable for use with a thermocouple input, was also on view. It operates on a 50-cycle mains supply. Each stage consists of a balanced pair of self-excited transducers with overall negative feedback, which reduces variations due to supply voltage, increases the effective input resistance, and reduces the time constant. The unit has the following characteristics: input impedance, 350 ohms; input winding resistance, 20 ohms; output load resistance, 500 ohms; input voltage for full output, 4 millivolts; output current for full output, 5 milliamperes; long-term zero drift, less than 10^{-10} watts equivalent input.

Another investigation concerned the random failures of relay contacts of platinum-gold-silver alloy working under very light pressures. Dust concentration was found to have some effect when very light pressures were used, but at higher pressures it was concluded that some other effect was present, possibly the formation of a surface film on the contacts. This aspect is now being investigated.

PHYSICS DEPARTMENT.

In addition to the general physics laboratory, the physics department possesses a high-vacuum laboratory, illustrated in Fig. 4, on page 664, where optical components are coated by evaporation techniques. Some of the products developed by this means which were displayed included a reflecting heat filter, with a six-layer film, for use with cinema projectors; anti-reflection films, comprising a transparent film of magnesium fluoride about 1,000 Å. thick, which are now widely used in optical lenses and prisms to reduce the loss of contrast due to surface reflections; interference filters for visible light, giving relatively narrow transmission bands; and metal-on-glass mirrors, using rhodium evaporated from rhodium-plated tungsten filaments.

An interesting development in humidity measurement was displayed. Investigations are in progress on the use of porous ceramic blocks, a few cubic millimetres in volume, as compact highly-responsive humidity-sensitive elements, for use with remote-indicating instruments. The electrical resistance of such elements changes with varying humidity; for example, a typical element has a resistance of 10 megohms at 5 per cent. relative humidity, whereas at 95 per cent. relative humidity it drops to 0.1 megohm. At present B.S.I.R.A. are working on improving their stability; some elements have already shown calibrations stable within 3 per cent. relative humidity over a period of two months.

An investigation of importance to the electrical industry is concerned with reducing the "stickiness" of mercury in tilting switches and in capillary tubes. A laboratory still for producing "extra-pure" mercury for this investigation was demonstrated. A silver content of 1 part in 10^6 has been reduced to less than 1 part in 10^8 by this method. In addition to the use of purified mercury for reducing stickiness, it has been found that silicone-treating the glass container is also beneficial. This investigation is part of a research programme on the general properties of mercury in instruments.

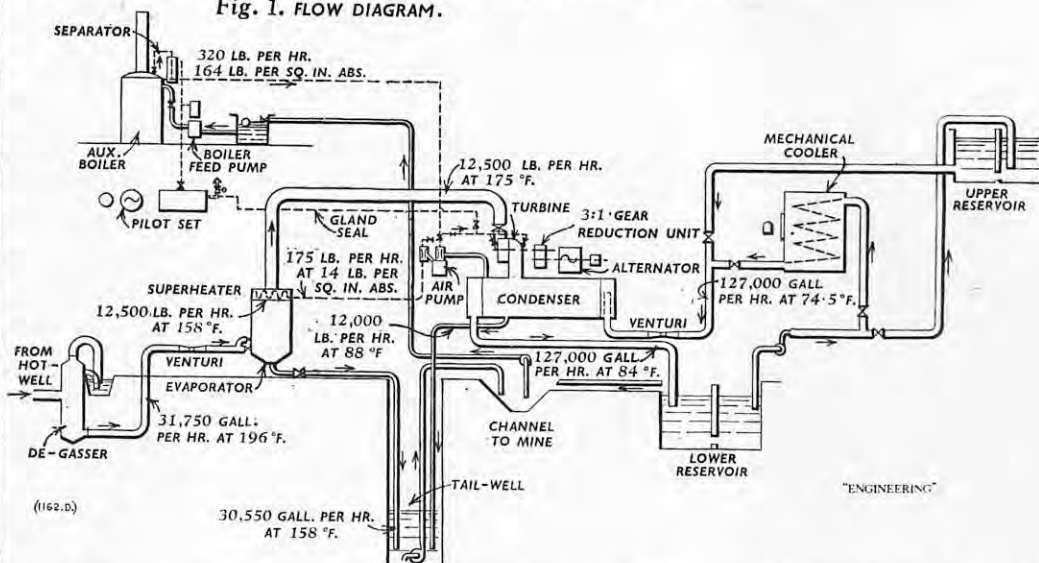
In order to provide data for manufacturers of thermocouples for furnace installations, the physics laboratory have developed a method for measuring the rate at which hydrogen penetrates the walls of refractory thermocouple sheaths. This is carried out by passing a stream of nitrogen through the sheath which collects any hydrogen diffusing through the wall. The concentration of the hydrogen in the gas stream is then measured by a thermal-conductivity gauge capable of reading down to 0.002 per cent. of hydrogen. The tube assembly is inserted in a tubular furnace, and it is thus possible to compare the permeabilities of sheath materials at temperatures in the region of 1,000 deg. C.

Among other researches displayed may be mentioned the production of single crystals of thallium bromo-iodide transparent to radiations in the infra-red region from 0.5μ to 40μ. Its mechanical properties and chemical resistance render the material highly suitable for optical components;

POWER GENERATION FROM A HOT SPRING.

BELLISS AND MORCOM, LIMITED, BIRMINGHAM.

Fig. 1. FLOW DIAGRAM.



it can be machined, ground, and optically polished. This research is sponsored by the Admiralty.

OTHER DEPARTMENTS.

Although the work of the chemical, optical instruments, and photographic and optical process laboratories does not lie directly within the scope of *ENGINEERING*, a brief summary is given of some aspects of their work which was on view. The chemical department showed the preparation of an optical cement, known as Gelva, that they have developed with some properties superior to those of Canada balsam. They have also developed polarising films on a flexible base, improved methods for glass analysis, and a filter for use with photo-electric cells to reproduce the visibility curve of the human eye. The optics laboratory demonstrated the testing of optical materials by interferometry, polarimetry, and microscopy. In the optical processes laboratory the exhibits comprised optical cements for a wide range of climatic conditions, pinhole-free silver mirrors, and the chemical etching of glass. Various methods for graticule production were on view in the photographic processes laboratory, and an apparatus for determining the weathering properties of optical glasses under tropical conditions was also displayed.

In addition to the preparation of a regular monthly abstract bulletin, and on bibliographies on request, and the provision of a library lending service, of which member firms are making considerable use, the information department is called upon to answer both technical and trade inquiries. For the latter purpose the department possesses a comprehensive trade-catalogue collection, including some early instrument catalogues published in the Nineteenth Century, some of which were on view.

SCHOLARSHIPS IN NAVAL ARCHITECTURE AND MARINE ENGINEERING.—Competitions for five university scholarships, value £175l. per annum and tenable for three or four years, will be held by the Institution of Naval Architects in 1953. Entries for the Institution of Naval Architects scholarship in naval architecture close on January 15, 1953; this scholarship is open to British shipyard apprentices or pupils under 23 years of age. Entries for the other four scholarships close on May 30, 1953; the Trewent scholarship in naval architecture is open to British private-shipyard apprentices or pupils under 19 years old. Two Denny scholarships, one in naval architecture and one in marine engineering, are open to British subjects under 19 who have not yet started their apprenticeship, or who have served not more than one year with William Denny & Bros., Ltd., Dumbarton; these scholarships are tenable for four years at Glasgow University, with five years' apprenticeship. The Parsons scholarship in marine engineering is open to British apprentices or pupils under 21 in marine engine works or the Royal Dockyards. Full particulars may be obtained from the secretary of the Institution, 10, Upper Belgrave-street, London, S.W.1.

POWER GENERATION FROM A HOT SPRING.

BUT few attempts have yet been made to utilise the latent energy available in the natural hot springs of the world, but the following article describes in detail a plant that has been designed and built to generate electrical power from a hot spring in the Belgian Congo. The peculiarities of the site concerned are particularly favourable to the development of a steam power plant, but the success achieved during the trials suggests that further attempts might well be made to utilise similar sources of energy.

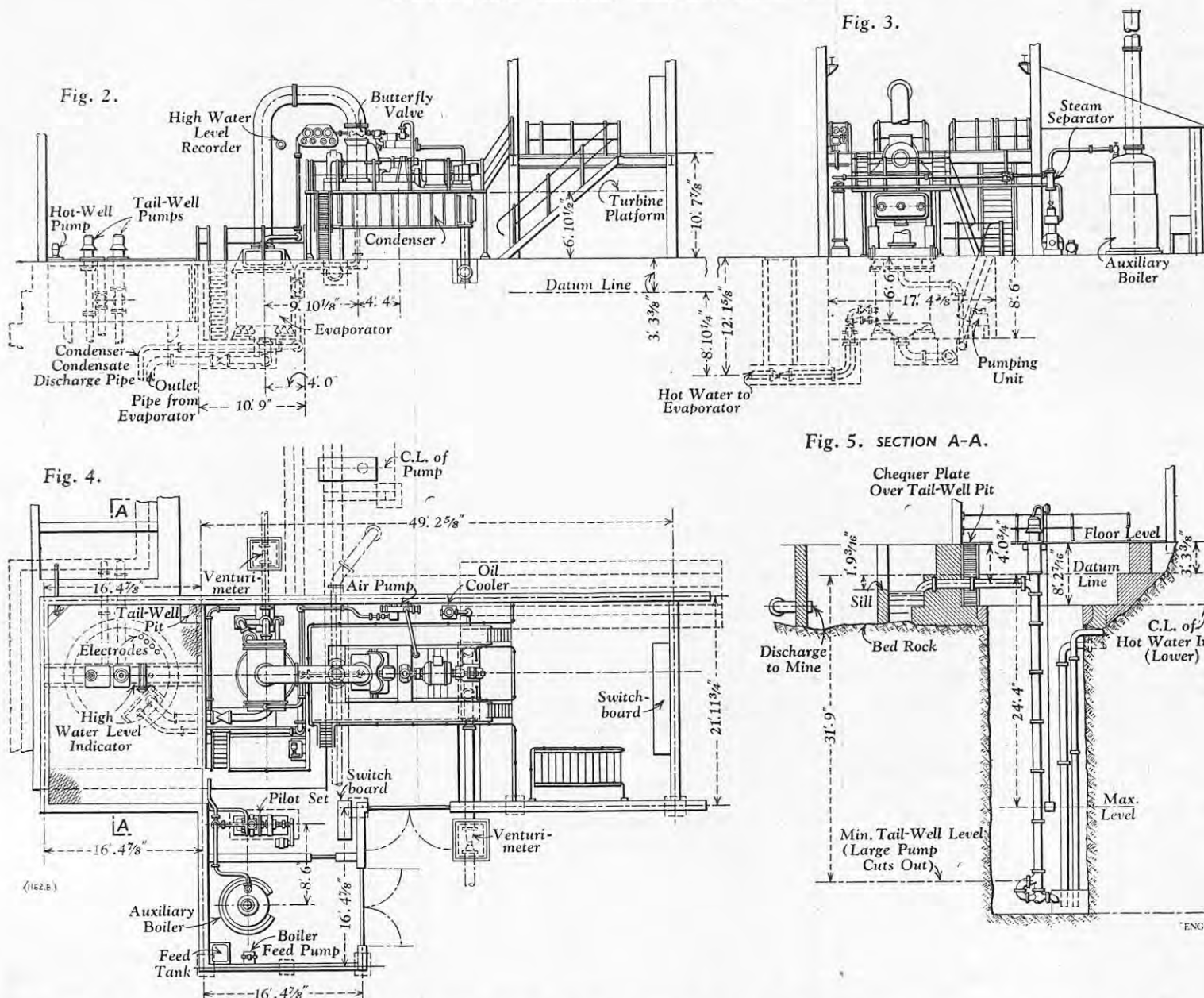
The plant that has been built, and is described below, is to supply power for a tin mine that is to be opened-up by the Société d'Exploitation et de Recherches Minières au Katanga in the Belgian Congo. Located in mountainous country, 2,500 ft. above sea level, the mine is 100 miles from the nearest settlement. It is intended to work the mine for 24 hours each day, and in consequence the power-generation plant will have to be in continuous operation, although there will be slacker periods during the night and at week-ends. The production of power from ordinary fuels such as coal, wood or oil would be very expensive as local fuel supplies are inadequate and the cost of transport of fuel to the site would be prohibitive. Fortunately, however, there is a hot spring close to the mine and the Société investigated the possibility of utilising this source of power in conjunction with cold water obtained from natural drainage.

Preliminary investigations showed that the quantity of hot water and its temperature were fairly constant at a given datum overflow level; local history confirms that the spring has been in existence from time immemorial, but even should the spring itself cease, a recent geological survey has shown that borings could be made that would tap an inexhaustible volume of hot water. The normal flow of the spring is approximately 31,750 gallons per hour at a temperature of 196 deg. F., but it has been found that the quantity of hot water and its temperature can both be increased by lowering the natural overflow level; by lowering the overflow by a few feet it is possible to increase the flow up to 55,000 gallons per hour, and raise the temperature to 200 deg. F. About 600 ft. away from the hot spring and about 20 ft. higher up the hillside, there is a cold-water lake, the size of which is dependent upon the rainfall; it is estimated, however, that for the greater part of the year, cold water at 74.5 deg. F. is available at the rate of 127,000 gallons per hour.

These were the natural resources that the Société wished to exploit for the continuous generation of power in order to work the mine, but some difficulty was experienced in finding a manufacturer who would consider the project. Messrs. Belliss

POWER GENERATION FROM A HOT SPRING.

BELLIS AND MORCOM, LIMITED, BIRMINGHAM.



and Morcom, Limited, Ledsam-street, Birmingham, however, undertook to build a plant depending upon these resources that would have a normal output of 220 kW with an overload peak of 275 kW.

As the quantity of cold water available depends upon the rainfall, provision had to be made to ensure a continuous supply during the dry season. In this respect the problem was eased by the natural contours of the ground, and it has been possible to construct a large reservoir at a slightly lower level than that of the power plant, the level being closely determined by the overflow level of the hot spring. The power demand will not be constant throughout the whole 24 hours, being greatest during the day shift and averaging 200 kW, while during the remaining 16 hours the load will fall to an average of 150 kW. Since the hot-water supply is continuous, surplus power is available during 16 hours, and this will be used for pumping back the cold water from the lower reservoir to the upper source. Three pumps are to be installed for this purpose, proportioned so that one or all of them can be used, depending upon the availability of water from the upper source. The areas of the upper and lower reservoirs have been fixed at 24,500 sq. ft. and 73,000 sq. ft., respectively, but although high air temperature does not coincide with high humidity, some form of additional cooling will probably be necessary, particularly as the cold supply in the upper reservoir may fail entirely in the dry season. To cover this eventuality, it has been thought advisable to install a forced-draught

water cooler at a level somewhat higher than the plant, so that the three circulating pumps can be used to pump water from the lower reservoir over the cooler instead of to the upper reservoir. The re-cooled water then gravitates through the plant back to the lower reservoir.

Having explained the conditions governing the hot and cold water supplies, the application of these to the production of power may next be considered. A flow diagram for the plant is given in Fig. 1, opposite, and the general arrangement is shown in Figs. 2 to 5, above. The hot-water inlet temperature is fixed and the exhaust-steam temperature from the turbine is limited by the outlet cold-water temperature. Obviously there must be some optimum value of the temperature drop of the hot water to produce the steam and the heat drop through the turbine to produce the power. The optimum temperature of steam generation at a load of 220 kW is 158 deg. F., corresponding to a vapour pressure of 4½ lb. per square inch absolute; after allowing for a drop of ½ lb. per square inch in the steam supply between the evaporator and the turbine, and a drop of ½ lb. per square inch across the turbine governor valve, the resulting pressure in the turbine chest at this load is 4 lb. per square inch absolute. The vacuum at the turbine exhaust is taken to be 28.64 in., with the barometer at 30.0 in. and the cold water at 74.5 deg. F.

One of the most important elements of the plant is the air pump, and the merits of the water-jet and the steam-jet air pumps had to be given careful

consideration. As no external electrical current is available, a pilot set is required for starting purposes and this might have been either oil- or steam-driven. As, however, oil would have to be transported to the site and as there is a small amount of wood fuel in the neighbourhood, steam pumps offered advantages over water-jet air pumps. Water-jet air pumps could be run from the main unit once the turbine had run up to speed but this would reduce the power available for the mine during the day shift, and the peak load was expected to reach the maximum obtainable from the hot water. In addition, the heat from the second-stage steam in a steam-jet air pump could be reclaimed and used in the steam supplied to the turbine by incorporating a superheater in the evaporator; this not only improves the turbine steam consumption, but also reduces the possibility of erosion on the turbine blades. For these reasons a steam-jet air pump was finally selected for producing the vacuum, the steam being obtained from a small wood-fired boiler.

(To be continued.)

WELSH IRON AND STEEL PRODUCTION.—The output of steel and pig iron in South Wales fell in October. The average weekly output of steel ingots and castings was 67,110 tons against 76,480 tons in September. Pig-iron production declined from a weekly average of 33,940 tons in September to 30,650 tons last month. The decrease was due to the strike at Port Talbot early in the month.

NOTES FROM THE INDUSTRIAL CENTRES.

SCOTLAND.

IRON AND STEEL PRODUCTION.—Reflecting an improved raw-material supply position, the output of steel ingots and castings in Scotland during October increased to an annual rate of 2,309,900 tons, compared with 2,214,200 tons in September. The corresponding figure in October last year was 2,147,800 tons. Scrap supplies improved, particularly from ship-breaking yards. Pig-iron production declined slightly, although the level was high having regard to the capacity of the furnaces in blast. The annual equivalent during the month was 878,900 tons, against 890,700 tons in September and 847,700 tons in October, 1951.

THORNTON MARSHALLING YARD.—British Railways, Scottish Region, announce that work is to commence shortly on the preliminary stages of a new marshalling yard at Thornton, Fife. The project has been estimated to cost some 750,000/. Thornton is the focal point of the principal part of the Fife coalfield. With connecting lines to the adjacent Rothes Colliery, now under construction, the new yard at the outset will have 20 sorting sidings, each having a standing capacity for 60 wagons. Later, the number of sorting sidings will be increased to 35.

OBAN RESERVOIR.—Reconstruction of the dam at Oban Reservoir has been completed. After the work began, two years ago, the engineers found it necessary to rebuild the dam from the old foundations to stop wastage through leakage. This has been reflected in a final cost of 62,000/., compared with the initial estimate of 30,000/.. The reservoir is expected to reach its full capacity of 200,000,000 gallons by the spring of 1953.

THE LATE MR. A. M. WILSON.—The death is reported, on November 7, of Mr. Allan Murray Wilson, founder of the firm of Clyde Blowers, Ltd., Clydebank. Initially an importer of Continental engineering specialties, he developed an extensive business in the manufacture of soot-blowing equipment for land and marine boiler plant.

CLEVELAND AND THE NORTHERN COUNTIES.

TEES-VALLEY WATER SUPPLIES.—Alderman C. W. Allison, chairman of the Tees Valley Water Board, said, at the Board's annual meeting in Middlesbrough on November 10, that Tees-side would be sure of an adequate water supply for the next quarter of a century at least when the new reservoir at Selsat was completed. He added that the Board were considering a Bill to be submitted to Parliament, seeking authority to proceed with plans for the construction of the reservoir and other work, at a total cost of more than 7,000,000/.. The reservoir will be between Middleton-in-Teesdale and Brough.

SHIPBUILDING ON THE WEAR.—The last launches on the River Wear, for this year, have been arranged, and provisional figures show that the output for the year will be 25 ships, totalling about 168,000 gross tons, compared with 28 vessels making together 197,920 tons last year. These are the lowest figures since 1939, when 24 ships aggregating 122,745 tons entered the water. The fall this year is attributed entirely to the difficult steel position.

GERMAN COMPETITION IN EXPORT MARKETS.—Mr. B. Porter, northern regional secretary of the Engineering Industries' Association, who is carrying out a survey of the export-trading difficulties experienced by North-Eastern firms, states that Germany is carrying out a nationally-organised offensive on the export trade. German exporters, he adds, are subsidised by their Government and are receiving the co-operation of German trade unions, which are making few demands for higher wages.

COLLIERY UNDERGROUND RAILWAY.—Work has commenced on the building of an underground railway at Watergate Colliery, Co. Durham, to take men from the shaft bottom to the working face. The line will be about two miles long and will take about six months to complete. Diesel locomotives will be used.

THE LATE MR. J. W. HARRISON.—Mr. James W. Harrison, of Darlington, managing director of Darlington and Simpson Rolling Mills, Rise Carr, Darlington, has died in hospital at the age of 64. He was due to retire shortly. Mr. Harrison had been connected with the company for 42 years, and was formerly a member of Darlington Town Council.

THE LATE MR. G. R. DENNEY.—Mr. George Rawling Denney, of Middleton-in-Teesdale, who was appointed managing director of Westool, Ltd., engineers, Bishop Auckland, County Durham, six years ago, has died in hospital at Newcastle-on-Tyne at the early age of 50. He was an accountant and had been previously accounting officer to the Federation of British Industries, London.

LANCASHIRE AND SOUTH YORKSHIRE.

SHEFFIELD STEEL.—During October, the Sheffield steel industry produced an average of 47,600 tons of ingots and castings weekly. This was less than the average for September, which was 47,900 tons, but it was over 5,000 tons a week more than the figure for October last year, when the average weekly figure was 42,500 tons.

HIGH COAL OUTPUT.—Yorkshire collieries, in the week ended November 8, produced 1,045,000 tons of coal, the highest output in a normal week since the nationalisation of the mines. The total was 9,000 tons more than the previous week and was the eighth weekly period in which the million tons mark has been passed. The output of the six South Yorkshire areas of the North-Eastern Division was 804,477 tons.

SHEFFIELD EMPLOYMENT.—The latest returns show that the percentage of unemployment in Sheffield is less than half the national average of 1.9 per cent. The number of men temporarily stopped by Sheffield firms, chiefly in the cutlery industry, has fallen from 294 to 201. Men wholly unemployed are fewer; the number has dropped from 1,270 to 1,222, although the number wholly unemployed in the heavy industries of Attercliffe has risen from 96 to 121.

AUSTRALIAN IMPORT RESTRICTIONS.—Sheffield manufacturers are anxious to obtain fuller information concerning the easing of Australian import restrictions which caused a serious situation in the hand-tool and cutlery industries when they were imposed some little time ago. Some firms had large stocks on their way to Australia when the order came into force and they are trying to ascertain the effect of this in view of the new import quotas.

THE MIDLANDS.

EXPORTS TO AUSTRALIA.—The news that there is to be some relaxation of the Australian ban on imports from this country is welcomed in Birmingham and the Black Country. The area has not yet felt the full effect of the Australian restrictions, but signs have not been wanting that some reduction in output was likely. The motor-car trade has been affected badly by the import cuts, and several manufacturers have been told that production schedules might have to be altered at as little as three days' notice. Relaxation of the Australian import ban, if it operates on a large enough scale, may prevent redundancies.

ELECTRIC ANNEALING OF MALLEABLE CASTINGS.—H. & J. Hill Ltd., malleable ironfounders, Walsall-road, Willenhall, Staffordshire, have installed an electric furnace for annealing malleable castings. The installation, which has cost 20,000/., replaces nine coal-fired furnaces of the traditional type, and is the first of its kind in the area. The company are also installing new cupolas with spark arrestors. The town of Willenhall suffers from atmospheric pollution to the extent of about 30 tons per month per square mile, and the local authorities are hoping that other manufacturers in the town will install similar plant.

GAS PRODUCTION.—The annual report of the West Midlands Gas Board, which covers the year ended March 31, 1952, shows that, during that period, carbonising capacity was increased by nearly 7,000,000 cub. ft. a day. This, with the increases during the two previous years, represents an addition of one-seventh to the capacity of the various plants at the date when the Board took them over. Further additions to plant will add another 82,000,000 cub. ft. to the daily manufacturing capacity, but the Board report that progress in the work of erecting new plant has been delayed by the shortage of steel.

REMOVAL OF INDUSTRIAL BUILDING.—A contract has been placed with Carter-Horseley (Engineers) Ltd., Tipton, to dismantle the cast-house at Level New Furnaces, Brierley Hill, and re-erect it at the works of British Federal Welders, Ltd., Dudley. The cast-house, which is a large building of structural steel, is all that now remains of the No. 3 blast furnace, which was built during the war but never blown in.

SAFETY EXHIBITION.—In view of the success of the safety exhibition held at Bingley Hall, Birmingham, last year, the Birmingham and District Safety Group have decided to hold another exhibition in the same place next June. Next year's exhibition will be wider in scope, and while it is open, the group will hold a conference on industrial safety and health training. The chairman of the organising committee is Mr. R. Bramley-Harker, H.M. Superintending Inspector of Factories, South Midland Region, Somerset House, Temple-street, Birmingham, 2.

GOODYEAR TYRE AND RUBBER COMPANY.—On December 15, the Goodyear Tyre and Rubber Co. (Great Britain), Ltd., will celebrate the 25th anniversary of the opening of their Wolverhampton factory. The company took over an existing factory at Bushbury, Wolverhampton, in July, 1927, and in December of that year started the production of rubber tyres. Since then, other products have been added to the list of goods made at Bushbury, and the works are now one of the largest employers of labour in the town. By January, 1952, 22,000,000 tyres had been produced.

NEW FOUNDRY FOR GEORGE KENT, LTD.—On August 5, the first casting was produced in the non-ferrous foundry at the new Lea Works, Luton, of George Kent, Ltd. The new foundry, which occupies 20,000 sq. ft., produces 15 tons of sand castings a week in sizes ranging from a few ounces to 3,000 lb., in various alloys. It is highly mechanised, with modern sand-handling and reclamation plant. The Lea Works, it is intended, will concentrate on the manufacture of Kent small mechanical meters for water, oil and petrol.

PROPOSALS FOR A NEW GAS GRID.—Suggestions for the construction of a gas-grid system to convey coke-oven gas from the Midlands to the area of the Eastern Gas Board are now under active consideration by the Board, according to a statement made by Sir John Stephenson, the Board's chairman, on Monday last. Speaking at a meeting of the Eastern Gas Consultative Council in London, Sir John said that if the plans for the new grid were put into effect, the problem of peak demands for gas should be largely solved. These demands would otherwise involve the installation of additional plant of a very costly nature.

SOUTH-WEST ENGLAND AND SOUTH WALES.

INCREASED PRODUCTION AT LLANDARCY.—New refining plant, which has been under construction for two years and has cost nearly 2,000,000/., will shortly come into operation at Llandarcy, where it will increase the output of the Anglo-Iranian Oil Company's refinery by about 250,000 gallons of petrol per day. It has been designed principally to produce the premium grade of petrol which will be on sale next February.

DRY DOCK AT CARDIFF.—Support for the suggestion that a new large dry dock should be built at Cardiff has been forthcoming from the Cardiff Pilotage Authority. Following a full discussion, the general view is that such a dock is essential to the port and it has been decided to ask the Cardiff Port Development Association to pursue the matter actively.

ELECTRICITY SUPPLIES IN CARMARTHENSHIRE.—A survey of public-utility services, prepared as part of Carmarthenshire's development plan, states that, with the completion of the new Carmarthen Bay power station within the next five years, ample supplies of electricity would be available; though large areas of the county near the source of supply will be unable to benefit for many years. The cost of the main distributive network for the South Wales rural area is estimated to be about 15,000,000/.. The initial programme, approved by the South Wales Electricity Consultative Council, is estimated to cost 300,000/.. and is expected to be carried out in two years.

TRADE AT SOUTH WALES PORTS.—Docks and Inland Waterways Executive statistics, which cover the trade of the South Wales ports from January 1 to November 2 this year, show that a total tonnage of 19,076,096 tons was handled, compared with 17,170,191 tons in the corresponding period of 1951. Of the total, Swansea dealt with 9,717,002 tons which was more than the total of all the other ports put together. The chief reason for Swansea's big increase is the growth of the oil trade. Iron-ore imports at all the ports increased from 1,661,163 tons in 1951 to 1,857,398 tons this year and those of iron and steel from 432,585 tons to 622,105 tons. Shipments of partly manufactured iron and steel goods were 188,667 tons against 224,255 tons, but tin-plate exports were up by 42,318 tons to 216,307 tons.

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.

INSTITUTION OF ELECTRICAL ENGINEERS.—Radio Section: Monday, November 24, 5.30 p.m., Victoria-embankment, W.C.2. "Recent Progress in Radar Duplexers, with Special Reference to Gas-Discharge Tubes," by Mr. P. O. Hawkins. **North-Eastern Centre:** Monday, November 24, 6.15 p.m., Neville Hall, Newcastle-upon-Tyne. "Uses of Earthed Signal Conductors on Transmission Circuits," by Mr. W. Casson. **North-Western Centre:** Monday, November 24, 7.30 p.m., Free Trade Hall, Manchester. Faraday Lecture on "Light from the Dark Ages or the Evolution of Electricity Supply," by Mr. A. R. Cooper. **London Students' Section:** Tuesday, November 25, 7 p.m., Victoria-embankment, W.C.2. "The Measurement of Very Small Direct Currents," by Mr. M. W. Jervis. **Supply and Measurements Sections:** Wednesday, November 26, 5.30 p.m., Victoria-embankment, W.C.2. (i) "The Electrolytic Analogue in the Design of High-Voltage Power Transformers," by Mr. D. McDonald. (ii) "The Accurate Mapping of Electric Fields with an Electrolytic Tank," by Dr. K. F. Sander and Mr. J. G. Yates. **South Midland Centre:** Wednesday, November 26, 7.15 p.m., Winter Gardens Restaurant, Malvern. "The Measurement of Electrical Activity in the Human Body," by Mr. J. C. Shaw.

INSTITUTION OF PRODUCTION ENGINEERS.—Sheffield Section: Monday, November 24, 6.30 p.m., Royal Victoria Station Hotel, Sheffield. Discussion on "Apprentice Training." **Luton Section:** Tuesday, November 25, 7.15 p.m., Town Hall, Luton. "A Recent Advance in Plastics," by Mr. E. M. Elliott. **Wolverhampton Graduate Section:** Tuesday, November 25, 7.30 p.m., Star and Garter Royal Hotel, Wolverhampton. "Textile Production Engineering," by Mr. G. A. D. Coghlan. **Shrewsbury Section:** Wednesday, November 26, 7.30 p.m., Technical College, Shrewsbury. "History and Development of the Tube Industry," by Mr. C. G. Goldsworthy. **Lincoln Section:** Wednesday, November 26, 7.30 p.m., Canteen, Ruston and Hornsby, Ltd., Boultham Works, Lincoln. "Production Management's Responsibility for Productivity," by Mr. B. H. Dyson. **South Wales Section:** Thursday, November 27, 6.45 p.m., South Wales Institute of Engineers, Park-place, Cardiff. Discussion on "Metal Finishing." **Institution:** Thursday, November 27, 7 p.m., Royal Empire Society, Northumberland-avenue, W.C.2. "Management Accounting and the Production Engineer," by Mr. H. H. Norcross.

INCORPORATED PLANT ENGINEERS.—West and East Yorkshire Branch: Monday, November 24, 7.30 p.m., University, Leeds. Film on "Conveyors." **South Yorkshire Branch:** Thursday, November 27, 7.30 p.m., Grand Hotel, Sheffield. "Radiology and Its Uses in Steelworks," by Mr. F. Hinsley.

ASSOCIATION OF SUPERVISING ELECTRICAL ENGINEERS.—Bournemouth Branch: Monday, November 24, 8.15 p.m., Grand Hotel, Bournemouth. Discussion on "The Formation of Ducts in Concrete Non-Expendable Material." **York Branch:** Tuesday, November 25, 7.30 p.m., Creamery Restaurant, Pavement, York. "Production and Application of Toughened Glass," by Mr. P. M. Davidson. **Luton Branch:** Wednesday, November 26, 8 p.m., George Hotel, Luton. "A Camera and the Engineer," by Mr. G. E. Whalley.

CHADWICK TRUST.—Tuesday, November 25, 2.30 p.m., Royal Sanitary Institute, 90, Buckingham Palace-road, S.W.1. "History of the Main Drainage of London," by Mr. J. Rawlinson.

INSTITUTION OF CIVIL ENGINEERS.—Road Engineering Division: Tuesday, November 25, 5.30 p.m., Great George-street, S.W.1. "Soil Stability Problems in Road Engineering," by Mr. R. Glossop and Mr. G. C. Wilson. **Midlands Association:** Wednesday, November 26, 7 p.m., Loughborough College, Loughborough. "Highway Design and Layout," by Mr. R. W. Grigson. **Yorkshire Association:** Thursday, November 27, 6.30 p.m., Blue Bell Hotel, Scunthorpe. Joint Meeting with the INSTITUTION OF STRUCTURAL ENGINEERS (Yorkshire Branch). "The Plastic Theory and Its Application to the Design of Mild Steel Beams and Rigid Frames," by Mr. F. A. Partridge.

INSTITUTE OF FUEL.—Tuesday, November 25, 5.30 p.m., Institution of Mechanical Engineers, Storey's-gate, St. James's Park, S.W.1. "Experiments on the Sampling of Coal," by Mr. E. H. M. Badger. **East Midland Section:** Thursday, November 27, 6.15 p.m., Gas Show-rooms, Nottingham. "Some Aspects of the Work of the British Coal Utilisation Research Association," by Mr. R. L. Brown.

ILLUMINATING ENGINEERING SOCIETY.—Cardiff Centre: Tuesday, November 25, 5.45 p.m., Offices of the South Wales Electricity Board, Cardiff. "Lighting of Modern Ocean Liners," by Mr. T. Catten. **London:** Wednesday, November 26, 6 p.m., Lighting Service Bureau, 2, Savoy-hill, W.C.2. Discussion on "Home Lighting."

INSTITUTION OF HEATING AND VENTILATING ENGINEERS.—South Western Branch: Tuesday, November 25, 6.30 p.m., G.E.C. Building, Cathays Park, Cardiff. "The Impact of Environmental Warmth upon Personnel in Industry," by Mr. F. R. L. White.

SOCIETY OF INSTRUMENT TECHNOLOGY.—Tuesday, November 25, 7 p.m., Manson House, 26, Portland-place, W.1. Symposium on "Control Valves."

INSTITUTE OF ROAD TRANSPORT ENGINEERS.—North East Centre: Tuesday, November 25, 7 p.m., County Hotel, Newcastle-upon-Tyne. "Fleet Maintenance on a Large Scale," by Mr. W. R. T. Thomas. **Western Centre:** Thursday, November 27, 7.30 p.m., Grand Hotel, Bristol. Brains Trust Meeting.

IRON AND STEEL INSTITUTE.—Wednesday, November 26, 10 a.m. and 2.30 p.m.; and Thursday, November 27, 10 a.m., 4, Grosvenor-gardens, S.W.1. Autumn Meeting. For programme, see page 613, ante.

ROYAL UNITED SERVICE INSTITUTION.—Wednesday, November 26, 3 p.m., Whitehall, S.W.1. Colour Films: "Exercise Mainbrace" and "S.B.A.C. Air Display, Farnborough, 1952," presented by Mr. William Courtenay.

INSTITUTION OF MECHANICAL ENGINEERS.—Yorkshire Branch: Wednesday, November 26, 6.30 p.m., University, Sheffield. Thomas Hawksley Lecture: "The Mechanism of Work-Hardening in Metals," by Professor N. F. Mott, F.R.S. **Southern Branch:** Wednesday, November 26, 7.30 p.m., R.A.E. College, Farnborough. "Some Fuel and Power Projects," by Dr. H. Roxbee Cox. **Institution:** Friday, November 28, 5.30 p.m., Storey's-gate, St. James's Park, S.W.1. Joint Meeting with the *Education and Hydraulics Groups*. "Instruction and Research in Hydraulic Laboratories," by Mr. Herbert Addison. **AUTOMOBILE DIVISION.—Birmingham Centre:** Tuesday, November 25, 6.45 p.m., James Watt Memorial Institute, Birmingham. (i) "Utilisation of Anti-Knock Quality in Automobile Engines," by Mr. J. D. Davis; (ii) "Developments in 'Knock' Research," by Mr. D. Downs and Mr. R. W. Wheeler; and (iii) "Significance of Octane Numbers in Relation to Road Performance," by Mr. H. J. Eatwell and Mr. J. G. Withers. **Western Centre:** Thursday, November 27, 6.45 p.m., Grand Hotel, Bristol. "Changing Practice of Automobile Engineering," by Mr. Maurice Platt.

MANCHESTER METALLURGICAL SOCIETY.—Wednesday, November 26, 6.30 p.m., Engineers' Club, Manchester. "Uses of Tin in Industry," by Dr. J. W. Cuthbertson.

ENGINEERS' GUILD.—West Midlands Branch: Wednesday, November 26, 6.45 p.m., Imperial Hotel, Birmingham. "The Relation Between a Consulting Engineer and His Client," by Major A. H. S. Waters.

ROYAL STATISTICAL SOCIETY.—Birmingham Industrial Applications Group: Wednesday, November 26, 6.45 p.m., 95, New-street, Birmingham. "Analysis and Cost of Labour Turnover," by Mr. J. Murdoch.

INSTITUTE OF BRITISH FOUNDRYMEN.—Birmingham, Coventry and West Midlands Branch: Wednesday, November 26, 7.15 p.m., James Watt Memorial Institute, Birmingham. "The 'C' Process of Moulding," by Mr. J. Butler. **Falkirk Section:** Friday, November 28, 7.30 p.m., Temperance Café, Lint Riggs, Falkirk. "Controlling the Structure and Composition of Cast Iron by the Use of Ferro-Alloys," by Mr. H. P. Hughes.

ROYAL AERONAUTICAL SOCIETY.—Thursday, November 27, 6 p.m., Institution of Mechanical Engineers, Storey's-gate, S.W.1. "Photoelasticity and Aircraft Research," by Colonel H. T. Jessop.

SOCIÉTÉ DES INGÉNIEURS CIVILS DE FRANCE (BRITISH SECTION).—Thursday, November 27, 6 p.m., 11, Upper Belgrave-street, W.1. Joint Meeting with the INSTITUTION OF STRUCTURAL ENGINEERS. "An Introduction to Vacuum Concrete," by Mr. I. Leviant.

INSTITUTE OF WELDING.—Medway Section: Thursday, November 27, 7.15 p.m., Sun Hotel, Chatham. Film Evening.

SHEFFIELD METALLURGICAL ASSOCIATION.—Thursday, November 27, 7.30 p.m., Grand Hotel, Sheffield. "The Direct Reading Spectrometer," by Dr. A. Hasler.

INSTITUTION OF ENGINEERING INSPECTION.—North-Western Branch: Thursday, November 27, 7.30 p.m., Engineers' Club, Manchester. "Measurement Standards," by Mr. J. Parker.

INSTITUTION OF STRUCTURAL ENGINEERS.—Midland Counties Branch: Friday, November 28, 6 p.m., James Watt Institute, Birmingham. "Tubular Structures," by Mr. E. McMinn.

NORTH EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.—Friday, November 28, 6.15 p.m., Neville Hall, Newcastle-upon-Tyne. Annual Meeting. "Springs," by Mr. W. E. Frost.

MANCHESTER ASSOCIATION OF ENGINEERS.—Friday, November 28, 6.45 p.m., Engineers' Club, Manchester. "Economic Review," by Mr. A. Elliott.

JUNIOR INSTITUTION OF ENGINEERS.—Friday, November 28, 7 p.m., Townsend House, Greycoat-place, Westminster, S.W.1. Annual Meeting.

PERSONAL.

REAR-ADMIRAL (E) F. T. MASON has been appointed Engineer-in-Chief of the Fleet, in succession to Vice-Admiral (E) the Honourable SIR DENIS E. MAXWELL, K.C.B., C.B.E. The appointment will take effect about the end of April, 1953.

AIR COMMODORE E. R. PEARCE, O.B.E., B.Sc., has been appointed North American sales representative for the aero-division of Rolls-Royce Ltd., and will be stationed with Rolls-Royce of Canada Ltd.

MR. JACK DIAMOND, M.Sc., B.Sc. (Eng.) (Lond.), Wh.Sc., A.M.I.Mech.E., a senior principal scientific officer, Atomic Energy Research Establishment, Harwell, has been appointed by the Council of the University of Manchester to be the first holder of a Chair of Mechanical Engineering which has recently been established in the Faculty of Science. The new chair is in addition to the Beyer Chair of Engineering, founded in 1868, and the Chair of Electro-Technics, founded in 1912, in the Faculty of Science.

LT.-COL. E. W. EAGERS, O.B.E., M.I.Mech.E., has been appointed plant superintendent with Melville, Dundas and Whitson Ltd., Glasgow.

MR. J. G. STEPHEN, a director of Alexander Stephen & Sons, Ltd., has been elected President of the Shipbuilding Employers' Federation, in succession to Mr. A. L. COCHRANE, chairman and managing director of Cochrane & Sons, Ltd. Mr. T. EUSTACE SMITH, managing director of Smith's Dock Co., Ltd., becomes senior vice-president. Mr. C. A. WINN, joint managing director of C. H. Bailey Ltd., and Mr. HORACE WILLSON, chairman and managing director of William Hamilton & Co., Ltd., have been elected vice-presidents. Mr. H. H. HAGAN, director of Lobnitz & Co. Ltd., has been elected chairman of the Conference and Works Board, and Mr. R. CYRIL THOMPSON, chairman and joint managing director of J. L. Thompson & Sons, Ltd., vice-chairman of this Board.

MR. JAMES MACALISTER, M.I.C.E., M.I.W.E., engineer, Corporation Waterworks, Greenock, Renfrewshire, is retiring on November 27.

CAPTAIN (E) M. LUBY, R.N. ret., M.I.Mech.E., has been appointed director and general manager of Rotax Ltd., and a director of Joseph Lucas (Gas Turbine Equipment) Ltd.

DR. F. A. FOX, F.I.M., has joined the Australian Government Department of Supply as superintending scientist in charge of the Department's chemical and physical research laboratories, Maribyrnong, Melbourne. His address after January 4, 1953, will be: c/o Department of Supply, 339, Swanston-street, Melbourne, Australia.

MR. HAROLD BURKE, a director of Concentric Manufacturing Co. Ltd., Priory-road, Birmingham, 6, has been appointed joint managing director of the firm with Mr. S. G. MORGAN, the former managing director. Mr. THOMAS MILLER, managing director of Rowmill Metals Ltd., has been appointed a director.

MR. ERIC N. SIMONS, publicity manager to Edgar Allen & Co., Ltd., and co-author with Dr. Edwin Gregory of the book, *Steel Manufacture Simply Explained*, and similar works, has accepted the invitation of the British Broadcasting Corporation to join the Corporation's new North Regional Council.

MR. S. J. CLARKE, T.D., who until recently was manager of the Swansea district office of the British Thomson-Houston Co., Ltd., Rugby, has been appointed manager of the company's Newcastle-upon-Tyne district office, in succession to Mr. F. C. BARFORD, who will be taking up another position with the company shortly. As announced on page 503, ante, Mr. Clarke has been succeeded at Swansea by Mr. K. M. Fox.

MR. G. C. TOMLINSON, a teacher at the Howard and Bullough Works School, Accrington, has been appointed to the Colonial Engineering Service as a technical instructor in Aden.

MR. VAL CRONSTEDT has been appointed director of engineering of the gas-turbine division of A. V. Roe Canada Ltd., Malton, Ontario, Canada. He will be closely concerned with the production of the Orenda jet engine, the power plant of the Avro Canada CF100 fighter aeroplane.

DR. W. H. KELLER has been appointed director of the Chemistry Department at the National Research Corporation, 70, Memorial-drive, Cambridge, Massachusetts, U.S.A.

On and from Tuesday, November 25, the address of the NATIONAL BRASSFOUNDRY ASSOCIATION will be 4, Calthorpe-road, Five Ways, Edgbaston, Birmingham, 15. (Telephone: EDGBASTON 2177-2178.)

BRITISH ELECTRONIC PRODUCTS (1948) LTD., which became one of the subsidiary companies of the Lancashire Dynamo Group in the early part of 1950, have now changed their name to LANCASHIRE DYNAMO ELECTRONIC PRODUCTS LTD. The address, namely, B.E.P. Works, Rugeley, Staffordshire, is unchanged.

THE BRITISH SCIENTIFIC INSTRUMENT RESEARCH ASSOCIATION.
(For Description, see Page 659.)



FIG. 1. TEST RIG FOR INVESTIGATION OF GLASS GRINDING.

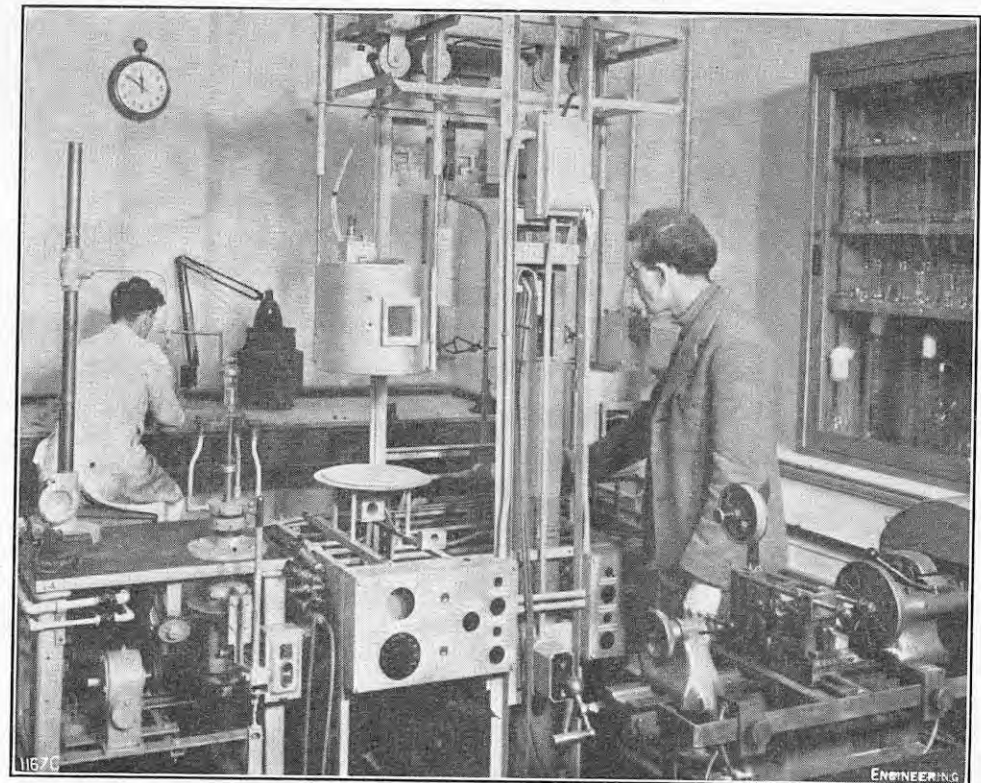


FIG. 2. THERMIONICS LABORATORY.



FIG. 3. THICKNESS GAUGE FOR NON-FERROUS METALS.

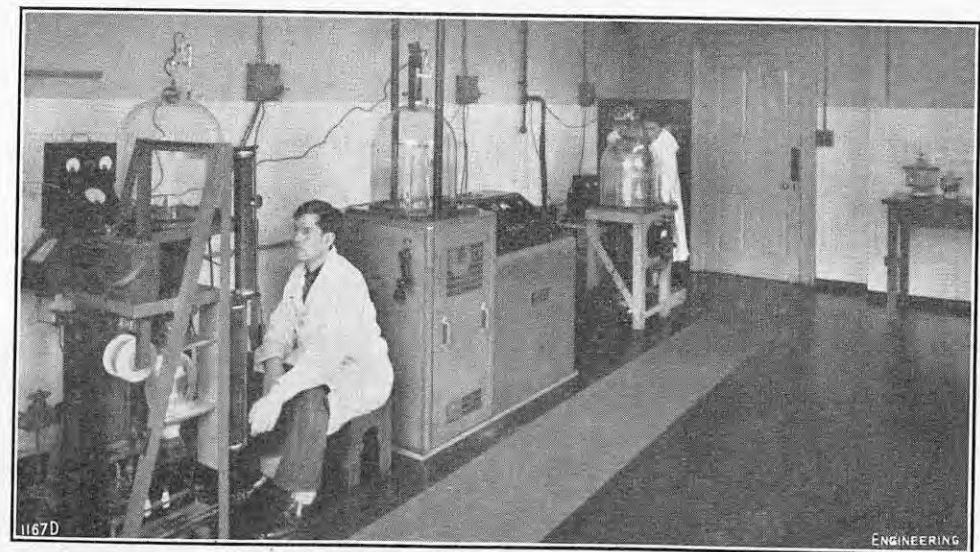


FIG. 4. HIGH-VACUUM LABORATORY.

ENGINEERING

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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 $2\frac{1}{4}$ 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 an 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; $12\frac{1}{2}$ per cent. for thirteen; 25 per cent. for twenty-six; and $33\frac{1}{3}$ 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.

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ENGINEERING

FRIDAY, NOVEMBER 21, 1952.

VOL. 174.

No. 4530.

THE TRANSPORT BILL.

THE debate on the Second Reading of the Government's Transport Bill in the House of Commons on November 17 and 18 may have been a necessary item of Parliamentary procedure, but it was not notably stimulating as a discussion of a measure that, if passed, will certainly affect to some extent the greater part of the population of this country. The introduction of the motion, by the Minister of Transport (Mr. Alan Lennox-Boyd, M.P.), "That the Bill be now read a second time," was a reasonable argument enough, and reads fairly smoothly and connectedly in the columns of *Hansard* in spite of sundry interruptions. It would be idle to pretend that the Bill satisfies everybody, even among the Government supporters, but it is an improvement on the earlier version and may be improved much more in "committee of the whole House," to which it was committed on the conclusion of the debate. No doubt, the report of those proceedings will be more satisfying, and the comments of the Members much more to the point, than can be said of the Second Reading debate, which conveys the impression that nobody, except the Minister, was taking the matter very seriously; that the Opposition opposed as a principle and not from any deep conviction that they were right and the Bill was wrong; and that, in their heart of hearts, some

of them were decidedly lukewarm about the practical merits of nationalised and integrated transport.

The main purposes of the Bill are "To require the British Transport Commission to dispose of the property held by them for the purposes of the part of their undertaking which is carried on through the Road Haulage Executive; to amend the law relating to the carriage of goods by road and to provide for a levy, for the benefit of the said Commission and for other purposes, on motor vehicles used on roads; to provide for the re-organisation of the railways operated by the said Commission and to amend the law relating to the powers, duties and composition of the said Commission . . ." and sundry other matters which require detailed reference to the Transport Act, 1947, and the Cheap Trains Act, 1883. It is seldom safe, of course, to dismiss as trivial any such apparently incidental provisions—they may prove, on examination, to be the tail that may eventually wag the dog.

The primary point in the Bill is that it sweeps away the British Transport Commission's virtual monopoly of long-distance road haulage, while leaving them free to engage in it on a competitive basis. They are required (to quote the explanatory memorandum) "to invite tenders for the purchase of the road haulage property" which they possess at present; but they may still "set up companies to engage in road haulage . . . and transport units may be made over to them or to other companies under the control of the Commission up to a limited amount." The purchasers of the Commission's fleets of road-haulage vehicles will be required to pay a levy to cover (in the Minister's words) "payment for any loss of goodwill that the sale may occasion, compensation . . . to those displaced who qualify, and a fixed sum to the Commission for the disturbance of their activities during the transition." These powers, taken in conjunction, would seem to indicate that the Commission would be able to dispose of their part-worn vehicles to private owners, collect compensation in addition in the form of a levy, and then, if they so desire, equip themselves with new fleets wherewith to compete with the part-worn vehicles that they have sold.

The method of calculating the levy is, perhaps, a little outside of the purview of this journal, but it may be of interest to note that, according to Clause 10 of the Bill, it "shall be charged for the periods covered by the licences taken out in respect of the vehicle in question . . . and the amount charged by way of the levy for any such period shall be the amount by which the excise duty payable upon that licence would be increased by the amount arrived at by multiplying the unit charge, as defined in subsection (3) of this section, by the appropriate multiplier, as defined in subsection (4) thereof." That clause in itself seems to provide sound reasons for opposing the levy *in toto*, since the task of calculating it threatens to impose a considerable burden on the Commission, the re-born private industry, or both. In its arbitrary complexity, it ranks fairly with the late unlamented development charge on property, and might conceivably have a similar obstructive and repressive effect. We share the view that has been cogently expressed by the British Road Federation, that the levy is wrong in principle; and we shall not be surprised if, in the "Committee of the Whole House," it proves to be the toughest of all the bones of contention. The amount (an estimated 4,000,000*l.* per annum) may be small in relation to the 340*l.* millions or so that road-transport users already contribute to the Exchequer in taxation of various kinds; but the significance attached to matters of principle, and the heat engendered by them, are not always calculable.

The provisions for the re-organisation of the railways appear to be comparatively straightforward in essence, though not very definite in detail; in

fact, they are the reverse of definite, as they merely require the British Transport Commission to "prepare and submit to the Minister a scheme . . . for the abolition (if it has not already been abolished) of the Railway Executive; for the setting up, for such areas as may be specified by or under the scheme, of such authorities as may be so specified"; and for the setting up of various other authorities and the delegation to them of "such functions of the Commission . . . as may be specified by or under the scheme . . ." etc. In short, while the details have been worked out, presumably, to a fairly advanced stage (otherwise the Government, as sponsors of the Bill, would not know what they were sponsoring) the legal draughtsmen must find a form of words which will permit the desired things to be done, without tying anyone down too firmly.

In proposing what amounts to the creation of a number of virtually autonomous railway authorities, the Bill is on fairly safe ground. Nationalisation has not proved quite so effective a solution of the railway-users' problems as many had hoped. In a few directions, there have been improvements, no doubt; but they have not been exactly spectacular, and in many other directions, the quality of the service given by the railways has declined, while the cost of those services has increased materially. It may be that, from the operating point of view, there have been substantial advantages from the standardisation of locomotives and rolling stock, the closing of unremunerative branch lines, the greater freedom to interchange stock between one region and another, etc., and that these advantages are reflected somewhere in the annual accounts. The critical public, however, are apt to argue that standardisation of locomotives does not concern them directly; that many of the branch lines might not have been unremunerative if the railways had provided a better service on them; and that (as was mentioned in the House of Commons debate) nationalisation took away the railwayman's old-established—perhaps old-fashioned—loyalty to his railway and to the chiefs of its departments, some of whom he would probably know personally, and put nothing equivalent in its place. There can be no question that the pre-nationalisation railway employee, in more cases than not, did take a personal pride in the line that he served; it was probably more marked in the provinces than in London. If, however, that loyalty is to be restored or re-vivified, the Minister of Transport must insist very firmly that the old railway titles, or something closely akin to them, shall be adopted again; the ordinary man finds it difficult to work up any real enthusiasm over a "Region" or an "Area." It would be sound policy to admit candidly that the old designations had "something that the others hadn't got," and go back to the Great Western Railway, the London and Midland Railway (or, still better, the "Midland" simply), even though, as seems inevitable, the railways of Scotland are to be regrouped as one.

The most important thing of all, however, is to provide the public with good, quick and courteous service, at the lowest possible cost; and to get away entirely from any view that the railways, road transport, or any other service affected, is run primarily for the benefit and convenience of those employed in it. This is a claim that is seldom made in words, though it seems to have a surprising number of adherents; but it is an absolute negation of all that is implied by the word "service" and, if carried to its logical conclusion, can only result in complete stagnation. Something approaching that situation has developed already in some countries and, in general, those countries are not remarkably prosperous. If the new Transport Bill, by removing a few of the bureaucratic and other shackles, promotes a greater freedom and flexibility of transport, the whole country should benefit.

PLASTICS.

DESIGNERS share with managers the heavy responsibility which comes from having to choose one of many possible courses of action, but whereas managers can never banish altogether the thought that a decision may not have been the best in the circumstances, designers can too easily forget that their good design might have been better. Especially are they liable to forget that the materials of construction now available to them are not limited to the half-dozen or so that they, and their drawing offices, have been using for years past. The prospect of searching through a seemingly endless range of materials may be sufficient to convince a designer that it would be wiser to remain faithful to the existing standards. At this point, perhaps, the manager, being more aware than the designer of the consequences of lagging behind a competitor, may exercise those powers of initiating action which characterise his profession: he may order an inquiry to be made into more efficient materials of construction.

Enterprise of this kind is not universally apparent, since it calls for that extra marginal effort which most engineers, in their workaday world, cannot spare. Mr. J. E. Gordon, who gave the 4th annual lecture of the Plastics Institute on November 13, suggested that engineering was a "broad human activity employing large numbers of ordinary people at all levels and catering for all kinds of ordinary human needs." It was, he thought, subject to much the same human limitations as apply to other large bodies of people, such as armies; its technology had to be suited to the capacities of the average man. Most people constructed for themselves a cage within which they could work happily; by that means they limited the choices that were available to them. An engineer, however, whether as manager or designer, is enterprising and successful in proportion as he voluntarily accepts for consideration the widest possible range of choices. He must go on asking himself whether there is not some other way, some better way, of managing or designing. His cage must always be as large as his experience and imagination will allow, and occasionally—very occasionally—he will find that he can break out from it.

In Mr. Gordon's view (we hope to reprint his lecture in abridged form in a future issue of *ENGINEERING*), an opportunity is approaching which will enable many engineers to break out from the limited range of materials and processes with which they are generally content to work. Certainly his review of potential developments in the manufacture and use of plastics provided something infinitely more tangible and significant to the engineering industry than has been provided by the advance guard of plastic toys and ornaments which, to many, are the beginning and end of plastics. Having available some results of research and development work which is being undertaken in this country, he was able to sketch the outlines of possible future applications in the engineering industry. In the design and construction of airframes for, say, a light transport aircraft of the private-owner type, he suggested that there were now no insuperable technical difficulties to the use of structural plastics. Owing to the low wing loadings, and therefore low structure loadings, which are necessary, the thin plastic panels would require to be stabilised, probably by a foamed material. The cost of such a method of construction is already comparable with that of normal methods, and a relatively small reduction in cost—which is very probable in such a material—would make it economically worthwhile. Mr. Gordon pointed out that for some time aerodynamicists have had available wing sections of considerably reduced drag, if only

smoother surfaces could be attained. Plastics might be the means of achieving this aim, and they would lead to improved performance.

It is not only in the rapidly-developing aircraft industry that Mr. Gordon visualises the adoption of plastics. Assuming that a sufficiently cheap plastic is available, he described how it might be used for motor-car bodies, in which application it would have a number of advantages. The objection to the difficulty of repairing a plastic car body may be overcome by using a series of panels, not more than 2 ft. or 3 ft. square, which would be readily detachable, the joints between them being finished with a plated beading. Each panel, he envisaged, would comprise the outer finish, the structural shell, much of the inner finish, and possibly certain wiring and fittings, all moulded in one operation. Replacement panels sold separately would be a cheaper form of repair than the present system of panel-beating followed by re-cellulosing. Quantity production, using dies with a production rate comparable with that of pressed-steel work, would be necessary, but there is a difficulty in obtaining a rapid curing cycle. At Farnborough, an electrical curing system is being developed which gives virtually instantaneous curing of phenolic-resin plastics, and these plastics are cheap enough to be worth consideration for the application to motor-car bodies. Such a process would enable the mouldings to be produced at a high rate from the necessarily expensive dies. Car bodies constructed in this way would be lighter in weight than existing designs, and some economy could therefore be made in the weight of the chassis, with corresponding savings in cost.

In no field would it be more surprising to find an extended use of plastics than in civil engineering, yet, as Mr. Gordon remarked, it is in the making of shaped shells that metals are not altogether satisfactory, and that plastics might be applied. Moreover, with plastics there is a remarkable range of flexible materials. These can be used for such obvious purposes as flexible piping, but there is the more interesting application to the construction of an air-supported roof. This idea was discussed some years ago by the late Dr. F. W. Lancaster, who realised that quite a small pressure of air would suffice to support a shallow domed roof made of flexible material. A very large building could be made in this way, and it would have an unobstructed floor space which would be ideal for meetings, exhibitions, the storage of aircraft and many other purposes. Lanchester proposed air-locks for entrances and exits, but Mr. Gordon pointed out that they might not be necessary if they were small in relation to the size of the building. When Lanchester considered the idea of an air-supported roof, he had to think in terms of a special fireproof and weather-proof canvas, but Mr. Gordon, with the plastics industry developing, can visualise a flexible plastic that would also have the great advantage of transparency. Such domes, he said, would be quite stable in high winds and could withstand snow loading.

We may leave the two most intriguing ideas for plastics to be read in the lecture itself. These and the other proposals are not wild dreams; they are likely developments in the not very distant future, and such developments will go to those who can make the extra marginal effort, over and above their normal work, which will be required to find engineering uses for plastics. The newer industries—aircraft, for instance—may take the lead, simply because they are educated to the acceptance of new ideas, but it would be unfortunate if others only waited to see what happened. The prospects are equally good in the design and manufacture of other products, and there are engineers in the plastics industry who are ready to co-operate with potential users in the creative application of these comparatively unknown materials.

NOTES.

THE KIRKUK-BANIAS OIL PIPELINE.

ON Tuesday, November 18, at Kirkuk, Iraq, H.M. King Feisal II inaugurated the new 30-in. pipeline which has been constructed from the North Iraq oilfield of the Iraq Petroleum Company to Banias, 555 miles distant, on the Syrian coast. The corresponding ceremony at the Banias end will take place on November 24, when the Chief of State and Prime Minister of Syria, Brigadier General Fawzi Selo, will officiate. In fact, the pipeline has been conveying Kirkuk crude oil to Banias since April, and it is now operating at the rate of about a million tons a month. It is stated to be the largest in the world, with diameters of 30 in. and 32 in., and has cost 411. millions. Two diameters were chosen so that the 30-in. size could nest inside the 32-in. size to economise shipping space and charges. The pipe is in lengths of 31 ft. and was made in the United States; the total weight of steel exceeds 180,000 tons. The lengths are butt-welded together, and all the seams were X-rayed after welding. To reduce the amount of welding to be done in the desert, three 31-ft. lengths were welded together on discharge from the ships, either at Tripoli in Lebanon or at Basrah, in the Persian Gulf. To transport these 93-ft. lengths, 35 tractors of the Thornycroft "Mighty Antar" type were ordered, each capable of taking nine 93-ft. pipes. Some particulars of the undertaking were given by Admiral of the Fleet Sir John Cunningham, G.C.B., M.V.O., the chairman of the Iraq Petroleum Company. The pipeline, he said, had been completed in 17 months—six months ahead of the expected date—and had enabled production to be practically trebled at the Kirkuk field. Under the equal profit-sharing agreement which the Iraqi Government and the company, concluded last year, Iraq will receive in respect of 1952 more than 301. millions, and probably nearly twice that amount in 1953. Seventy per cent. of the revenue thus accruing is to be spent by the Iraqi Government on assets of permanent value—hydro-electric power, irrigation schemes, etc.—so that the increased prosperity now enjoyed may be retained when the oil yield begins to decline, as some day it must. The first pipeline across the desert from Kirkuk to the Mediterranean was completed in 1934, and was of 12-in. bore. Before the war, plans were prepared to duplicate the 12-in. lines (a second one had been constructed by 1938) by laying 16-in. lines beside them. The war interfered with this project, but the material was ordered and work began in October, 1946. Because of unrest in the area, the material was transferred to Tripoli, where pumping began in July, 1949. The undertaking gave employment to about 7,000 Arabs and about 400 British and American technical staff.

THE THOMAS HAWKESLEY LECTURE.

Some of the simplest questions require the most complicated answers, as every father knows. To the simple question, that any engineer might ask, What causes metals to work-harden? Professor N. F. Mott, F.R.S., last week gave, if not a complicated answer, at least one which required the listener to exercise his powers of concentration. Delivering the 39th Thomas Hawksley Lecture to the Institution of Mechanical Engineers, on November 14, Professor Mott expounded "The Mechanism of Work-Hardening of Metals" in a way that some other lecturers, who dreadingly adhere to a text that is intended to be read rather than spoken, would do well to emulate. He was able to explain the significance to engineers of some of the latest findings in metal physics, particularly some recent results obtained at the Harwell Atomic Energy Research Establishment. He said that when a metal was mechanically deformed at ordinary speeds and moderate or low temperatures, the deformation was all, or nearly all, concentrated in slip lines. When formed at low temperatures, each slip line was the result of a displacement of the material along a single lattice plane through a distance of about a thousand atomic diameters. The steps on the surface which slip lines caused were thought to attain full height in a small fraction of a

second, though they might increase slowly in length. At higher temperatures and at slow rates of strain the slip bands appeared, under the electron microscope, as clusters of lines about a hundred atomic diameters apart. The mechanism of work-hardening at low temperatures could be explained as follows. As the stress was increased, slip spread out from certain points in the crystal. If the slip could spread right across a single crystal, little or no hardening would occur. If, however, slip was stopped by a grain boundary or a "sessile" dislocation (a meeting of two or more slip lines), an intense centre of internal strain was formed there. This was locked in position by the formation of further sessile dislocations, and the random strains so formed within the material were directly responsible for work-hardening. Another conception which Professor Mott brought into his lecture was the "vacant lattice site," i.e., a point within the crystalline structure of a metal from which the atom was missing. For thermal softening it was necessary to heat to a temperature which allowed vacancies to be formed thermally, while to get rid of the vacancies formed by cold-work the metal had only to be hot enough to allow them to move.

SCIENCE MUSEUM MINING COLLECTION.

The basic conception in the design of a new mining collection, opened at the Science Museum, South Kensington, London, S.W.7, by Mr. Geoffrey Lloyd, Minister of Fuel and Power, on November 18, has been to give the visitor an impression of being underground in the actual workings of a coal mine. The collection, which occupies an area of 9,000 sq. ft., includes a full-scale "district" in a colliery, the coal face being supported by steel props and bars, equipped with a coal cutter and chain conveyor, and illuminated by a modern system of fluorescent coal-face lighting. Some figures of miners wearing electric cap lamps are seen carrying out their various duties at the face. Leading from the centre of the coal face is a "gate road" supported by steel arches and equipped with a gate belt conveyor and mining switchgear, the latter for controlling the machinery at the coal face. Adjacent to the "mine workings" are displayed exhibits showing the historical development of the many ancillary services which are essential in mining and have played an important part in promoting safety in operations underground. The progress made in mine transport from the carriage of the extracted material in baskets and sledges to modern conveyor systems and the use of electric and Diesel locomotives is indicated by a series of models. The first two Davy lamps ever used underground are valuable exhibits, and, beside these are a variety of safety lamps designed and used since 1915. Electric hand and cap lamps, gas detectors, and modern mine lighting installations are also exhibited. The progress made in mine-winding practice, the various methods employed in mine ventilation, the development of rescue apparatus and methods, the processes used for mining surface deposits and the methods adopted for putting down boreholes in the ground, and the sinking of mine shafts are shown by means of models, diagrams and other exhibits. The different types of hand-tools, roof supports and ancillary equipment used in modern pits are also on view. The Science Museum is open free on weekdays from 10 a.m. until 6 p.m., and on Sundays from 2.30 to 6 p.m.

SYMPOSIUM ON PROPERTIES OF METALLIC SURFACES.

A general meeting of the Institute of Metals was held at the Royal Institution, London, on November 19, to discuss a series of 13 papers on "Properties of Metallic Surfaces." Two technical sessions, one in the morning and the other in the afternoon, were held and the morning session was preceded by a short business meeting during which the President, Dr. C. J. Smithells, M.C., occupied the chair. After the minutes of the previous general meeting, that held in Oxford from September 15 to 19, had been dealt with, the secretary made a number of announcements. The first of these was that an informal discussion on "Roll Maintenance in the Non-Ferrous Metals Industry" would be held at the University of Birmingham on Thursday, January 8, 1953, at

11.30 a.m. (and not at 2.30 p.m., as originally announced). Prior to the meeting, at 10.30 a.m., the Aitchison Laboratories of the University would be open for inspection. The second announcement was that the spring meeting of the Institute would be held in London from Monday to Thursday, March 23 to 26, 1953. In connection with this meeting there would be an all-day symposium on "The Control of Quality in Melting and Casting." The final announcement made by the secretary was that the Institute's autumn meeting would be held in Southport from Monday to Friday, September 21 to 25. The President then stated that the present symposium had been organised by the Institute's metal-physics committee, the chairman of which was Professor A. G. Quarrell, D.Sc., A.R.C.Sc., whom he called upon to take the chair for the remainder of the morning session. Professor Quarrell, in a brief preliminary address, announced that the seven papers which would be discussed that morning dealt with methods of examining metal surfaces and with the characteristics of these surfaces. The *rapporteur*, Professor A. H. Cottrell, Ph.D., then introduced the papers which were by Professor S. Tolansky, F.R.S.; Dr. M. T. Simnad; Drs. P. Gay and P. B. Hirsch; Mr. D. M. Dovey, Dr. I. Jenkins and Mr. K. C. Randle; Mr. H. W. L. Phillips; Dr. U. R. Evans, F.R.S.; and Drs. R. G. Chambers and A. B. Pippard. We intend to deal with the technical proceedings in due course.

ANNUAL DINNER OF THE OLD CENTRALIANS.

College reunions have a character that is all their own, but the annual dinner of the Old Centralians—the association of former students of the City and Guilds (Engineering) College and the slightly older foundation, Finsbury College—while partaking of all those characteristics, has a quite distinctive and peculiar quality by virtue of the remarkable engineering eminence that, in the aggregate, their alumni have acquired in the course of years, in this country and many others. This statement could be proved in detail by citing the list of those who attended the 42nd annual dinner, held on Monday, November 17, in the hall of the Worshipful Company of Grocers, Princes-street, London, E.C.2; but to quote all the distinguished names is impracticable. It must suffice, therefore, to record that the chair was taken by the President, Mr. A. G. Ellis, F.C.G.I. (1901); that he was supported by two Old Centralians of the 1892 vintage, in the persons of Sir Lewis Casson and Mr. E. M. Rich; and that the speakers included Sir Frederick Handley Page, C.B.E. (1901). Some 260 attended—perhaps 10 per cent. of the full strength, after allowing for the guests; but it has always been the case that a large proportion of the members are pursuing their professional avocations overseas, proof of which was forthcoming during the evening in the receipt of a cablegram from the South African branch of the association. The toast of "The Old Centralians and the City and Guilds College" was proposed by Sir John Maud, K.C.B., Permanent Secretary (of seven weeks' permanence, as he observed) of the Ministry of Fuel and Power, who recalled that His late Majesty King George VI had remarked, towards the end of the recent war, that "D-Day seemed to be largely due to the City and Guilds College." Quoting an alleged Chinese proverb, "if you plant for a year," he said, "plant seed; if for ten years, plant trees; but if for a century, plant men"—which was the function of the College. The President, in responding, said that, since the College was founded in 1884, some 8,000 students had qualified there, to which were to be added a further 2,500 at least from Finsbury College before it was closed some 26 years ago. Professor Willis Jackson, M.I.E.E., Dean of the College, who also replied, reviewed the year's work and explained the steps that were being taken to ensure that the students left the College with a broader outlook than could be given by a purely technical education. In response to the toast of "The Guests," proposed by Sir Frederick Handley Page, the Hon. Mr. Justice Wynn Parry (after a judicial examination of the legend of Good King Wenceslas, penetrating in its detailed analysis, but impossible to summarise) paid an appreciated tribute to the work that the College had accomplished in the training of engineers during the 68 years of its existence.

OBITUARY.

MR. S. B. DONKIN.

It is with great regret that we record the death on November 12, at Albury, Surrey, of Mr. S. B. Donkin, head of the consulting firm of Kennedy and Donkin, and a former President of the Institution of Civil Engineers. The portrait herewith is reproduced, by permission, from the oil painting belonging to the Institution.

Sydney Bryan Donkin was born on June 24, 1871, so was in his 82nd year. He came of a distinguished engineering family, as readers of Samuel Smiles's biographical works will recall; was associated in his professional practice with another—that of Professor Sir A. B. W. Kennedy, famous as a pioneer of electric power generation; and had every reason to develop a keen interest in the annals of both families, and of engineering in general, since he married, just 50 years ago, Miss Phoebe Smiles, a grand-niece of the biographer. He was educated privately and at University College, London, and served his apprenticeship to Messrs. Bryan Donkin and Company (then in Bermondsey) and with Sulzer Brothers, at Winterthur, Switzerland. He was engaged as assistant by Sir Alexander Kennedy in 1897. Kennedy's firm at that time was known as Kennedy and Jenkin, and was concerned with a number of tramway, lighting and power schemes, mainly of a municipal character. They included, between 1897 and 1908, when Donkin was admitted as a partner, the electrification of the Waterloo and City Railway; the erection of electricity works at Edinburgh, Carlisle, Manchester, West Hartlepool, and Weymouth; the Great Western Railway's urban electrification; a generating station for the Central Electric Supply Company; and—one which aroused and still arouses some controversy—the London County Council's tramway power station at Greenwich. He was concerned also with the first section of the L.C.C. electric tramways.

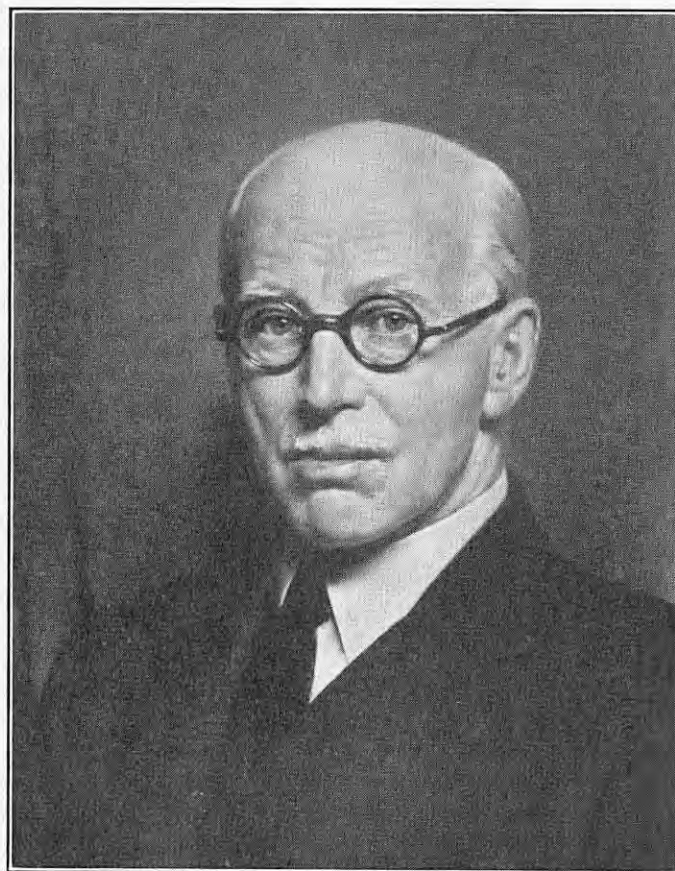
Donkin was taken into partnership, as stated above, in 1908; but the firm was still Kennedy and Jenkin, and remained so until 1913, when it was changed to the present form of Kennedy and Donkin. One of the principal contracts with which he was associated as consultant after being taken into partnership was the Horseferry-road power station of the Westminster Electric Supply Corporation. This was followed by extensions to the Edinburgh power station and to the Central Electric Supply Company's station at St. John's Wood, and a succession of War Office installations, including those at the Curragh camp in Ireland, and at Sandhurst. With the development of electricity supply on a nationally-organised scale, Mr. Donkin, in association with Sir Alexander Kennedy (who died, however, in 1928), was closely concerned with

the various regional schemes sponsored by the Central Electricity Board, the firm being appointed as consultants to the Board for the Central and South Scotland, North-West England and North Wales, and South-West England and South Wales schemes. The last-mentioned inevitably brought him into consultation on the Severn Barrage. In 1943, he was appointed, in conjunction with Sir William Halcrow and Mr. A. G. Vaughan-Lee, to review the conclusions of the Severn Barrage Committee "in the light of later engineering experience and practice and of other developments, and to suggest what modifications, if any, should be

in that year. He was a member of very long standing in the Institution, having been admitted first as a student. He became an associate-member in 1898 and a member in 1912. He was also a member of the Institution of Mechanical Engineers and of the Institution of Electrical Engineers, both of which he joined in 1911. He was, of course, a member of the Association of Consulting Engineers, and served as chairman of the Association in 1927-28. In the following year he accepted the presidency of the Association of Supervising Electrical Engineers, to whom he delivered an address on "The History and Development of the Electricity Supply Industry under the 1919 and 1926 Acts, with special reference to the Central Electricity Board's Scottish Scheme." On being re-elected for a second year of office, he followed this address with another on "The Production of Power from Natural Sources other than from Fuel."

As befitted one whose family had been engaged in civil and mechanical engineering for a century and a half, Mr. Donkin took a keen interest in the historical side of his profession. He was a member of the Smeatonian Society and was its President in 1949; and he was also a member of the Newcomen Society, to which he contributed a paper on the Smeatonian Society in 1935, and another, on his ancestor, Bryan Donkin, F.R.S., in 1950. Both showed a mastery of facts and a precision in the presentation of them that those who knew Mr. Donkin will recall as characteristic of all that he did.

Any engineer who lives to become an octogenarian must inevitably see great changes in the technique of his profession and the scale of its operations. Throughout his life, Mr. Donkin had been interested in the possibilities of hydro-electric power generation, even though his own early experience had been with thermal stations, of moderate size by the standards of the present day. It is an interesting commentary, however, on the developments with which one man could be associated that he, who had begun his consulting career in the days when reciprocating engines



THE LATE MR. S. B. DONKIN.

made . . . " The panel presented their report to the Minister of Fuel and Power in the early part of 1945, when it transpired that Mr. Donkin had been responsible for its electrical aspects; he contributed to it several appendices, discussing methods of utilising the energy from the Barrage, the output to be expected, the transmission system that would be required to distribute the current, and the economic considerations involved. We reviewed the report in our issue of March 2, 1945 (vol. 159, page 171).

The economics of power generation was a subject to which Mr. Donkin had devoted attention over many years, and it formed the principal feature in his presidential address to the Institution of Civil Engineers in 1937, which was reprinted, somewhat abridged, in *ENGINEERING* of November 5 and 12

were still regarded as modern prime-movers for electric-power generation, should have been directly concerned, in his closing years, with great schemes for hydro-electric power and, by contrast, with the latest application of district heating, namely, the Pimlico housing estate.

MR. S. R. ROGET.

WE also regret to record the death of Mr. S. R. Roget, which occurred at Walmer, Kent, on Monday, November 17, at the age of 77.

Samuel Romilly Roget, who was a member of a distinguished Huguenot and legal family, was born on April 11, 1875, and was educated at University College School, London, and at Trinity College, Cambridge, where he obtained a first class in the

Mechanical Science Tripos. After a short time as assistant to Ewing he joined the firm of Siemens Brothers and Company, Limited, and until 1905 was engaged with them on the construction and erection of various classes of electrical machinery and equipment and subsequently on the design of traction motors and on the preparation of tenders for collieries and power transmission schemes. In 1905, he became assistant editor of our contemporary *The Electrician* (now *The Electrical Journal*), and when, a year later, the editor—Mr. F. C. Raphael—founded *Electrical Engineering*, Roget became its assistant editor. He remained in that position until publication ceased in 1916.

During the 1914-18 war, Roget served in the Royal Naval Volunteer Reserve and attained the rank of lieutenant. Subsequently, he devoted his attention almost entirely to free-lance editorial work but, in addition, prepared and published his well-known *Dictionary of Electrical Terms*, a book the usefulness of which none who have had occasion to consult it will deny. Roget was elected an associate member of the Institution of Civil Engineers in 1902, and of the Institution of Electrical Engineers in 1904.

MR. J. S. DANIELS.

By the death on November 13, at his home in Nailsworth, Gloucestershire, of Mr. John Stuart Daniels, the West Country has lost one of its best-known engineers and, it is safe to say, one of the most respected. Mr. Daniels, who was 78 years of age, had been associated throughout his working life with the family business of T. H. and J. Daniels, Limited, Lightpill Iron Works, Stroud, and was chairman of the company at the time of his death. He was a grandson of the founder, Thomas Daniels.

Mr. Daniels was born on October 27, 1874, and received his general education at Wycliffe College, Stonehouse, Gloucestershire; but he left school at the age of 14 and thereafter broadened his mind "on the job" or at evening classes. His works training was thorough and varied; as he told the guests at the company's centenary celebration (postponed from the correct date—1940—because of the war), he had to turn his hand to anything and everything, including sales, maintenance, estimating and costing, acting as a spare foreman, and design and production. In 1904, he was made technical director and, in 1921, chairman. During the 1914-18 war, the works were engaged mainly on experimental and secret war work, but they also turned out large numbers of "G.S. wagons" for the Army. They have always been prepared to make new devices for inventors, and thus it came about that John Daniels was concerned in the construction of some of the early Still engines, the first Hele-Shaw "Streamline" filter, and Dr. Hele-Shaw's variable-speed oil-operated transmission gears. Latterly they have been active in the manufacture of injection-moulding presses and other plant for the plastics industry, which led to Mr. Daniels becoming a member of the Plastics Institute. He was also a member of the Institution of Mechanical Engineers, serving on the Council as chairman of the Western Branch; a member, and branch chairman, of the Institution of Production Engineers; and a member of the Institute of British Foundrymen.

MR. GEOFFREY M. GULLICK, C.B.E.

We have noted with regret the death in Sheffield, on November 11, of Mr. Geoffrey M. Gullick, C.B.E., chief mining director of Messrs. Mavor and Coulson, Limited, Glasgow. He was 63 years of age and had been active in the mechanisation of mines since he was a young man of 19.

Geoffrey Merton Gullick was born in London on November 20, 1888, and was educated at Dulwich College. In 1906 he was articled to his uncle, who was agent to one of the large Lancashire collieries. His connection with Messrs. Mavor and Coulson began in the following year, when the first coal-cutter was delivered to Pemberton Colliery. Largely due to his efforts, the machine was operated satisfactorily in spite of adverse conditions. With this experience, he started buying his own machines from Messrs. Mavor and Coulson in 1908, using

them to cut coal by contract at a tonnage rate. He succeeded in this enterprise by hard work and ability, and by 1914 he and his younger brother were employing nearly 200 men. At the outbreak of war he was commissioned in the 3rd Battalion of The King's (Liverpool) Regiment and served in France. In 1919 he joined the staff of Messrs. Mavor and Coulson and as head of their mining department became influential in the development of machine mining methods. In the second World War he was appointed adviser to the Director-General of Coal Production on mechanical mining and later Chief Mechanisation Adviser to the Ministry of Fuel and Power. After the war he returned to Messrs. Mavor and Coulson. The introduction and improvement of mechanical methods in mines owe much to his imagination and enterprise.

MR. A. P. WOOD.

We also regret to record the death of Mr. A. P. Wood, which occurred at Hale Barns, Altrincham, Cheshire, on Friday, November 7. He was 80 years of age.

Arthur Pemberton Wood was educated privately and was apprenticed with the firm of Mather and Platt, Limited, in 1888. During the four years of his service he also studied at Owens College. On the completion of his time he remained with the firm as outside engineer, and took part in the construction of tramways in the Isle of Man and in Sweden. In 1899, at a time when the development of the Trafford Park area of Manchester was being developed industrially, Mr. Wood realised that the transition from steam to electric power would mean an increased demand for motors. With the late Sir Harry Kilvert and his brother, Mr. Nicholas Kilvert, he therefore formed the Lancashire Dynamo and Motor Company. Initially, the production of his firm was confined to direct-current motors, which were manufactured in temporary premises at Pendleton, but works were soon established at Trafford Park and the range of activities extended. At first, Mr. Wood acted as general manager with charge of the works, but became managing director in 1903, a position he held for some 30 years. On his retirement in 1933, shortly after the firm had amalgamated with the Crypto Electrical Company, he joined the board of Laurence Scott and Electromotors, Limited, as sales director, but relinquished that position a year later. Mr. Wood was elected an associate member of the Institution of Electrical Engineers in 1899 and a member in 1903.

LETTER TO THE EDITOR.

THE GREENWICH TIME BALL.

TO THE EDITOR OF ENGINEERING.

SIR,—In your issue of November 7, 1952, on page 603, *ante*, you published a note on the Greenwich Time Ball, in which it was stated that the present ball, with its operating mechanism, was designed and made by Maudslay, Sons and Field, and erected in September, 1833. It is true that this firm made the original ball and mechanism. Apart from an accident which occurred on December 6, 1855, when the ball was blown down in a gale and subsequently re-erected after repairs to ball and mast, it remained in operation up to 1919. In that year, a new aluminium ball, a new winch and part of the raising machinery, which had been supplied by Messrs. E. Dent and Company in 1914, and held in store during the war years, were installed. To that extent, therefore, the original gear has been modified or renewed. Without any reflection on the excellent work of Messrs. Maudslay, whose apparatus was in use for 86 years, it is fair that mention should be made of the replacements, supplied by Messrs. Dent 33 years ago, which are part of the Time Ball in its present form.

Yours faithfully,

H. SPENCER JONES,
Astronomer Royal.

Royal Greenwich Observatory,
Herstmonceux Castle,
Sussex.

November 13, 1952.

NEW BUILDING, DEPARTMENT OF ENGINEERING, CAMBRIDGE UNIVERSITY.

THE engineering department of Cambridge University has been well treated in the allocation of building licences since the end of the war. This has no doubt been due, quite rightly, to a realisation in Government quarters of the important part played by engineering education in the overall economy of the country. The first permission for building of any magnitude was acted on in 1947, when work was started on the new workshops which were completed in 1949 and formally opened on June 10 of that year by the late Field-Marshal Smuts, at that time Chancellor of the University. An illustrated description of these workshops appeared in our issue of June 16, 1950, on page 669. The workshops were not completed when a start was made on the new block which was opened by the Duke of Edinburgh on Thursday of last week. The new building, a five-storey erection, 70 ft. in height, is the first major university building in Cambridge to be completed since the war. The main, east, elevation of the building is shown in Fig. 1, on page 670.

The history of the engineering department since its move from the original site in Free School-lane to the Seroope House estate in 1922, has been one of almost continuous progress. This move was made during the professorship of the late Sir Charles Inglis, who followed Professor Bertram Hopkinson as head of the department; Professor Hopkinson was killed in an aeroplane accident during the first World War. The grounds of Seroope House are three acres in extent and when the move was made a four-storey building lying to the west of the House was constructed. It has an area of 50,000 sq. ft. and was completed in 1922. Its position is shown at the top of the sketch plan reproduced in Fig. 2, on page 670. This building houses the main teaching laboratories covering heat engines, hydraulics, structures, materials and electricity. The Professorship of Aeronautical Engineering, which had been established in 1919, was provided with an aeronautical laboratory in temporary hut buildings.

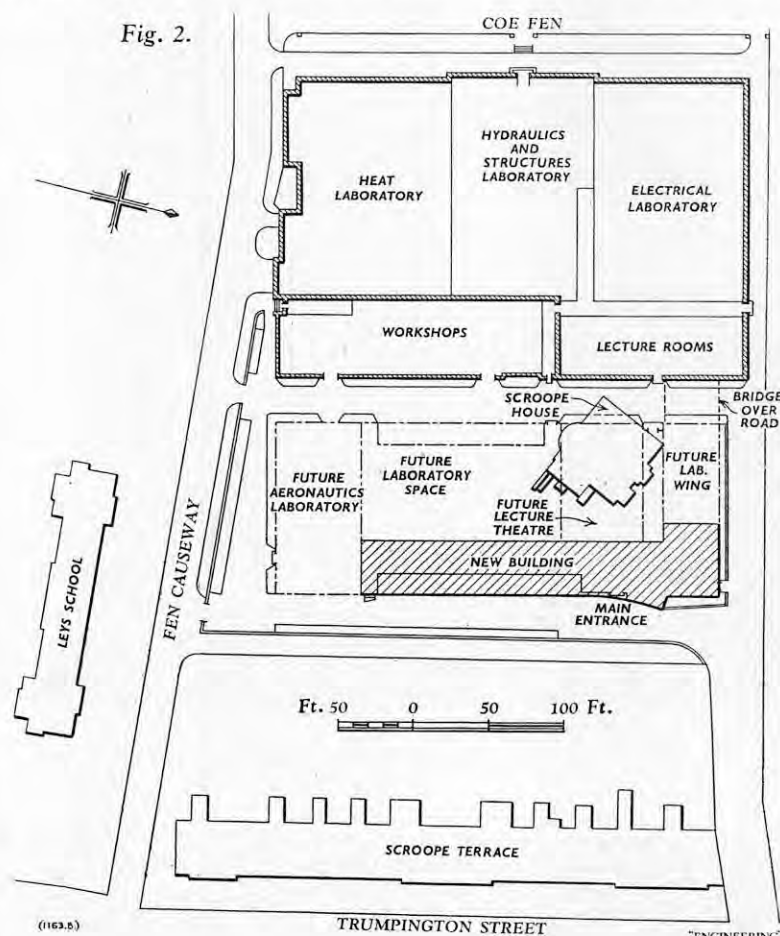
At the time of the move to Seroope House, the number of students was about 250, but after the first World War it had increased to about 550 and to add to the accommodation provided by the mansion, a two-storey building containing two lecture theatres on the ground floor with a drawing office above, was built in 1931. Its position at the north-east side of the 1922 building is indicated in Fig. 2. In 1943, Sir Charles Inglis was succeeded as head of the department by Professor J. F. Baker, who immediately considered plans for post-war development. These included provision for a moderate increase in the number of undergraduates and a considerable increase in the facilities for post-graduate and research work. The first stage covered by these plans was the workshop and instrument building completed in 1949 and referred to in the first paragraph of this article. It is situated to the east of the 1922 block. Various workshop departments, such as the smithy and carpenters' shop, which had been scattered previously in independent buildings or huts, were moved to the new workshops.

The second, and major, step towards the consummation of these post-war plans has been the completion of the new building which was inaugurated last week. As shown in Fig. 2, it is situated to the east of, and is separate from, the teaching-laboratory building. Before describing it, it should be said that this impressive addition to the establishments of the department does not represent the completion of the present plans. Ultimately, the building will be extended on its west side by the addition of laboratory space for heavy equipment, further

NEW BUILDING FOR ENGINEERING DEPARTMENT, CAMBRIDGE UNIVERSITY.



[FIG. 1. EAST ELEVATION FROM SOUTH.]



accommodation for aeronautical work and a lecture theatre to accommodate an audience of 400. The aeronautical department is still inadequately housed in a wooden hut and the present intention is that the aeronautical wing shall first be built when permission and funds permit the extensions to be put in hand. The space which will be occupied by the extensions is shown in Fig. 2, which gives an outline ground plan of the whole scheme as at present conceived. It will be noted that these extensions will impinge on the site of Scroope House, which will have to be pulled down, and that a bridge will connect the teaching laboratories and the new research and administrative building. For the present, Scroope House has not been interfered with and is fully occupied; extra teaching accommodation has been made available by the removal of the library from the old mansion to the new building. Provision is made in the plans for the future extensions and the view of the east elevation of the new building, as seen from the south, which is given in Fig. 3, opposite, shows the section of semi-temporary outer wall, constructed with asbestos-cement sheets, forming the position at which the future aeronautical wing will connect to the present buildings. No date can be suggested for the putting in hand of this aeronautical section. A large new building for the chemistry department of the University is now under construction in Cambridge and it is possible that the engineering department will have to be satisfied with its present additional premises for some years.

Although the accommodation in the new building has been provided largely for administrative services and research, the requirements of the students, of whom there are now 661, have not been overlooked. The mezzanine floor of the building is given over to administrative offices and professors' rooms, but the first floor is devoted to undergraduate

activities and contains lecture rooms, a library and a reading room. The reason the junior members of the organisation have been favoured by accommodating them on the first floor, instead of placing them higher up, is that as their numbers will greatly exceed that of any other type of worker, demands on the lift and staircases will be greatly reduced. This remark must not be taken to mean that there are only some half-dozen research workers to be provided for; actually there are about 50 working in the department at the present time. As in addition to the 661 undergraduates and 50 research workers, there are four professors, 50 lecturers and demonstrators and 75 additional members of the staff, it will be realised that a site of three acres on which to provide the necessary offices, lecture rooms and laboratories is rather small.

It is this relatively restricted site which has resulted in the building of a five-storey block, 70 ft. high. Such a structure may be asserted to be out of character with other university buildings in Cambridge, but it is well separated from the various colleges and most engineers will agree that the architects, Messrs. Easton and Robertson, have provided a design both workmanlike and attractive. This applies particularly to the main, east, frontage illustrated in Fig. 1. At present, only the upper part of the building can be seen from Trumpington-street, one of the main roads of Cambridge, but if at some future date Scroope-terrace is pulled down the building will form an attractive feature of the city. The rear elevation of the building, shown in Fig. 3, opposite, is less ornate, but this will be largely hidden when the projected extensions are built. The building is a steel-framed structure with an overall length of 237 ft. and a width of 39 ft. To allow of a wider staircase than would be permitted by the 11-ft. steel grid, the eastern elevation of the building is swept out in a curve at the north end, as shown in Fig. 2. The external walls are of Buckinghamshire

brick, 13½ in. thick, with Portland stone facings and cornice.

The principal floors are of solid concrete and are designed to carry heavier loads than are in most cases produced by the present equipment. In the rapidly-extending department, it is not possible to foresee future requirements and the internal partitions of hollow breeze blocks could be easily removed if rearrangement of the rooms became necessary. Considerable attention has been paid to sound insulation; the corridors have acoustic ceilings, sound-deadening arrangements have been provided between floors and individual rooms and a floating screed has been laid over the whole of the first floor separating the undergraduates' quarters from the professors' room and administrative quarters. The basement, a frequent source of trouble in Cambridge clay, is not tanked. Instead of this, a skin is built inside the structural concrete box and permits the free passage of water to a sump. In the floor, this inner skin is formed by precast concrete tiles resting only on their corners, leaving a waterway beneath them. The screed and floor finish are laid on these tiles.

The basement contains the boiler house, which serves the whole site. Heating is by low-pressure water circulated to radiators. A switch room is also situated in the basement. It contains, in addition to the usual switchgear, a mercury-arc rectifier to supply direct current in addition to the main alternating-current service. A minor inconvenience is encountered at the moment in transferring some types of apparatus from the old building to the new as the new block is supplied at the standard 250 volts and the old is still connected to the Cambridge 200-volt system. The latter will be standardised at a later date. There are also undergraduates' cloakroom and lavatories in the basement; they can be reached from an outside entrance away from the main entrance to the

ENGINEERING BUILDING, CAMBRIDGE UNIVERSITY.



FIG. 3. WEST ELEVATION FROM THE SOUTH.



FIG. 4. STRUCTURES RESEARCH LABORATORY.

building. On the ground floor, in addition to the entrance hall, there is a large lecture room, but a considerable part of the area of this floor is occupied by a garage and the lower part of the structures laboratory, which extends over two floors, as will be clear from Fig. 4.

The library on the first floor contains 14,000 volumes, and 120 periodicals are taken. The annexed reading room, of which a view is given in Fig. 8, on Plate LIV, is an attractive apartment and provides seating accommodation for 30 readers. Undergraduates are permitted to borrow books from the library and the advantages of this large collection of volumes on the spot are very material. Naturally, all books are available in the University Library but this is situated at a considerable distance from the engineering buildings. The distribution of lecturers' and demonstrators' rooms, lecture rooms, board room and common rooms on the various higher floors need not be referred to in detail, but a fitment available in some of the lecture rooms may be mentioned as it might well be introduced elsewhere. It consists of a portable projector, carried on a simple frame built up from tubes. It is equipped with a large lens and a 500-watt lamp. It throws such a clear image that slides showing diagrams or apparatus may be exhibited to a class in the course of a lecture without it being necessary to darken the room. The projectors were made in the engineering workshops.

Although such matters are not of specific engineering interest, it may be said that all room walls are plastered and painted and doors and skirtings made from polished hardwood. Floors are covered with cork, wood blocks or linoleum, depending on the particular purpose they serve. The furniture is of teak and was specially designed by Professor R. D. Russell and constructed by Scottish Furniture Manufacturers, Limited. The woodwork in the library and reading room is of polished African walnut, excepting the tables, the tops of which are of American walnut.

The top floor of the building is occupied by the caretaker's flat, research laboratories and studies for research students. Not a great deal can be said about these special research laboratories as, generally speaking, they are not yet equipped with apparatus. The only two in which apparatus has been installed sufficiently to enable work to be started are those devoted to soil mechanics and stress analysis. In the former apparatus is in use to determine the shear strength of soils and in the latter an elaborate machine, constructed in the engineering workshops, is being employed to study the stresses in gear teeth under dynamic loading. The apparatus is furnished with gear wheels of transparent material the speed and load of which can be varied, hand control enabling photo-elastic patterns to be obtained under any selected conditions. Investigation on strain gauges are also being carried on in this room. Views of the soil-mechanics and stress-analysis laboratories are given in Figs. 5 and 6, respectively, on Plate LIV. Fig. 7 shows the apparatus for studying dynamic stresses in gear teeth.

The testing of soil samples is, of course, affected by temperature and humidity but the magnitude of the effects is not known and it is hoped to ascertain whether or not they are sufficiently small to be neglected, or if better control is necessary in order to obtain reliable results. Annexed to the soil-mechanics laboratory, there is a constant-temperature room, just visible through the open door in Fig. 5, giving a range of from -15°C . to $+70^{\circ}\text{C}$. The room is equipped with a refrigerating plant and heating coils in the louvred ceilings, fans ensuring an even distribution of air. Indicating and recording instruments are provided in the laboratory, connections being made through the wall. The laboratory is

fitted with compressed-air and vacuum arrangements so that de-aeration of water for intake can be carried out. The apparatus includes a shear testing machine, a model seepage tank, a variable-humidity sample-preparation cupboard and electro-osmosis apparatus. There is also a mobile laboratory so that specimens may be taken from borings and tested on site.

On the top floor, there is a computing room, equipped with various calculating machines, and also a small drawing office for research workers. Other special laboratories are provided for aeronautical and thermodynamic work and study of the mechanism of machines. None of these is yet in effective operation. The first experimental work likely to be transferred to the thermodynamics laboratory is concerned with a small smoke tunnel, in which jets of smoke reveal the flow of air around sections of compressor blades. Although work has not started in the mechanics-of-machines laboratory, it has been equipped with a lathe, a self-contained compressed-air plant and a five-channel oscillograph made by Southern Instruments, Limited, of Camberley, Surrey.

Gas, water, drainage and electric services are provided throughout the building. All, except the electric service, are available in stacks spaced every 22 ft. along the east front with connection to ducts at every floor. The electricity supply from the switch room connects to a ring main rising at each end of the block and connected horizontally under the roof and along a crawl-way under the ground floor. All services in the stacks collect in this crawl-way, so that all pipework, including drainage, is accessible inside the building. Ventilation extraction fans are provided in all lecture rooms and the large room has also input fans. The building is served by a wide main staircase and a narrower staircase at the other end. The lift is fully automatic and can carry 15 passengers or a ton of goods. The flat roof of the building is of asphalt on vermiculite screeding, with wood-wool insulation below the stack. The roof carries a large water tank sheeted in aluminium.

The only other apartment calling for mention is the structures-research laboratory. Professor Baker's work on the plastic behaviour of structures is well known and does not call for comment here, but the extra facilities provided by the new laboratory will, no doubt, lead to its extension and development. The main equipment of the laboratory consists of a series of frames which can be adapted for a variety of tests. One of them can be seen in Fig. 4, on page 671, but the photograph from which this illustration was prepared was taken before the full equipment had been installed.

Although it is straying somewhat from the immediate subject of this article, so much has been heard about the neglect of the results of scientific research by industry, that one of the activities of the engineering department in connection with structural work may be mentioned. This is the inauguration of a course on the Theory of Structures and Strength of Materials, intended for engineers already engaged in industry. The course lasts nine months, and the first, which started in October, 1951, was attended by six men; the second, which started in October of this year, by nine.

In concluding the description of this building, which forms such an important contribution to the facilities for engineering education in Great Britain, we would express our thanks to the architects, Messrs. Easton and Robertson, of 53, Bedford-square, London, W.C.1, for the loan of photographs and for providing descriptive material relating to the structure. Other names which should be mentioned are Messrs. R. T. James and Partners, who acted as consulting structural engineers, and Messrs. William Sindall, of Cambridge, the main contractors.

LABOUR NOTES.

"Mad and crazy" are terms used by the Association of Supervisory Staffs, Executives and Technicians to describe the present scramble after higher wages. In an article headed "Asset Opinion" in the November issue of the Association's journal, the writer also affirms that the wage-restraint policy of the Trades Union Congress failed to last out the first day. He asks how it could do otherwise when one prominent trade-union leader launched a substantial wage demand just before the discussion and another advocated restraint knowing that his members were protected by a cost-of-living sliding scale. No one, he states, would deny the necessity for greater production at lower costs to enable the country to compete effectively in foreign markets, but to restrain wages when prices were rising, and thereby restrict the sacrifice to workpeople, was to invite reduced production and higher costs. The whole basis of wage restraint was unsound and unrealistic.

Trade unions were not to be absolved, the writer considers, from their responsibility for the modern tragedy which so many leaders miscalled "our wages structure"; it only succeeded in putting off a mad wages scramble which benefited no one, least of all the employees. The time was long past when it could be seriously contended that the continued "losing race of wages chasing after prices" had in it any benefits for wage earners. Over the past fifty years, the wages proportion of the national income had increased by no more than two per cent. In spite of this poor record, there were still those among the leaders of the trade-union movement who openly contended that the British method of wage fixing was the finest in the world. As a result of that method, the writer affirms that relationships between employers and trade unions were more amicable than they would be otherwise and that, undoubtedly, there was greater readiness to compromise and conciliate. He disagrees "most certainly," however, that better results were achieved for those whom the trade-union leaders represented.

He condemns "a system of collective bargaining on a national scale" that permitted employers' organisations to enter into wage agreements in accordance with the ability of the least efficient firms to pay, for it enabled them not only to maintain prices but also to secure low wage levels that every business could afford. The system should be compared with what happened in the United States, where competitive enterprise still operated. In that country, a company paid the wage rate an efficient undertaking could afford or lost its employees. Consequently, a business had to be efficient to exist. Each employer was played off against the others and national agreements to cushion the effect of high wages on inefficient employers did not exist. This method was admittedly no more desirable than the British system as a wage-fixing procedure, but it had undoubtedly raised the rate of wages, the standard of management and the rate of production to heights unknown anywhere else in the world.

Elsewhere in the same issue Mr. Harry G. Knight, the Association's general secretary, suggests that a nationally-agreed minimum wage could provide one answer to the present "crazy set-up." After the establishment of such a minimum rate to cover the lowest-paid time-rate employees in all industries, unions would be free to negotiate differentials for the various categories of skilled and semi-skilled workpeople, as well as piecework prices, lieu and other bonuses. There was nothing new about the suggestion, which had been operated in Australia and New Zealand for many years. He states, however, that the T.U.C., having since the early nineteen-twenties advocated such a principle, have departed from the idea in recent years.

London dock employees are seeking to obtain increased wages and larger pensions on retirement. Owing to recessions in Britain's overseas trade, there has been some reduction in employment at docks

throughout the country during the last few months and it is reported that every day one docker in every five or six is idle. This has resulted in many men having to depend upon their "fall-back" pay, the guaranteed minimum wage of 4l. 8s. a week to which every registered able-bodied docker is entitled, whether work is found for him or not, provided he reports daily as being available for work. During the past two weeks the man-power situation at the docks has engaged the constant attention of the National Dock Labour Board. The position was also discussed at a meeting on November 11 between members of the Board and leading officials of the Ministry of Labour.

This appears to have led the men's unofficial leaders to consider that some reduction in port employment registers is in contemplation. A mass meeting of London dockers, called by the "port workers' committee," an unrecognised body which has been prominent in a number of post-war dock strikes, met at Canning Town Public Hall on Sunday last. The men passed unanimously a resolution stating that they would not tolerate any temporary or permanent discharge of dockers from the industry. They also demanded the implementation of a policy which would provide immediate negotiations with all countries for an increase in trade with Britain; the restoration of the six-million-pound cuts in imports; increases in wages; improvements in the "fall-back" guarantee and in attendance money, in line with the rise in the cost of living; a "decent" pension; and the limitation of calls upon them to one a day.

Copies of the resolutions passed at the mass meeting on Sunday were to be sent to the Transport and General Workers' Union, to which many dockers belong, and to Government Departments connected with the dock-transport industry. Actually, only some four to five hundred dock employees, out of the many thousands employed at the Port of London, attended the meeting. It is understood that the "port workers' committee" is endeavouring to raise the men's minimum rate of pay from the present level of 22s. 6d. a day to 30s., and the "fall-back" guaranteed wage to an all-round level of 6l. a week. Under existing agreements, able-bodied men receive a "fall-back" wage of 4l. 8s. a week, while those over 60 years of age, or physically unfitted for certain kinds of employment, are paid smaller amounts.

Increases of 2d. an hour for men and 1½d. an hour for women have been granted to employees in the electrical cable-making industry under an award made by the Industrial Disputes Tribunal, the terms of which were announced on Monday last. Smaller increases have been conceded to juveniles engaged in the industry and it was ruled that all these increases should come into effect immediately.

Discussions on wage problems in the coal-mining industry are continuing. At a meeting of the executive committee of the National Union of Mineworkers on November 13, it was decided to proceed immediately with the claim for increased pay for miners employed on a day-wage basis, which includes men in the lowest-paid grades in the industry. The new claim was accordingly presented to the National Coal Board on the same day, but, so far as has been revealed to date, without any definite sum being mentioned. The union's representations were discussed at some length last Friday, at a full meeting of the industry's joint national negotiating committee, which comprises representatives of both the N.U.M. and the Board. No official statement was issued after the meeting, beyond the mere announcement that the committee had adjourned until yesterday. This action was taken, it may be reasonably presumed, to allow the union's representatives time to consider independently certain aspects of the wage situation put forward by the Board, and a meeting of the executive committee of the union did, in fact, take place last Wednesday. It appears that the need for stabilising piece rates, at all events for the time being, is involved in these negotiations. The existing agreement on piece rates expires to-day.

NEW BUILDING FOR THE DEPARTMENT OF ENGINEERING, CAMBRIDGE UNIVERSITY.

(For Description, see Page 669.)



FIG. 5. SOIL-MECHANICS LABORATORY.



FIG. 6. STRESS-ANALYSIS LABORATORY.

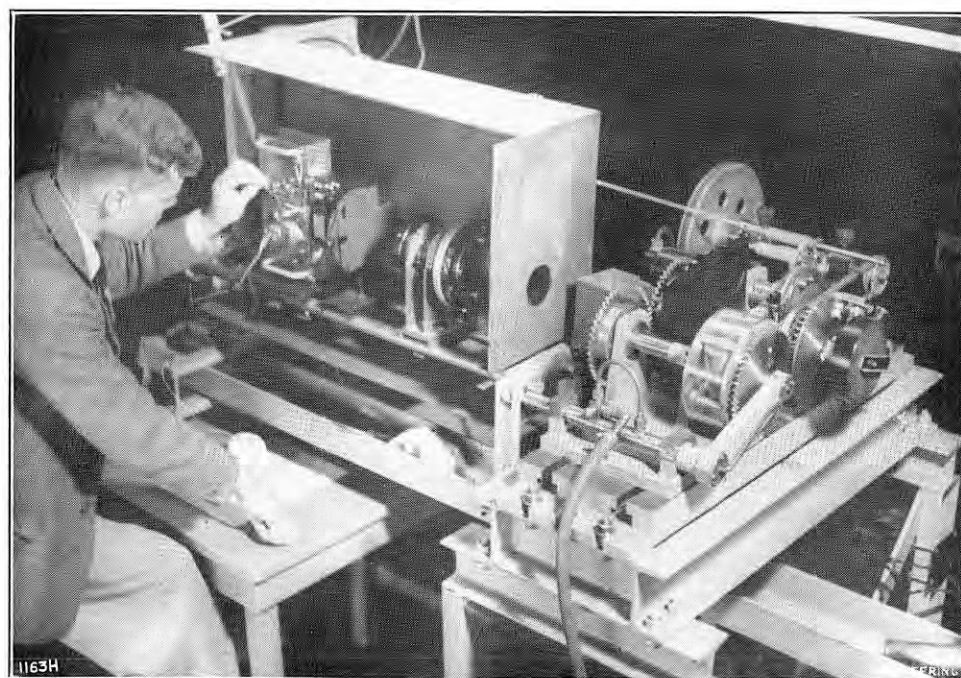
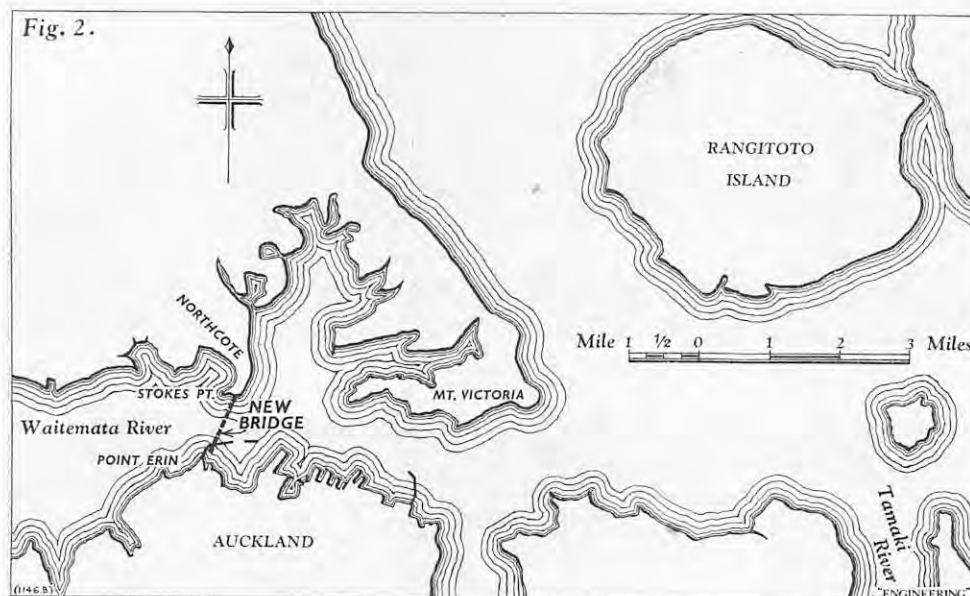
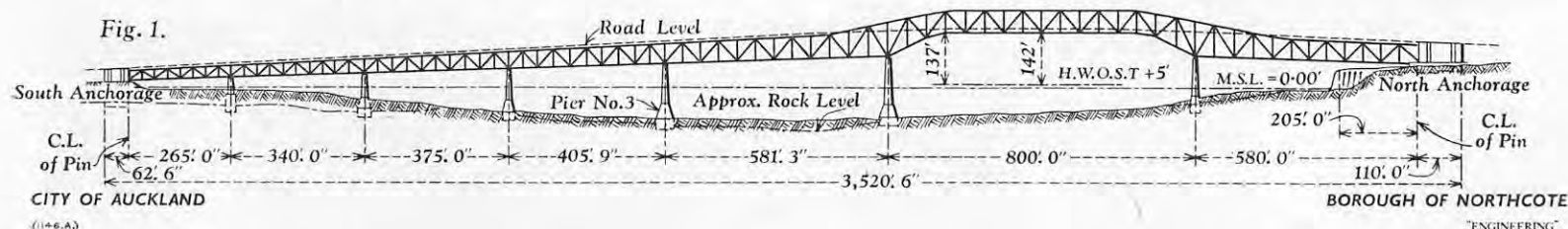


FIG. 7. APPARATUS FOR STUDYING DYNAMIC STRESSES IN GEAR TEETH.



FIG. 8. READING ROOM, SEEN FROM THE LIBRARIAN'S OFFICE.

PROPOSED AUCKLAND HARBOUR BRIDGE.



AUCKLAND HARBOUR BRIDGE PROJECT.

It has recently been announced that the Auckland Harbour Bridge Authority have accepted, subject to the Authority raising the necessary capital in the near future, the joint tender of two British firms, the Cleveland Bridge and Engineering Company, Limited, Darlington, and Dorman, Long and Company, Limited, Middlesbrough, for the construction of a toll road bridge at Auckland, New Zealand. The consulting engineers to the Harbour Authority, who are responsible for the design of the proposed bridge, are Messrs. Freeman, Fox and Partners, 68, Victoria-street, London, S.W.1. It is understood that raising the necessary capital, partly in London and partly in New Zealand, will be one of the subjects discussed at the forthcoming Commonwealth Economic Conference to be held in London at the end of November. The authorisations for steel have already been issued to the prospective contractors. The Harbour Bridge Authority propose to impose a scale of toll charges at a rate lower than that for the existing ferry, but sufficient to cover the costs of a sinking fund, interest, maintenance and administration of the bridge. It is thought that, whereas the bridge tolls can be fixed at a level which will remain unaltered for many years, the ferry tolls must inevitably be increased in the near future. The importance of the contract to the British engineering industry cannot be over-emphasised. If this country is to maintain its lead in the construction of large bridges it is essential that practical experience shall be seized wherever possible or the *savoir faire* will be rapidly dissipated. The need of Great Britain to invest capital and to sell to New Zealand, in order to buy meat and other dairy produce which are so urgently required, gives rise to optimism that this item of the economic talks will be successfully concluded with official sanction being granted to commence, first, the obtaining of the capital and then the construction of the bridge.

The need for the bridge has been felt for many years in Auckland, where the large dormitory borough of Northcote has developed on the far side of the harbour waters from the city. Traffic is at present carried by toll ferries and the resultant congestion and delay are both severe and costly; if

the bridge is not built the ferries themselves will have to be replaced. Previous schemes for the construction of a tunnel had already been rejected, as had the proposals for a combined road-rail bridge. The scheme on which the tenders have been based is for a road bridge on the alignment shown on the accompanying map, Fig. 2, and with the elevation, shown in Fig. 1, above, of which some details are given below. The project, as far as it has been considered and covered by the tender recently accepted, is concerned solely with the bridge *per se*, its superstructure, piers and abutments, and no decision has so far been made in respect of the lengthy approach ways that will be required on both banks. Twelve toll booths will eventually be provided to deal with a maximum of 2,000 cars per hour in either direction.

The superstructure of the bridge comprises a series of truss spans carrying a roadway 55 ft. wide with two 6-ft. wide footways over a total length of 3,520 ft. The roadway has a gradient of 1 in 20 on each side of the navigation span, with a vertical curve 800 ft. long over the main span. The design embodies top and bottom chords arranged to suit the change from deck-span to through-span where more clearance is required for navigation. The main navigation span of 800 ft. gives a maximum clearance of 142 ft. over high water (ordinary summer tide).

The three main spans, of 580 ft., 800 ft. and 581 ft. 3 in., are linked together along the bottom chord line and anchored to the north abutment. At pier 3, there is an expansion joint in the structure, and from there to the south bank the four spans, of 405 ft. 9 in., 375 ft., 340 ft. and 265 ft., respectively, are similarly linked in the line of their bottom chords and finally anchored to the south abutment. The eight spans of the bridge are thus divided at pier 3 into two separate chains each anchored at its shore end.

The trusses have been designed throughout in standard structural high-tensile steel and the individual members so designed that the spans may be erected by cantilevering out from each of the shore anchor spans. By this method the use of staging in the harbour will be avoided, except for that required near the banks for the erection of the shore spans. The prolonged taper in the depth of the trusses, when considered in conjunction with the high navigation span, is thought to enhance

the appearance of the bridge, but it has the more important advantage of permitting the bottom chord to be retained in a straight line to provide the maximum resistance to earthquake shocks.

The proposed roadway surface is an asphalt carpet, 1 in. thick, laid on a reinforced concrete slab supported by welded steel stringers whose top flanges are bonded into the slab by shear connectors. A similar construction has been adopted under the pathways, where ducts (2 ft. 9 in. wide by 1 ft. 2 in. deep) have been provided for services; the ducts are to be covered by removable concrete slabs and sealed by a 1/2-in. thick asphalt carpet. It is proposed that the parapet shall be 3 ft. 9 in. high.

The form of the piers and of the abutments has been determined by the need to provide adequate resistance to earthquake tremors. The two anchorages, to which each of the two parts of the bridge superstructure are locked, have been designed to take the whole of the longitudinal forces engendered by an earthquake. The construction of the piers is intended to withstand only the forces induced by their own inertia and that of the "virtual mass" of the surrounding water. The location of the abutments has, therefore, been influenced by the nearness of the bed-rock to ground level and the most efficacious pier has been found to be one with a broad base tapering rapidly as a hollow shaft of minimum thickness and lowest possible mass. Provision has thereby been made for continuous inspection of the rock foundation. The piers have therefore been designed as caissons to be sunk by manual excavation in compressed air; the location of pier No. 3 has been determined, in part, by the need to avoid an air pressure in excess of 50 lb. per square inch. It is anticipated that during sinking the caissons will be supported by floating craft and that fixed staging will not be required.

As has already been noted, particular attention has been paid in the design to the problem of developing resistance to possible earthquakes, and the intention has been to design a structure that will survive shocks of an intensity up to eight points on the Rossi-Forel scale; it is generally considered impracticable to design such a structure to resist more severe shocks. To this end the superstructure will be in an elastic material, and be well braced in all directions and securely anchored, while the deep rocker bearings at each pier will allow large longitudinal movements to occur without damage to the structure or piers. For the purpose of the present design the forces due to the earthquake were assumed to co-exist with one half the maximum live load on the bridge, a full wind load of 20 lb. per square foot, together with the worst conditions of temperature variation. It is thought that the piers will be able to withstand a displacement of 3 ft. in any direction and that the superstructure will safely accommodate a similar lateral movement and a vertical settlement considerably in excess of 3 ft.

The joint tender of the two British companies has been accepted, subject to the proviso already noted, for a contract price of 4,236,000l. The intention is that the bulk of the steel, 10,000 tons, will be rolled in Dorman, Long mills and that the companies will share equally in the fabrication and erection of the superstructure as well as in the construction of the piers and abutments. The construction of the bridge will mean sending a considerable number of engineers and skilled tradesmen to Auckland, where a site encampment will have to be provided for their accommodation. It is expected that the construction of the bridge will take about four years.

THE PLYMOUTH "B" POWER STATION OF THE BRITISH ELECTRICITY AUTHORITY.

THE Plymouth "B" power station of the British Electricity Authority (the present capacity of which is 90 MW) is the first of three new stations in the South-Western Division to come into operation. It has been built on a 15-acre site at Prince Rock on the west bank of the Cattewater and lies alongside the "A" station, which has been supplying electricity since 1899. Approval for its construction was received from the Central Electricity Board in 1946 and the work was carried out primarily under the supervision of Mr. H. Midgley, the then city electrical engineer, with Messrs. Mouchel and Partners, Limited, 38, Victoria-street, London, S.W.1, as civil engineering consultants and Mr. J. H. Somerset as consulting architect. After April, 1948, however, the direction passed to the Divisional Controller of the South-Western Division, Mr. J. T. H. Legge, who was succeeded in 1951 by Mr. A. C. Thirtle. The first boiler unit and turbo-alternator were commissioned in December, 1951, and the second about six months later. The third will be in service early next year.

The main power station and switch houses are steel-framed concrete-encased structures with brick panel walls, while the ancillary buildings have reinforced concrete frames with brick panel walls. The wharf consists of a concrete deck supported on piles and cylinders, which are founded on the rock and are tied together by pre-cast beams and bracings. As an under-water cliff crosses the wharf at about its mid point, the use of long piles with a maximum length of 110 ft. was necessary. The building and civil engineering work was carried out by Messrs. John Laing and Son, Limited, London, N.W.7, and the structural steel-work by Messrs. Peirson and Company, Limited, 20, High Holborn, London, W.C.1.

The coal-handling plant, which has been designed to meet the requirements of the completed station, consists of two Stothert and Pitt level-luffing travelling jib cranes, each with a capacity of 100 tons per hour, which unload the coal from colliers into travelling hoppers. From these hoppers it is taken by a system of belt conveyors, with a capacity of 350 tons per hour, either to the boiler house or to the working store. Coal is recoverable from this store by a drag scraper with a capacity of 200 tons per hour. The contractors for the coal-handling plant were International Combustion, Limited, 19, Woburn-place, London, W.C.1.

The coal for each of the three boilers at present installed is fed from the bunkers through automatic weighers into three Lopteco pulverisers, the capacity of which is such that two can maintain 90 per cent. of the maximum continuous rating with coal having an ash content of 15 per cent. and a moisture content of 10 per cent. The pulverised fuel is then withdrawn by exhaustor fans and blown into the boilers through burners in the corners of the furnace. Each boiler, which was constructed by Messrs. Yarrow and Company, Limited, Scotstoun, Glasgow, W.4, is of the twin-drum type and is capable of supplying 320,000 lb. of steam per hour at the maximum continuous rating with a stop valve pressure of 625 lb. per square inch and a temperature of 865 deg. F. The drums are of forged steel and are 35 ft. 4½ in. long, 54 in. in diameter and 2½ in. thick. The furnace is water-cooled by finned tubes and the volume of the combustion chamber is 22,800 cub. ft. The superheater is of the two-stage self-draining Melesco type, and was manufactured by the Superheater Company, Limited, 53, Haymarket, London, S.W.1; the heating surface of the primary stage is 7,500 sq. ft. and of the secondary stage 3,630 sq. ft. A Melesco de-superheater is placed between the two stages and is fitted with the Kent-Multilec control system. Air for combustion is drawn from the top of the boiler by two forced-draught fans with an output of 67,500 cub. ft. per minute; it passes thence through tubular air heaters with a surface of 90,500 sq. ft. into the furnace. The gases from the furnace pass through a

PLYMOUTH "B" POWER STATION.

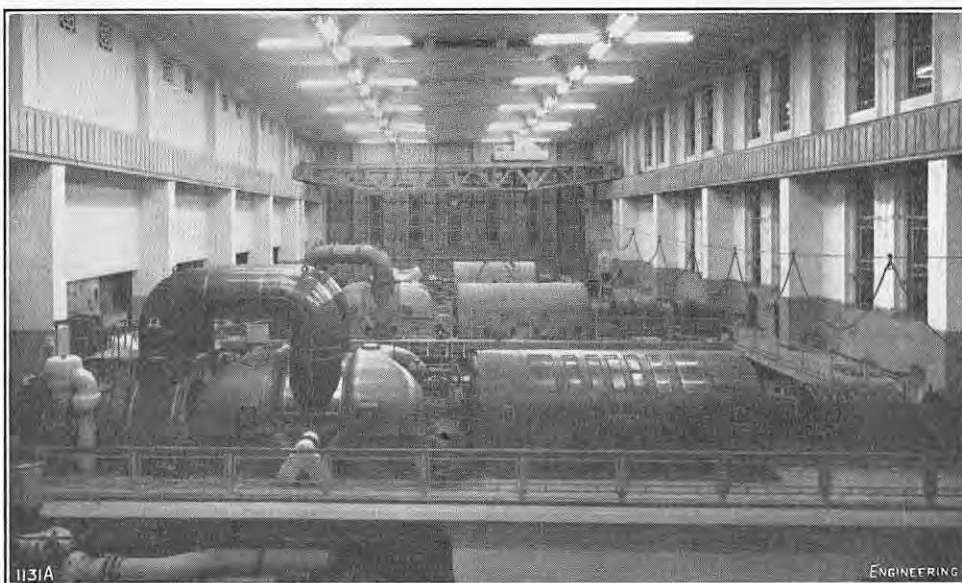


FIG. 1. TURBINE ROOM.

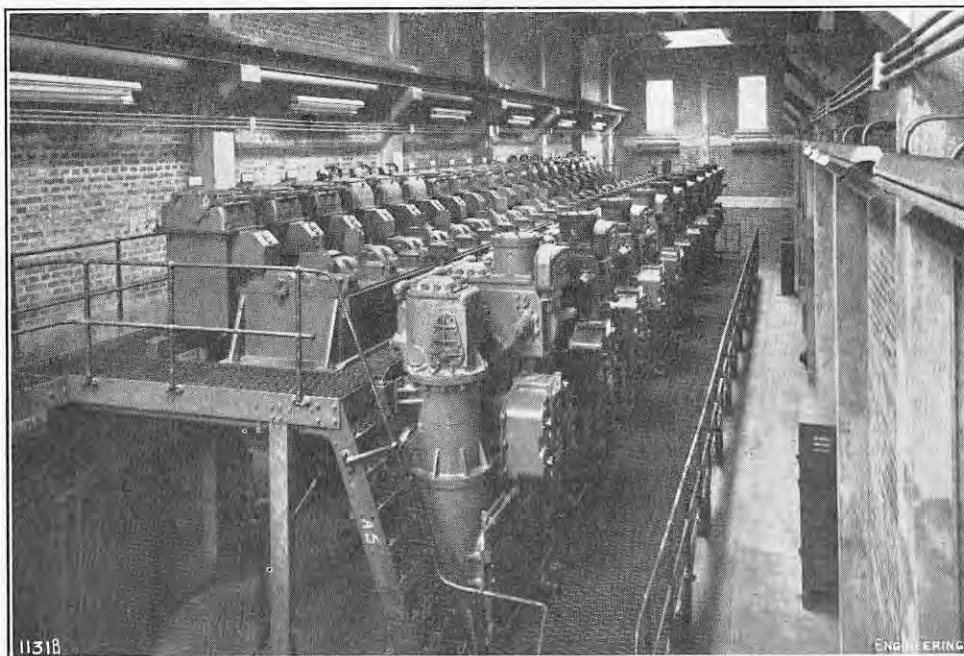


FIG. 2. HIGH-TENSION SWITCHGEAR.

Senior gilled twin-tube economiser with a surface of 19,200 sq. ft. and then through the air heaters and Lodge-Cottrell electrostatic precipitators before being finally discharged by twin induced draught fans with an output of 93,000 cub. ft. per minute into the chimney. Both the forced and induced draught fans were provided by Messrs. Davidson and Company, Limited, Belfast.

The boilers are equipped with automatic oil-fuel lighting-up equipment, which was supplied by the Wallsend Slipway and Engineering Company, Limited, Wallsend. The oil for this purpose is pumped into storage tanks from tankers on the railway sidings or delivered direct from road vehicles. From the storage tanks it is pumped into service tanks and thence through heaters to the burners in the corners of the furnaces. Automatic ignition equipment, which includes photo-electric cells, is provided on each burner. The boilers are designed for fully automatic operation, compressed air being used for regulating the fan motor speeds through induction regulators or fluid couplings, while the dampers are operated hydraulically. Manual control is also fitted. The plant and apparatus for these purposes was manufactured by the Electroflo Meters Company, Limited, Park Royal, London, N.W.10. Fully-automatic sequence-operated soot-blowers, made by Messrs. Hopkinsons, Limited, are provided for cleaning the furnace

walls and superheater and screen tubes. The dust and ash-handling plant was constructed by Messrs. Babcock and Wilcox, Limited, Farringdon-street, London, E.C.4, and is of their Hydrojet sluicing type. The dust is dealt with on the Hydrovac principle.

The generating plant is illustrated in Fig. 1 and at present consists of three Metropolitan-Vickers turbo-alternators, each with a maximum continuous rating of 31.5 MW. The turbines, of the two-cylinder type, are supplied with steam from each boiler through a separate receiver and the low-pressure cylinder exhausts into twin condensers with a total cooling surface of 28,000 sq. ft. Steam is extracted from the turbine to supply two low-pressure and two high-pressure feed heaters, which raise the feed water to a final temperature of 340 deg. F. at the maximum continuous rating. The feed line in which these heaters are connected includes a total of five electrically-driven feed pumps, each with an output of 350,000 lb. per hour at a pressure of 870 lb. per square inch, and three steam-driven pumps, each with an output of 175,000 lb. per hour. All these pumps were manufactured by Messrs. Mather and Platt, Limited, Manchester, 10. Live steam is supplied to a triple effect central evaporator which has an output of 20,000 lb. of distilled water per hour. Although the plant is designed for operation on the unit system, inter-

connections are provided on both the steam and feed systems.

Circulating water for cooling the condensers and for the air and oil coolers on the alternators is drawn from the Cattewater through two 5-ft. by 6-ft. 6-in. reinforced concrete culverts, which run under the basement floor of the turbine house. The water is drawn into these culverts through four Brackett screens by six pumps, which are installed at the west end of the wharf. These pumps, which were also made by Messrs. Mather and Platt, Limited, are of the vertical-spindle type and each is capable of delivering 16,000 gallons of water per minute against a head of 52 ft. Chlorinating plant has been provided to inject chlorine into the water and thus to prevent the growth of mussels and slime on the culvert walls and condenser tubes. The water is finally discharged into the estuary through two reinforced concrete culverts.

Each turbine is coupled to a main alternator with a maximum continuous output of 31.5 MW at 33 kV when running at 3,000 r.p.m. This main alternator is in turn coupled to a 1,500-kW 3.3-kV house alternator. The latter machine is connected to a unit switchboard, from which supplies are taken to motors driving the boiler-house and turbo-alternator auxiliaries. The main 33-kV switchgear, which is shown in Fig. 2, opposite, has a rupturing capacity of 1,500 MVA. It is at present installed in two switch houses and controls the output of the main alternators and the feeders to the grid and the South-Western Electricity Board's distribution system. A supply is also given through two 7.5-MVA 33/3.3-kV Hackbridge and Hewitt transformers to a station auxiliaries board for the whole station and to unit distribution boards, of which there is one for each set. The 415-volt circuits are supplied from these boards through one 2,000-kVA and three 250-kVA Metropolitan-Vickers transformers, while the lighting installation is fed at 415/432 volts through four 100-kVA units. A total of 230 motors, with outputs varying from $\frac{1}{4}$ to 560 h.p., have been installed for operating the plant auxiliaries. With the exception of those driving the turbine barring gear and flushing pump and the circulating-water pumps, these were manufactured by Messrs. Laurence Scott and Electromotors, Limited, Norwich. Current for operating the switchgear and telephones, and supplying the emergency lighting, is obtained from two 120-cell batteries, each with an output of 200-ampere-hours at 240 volts, and from a 24-cell battery with the same output at 50 volts. These batteries were made by Chloride Batteries, Limited, Clifton Junction, near Manchester.

TESTING PAINTS FOR LONDON COUNTY COUNCIL.—The chemical laboratories at County Hall, London, S.E.1, are to be extended to enable a systematic check to be maintained on the quality of paint used by the London County Council on housing estates, schools and other establishments. The new laboratory will be equipped with a "weatherometer" for carrying out accelerated weathering tests, simulating the effects of a long exposure to the atmosphere of a town in a relatively short time; a humidity cabinet to enable the anti-corrosion properties of paint films to be assessed; an automatic scratch-test apparatus for measuring the hardness and adhesion of a paint film; and a gloss meter. It is expected that the new facilities, by ensuring that the most suitable paints are used, will reduce the heavy costs of labour and materials involved in re-painting.

CONFERENCE ON ATOMIC ENERGY.—A conference between representatives of Canada and the United Kingdom was held at the Atomic Energy Research Establishment, Harwell, on November 7 and 8 to discuss technical policy on atomic energy. Canada was represented by Dr. C. J. Mackenzie, Dr. W. B. Lewis and Mr. I. N. Mackay, and the United Kingdom delegation was led by Lord Cherwell, Lieut.-General Sir Frederick Morgan, K.C.B. (Controller of Supplies, Atomic Energy), Sir John D. Cockcroft, C.B.E., F.R.S. (Director of Atomic Energy Research Establishment) and Sir Christopher Hinton (Deputy Controller of Supplies, Atomic Energy). The agenda included a discussion of the immediate and long-term objectives of the Canadian and United Kingdom programmes on the industrial application of atomic energy, of the economics of nuclear power production and of the production of special materials required for these programmes.

THE INSTITUTION OF CIVIL ENGINEERS: PRESIDENTIAL ADDRESS.*

By H. F. Cronin, C.B.E., M.C., B.Sc.(Eng.)

(Continued from page 623.)

THE LONDON COUNTY COUNCIL AND LORD BALFOUR'S ROYAL COMMISSION.

FOR the next few years, the companies continued to develop their works peacefully to meet the rising demands, but in 1889 a new protagonist appeared on the scene. This was the London County Council, which had come into being consequent upon the passing of the Local Government Act of 1888. The Council immediately directed their attention to the water supply, formed a special Water Committee, obtained powers to spend money on these matters, and expressed strong views that the water supply to London should be under the control of a public authority. As a result of their representations to the Government, a third Royal Commission was appointed in 1892, under the chairmanship of Lord Balfour of Burleigh, part of whose terms of reference was: "Whether, taking into consideration the growth of the Metropolis and the districts within the limits of the Metropolitan Water Companies and also the needs of localities not supplied by any Metropolitan Company but within the watersheds of the Thames and Lee, the present resources of these Companies are adequate in quantity and quality and, if inadequate, whether such supply as may be required can be obtained within the watersheds referred to, having due regard to the claims of the districts outside the Metropolis but within those watersheds or will have to be obtained outside the watersheds of the Thames and Lee."

The Commission received a great deal of important and interesting evidence on engineering, geological, and other subjects connected with the water supply to the Metropolis, including the potential supply available from the Thames and the Lee and the underground sources in the vicinity of London, but they did not consider any scheme for bringing water from distant sources such as Wales. The report, proceedings, and appendices, published in 1893, contain a mass of valuable information upon the London water supply in all its aspects. The Commission stated that they were satisfied that the water then supplied to the consumers in London was of a high standard of purity and that, with adequate storage, the resources within the watersheds of the Thames and Lee were sufficient for a long time to come. They considered that, in 1931, the population to be supplied in an area of 845 square miles would be about 11½ million persons and, adopting a figure of 35 gallons per head per day for their future requirements, that the consumption in that year would be approximately 394 m.g.d.

In dealing with the resources of the Thames and Lee watersheds in the vicinity of London, the Commission estimated these to be:—

	m.g.d.
From wells and springs in the Lee Valley and in the Kent area	67½
From the River Lee with additions to the present storage system	52½
From the River Thames by the construction of storage reservoirs at no great distance above the present intakes of the Companies	300
Total	420

Considering the relatively few years for which the river gaugings were available and the limited extent to which the wells had been developed at the time of the Commission, these estimates, in the light of more than 50 years' subsequent experience, are remarkable for their accuracy.

Although the Government took no action upon this report, the findings did not satisfy the London County Council, who disagreed with the proposed storage scheme and, while reiterating their views that the water supply should be under public control, expressed the strong opinion that additional supplies should be obtained from a purer source than either the Thames or the Lee. They therefore

* Delivered at the Institution, Great George-street, Westminster, S.W.1, on November 4, 1952. Abridged.

instructed their chief engineer, Mr. (later Sir) Alexander Binnie, to prepare a scheme for a supply from Wales.

LORD LLANDAFF'S ROYAL COMMISSION.

In their campaign against the water companies, the London County Council obtained gratuitous assistance from an unexpected source. The rainfall in 1895 and in the early part of 1896 was below the average, and, in consequence, the flows in the River Lee were abnormally low. Since the East London Company did not possess sufficient storage, the water supply to the East End had to be drastically reduced during these summers. This, and the attempts by the London County Council in the Parliamentary sessions of 1896 and 1897 to obtain powers to purchase the water companies, resulted in the appointment, in May, 1897, of the fourth and last Royal Commission, under the chairmanship of Lord Llandaff, to inquire, *inter alia*, as to whether "... the Undertakings of the Water Companies should be acquired and managed either (a) by one Authority; or (b) by several Authorities; and if so, what should be such Authority or Authorities." Only two engineers served on this Commission, namely, Sir George Bruce, who was also a member of Lord Balfour's Commission, and Major-General A. de C. Scott, R.E. Much of the evidence placed before this Commission, and of their final report, dealt with finance. Nevertheless, they considered some engineering matters of great interest, one of the most important being the London County Council's scheme for a supply from Wales. This proposal was to obtain water from the Usk, the Wye and its tributaries, as well as from the Towy, the quantities varying between 121 and 165 m.g.d. for the first instalment, up to 208 m.g.d. for the completed scheme. The estimated cost of obtaining a supply of 121 m.g.d. was given by Sir Alexander Binnie as a little over 10,000,000/., but this was disputed by other witnesses. The Commission, however, rejected the Welsh scheme on the score of expense and endorsed the recommendations of the two previous Royal Commissions in favour of the Thames and Lee.

Another matter which was soon to assume—and which continues to assume—great importance was dealt with in their report, namely, the minimum flow of the river below the intakes. Upon this, Lord Balfour's Commission did not make any recommendation, though they did consider a storage scheme based on a minimum flow of 200 m.g.d. over Teddington Weir. A great deal of evidence was presented to Lord Llandaff's Commission on this subject, and in their report they expressed the opinion that the minimum flow over Teddington Weir should be fixed at 200 m.g.d., not to be reduced except under special safeguards and restrictions. On the principal matter referred to the Commission, they recommended that, both on engineering and financial grounds, it was desirable that the undertakings of the water companies should be acquired and managed by a single public authority. The Government accepted these findings and on January 2, 1902, a Bill was introduced into the House of Commons to provide for the formation of a Metropolitan Water Board to purchase and manage the undertakings of the London water companies. On December 18, it passed into law as the Metropolitan Water Act, 1902. The Board met for the first time on April 2, 1903.

THE EARLY DAYS OF THE METROPOLITAN WATER BOARD.

In June and July, 1904, the Board took over the works, duties, and obligations of the eight water companies and also the undertakings of Enfield and Tottenham Urban District Councils, for which they paid a total sum of approximately 47,500,000/.. Thus, nearly 300 years after the formation of the New River Company, the Metropolitan Water Companies came to an end. It has been fashionable to decry their achievements, but there is no denying that many of the works which they constructed and which are still in use are examples, and very good examples, of the best engineering practice of their day. Whatever may have been their shortcomings, one company at least appreciated the value of their chief engineer and it is on record that he received, in addition to a salary, certain

emoluments, and some relief from income tax, a commission on all the new works which he constructed. It need hardly be added that, under such an excellent arrangement, the works of this particular company were always up to date and fully adequate to meet the demands made upon them.

After determining procedure and deciding upon their organisation, the Board took stock of their position and commenced to integrate their heritage. Their obligations consisted of an increasing supply to some 6,400,000 persons who, together with the industry in the area, required about 210 million gallons per day. Lord Llandaff's Commission estimated that the population to be supplied in 1941 would be about 12 millions and that 35 gallons per head per day for all purposes would then be ample. Thus the total demands in 1941 were expected to be about 420 million gallons per day and these figures were adopted by the Board in preparing their programme of new works.

The assets on taking over were, in the light of present-day experience, not easy to define. So far as the wells were concerned, many of the yields given in evidence proved later to be on the optimistic side, while the Lee had already given signs, and later conclusive evidence, of being overdrawn. In the case of the main source, the Thames, the amount which could legitimately be abstracted was becoming inadequate. The conditions of abstraction did, however, include the important and favourable provision that 130 million gallons per day could be abstracted irrespective of the flow in the river. This was usually referred to as the "unrestricted right." It was, however, evident that more storage was required and that a minimum flow would be imposed sooner or later; therefore, the first major task of the Board was to secure authority to construct additional reservoirs in the Thames Valley.

Basing their calculations on the 1899 flows and on the then existing conditions of abstraction, the Board applied to Parliament in the session of 1910-11 for powers to build one reservoir near Sunbury and seven other reservoirs, having a joint capacity of about 20,000 million gallons, in the vicinity of Staines. Of these, the Sunbury reservoir was withdrawn before the Bill was considered, two were thrown out by the Parliamentary Committee, two were subsequently withdrawn by the Board, and powers for the remaining three were granted. These latter were eventually constructed, two being merged into the Queen Mary Reservoir (6,679 million gallons), and the third, enlarged under powers of the 1935 Act, to form the King George VI Reservoir (4,466 million gallons). In the same session, the Thames Conservancy introduced a Bill under which the Board were to be required to give up their "unrestricted right" to take 130 million gallons per day in exchange for additional powers of abstraction. By agreement between the two Boards, it was proposed that a statutory minimum flow of 140 million gallons per day should be maintained at Teddington Weir after the Water Board had constructed further storage.

Both Bills were considered together by the same Joint Select Committee of the two Houses and attracted considerable opposition. The result of the Water Board's application has already been stated, and, in the case of the Conservancy Board's Bill, the Committee decided on a statutory flow of 170 million gallons per day. As the Conservancy asked for 140 million gallons per day and their opponents pressed for 200, it is not difficult to follow the abstruse calculations which took place in the committee room while the contending parties waited in the corridor. Provision was also made in the Act whereby the Local Government Board and their successors could, in conjunction with the Ministry of Transport, reduce the statutory flow in an emergency. The conditions of abstraction have since been altered from time to time and the Board have now powers to abstract an average of 300 million gallons per day during any year, with a maximum of 1,200 million gallons on any one day, subject always to the maintenance of the statutory flow at Teddington Weir. The unrestricted right to take 130 million gallons per day came to an end in 1926, when the Queen Mary Reservoir was brought into use.

(To be continued.)

LOADER FOR TRIMMING BULK CARGO IN SHIPS

MERTON ENGINEERING COMPANY, LIMITED, FELTHAM.



MECHANICAL TRIMMING OF BULK SUGAR IN SHIPS' HOLDS.

UNTIL recently it has been the practice to ship raw sugar from the West Indies to the refineries of the United Kingdom in bags. Owing to the rising cost of these containers, however, there is a growing trend towards shipping in bulk. This has introduced two serious problems: trimming the sugar in the hold after it has been loaded, and collecting the sugar from the wings and ends of the hold to the square of the hatch so that it may be unloaded by grab. The London office of the International Cargo Handling Co-ordination Association were asked recently to consider methods for carrying out these operations more efficiently and cheaply than by manual labour. They consulted Materials Handling Equipment (Great Britain), Limited, 7, Chesterfield-gardens, London, W.1. It is hoped that the problem may be solved by a high-speed mechanical spreader now in process of development.

For collecting bulk sugar from the hold for grab discharge, it has been found that machines such as front-end loading shovels and bulldozers are not satisfactory because they have to turn round to discharge their load, and the necessary space is not available in a ship's hold. Materials Handling Equipment therefore suggested the use of the Merton overhead loader. Satisfactory trials have been carried out recently with one of these machines in No. 2 hold of s.s. Talca, of the Pacific Steam Navigation Company, at the Royal Victoria Dock, London. The vessel was loaded with 9,000 tons of bulk raw sugar, consigned to Messrs. Tate and Lyle, Limited.

The Merton loader is shown in the accompanying illustration. The machine, which is constructed by the Merton Engineering Company, Limited, Feltham, Middlesex, was on view at the recent Public Works and Municipal Service Congress and Exhibition at Olympia, and was described briefly on page 573, *ante*. It comprises a bucket which, after loading, is mechanically traversed along overhead tracks carried on a steel superstructure mounted on a new Fordson Major tractor. The bucket is tipped automatically at the rear of its travel. A spring mechanism immediately returns the unloaded bucket, which travels by gravity back to the loading position at the front of the machine. Thus the machine can be driven to any desired discharge point while the loaded bucket is traversing the tracks, and discharge can take place a few seconds after loading, generally in less than 20 seconds. The bucket, which is made of $\frac{1}{4}$ -in. and $\frac{3}{8}$ -in. steel

plate, with a manganese-steel tip plate, has a capacity of 14 cub. ft., and the average rate of loading and discharging is between 50 and 60 tons per hour. The Merton loader has an overall height of 11 ft. a wheel base of 6 ft. and an overall width of less than 7 ft., and thus is compact enough to operate in the lower hold of the average cargo vessel. The superstructure is so designed that no counterbalance weights are required. The digging angle of the bucket can be adjusted over a range of angles. Between loading and discharging, the bucket remains horizontal.

Before testing the loader on board the Talca, a space about 15 ft. square was cleared at the top of the hold, below the after end of the hatch opening, by a Priestman grab, and the machine was then lowered into this space by dock cranes. The grab was thus able to continue discharging on to barges alongside from below the forward end of the square of the hatch, while the overhead loader commenced loading at the after end and unloading to the centre of the hatch, where a pile of raw sugar gradually accumulated, awaiting discharge by the grab. The latter had an estimated average load of 22 cwt. and an estimated average discharge rate of 40 tons per hour. A "cliff" of sugar, about 25 ft. in height, surrounded the hatch, and it was feared that the loader might have difficulty in digging into the mass, or might be buried by a fall. In practice, however, the loader had no difficulty in coping with the material. As it attacked the base of the mass, the upper layers fell in a gradual stream towards the machine, assisting the loading of the bucket. There was no tendency for the viscous material to jam the mechanism of the loader. From these trials it was concluded that the Merton overhead loader, operated by one man, is capable of delivering to the hatch opening nearly three times the quantity of sugar in an hour that could be delivered by the conventional method, whereby a gang of eight to ten men employ shovels to load the sugar into long canvas-covered nets which are slung, when loaded, into barges. Certain modifications to the machine are considered desirable for handling bulk cargo, such as fitting a safety-glass window in the roof of the superstructure to enable the loader-operator to observe the position of the grab and the foreman directing operations; fitting teeth to the front edge of the bucket to enable it to penetrate hard materials; and, possibly, using a larger bucket to increase the rate of discharge. It is also suggested that a "walkie-talkie" radio should be installed for improving intercommunication. All these modifications are under consideration.

RADIOACTIVITY IN MINERAL DRESSING.*

By PROFESSOR A. M. GAUDIN, E.M., Sc.D.

RADIOACTIVITY can be put to use in mineral dressing in three ways: as a research tool; for the control of non-radioactive plant processes; and as a mineral-separating tool. As a research tool, radioactivity may be concerned with furthering knowledge of the physical and chemical properties of minerals, or of the detailed mechanism by which separating processes work. As a controlling device in practical operations, its functions are to evaluate certain operating variables and to use this evaluation to guide machines and processes. Finally, as a mineral-separating tool, radioactivity becomes the prime agency of mineral concentration.

In connection with our consideration of these three types of applications, it may be useful to indicate what is encompassed by the term "radioactivity." Initially, it referred to the three types of radiation observed to occur spontaneously in the decay of naturally radioactive elements such as radium, namely, α -, β - and γ -rays. Of these, the α -rays are positively-charged helium atoms, i.e., helium cations; the β -rays are electrons; and the γ -rays are bundles of energy similar to light and identical with X-rays. Alpha-rays, because of their huge reactivity and short range, have not been found useful in our field of work, so that we shall be concerned primarily with β - and γ -radiation. For research purposes, β -radiation is preferred because of its moderate range and the accuracy with which it can be measured. On the other hand, for practical applications in process control or in mineral separation γ -radiation is preferred because of its greater penetration and its action at a distance.

USE IN INVESTIGATIONS.

Radioactivity is a property of the nucleus of atoms. It is independent of the molecular arrangement of atoms, of the temperature of the system, and, in fact, of every variable capable of affecting chemical substances. In a very real way, radioactivity is a non-chemical attribute of matter. Radioactively-marked atoms have been proposed and widely used as tracers to follow chemical reactions. The fact that radioactivity is an attribute of the nucleus of the atom and is not transferable from one nucleus to another permits us to identify a given individual atom even in an environment of unmarked atoms of the same element. This, in turn, makes it possible to study self-diffusion in the gaseous, liquid, or solid states; that is, the movement of an element within an environment of its own kind.

An example of a study based on this property is the self-diffusion in solid metals, as of copper atoms in crystals of copper. In the field of minerals, Dr. Kenneth Vincent, about ten years ago, had occasion to study the diffusion of copper atoms in chalcocite, the cuprous sulphide, and of sulphur atoms in the same mineral. To his surprise, he found that, at room temperature, copper atoms move very freely within the mineral while sulphur atoms are rigidly immovable. This property harmonises with what is known of the lattice of the compound and of the dimensions of the copper cation, which is very small, and the sulphur anion, which is large; and they may well be related to the semi-conducting properties of the mineral. It is interesting to observe that the lattice of cupric sulphide is such that motion of copper appears unlikely; and indeed it is not found to occur when the experiment is made. Realisation of studies in self-diffusion were obviously impossible by the usual chemical techniques. It is only through the use of radio-nuclides, and more generally of isotopic tracers, that any progress has been made in this field.

It has long been known that flotation collection is associated with the abstraction of the collector by the mineral from the aqueous solution. Measurements of the extent of this abstraction, however,

were not available under normal flotation conditions because the quantities and/or the concentrations involved were so small that chemical analysis by standard methods was generally unreliable. Thanks to the availability of radio-carbon (carbon 14), it is now possible to study the behaviour of any flotation collector, because all flotation collectors contain hydrocarbon chains. It is necessary, of course, first to synthesise the marked collector. This may be fairly easy, as in the case of saturated compounds such as *n*-dodecylamine or of lauric acid, or difficult as in the case of unsaturated compounds such as oleic acid. In any case, it is a task for an organic chemist trained in radiochemistry.

After the marked collector has been synthesised, and the activity of the preparation has been measured and standardised, measurements are made of the partition of the agent between mineral and aqueous solution, or between float and non-float solids. This requires the development and perfecting of appropriate analytical techniques for the analysis of solids and of solutions. From a knowledge of the reagent partition, or the so-called "adsorption isotherm," important conclusions can be deduced, with a significant bearing on flotation theory.

Reference may be made to the typically careful work of Dr. P. L. de Bruyn, Mr. F. W. Bloecher, Dr. C. S. Chang and Mr. John Morrow, who have studied the adsorption of marked *n*-dodecylamine and of marked lauric acid on various oxygen minerals, principally quartz. To make quartz float a coating of the collector is required. This coating need not be several molecules thick, or even one ion thick. In fact, a coating which is only 5 per cent. as complete as a monolayer provides excellent recovery; and a coating that covers less than 1 per cent. of the surface with a monolayer makes a tangible increase in the amount floated.

Diffusion studies of flotation collectors have shown that there is exchange between the collector adsorbed on the mineral and the collector moving about in the surrounding liquor. Thus, a dodecylaminium ion adsorbed on hematite exchanges places with a dodecylaminium ion in solution. If the agent on the mineral is radioactively marked, the radioactivity moves to the solution on exposure of the marked mineral to a solution of unmarked agent having the same concentration as that which initially marked the mineral, and vice versa. This exchange has also been observed to occur in the quartz-dodecylamine system.

A beginning has also been made in the understanding of the action of reagents other than collectors. Thus, the activation of sphalerite by copper and silver salts has been explored. Mr. M. P. Corriveau has found that silver forms a coating on the mineral, which changes with time. This ageing is much more pronounced at elevated temperatures and is interpreted as reflecting the diffusion of silver atoms and their re-arrangement into a more stable lattice. When cold, the mineral takes up silver ion in exchange for zinc ion, to the extent of forming a layer two ions deep; but if warm, the silver ions seem to move sufficiently to provide bare spots on which additional pick-up of silver can take place. Thus, a coating that is relatively thick on the average can form. With copper at room temperature the coating proceeds to the formation of the layer two ions deep and stops, but at suitably elevated temperatures a silver-like behaviour may occur.

RADIOACTIVITY IN PLANT CONTROL.

The second group of applications of radioactivity to mineral dressing is, in a sense, a transition group of applications ranging from inquiries into how a device is operating in a plant and how to control that device in order to cause it to operate at the optimum level most of the time. For example, a heavily-adsorbed short-lived radiotracer that gives a strong γ -emission could be used to evaluate the position of the sediment in a thickener. In conjunction with appropriate reagent-feeding devices, or with port-opening devices, this tracer could be used to keep the sediment level continuously at the most appropriate height. In filtration, use could be made of a radio-nuclide that is not markedly adsorbed for the purpose of evaluating the efficiency of dis-

placement washing, and further to control the flow of wash water so as to maintain the displacement washing at the optimum level. In flotation or leaching plants radio-nuclides could help to evaluate tonnages in complex interconnected flows, to estimate the dilution of pulp or liquor flows with added water, and the time required for the pulp to pass from one point to another.

USE FOR SEPARATING MINERALS.

The third group of applications of radioactivity to mineral dressing is in the actual separation of the minerals. As such, radioactivity would take its place with gravity concentration, magnetic separation, electrostatic separation and flotation as one of the processes available to the practising mineral engineer. Up till the present, radioactive processes have been essentially sorting procedures, but it is hoped that the future will bring the invention of a process in which particles in two or three dimensions can be acted upon simultaneously on the basis of their radioactivity. Such a development would represent a great forward step for radioactivity as a concentrating tool. A radioactive sorting process was proposed by Dr. Christian Lapointe, of the Canadian Department of Mines and Resources, for the purpose of sorting uranium-bearing pieces from non-uraniferous pieces. This process works well in limited circumstances and when cleanliness and absence of dust are of particular importance. This process depends for its operation on the natural differences in radioactivity between uraninite (or pitch-blende) and other minerals.

The ore is first sorted according to size; each size is then passed on a belt under a Geiger-Müller counter. Since each piece is of approximately the same size and affects the counting tube for the same length of time, the tube, in effect, makes a crude analysis of each and every piece of ore. According to this analysis the tube actuates a relay, or fails to actuate it, and the piece of ore goes either to one pile or to another. Each piece is thus sorted according to composition, a mechanised decision having been reached by the counter as to the pile to which the piece should be delivered. The Lapointe process is very limited in scope as there are few naturally-occurring elements that are radioactive. In fact, it is limited to minerals containing, besides uranium, the following elements: thorium, lutecium, rubidium and potassium. Of these elements only uranium and thorium appear to be sufficiently active for treatment by the Lapointe process.

More recently, it has been proposed by Messrs. John Dasher and James Pannell to utilise in a sorting process not natural radioactivity but induced radioactivity. Briefly, the proposal, which is limited to the concentration of coarse beryllium ore pieces, requires the utilisation of a nuclear reaction specific to beryllium. The neutrons emitted by beryllium are evaluated in neutron-counting tubes and thereafter the process is substantially the same as the Lapointe process. The scheme suffers from considerable complexity and from the difficulty in obtaining a neutron-free γ -flux. This is hard to accomplish with radium as a γ -radiation source because of beryllium impurities in the radium, but it is readily attainable in an X-ray generator of the van de Graaf type. This beryllium process obviously could be used to sort aquamarines or emeralds from waste, even when they are enclosed in lumps of rock. It is interesting to observe that a suitably arranged variant of this sorting process provides the most accurate method for the analysis of beryllium.

CIVIL AIRCRAFT INSPECTION PROCEDURES.—The Air Registration Board have issued the following leaflets to subscribers to "Civil Aircraft Inspection Procedures": *Contents List*, Issue 5; *Foreword*, Issue 2; *BL/7-2*, Issue 1, *Cadmium Plating*; *AL/4-1*, Issue 2, *Installation and Maintenance of Hydraulic Systems*; *AL/9-1*, Issue 1, *Repair of Metal Aircraft*; *AL/10-3*, Issue 1, *Adjustment and Compensation of Direct-Reading Magnetic Compasses*; *PL/1-1*, Issue 1, *Installation and Maintenance of Fixed-Pitch Propellers*; *ML/1-2*, Issue 1, *Weighing of Aircraft*. The leaflets may be obtained, price 4d. each, from the Board's Publications Department, Greville House, 37, Gratten-road, Cheltenham, Gloucestershire.

* Third Sir Julius Wernher Memorial Lecture, delivered before the Institution of Mining and Metallurgy on Monday, September 22, 1952. Abridged.

CENTRIFUGAL OIL SEPARATOR FOR COMMERCIAL VEHICLES.

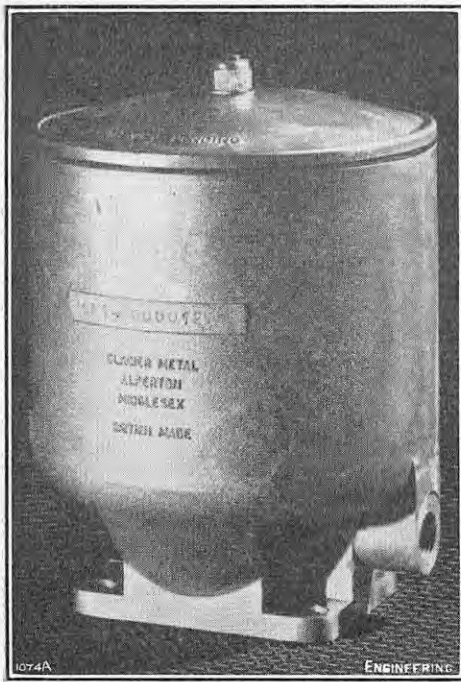
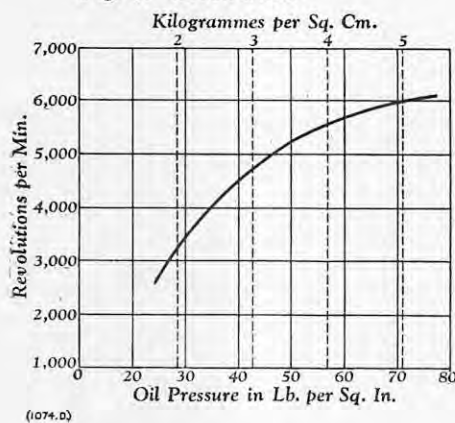


FIG. 1.

Fig. 4. ROTOR SPEED.



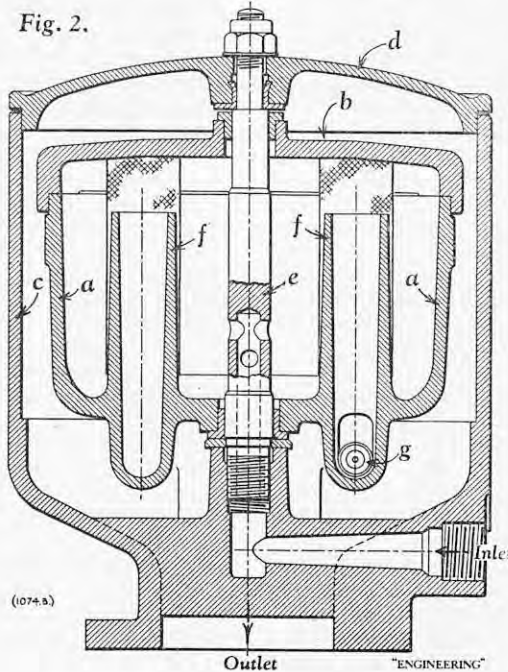
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CENTRIFUGAL OIL SEPARATOR FOR COMMERCIAL-VEHICLE ENGINES.

ALTHOUGH the benefits of centrifugal separation of engine oil have long been appreciated by the operators of commercial vehicles, it has generally been considered that the complications involved in installing a suitable separator on the engine and arranging for the necessary drive outweigh the advantages. These complications do not apply, however, to the new centrifugal separator illustrated in Fig. 1 herewith, as its overall dimensions, namely, 7 $\frac{3}{8}$ -in. high by 5 $\frac{1}{2}$ -in. diameter, are not much greater than a standard fabric filter and it can, as a consequence, be installed with comparative ease on engines of practically all commercial vehicles. Furthermore, the rotating parts are not driven mechanically but by the reaction of the oil as it leaves the separating bowl. It can, therefore, be fitted in any position on an engine provided a connection can be made to the lubricating-oil system. The unit was developed by the Glacier Metal Company, Limited, Alpertown, Wembley, in conjunction with Albion Motors, Limited, Scotstoun, Glasgow. It is being manufactured and distributed by the former firm and is suitable for use on engines of from 60 to 120 brake horse-power.

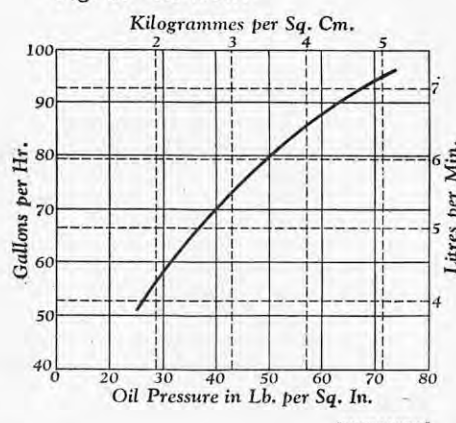
The operation of the separator will best be understood by reference to the cross-sectional drawing reproduced in Fig. 2, herewith. The two major parts are the rotating bowl or rotor *a* and its cap *b* and the bowl *c* which, together with its cover *d*, forms a chamber in which the rotor operates. The

Fig. 2.



(1074.5)

Fig. 5. OIL FLOW.



"ENGINEERING"

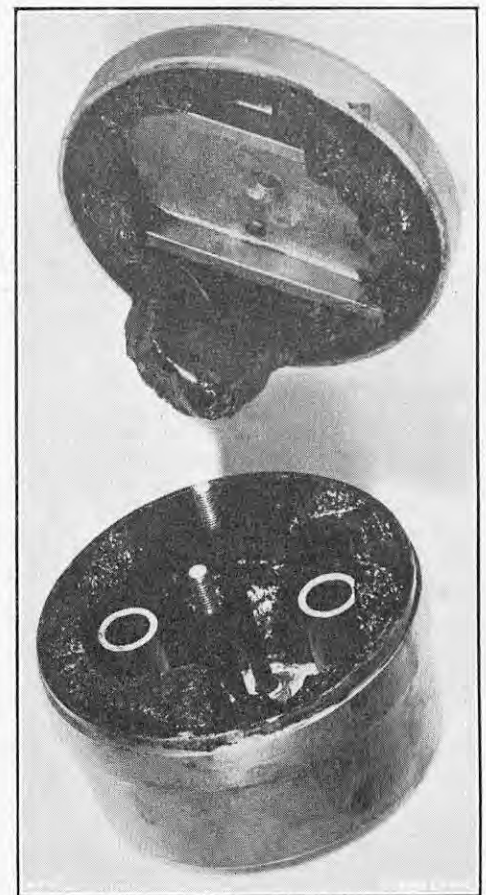


FIG. 3.

cover. To dismantle the complete unit entails only the removal of the nut which secures the cover to the outer chamber, after which the rotor assembly is lifted out bodily and dismantled by undoing the nuts at the top of the two studs, which hold the rotor cover in position. Several advantages are claimed for the separator over the more conventional pack or gauze types of filter normally fitted to vehicle engines; the oil as it is treated, for example, does not pass through the collected dirt and the unit can be cleaned without breaking any external oiltight joints. Furthermore, there is little likelihood of it becoming clogged and the efficiency does not fall off as dirt accumulates.

The minimum working pressure is 30 lb. per square inch, and although the unit will operate with lower pressures, the makers do not recommend this practice as the rotor speed will be insufficient to pack the dirt firmly against the wall of the rotor and the periods between cleanings, as a consequence, will be reduced considerably. The rotor speed and oil flow depend, of course, on the viscosity of the oil and the temperature, but curves giving the rotor speeds and the oil flows for different pressures are given in Figs. 4 and 5, respectively, these two curves referring to S.A.E. 30 oil at a temperature of 140 deg. F.

The unit was, of course, subjected to a series of severe tests before it was put into production. In one test, a quantity of 120-mesh Abra dust, as used in air-cleaner tests, was added to the oil as it entered the separator over a period of 20 minutes. As soon as the addition of the dust had been completed, the separator was stopped and it was ascertained that 98 per cent. of the dust had been trapped in the bowl of the rotor. In a further test, a quantity of Abra dust and carbon dirt removed from other centrifuges, and sufficient to fill the separator rotor, was mixed with oil and circulated through the unit. The jets functioned satisfactorily throughout the test, and on stopping and dismantling the bowl it was found to be in the condition shown in Fig. 3, herewith, the only clear spaces being two channels which led from the spindle to the top of the stand pipes.

rotor is free to spin about the hollow spindle *e*, being located by sleeve bearings fitted to the base and cap, respectively. It will be noted, however, that the rotor has integral with it the two pipes *f*; these are known as stand pipes and each is provided at the base with an orifice arranged so that the discharge is tangential to the rotor; one of the orifices can be seen in Fig. 2, where it is lettered *g*. The oil to be purified enters the rotor through holes drilled in the wall of the hollow spindle, being directed thereto through a passage formed in the supporting web that spans the outlet duct. When the purifier is put into operation, oil enters the rotor through the hollow spindle, rises inside the rotor and fills the complete rotor assembly, the pressure of the oil being the same as that of the main lubricating system. The oil escapes from the rotor through the orifices fitted in the lower extremities of the stand pipes and, due to the comparatively high pressure within the system, leaves at a considerable velocity, the reaction set up by the jets being sufficient to spin the rotor at a high speed. Thus, the oil is subjected to an appreciable centrifugal separating action as it passes through the bowl of the rotor and the particles of dirt, etc., are forced out towards, and adhere to, the inner surface of the bowl.

The unit is of simple construction and is easy to operate; there is little to go wrong and the possibility of the orifices becoming choked is guarded against by fine-mesh gauze sleeves fitted to the top of the stand pipes and arranged so that they make contact with the underside of the rotor cover. This is held in position by two studs screwed into the base of the rotor, the upper ends of which project through holes drilled in the

UTILISATION OF SOLAR ENERGY.*

(Concluded from page 646.)

AN estimate can be made of the possibilities of the wood-fired steam engine for irrigation. If it is assumed that the land to be irrigated requires during the year the equivalent of 0.5 m. of water to be raised from a depth of 10 m., it can be shown, using the figures given above for yield, calorific value and efficiency, that the amount of land required for growing fuel for the engine is about 1/50 of the area to be irrigated. The value assumed for yield is what would be obtained under good conditions and is substantially greater than would be expected from peasant holdings. Even if a factor of 5 is allowed on account of optimistic assumptions, the project still seems practicable.

A significant comparison is with the bullock, which is the commonest method of obtaining power on small-holdings in India. An Indian bullock has been known to exert a force of 0.16 tonnes at 1.6 km. per hour for 8 hours. For this period the bullock was producing 0.72 kW. The average performance of bullocks in good condition is probably a third of this. The average for a 24-hour day is therefore 80 watts. The mean of five summer rations for Indian bullocks suggested by P. E. Lander¹⁷ is 12 kg. per day (dry weight 7 kg. per day). The winter rations are larger (30 kg. per day for the one example given), but the dry weight of 8 kg. is not very different. With a calorific value of 1.7×10^4 joules per gramme (4,000 calories per gramme) the bullock is consuming food which, if burnt, would give 1.5 kW of heat. Its efficiency is therefore about 5 per cent. Put in another way, a bullock produces an average power of 80 watts and consumes about 2.7 tonnes (dry weight) of food in a year. To obtain 80 watts by burning wood would require 1.2 tonnes of wood.

Thus, from the point of view of thermodynamics, the wood-fired steam engine has advantages over the bullock as a source of power. There is a further advantage in that the steam engine does not need to be supplied with fuel when it is not working or when it is too young or too old to work. It can therefore save fuel when power is not needed and use it all during the season when water pumping or ploughing is required. In addition the steam engine will probably be used with more efficient pumps and ploughs than will the bullock. This may be a considerable gain as the efficiency of indigenous Indian water-raising appliances is only about 35 per cent. The disadvantages of the steam engine are high first cost, the lack of fuel and the lack of versatility. It would be difficult to use the same steam engine for pumping, ploughing and as a means of transport. These objections may well make the replacement of the bullock by the steam engine a very slow process. Nevertheless, it does seem desirable that a small steam engine fired by vegetable matter should be designed. It is possible that such an engine might be of value in some areas where coal and oil fuel are not available, but wood or other suitable plants are.

The production of large amounts of power by burning wood is in principle possible. To produce 10,000 kW with a power station having an overall efficiency of 32 per cent. would require 20 sq. km. of forest. That is, this area of forest could yield every year, for ever, enough wood to fire the boilers of the power station. There is a large margin of uncertainty in the estimation of the yield of timber and that assumed is probably optimistic. The

project does not appear attractive, but is not entirely impracticable. The widespread use of plants as a source of power would require so large an area of ground as seriously to affect the area available for growing food. Spoehr points out¹⁸ that if half the food produced in the United States during an average year between 1913 and 1918 were fermented to alcohol, it would just be able to replace the 1920 gasoline production. This comparison shows how entirely inadequate such a source is to provide an amount of power comparable with that at present in use.

The above estimates are based on the rate of production of vegetable matter by existing plants. It is conceivable that higher rates could be achieved by breeding plants specially for high rates of production. This would only be possible if the rate of production were not limited either by the usable energy received or the amounts of carbon dioxide or other necessary material available.

Continuous Biological Photosynthesis.—It has been suggested that some form of plant could be grown in tanks and continuously withdrawn and burnt, or fermented to alcohol. The attraction of this scheme is that it provides a process by which mechanical or electrical energy can be obtained continuously from sunlight without the consumption of any material substance.

The efficiency of the photosynthetic process in systems of the kind contemplated is in some doubt. Recent work¹⁸ gives up to 65 per cent. of the absorbed energy as usefully employed. This result is not universally accepted and many authorities consider that the efficiency is only about 25 per cent.¹⁹ To give a high efficiency for photosynthesis the incident energy must lie within a certain range of wavelengths; outside this range the efficiency falls. The variation of efficiency with wavelength is even more uncertain than the absolute value. A reasonable guess would perhaps be that 30 per cent. of the energy is used with an average efficiency of 25 per cent., giving an efficiency of 7.5 per cent. for the transformation of solar energy into chemical energy. If the plant material were filtered off and burnt, about two-thirds of this energy would be obtained as useful heat; the remainder would be used in drying the plants and could not be recovered except at so low a temperature as to be useless for power production. This gives 5 per cent. of the incident energy or 10 watts per square metre of useful heat. With a power station efficiency of 32 per cent., the power produced is 3.2 watts per square metre. These figures are summarised in Table III. Fermentation of the plants to alcohol or methane is also possible, and perhaps more convenient, but would yield substantially less power.

TABLE III.—Production of Power by Continuous Photo-synthesis.

—	Per cent.	Watts per Sq. Metre.
Solar constant	100	1,300
Yearly average	15	200
7.5 per cent. transformed to chemical energy	1.1	15
Useful heat	0.8	10
Useful work	0.26	3.2

Owing to its complication, such a scheme would only be possible on a fairly large scale. A power station producing 10,000 kW would need 3.1 sq. km. of tanks. The depth of the tanks would have to be sufficient for the greater part of the light to be absorbed by the plants. It is not known what thickness is required, but it would probably be at least 30 cm. If this is so, the volume of water would be 0.9×10^6 cub. m.

With a calorific value of 1.7×10^4 joules per gramme (4,000 calories per gramme) and a power-station efficiency of 32 per cent., the weight of dry plants consumed would be 5.8 tonnes per year per kilowatt, or 58,000 tonnes per year for a 10,000-kW station. To get this from 3.1 sq. km. of tanks requires a productivity of 19 kg. per square metre per year. This is about five times higher than the highest rates achieved naturally. This high rate is a result of the assumption that conditions can be produced under which the rate of growth is controlled only by the light available. As so high a rate is obtained on this assumption it would be

necessary to be sure that there was not some other limiting factor. In particular it would be necessary to recover the carbon dioxide obtained by burning the plants and return it, possibly in the form of carbonates, to supply carbon for the next batch. It would also be necessary to recover or supply nitrogen, potassium and some other elements in a suitable form. The amounts to be handled are considerable; for example, most vegetable matter contains 0.5 to 1 per cent. potassium oxide. The amount required in a year is therefore 300 to 600 tonnes. Even more nitrogen would be required. The disposal of the heat not used by the plants might also be a serious problem, since for a 10,000-kW station it would reach over 3×10^6 kW at mid-day in summer.

On the figures given above, the scheme is clearly impracticable. An area of 3.1 sq. km. of tanks, which might have to be covered, is too great to be considered for the production of 10,000 kW. A reduction by a factor of at least 10 is necessary. An examination of Table III suggests that this can only come from an increase in the efficiency of the conversion of the sun's radiation into chemical energy, by increasing the range of wavelengths used or by increasing the efficiency of use of those wavelengths already utilised. On present evidence it does not seem that such substantial improvements are possible. If, at some future time, the cost of fuel becomes very much greater than at present, such possibilities might require serious consideration.

We have considered only the production of power from algae and have regarded their cultivation for food¹⁹ as outside our terms of reference.

DISTILLATION OF WATER.

There is scope for the solar distillation of water for drinking purposes in certain tropical areas. On the assumption that an average of 0.15 kW per square metre of radiant energy is available, the evaporation by direct distillation at 100 deg. C. would be approximately 5 kg. per square metre of heat surface per day. Distillation at pressure below atmospheric would not reduce the heat required per kilogramme of water, but the efficiency of heat collection would be greater because of the lower temperature. Considerable improvements have been made recently by introducing black dyes into the solution to increase the proportion of the heat absorbed.

There is considerable scope for a combination of solar heater and thermal pump. This system would enable almost complete recovery of the latent heat of condensation and would greatly increase the output for a given size of plant.

CONCLUSIONS.

There is at present no way in which the use of solar energy can make a large contribution to our sources of power, and no line of research and development can be suggested that is likely to lead to a way in the near future. Energy for domestic hot-water heating can, in favourable circumstances, be obtained and there is scope in certain tropical areas for the distillation of water using a combination of solar heater and thermal pump. The committee recommends that a cooking stove, utilising solar energy and suitable for large-scale production, be designed.

The development of air-conditioning equipment driven by solar power is worth consideration, as is the design of a flat-plate collector for driving a small engine. A small steam engine of high efficiency using wood or other plant material as fuel appears to have substantial advantages over power derived from animals for pumping water and driving light machinery. The development of such an engine is desirable and is being undertaken by Messrs. Ricardo and Company Engineers (1927), Limited, 21, Suffolk-street, Pall Mall, London, S.W.1, for the National Research Development Corporation.

REFERENCES.

- 17 P. E. Lander, *The Feeding of Farm Animals in India*, page 345. Macmillan, Calcutta, 1949.
- 18 D. Burk, S. Hendricks, M. Korzenovsky, V. Schocken and O. Warburg, *Science*, vol. 110, page 225 (1949).
- 19 W. H. Pearsall and G. E. Fogg, *Food Investigation Memoir No. 659*.

* Report of the Committee on the Utilisation of Solar Energy, published by the National Physical Laboratory. Abridged. The committee's terms of reference were: 'To investigate the possibilities of utilising solar energy and to recommend whether research work on this should be undertaken or sponsored by the Department of Scientific and Industrial Research. The committee members were: Dr. E. C. Bullard, F.R.S. (chairman), Professor P. M. S. Blackett, F.R.S., Professor F. G. Gregory, F.R.S., Professor E. A. Guggenheim, F.R.S., Professor W. R. Hawthorne, Dr. H. Heywood, Professor Willis Jackson and Professor F. E. Simon, F.R.S. We commented on the report on page 601, ante.

† That part of the report which deals with the production of fuel by means of solar energy is continued here.

NOTES ON NEW BOOKS.

The Composition and Assaying of Minerals.

By JOHN STEWART-REMINGTON and DR. WILFRED FRANCIS. The Technical Press, Limited, Gloucester-road, Kingston Hill, Surrey. [Price 17s. 6d. net.]

THIS is essentially a laboratory text-book on the wet assay of ores and minerals. After a general description of preliminary tests for the identification of basic and acid radicles, the principal subject matter consists of notes on the properties of about 25 of the commoner metals, a brief description of their various ores, and summaries of qualitative tests and quantitative assays. A few non-metallic minerals are also described, and there is a general scheme of analysis for silicate minerals. In fact, a former publication by one of the authors on quantitative assay methods has been enlarged by adding the material on qualitative tests for the commoner radicles and the descriptions of the ores. No mention is made of advanced methods of examination such as spot tests for trace elements or the use of the spectrograph, and the assay methods outlined are really intended for the use of geological chemists or assaying students in universities and technical colleges. The book, in its new form, will certainly be of use to such readers.

Materials Handling in Industry.

The British Electrical Development Association, 2, Savoy-hill, London, W.C.2. [Price 8s. 6d.]

THE theme of this book—which is No. 4 in the "Electricity and Productivity Series" of the British Electrical Development Association—is the axiom that "Every time a material is handled, something is added to its cost and nothing to its value." There is no suggestion that it has been inspired by the reports of teams sent to the United States by the Anglo-American Council on Productivity, though this may well be the case; for it will be remembered that practically every one of those reports, so far published, has laid particular stress on the advantages which accrue to American industry as a result of a liberal provision of mechanical handling appliances and the virtual absence of restrictions on their use to the utmost possible extent. Such restrictions undoubtedly do exist at present in this country, but there is welcome evidence of a gradual change of mind regarding the desirability of their retention. The numerous examples of modern handling appliances described and illustrated in this book should prove useful propaganda to that end, as well as providing a guide to the selection of suitable devices.

Addendum to the British Sawmilling Classification of Timbers.

The National Sawmilling Association, 14, New Bridge-street, London, E.C.4. [Price 2s. 6d.]

THE original *British Sawmilling Classification of Timbers*, published in April, 1951, contained some 2,600 commercial names of timbers as well as a botanical index. The addendum now issued covers 122 additional timbers, bearing no fewer than 210 trade names, and adds 124 further trade names of the timbers included in the original publication. To some extent, the names appear to depend on the use to which the timber is put; e.g., what is "birch" when used for fencing becomes "betula" to the interior decorator. Engineers in general are not connoisseurs of timber, but those who do require to deal with the more exotic varieties should appreciate this and the other authoritative manuals of the National Sawmilling Association.

Wire Rope Lubrication.

By E. V. PATERSON, A.M.I.Mech.E. Scientific Publications, 8, Walker-street, Wellington, Shropshire. [Price 3s., including postage.]

THE technical literature of wire ropes is not notably extensive and consists largely of papers read by specialists to a small number of institutions, supplemented by research reports. This booklet—it consists of only about 30 pages of text—is based largely on the material contained in the six references given in the bibliography at the end; but few of these will be readily available to the average user of wire

ropes, who will find it convenient, no doubt, to possess and study Mr. Paterson's summary. Some of the matter is rather elementary, but that applies to many aspects of industrial lubrication. It is, however, a subject which ought to be more widely studied, and attention to the principles here enunciated should pay good dividends. Some of the blocks used for the illustrations are badly worn and might be replaced with advantage when a further impression is contemplated.

TRADE PUBLICATIONS.

Air Compressor Lubrication.—An illustrated 72-page technical manual, entitled "Air Compressor Lubrication," has been issued by the Vacuum Oil Co., Ltd., Caxton House, Tothill-street, London, S.W.1. It covers the practical aspects of lubricating, reciprocating and rotary compressors, and also contains a section on the theory and practice of air compression.

Colloidal Graphite in Lubrication.—A booklet published by Acheson Colloids, Ltd., 18, Pall Mall, London, S.W.1, contains useful information concerning the use of their Oiltag colloidal-graphite-in-oil lubricants. The structure and characteristics of colloidal graphite are explained, and other sections of the booklet deal with its industrial applications, which include the lubrication of metal-working dies, bearings at high temperatures and reduction gearing, to mention but a few.

Fans and Allied Equipment.—Two illustrated brochures have been published by Musgrave & Co., Ltd., St. Ann's Works, Belfast, N.I.; one gives the dimensions, capacities and characteristic curves of their "G" type fans (12 to 108 in. in diameter) and the other illustrates the whole range of their products, which includes, besides fans, heating and ventilating equipment generally, dryers, grit and dust collectors and structural steelwork.

Machining the Rarer Metals.—Recommended practice for the machining of tungsten, molybdenum, tantalum, titanium and zirconium is described in a booklet issued by Protolite Ltd., Central House, Upper Woburn-place, London, W.C.1. Tool material, tool angles and shape, cutting speeds, feeds and depth of cut are among the factors on which data are given.

Abrasive Wheel Cut-Off Machines.—We have received three pamphlets from A. and S. Osmond, Limited, 254/6, Hotwell-road, Bristol, 8, describing some of their high-speed abrasive-wheel cut-off machines. Lists No. 210 and 211 refer to machines for cutting ferrous and non-ferrous sections and list No. 206A to machines designed for cutting glazed tiles and similar ceramics.

Diesel-Engine Conversion Set for Bedford Vehicles.—We have received from F. Perkins, Limited, Peterborough, a booklet describing the fitting of the Perkins P6S/V Diesel engine in the Bedford "O" series of goods vehicles. The booklet gives details of the modifications which have to be made to the chassis, installation instructions and useful hints on starting the engine.

Mechanical Shovel.—Details of the various improvements incorporated in the latest version of their mechanical shovel are given in a leaflet issued by the Chaseside Engineering Co., Ltd., Hertford. This shovel is fitted with the new Fordson Major petrol engine developing 39 h.p. at 1,600 r.p.m. but the Fordson Diesel engine, which develops 40 b.h.p. at 1,600 r.p.m. can be installed as an alternative. The shovel is elevated by means of a hydraulically-controlled friction winch.

Oil-Refining Equipment.—A brochure recording the work which they have carried out at the new Stanlow oil refinery of the "Shell" Refining and Marketing Co., Ltd., has been issued by Whessoe Ltd., Darlington. This work included the manufacture and erection of a catalytic-cracking plant, the first British-built unit, various distillation and fractionating columns, regenerator vessels for the doctor-treatment plant, butane storage spheres and a single-lift gasholder for the sulphur recovery plant. The firm also supplied a large number of heat exchangers, washing and treatment columns and lead-lined tanks, and storage tanks.

Fertiliser Plant.—A comprehensive booklet dealing with their range of machines and plants for the manufacture and treatment of fertilisers has been issued by the Sturtevant Engineering Co., Ltd., Southern House, Cannon-street, London, E.C.2. The booklet gives details of their rotary crushers, roll grinding mills and ring roll mills, the Sturtevant-Moritz-Standaert superphosphate den and the Sturtevant P.O. process for the manufacture of superphosphate. Much useful information is given also on the handling, granulation, mixing and bagging of fertilisers and the manufacture of phosphoric acid.

Storage, Handling and Dispensation of Lubricants.—The Vacuum Oil Co., Ltd., Caxton House, Tothill-street, London, S.W.1, have issued a booklet dealing with the storage, handling and dispensation of lubricants. The main subjects considered are the transportation of lubricants, their subsequent storage, distribution and purification.

BOOKS RECEIVED.

Jane's Fighting Ships, 1952-53. Edited by RAYMOND V. B. BLACKMAN. Sampson Low, Marston and Company, Limited, 25, Gilbert-street, London, W.1. [Price 4 guineas net.]

Colour Conscription. How to Use Colour in Industry. Second edition. British Paints Limited, Portland-road, Newcastle-upon-Tyne, 2. [Price 10s. 6d.]

Major Faults on Power Systems. By A. G. LYLE. Chapman and Hall, Limited, 37, Essex-street, Strand, London, W.C.2. [Price 45s. net.]

Tensors in Electrical Machine Theory. By DR. W. J. GIBBS. Chapman and Hall, Limited, 37, Essex-street, Strand, London, W.C.2. [Price 30s. net.]

Report of the Forest Products Research Board, with the Report of the Director of Forest Products Research for the Year 1951. H.M. Stationery Office, Kingsway, London, W.C.2. [Price 3s. net.]

Report of the Fuel Research Board with the Report of the Director of Fuel Research for the Year 1951. H.M. Stationery Office, Kingsway, London, W.C.2. [Price 2s. 6d. net.]

Report on the Work of the British Council for the Year Ended 31st March, 1952. Offices of the Council, 65, Davies-street, London, W.1.

Ontario Hydro, 1951. The Hydro-Electric Power Commission of Ontario, 620, University-avenue, Toronto 2, Ontario, Canada.

British Columbia. Minister of Mines. Annual Report for the Year Ended 31st December, 1951. British Columbia Department of Mines, Victoria, British Columbia, Canada.

Electricity Undertakings of the World, 1952-53. The Electrical Journal Red Book. Benn Brothers Limited, Bouverie House, 154, Fleet-street, London, E.C.4. [Price 30s. post free.]

Strength of Materials. By PROFESSOR ARTHUR MORLEY. Tenth edition. Longmans, Green and Company, Limited, 6 and 7, Clifford-street, London, W.1. [Price 25s. net.]

Modern Electric Lamps. By D. A. CLARKE. Blackie and Son, Limited, 17, Stanhope-street, Glasgow, C.4. [Price 20s. net.]

Methods of Electrical Measurement. By C. T. BALDWIN. Blackie and Son, Limited, 17, Stanhope-street, Glasgow C.4. [Price 17s. 6d. net.]

Essentials of Fluid Dynamics. By PROFESSOR LUDWIG PRANDTL. Authorised translation. Blackie and Son, Limited, 17, Stanhope-street, Glasgow, C.4. [Price 35s. net.]

British Motor Cars. Edited by JOHN F. SPEED. G. T. Foulis and Company, Limited, 7, Milford-lane, Strand, London, W.C.2. [Price 12s. 6d.]

Pioneers of British Industry. By F. GEORGE KAY. Rockliff Publishing Corporation, Limited, 1, Dorset Buildings, Salisbury-square, London, E.C.4. [Price 25s. net.]

Road Pence, Road Sense. The Economic Justification of Public Works. British Road Federation Limited, 4A, Bloomsbury-square, London, W.C.1. [Price 1s. 3d. post free.]

Jahrbuch der Schiffbautechnischen Gesellschaft. 1951. Springer-Verlag, Reichpietschnufer 20, Berlin W. 35, Germany. [Price 40 D.M.]

Underpinning and Strengthening of Structures. By L. E. HUNTER. Contractor's Record, Limited, Lennox House, Norfolk-street, Strand, London, W.C.2. [Price 25s.]

Ohio State University Engineering Experiment Station. Bulletin No. 148. Proceedings of the Conference on Cooling of Airborne Electronic Equipment, 1952. Held at the Ohio State University, March 20-21, 1952. The Director, Engineering Experiment Station, The Ohio State University, Columbus, Ohio. [Price 3.50 dols.]

Highway Curves. By the late HOWARD CHAPIN IVES. Fourth edition. *Highway Surveying, Location, Geometric Design, and Earthwork.* By PROFESSOR PHILIP KISSAM. John Wiley and Sons, Incorporated, 440, Fourth-avenue, New York 16, U.S.A. [Price 7 dols.]; and Chapman and Hall, Limited, 37, Essex-street, Strand, London, W.C.2. [Price 56s. net.]

Electron Tubes in Industry. By KEITH HENNEY and JAMES D. FAHNESTOCK. Third edition. McGraw-Hill Book Company, Incorporated, 330, West 42nd-street, New York 36, U.S.A. [Price 6 dols.]; and McGraw-Hill Publishing Company, Limited, 95, Farringdon-street, London, E.C.4. [Price 51s.]

National Building Studies. Special Report No. 14. An Inquiry into Domestic Hot Water Supply in Great Britain. Part II. The Use of Water Heating Appliances in Summer, and the Relation Between the Usage of Hot Water and the Appliances Available. H.M. Stationery Office, Kingsway, London, W.C.2. [Price 3s. net.]

Statistical Year-Book of the World Power Conference. No. 6. Annual Statistics for 1948-1950. Edited by FREDERICK BROWN. The Central Office, World Power Conference, 201-2, Grand Buildings, Trafalgar-square, London, W.C.2. [Price 35s. net.]