

CONTINUOUS PRODUCTION OF SOLID STEEL RAILWAY WHEELS.

(For Description, see Page 752.)

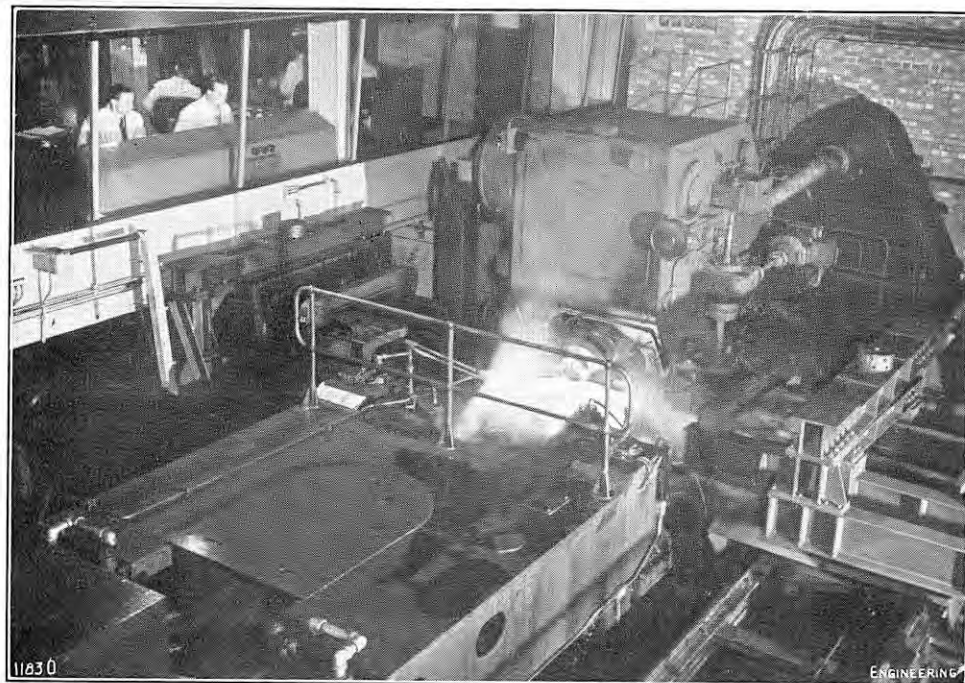


FIG. 18. ROLLING MILL AND CONTROL DESK.

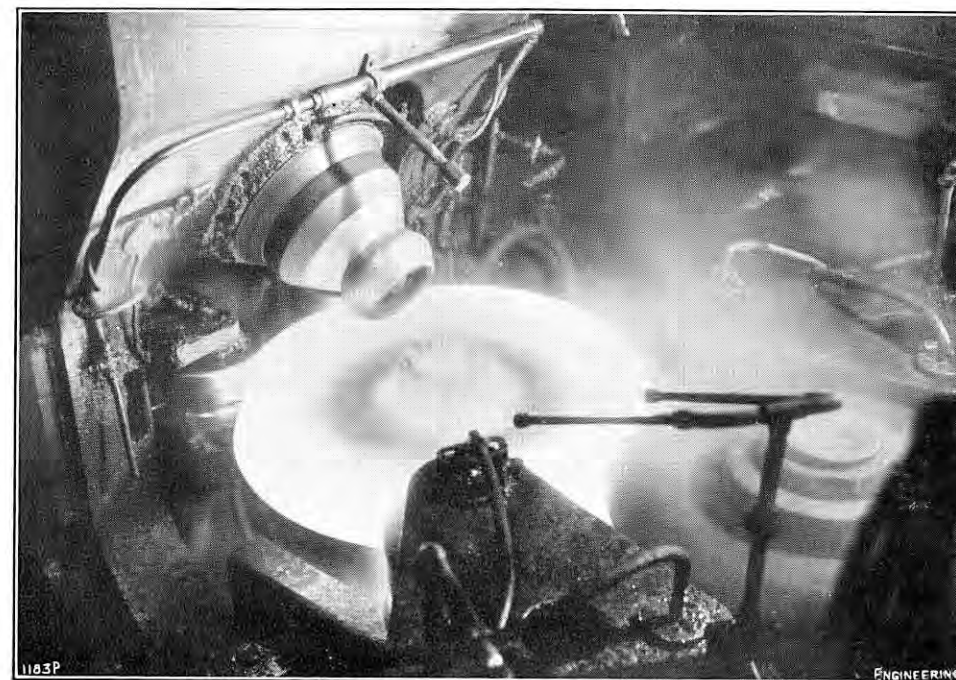


FIG. 19. ROLLING THE RIM SECTION ON A WHEEL.



FIG. 20. GAUGING WHEEL AFTER DISHING.

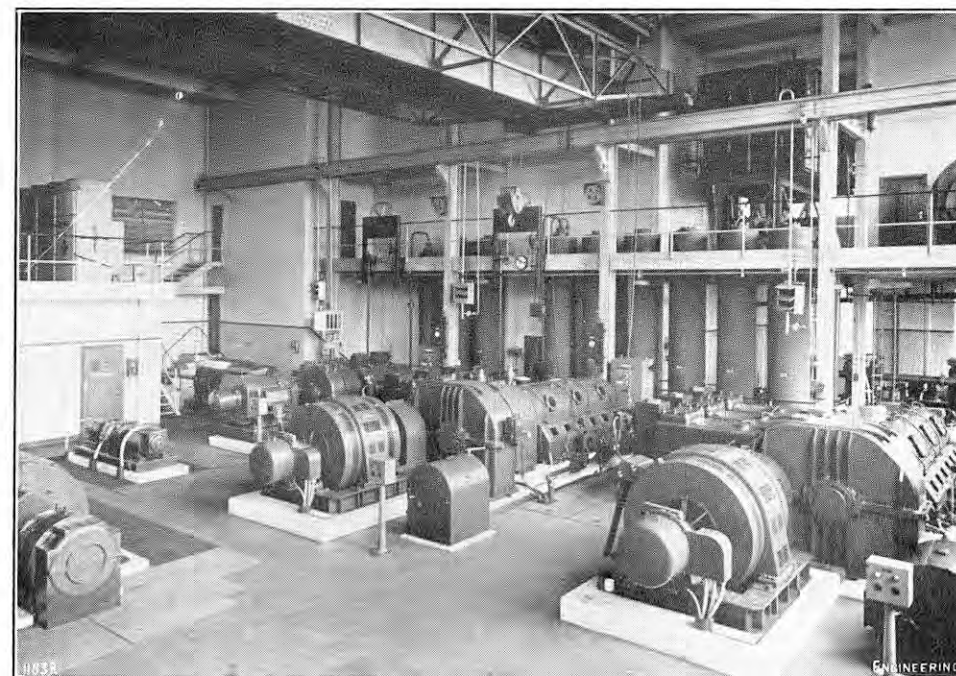


FIG. 21. MOTOR AND PUMP ROOM.

EXTENDED SURFACES FOR HEAT EXCHANGERS.

A FUNDAMENTAL improvement in the design of heat-exchange apparatus would have far-reaching effects on a wide range of plant. Such a development is to be found in the "Sunrod" system, which may lead to the adoption of heat-exchange for enhanced efficiency in circumstances where previously it was not economical. Its advantages are already available in the Sunrod fuel-oil heaters marketed by Messrs. Sunrod, Limited, 1 and 2, Hen and Chickens-court, 184, Fleet-street, London, E.C.4, and it will probably be applied in this country to superheaters, economisers, air-heaters, the recovery of heat from exhaust ducts (for example, the waste heat of blast furnaces), and to hot-air furnaces which utilise radiant heat. The design

has been patented (British Patent No. 661,909) by Messrs. A/B Svenska Maskinverken, of Sodertalje, Sweden, in which country its applications have already reached an advanced stage.

The principle involved is not new, but the design is based on certain theories and experiments which have resulted in a high efficiency. If a plain wall of, say, a tube is used as a heat-exchanging medium between, for example, combustion gases and water, an optimum efficiency cannot be achieved, because heat is not transferred from the gases to the wall as readily as it is from the wall to the water. The surface conductance of the gases may be as little as 9 per cent. of the surface conductance of water. Thus, in this example, the water in the tube could receive far more heat than the gases are able to impart to the tube. In the Sunrod design the area of heat-exchanging surface exposed to the fluid of lower conductance is increased (without increasing

the area exposed to the other fluid) to a point where the rate of heat transfer, under given conditions, is equal to the rate obtainable between the other surface and the fluid of higher conductance. This increase of surface is generally achieved by the method illustrated by several examples in Fig. 1: a number of heat-transfer elements in the form of small copper rods are welded to the surface of the tube. The shape and proportions of the elements are critical. In Fig. 1, the two top units are sections of fuel-oil heaters; that on the left is for small quantities and a large temperature rise, whereas that on the right is for large quantities and a small temperature rise. In the lower part of the illustration the two small units on the right are from lubricating-oil coolers and the other two are from economisers.

FUEL-OIL HEATERS.

In the Sunrod fuel-oil heater shown dismantled in Fig. 2, and shown in section in Figs. 3 and 4, the tube with its elements is a close fit in an outer tube, and thus the whole of the oil which flows along the annular space between the tubes is in close contact with the elements and its turbulent flow ensures an optimum rate of heat transfer. It will be seen that the outer tube, with oil inlet and outlet and connections for a manometer, etc., is permanently closed at the right-hand end. The left-hand end is closed by the cover which forms part of the inner tube assembly. The steam inlet pipe extends almost the full length of the inner tube, so that the steam, during the heat-exchange flow, passes from the right to the left inside the inner tube. Meanwhile, fuel oil flows in the contrary direction, past the heat-transfer elements, from which it absorbs heat.

The principal advantage of the design—whether for fuel-oil heaters or other purposes—is the very much smaller space and weight compared with those of previous designs. This feature arises from the optimum heat-transfer characteristic of the Sunrod elements. The inner tube assembly is readily removed for inspection and cleaning, as shown in Fig. 2. Special tools are not required and it is not necessary to break the oil-pipe joints. The fuel-oil heaters are not sensitive to changes in temperature or pressure, and they are not subject to expansion stresses. Moreover, oil leakage into the steam side is almost impossible. The standard range of oil heaters are suitable for oils with viscosities up to 2,500 seconds Redwood No. 1, using steam pressure up to 285 lb. per square inch and oil pressures up to 450 lb. per square inch, though provision can be made for higher pressures and temperatures. The chief dimensions and the weights of these standard heaters are shown in Table I, on page 746. The capacities are shown, in lb. and kg. per hour, in Figs. 5 and 6. Fig. 5 relates to medium fuel oil of 130 to 150 seconds Redwood No. 1, heated from 50 deg. to 175 deg. F., and Fig. 6 to heavy fuel oil of 400 to 2,600 seconds, heated from 85 deg. to 235 deg. F. Several heaters can be arranged in parallel or series to suit the required capacity.

APPLICATION TO BOILERS.

The application of the Sunrod system to the steaming section, the superheater and the economiser of a La Mont-type boiler are shown diagrammatically, as an example of the potentialities, in Fig. 7. Here, *a* is an economiser, *b* is a superheater, *c* is a steaming section and *d* is an air heater. The saving in space is shown pictorially in Figs. 8 and 9, where the hatched sections A and B (Fig. 8) denote, respectively, the convection surfaces and the air heater, and the sections A₁ and B₁ (Fig. 9) denote the convection surfaces and the air heater when the Sunrod design is employed. Moreover, it is then possible to extend the flue-gas duct directly up from the top of the combustion zone, owing to the great reduction in the space occupied by the con-

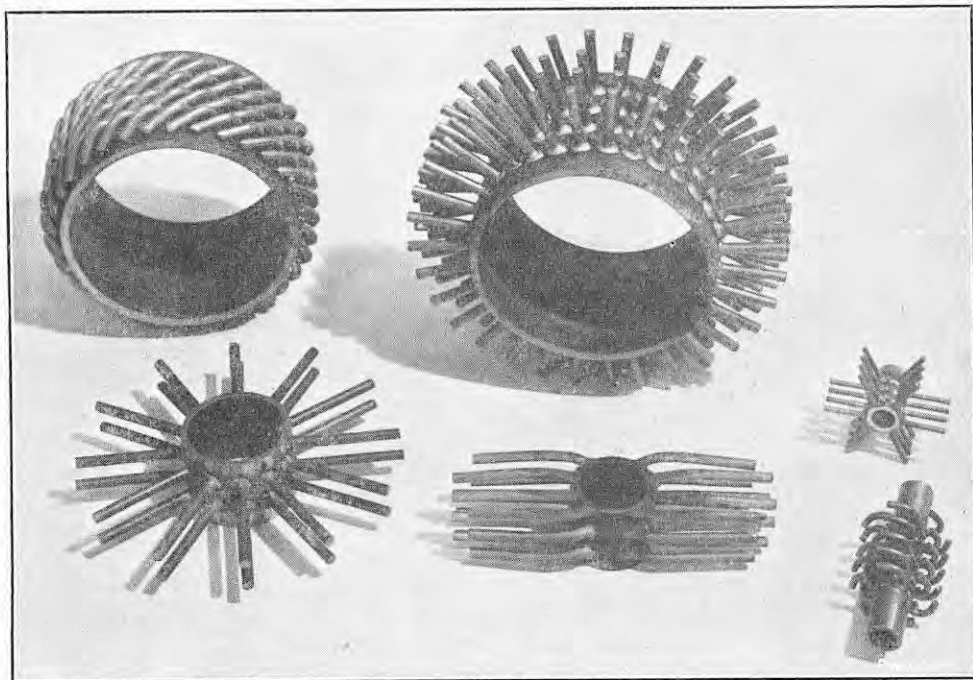


FIG. 1. "SUNROD" HEAT-EXCHANGER ELEMENTS.

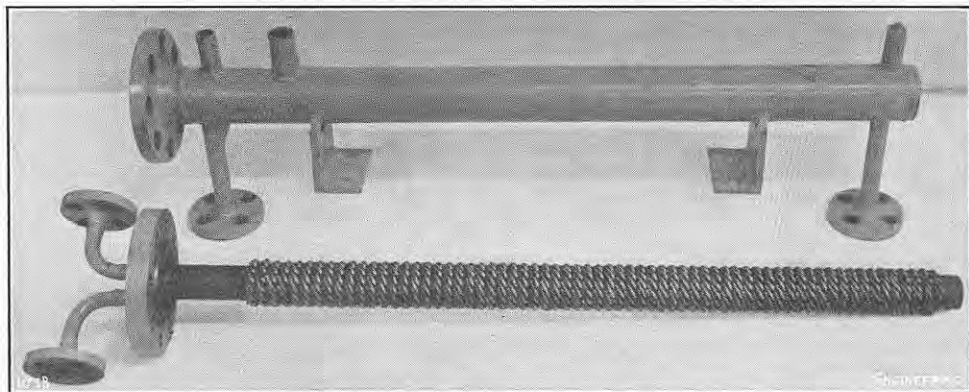


FIG. 2. APPLICATION OF EXTENDED SURFACES TO FUEL-OIL HEATER.

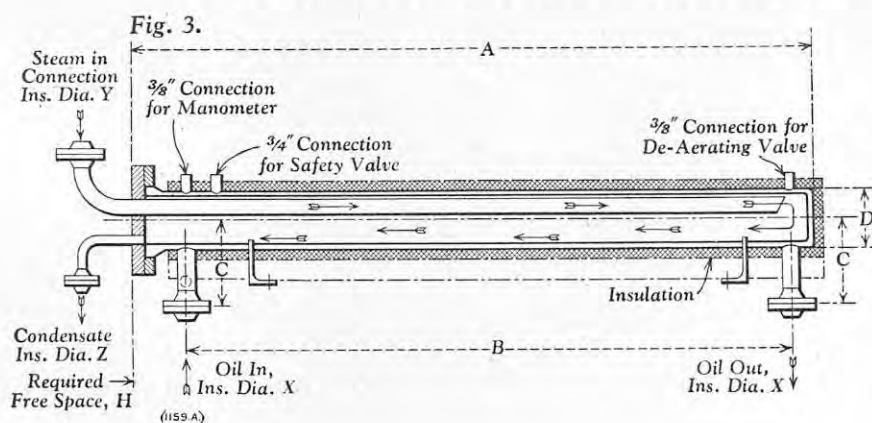
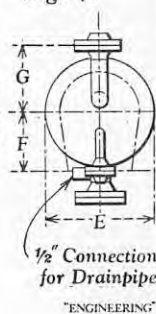


Fig. 4.



EXTENDED SURFACES FOR HEAT EXCHANGERS.

SUNROD, LIMITED, LONDON.

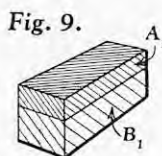
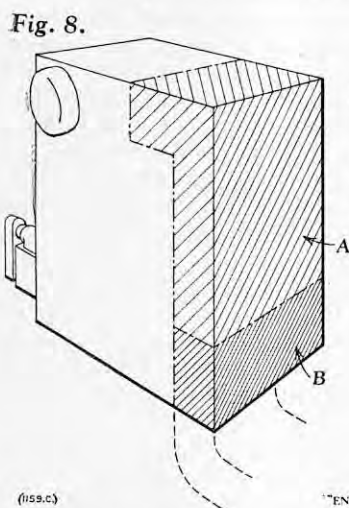
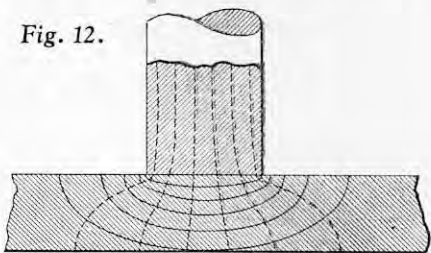
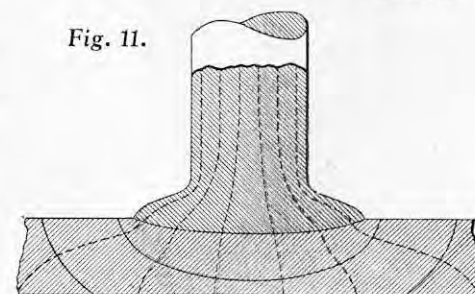
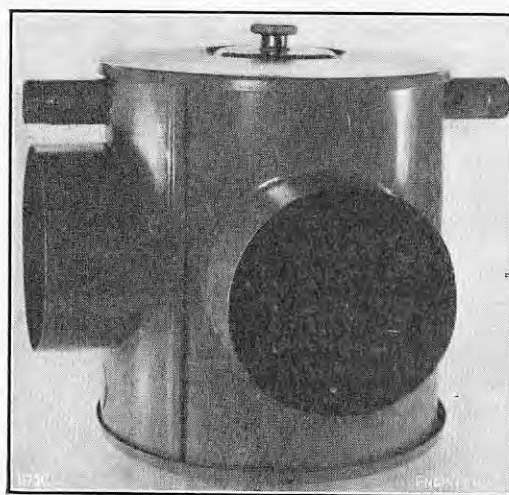
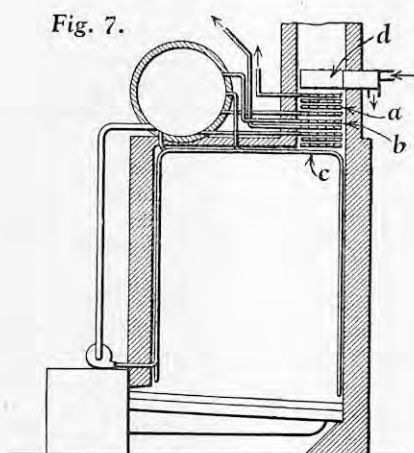
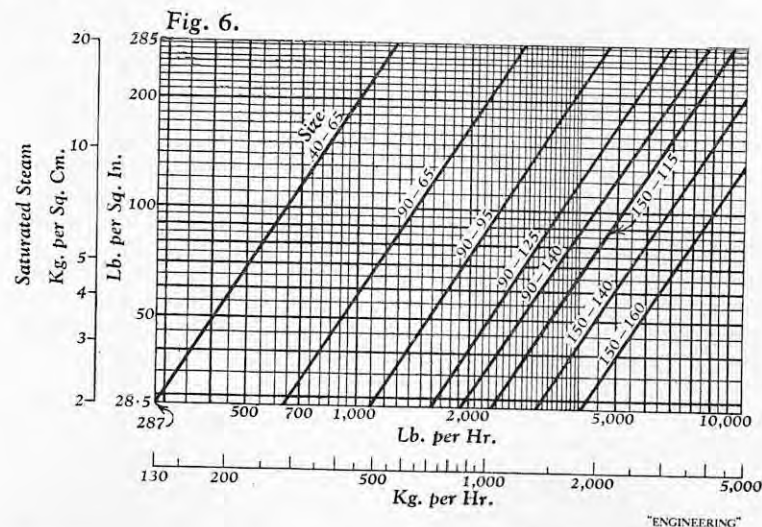
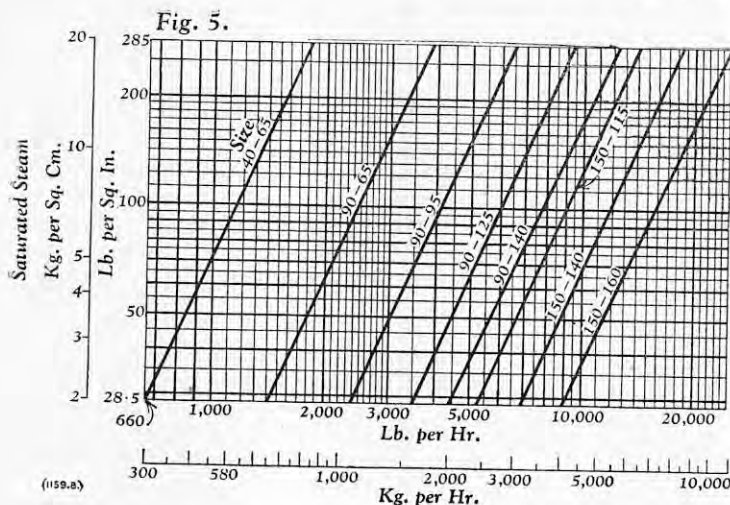
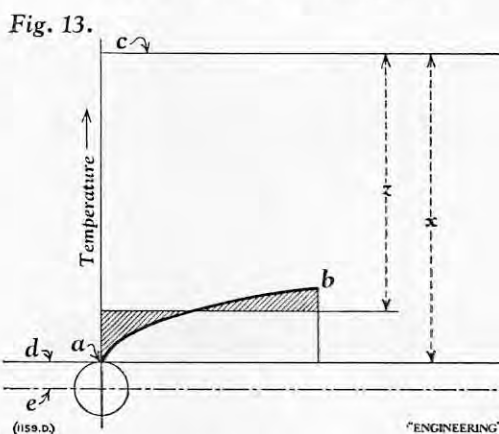


FIG. 10. DOMESTIC ECONOMISER.



vection surfaces. Fig. 10 shows the application of a Sunrod unit to a domestic economiser, which is fitted to the exhaust flue of the boiler to provide additional water heating.

THEORY OF THE DESIGN.

The surface conductance of the boiler fluid—steam or water—is at least a hundred times that of the gases; hence the advantage of increasing the area exposed to the gases by means of the Sunrod elements. As a result, the amount of tubing required in a boiler of the type shown in Fig. 7, is reduced by as much as 90 per cent. For most boiler applications the minimum length of each heat-transfer element is not less than ten times the square root of its cross-section. The optimum maximum length depends on the temperature to which the elements are subjected, their cross-sectional area, their coefficient of conductivity

(which in the Sunrod design is high, as the elements are made of copper), and the surface conductance, α , of the gas. This optimum maximum length can be determined by means of the following equation:—

$$\eta_g = \frac{1}{n} \times \frac{e^{2nl} - 1}{e^{2nl} + 1} \quad (1)$$

where η_g = heat-transfer efficiency of the elements,
 l = length of element or conductance path, in metres,
 e = natural logarithm base, 2.718.

The value of n is given by

$$n = \sqrt{\frac{\alpha F}{\lambda f}} \quad (2)$$

where α = surface conductance of the gases,

F = circumference of the element, in metres,

f = cross-sectional area of the element, in metres,

λ = coefficient of conductivity of the metal of the elements.

The heat-transfer efficiency of the elements (η_g) may be expressed in terms of the symbols used in Fig. 13. Here, the curve ab represents the temperature gradient along the length of an element, and the shaded areas above and below it, being equal in area, establish the mean temperature of the element. The gas temperature is indicated at c ,

TABLE I.—DIMENSIONS (IN INCHES) OF STANDARD FUEL-OIL HEATERS.

Size.	A.	B.	C.	D.	E.	F.	G.	H.	X.	Y.	Z.	Weight, lb.
40-65	42	36	8	3	7	4½	4½	47	1½	1½	1½	80
90-65	46	38	8½	5	10½	5½	8	52	1½	1½	1½	170
90-95	62	53	8½	5	10½	5½	8	67	1½	1½	1½	210
90-125	77	69	8½	5	10½	5½	8	85	1½	1½	1½	250
90-140	85	77	8½	5	10½	5½	8	98	1½	1½	1½	275
150-115	74	64	11	7½	14	7½	8½	80	2	1½	1½	420
150-140	86	77	11	7½	14	7½	8½	94	2	1½	1½	465
150-160	100	91	11	7½	14	7½	8½	108	2	1½	1½	500

the wall temperature of the tube on the gas side at d , and the steam and water temperature inside the tube at e . Thus, x is the difference between the gas temperature and the wall temperature at the gas side of the tube, and z the difference between the gas temperature and the mean temperature of the element. Then, η_g is the latter temperature difference divided by the former temperature difference:

$$\eta_g = \frac{z}{x}$$

Expressed another way, η_g is the relation between the heat transmitted through an element in an actual apparatus (in which the temperature necessarily varies along the length of the element) and the heat transmitted by the same element under similar conditions if the temperature throughout the element were constant and equal to the temperature at the base of the element where it is welded to the tube. The latter concept is, of course, idealistic, but this criterion of efficiency is useful in calculating the optimum length of the elements in relation to their cross-sectional area and other factors.

The surface conductance, α , of combustion gases, measured in kilocalories per square metre per hour per deg. C., is given by the following formulae, taken from *Der Industrielle Wärmeübergang*, by Dr. Ing. Alfred Schack (1940 edition, page 121):

For a staggered arrangement of elements,

$$\alpha = \left[1.29 + \frac{0.424}{\left(\frac{S_g}{d}\right)^2} + \frac{0.124 S_g}{d} \right] 4 \sqrt{T} \times \frac{V_0^{0.61}}{d^{0.39}} \quad (3)$$

and for elements arranged in parallel rows,

$$\alpha = \left[1.59 - \frac{0.97 \left(\frac{S_g}{d}\right)^{1.5}}{\left(\frac{S_l}{d}\right)^4} \right] 4 \sqrt{T} \times \frac{V_0^{0.61}}{d^{0.39}} \quad (4)$$

where S_g = centre-to-centre distance between adjacent heat-transfer elements, measured at right-angles to the direction of flow, in metres,

S_l = centre-to-centre distance between adjacent heat-transfer elements, measured in the direction of flow, in metres,

T = absolute temperature of the fluid (gas) in deg. C.,

V_0 = velocity of the gas in metres per second at 0 deg. C.,

d = diameter of heat-transfer elements in metres.

It has been found, however, that the values of α obtained with these formulae are too high. Therefore, α is taken as the value given by the formula, corrected by a 30 per cent. reduction.

The efficiency of Sunrod elements depends not only on the ratio of cross-sectional area to length, but also on the method of fixing the copper elements to the tube. The base of the element is formed into a mushroom shape, as shown in Fig. 11, by a combination of pressure and electric resistance welding. The increased area of junction thus obtained is between $1\frac{1}{2}$ and six times the cross-sectional area of the element. The advantages of this method of fixing, as compared with an ordinary stud-welding fixing of the type shown in Fig. 12, are that the thermal conductivity paths fan out to a greater extent (as shown by the dotted lines in Figs. 11 and 12); that the temperature drop between the base of the element and the inner surface of the tube is much less; and that, consequently, the heat from each stud is distributed over a larger area of tube. The full curved lines in Figs. 11 and 12 are isotherms which show the heat distribution in the wall. Due to the increased thermal influence of each element, a substantially uniform heat distribution is attained throughout the wall.

LITERATURE.

Marine Diesel Engines.

By C. C. POUNDER. George Newnes, Limited, Tower House, Southampton-street, London, W.C.2. [Price 35s. net.]

THERE are many books on Diesel engines, some of which, if not exclusively "marine" in their outlook and subject-matter, have devoted considerable space to the predominantly marine types; but the author of this work is probably justified in his claim that it is unique of its kind, being wholly concerned with Diesel main propelling engines for ships, and truly international in its scope and authorship. Mr. Pounder himself is well known as the engineering director of Messrs. Harland and Wolff, Limited, who must have had as wide an experience as any builders of this type of machinery—wider than any, indeed, in the construction of marine Diesel engines of the largest size. Bearing in mind, however, that the book is intended primarily for the use of marine engineers who are studying for Ministry of Transport examinations, he realised the importance of ensuring that the descriptions of other types should be equally authoritative. At his suggestion, therefore—and, it may be safely assumed, by his personal persuasion—five chapters have been included, each on a specific type and each written by a leading exponent of that type.

The book opens with a chapter on the elementary theory of the Diesel engine, and the method of evaluating its performance; and this is followed by a discussion of the propelling engine in relation to the complete installation of machinery in a ship—the layout, the various auxiliary systems, the associated pumps, waste-heat boiler, etc. Chapter III is the first of those dealing with specific types and is contributed by Mr. G. Biondi, of British Polar Engines, Limited, who describes that make. There follow chapters on the Doxford engine, by Mr. W. H. Purdie, of William Doxford and Sons, Limited; on the Harland and Wolff type, by Mr. Pounder; on the M.A.N. engine, by Mr. P. Schuler, director of the Maschinenfabrik Augsburg-Nürnberg; on the Sulzer engine, by Mr. W. J. Borrowman, of Sulzer Brothers (London), Limited; and on the Werkspoor engine, by Mr. F. G. van Asperen, of the Werkspoor N.V., Amsterdam. Of the remaining eight chapters, the last is merely a brief summary of conversion factors, etc., likely to be required in studying a branch of engineering that is largely metric in the dimensions used. The preceding seven, however, are particularly instructive as they deal with many of the practical details concerning the construction, operation and maintenance of Diesel engines, crankcase safety precautions, engine balancing, the chemistry of combustion, and what are commonly termed "fatigue cracks," which, Mr. Pounder points out, is "a complete misnomer" for they are more accurately described as "creeping cracks."

There is more condensed experience in some of these chapters than in many a text-book, and it is the more valuable for being presented in a way to encourage independent thinking and to inculcate the importance of attention to details. Moreover, the book is not only full of sound engineering observation and practice, but it is a model of clear descriptive writing; a quality rare in these days, when vocational training is so frequently regarded as synonymous with education, at least, where engineers are concerned. Mr. Pounder, in his preface, ventures to "respectfully suggest that British and other shipowners should arrange for copies of this volume to be placed on the bookshelves of their ships." We would go farther, and say that any engineer concerned with Diesel engines, and anyone else who aspires to write good technical English or whose business is to teach it, would do well to study this book, and study it carefully.

Les Engins Mécaniques de Chantier.

By ADIL GABAY. Librairie de l'Université, Lausanne, Switzerland. [Price 85 Swiss francs.]

PERHAPS the key to the rather unusual character of this excellently-produced reference book on civil-engineering contractors' plant is to be found in the fact that the author addresses his preface from Istanbul; where, it may be supposed, makers' handbooks and records of actual civil-engineering works carried out in the Western world, where such plant has reached its fullest development, are less plentiful than the potential opportunities for its use. As a book on its particular subject must necessarily be, it is in effect an annotated catalogue, with the addition of a certain amount of technical data and tables, mainly due, as the author explains, to his collaborators, Mr. P. Biaggi, L.-ès-Sc. (Paris), and Mr. E. Lavater. The basis of the book is an earlier work, published in 1946; but the developments since then in almost every field that it covers have been so great that the text has been virtually rewritten, and many new illustrations have had to be included.

The arrangement is in 14 sections, counting as one the bibliography and the manufacturers' directory at the end. Most of them are concerned with particular classes of machine, e.g., tractors, transport vehicles and scrapers, etc., bulldozers and similar appliances, excavators of various kinds, cableways, etc.; but interspersed with these are sections of considerable interest and value on, for instance, the horse-power of the different kinds of plant in relation to output, working costs, fuels and lubricants, and the selection and use of wire ropes. The bibliography, it may be remarked, is poor—and we do not base that opinion merely on the fact that it omits *ENGINEERING* from the very short list of "Revues"; there is no reference to the transactions of any learned society, and only one (a trade reprint by an American firm) to any conference on contracting or mechanical-handling plant. Out of some 90 names in the list of manufacturers who are mentioned in the text, only nine are of United Kingdom firms, though admittedly several of the American makers also have works in Britain; about 70 of the 90 are American, a proportion which may be a reflection on European salesmanship, but is probably not unconnected with Marshall Aid. Having made these few criticisms, however, we may say that the book as a whole is well worth perusal, the French text being clear and matter of fact, and the illustrations well chosen. The small line diagrams explaining the operation of the various types of plant are particularly commendable. As the publishers claim for it, the work should be of value to civil engineers, public-works contractors and to students of the relevant technologies.

Basic Engineering Thermodynamics.

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

THERE are now so many text-books on engineering thermodynamics that writers of new ones must be finding difficulty in devising distinctive titles. The present work, which covers the usual theoretical ground traversed by engineering students, is no more "basic" than most of its predecessors in its discussion of fundamentals, giving merely the usual explanation of pressure and specific heats of a perfect gas according to the kinetic theory. After an explanation of the terms used in thermodynamics and a discussion of the First and Second Laws, the author deals with the subject of entropy. In this connection he propounds the so-called Third Law of Thermodynamics as an unqualified assertion that the entropy of a substance is zero at the absolute zero of temperature, thus repudiating

all the restrictions usually imposed, including that of Nernst himself. Throughout the book, great stress is laid on the ideal of a reversible process. The author thinks it desirable that every one of the processes involved in the operation of an actual heat engine should be individually studied as regards its thermodynamic irreversibility, so that "the source or sources of the trouble may be located and receive proper attention." Since irreversibility arises either from a degradation of work into heat by friction or turbulence, or from the unproductive fall of temperature in the conduction of heat, and the object of every designer is to minimise these obvious imperfections, it is not likely that anything is to be gained from an attempt to evaluate each of them separately by means of Carnot's Law and Gibb's Function. The task would have as little practical usefulness as trying to improve a mechanism by calculating the friction loss of every moving element embodied in the design.

Actual machines, including steam and gas turbines, reciprocating engines, and refrigerating plant are all briefly discussed with a view to explaining the main principles involved. A section comparing steam turbines with reciprocating engines leads to a final statement that an engine of 10,000 kW will have about the same efficiency ratio as a steam turbine of 100,000 kW, the figure being about 80 per cent. in either case. Nowhere in the section is there a word to remind the student that a large turbine is likely to be working with a heat-drop something like twice as great as any reciprocating engine could use, so that a mere comparison of efficiency ratios is highly misleading.

Examples of the Design of Reinforced Concrete Buildings in Accordance with the British Standard Codes.

By CHAS. E. REYNOLDS, B.Sc., A.M.I.C.E. Concrete Publications, Limited, 14, Dartmouth-street, London, S.W.1. [Price 10s.]

MR. REYNOLDS'S *Practical Examples of Reinforced Concrete Design* is a well-known and well-trusted aid to the practical designer accustomed to working to the D.S.I.R. *Code of Practice for the Use of Reinforced Concrete in Buildings*, published in 1934. That book, however, like the code to which its recommendations conformed, has been out of date since the British Standard Codes of Practice for Buildings were issued under the aegis of the Ministry of Works, particularly the recently revised Codes, C.P.3. *Functional Requirements of Buildings: Chapter V, Loading* (1952), and C.P.114. *The Structural Use of Reinforced Concrete in Buildings* (1948), together with its sub-codes, and parts of the Codes on load-bearing walls and on foundations. Though the established principles of reinforced-concrete design have suffered no drastic change, loads, stresses, and allowances for rigid connections have been so modified as to require complete redrafting of much tabulated information and the re-drawing of many of the graphs in the older work. Accordingly, the author has taken the opportunity to prepare a completely new book, divided into two parts. Part I is divided into eleven chapters, covering design loads, working stresses and the interaction and design in detail of structural elements, much on the general lines of the earlier book. It contains 31 tables. Part II, which is entirely new, is devoted to the drawings and calculations for the design of a complete framed building with a basement, columns, ground floor and five upper floors, and a flat roof. Each floor slab is carried on main and secondary beams. Alternative designs are given for a floor spanning in two directions, without secondary beams, and for a floor-system with flat slabs and mushroom-headed columns. It is assumed that the designer has access to textbooks and to copies of the Codes. The theory of reinforced concrete is therefore not developed, nor is the wording of the Codes reproduced.

380-KV SWEDISH TRANSMISSION SYSTEM.



FIG. 1. 115-MVA SINGLE-PHASE TRANSFORMER.

380-KV POWER-TRANSMISSION SYSTEM IN SWEDEN.

THE 350-MW generating station of the Swedish State Power Board at Harsprånget, of which a description was given on page 585, *ante*, is connected to a transformer station at Hallsberg, a distance of 593 miles, by a line operating at 380 kV. At Midskog, midway between the two terminals, a connection is made to the existing 220-kV system; thus relieving the latter and increasing the load carried at 380 kV. Fig. 2 is an outline map showing the route of this 380-kV line and of the existing 220-kV and 130-kV lines in Sweden, and a diagram of the connections of the 380-kV line is given in Fig. 3, opposite.

As mentioned in our previous article, the three 105-MVA alternators at Harsprånget are connected by bare conductors to a common forced oil-cooled transformer unit. This unit consists of a group of four 115-MVA/16/370 $\sqrt{3}$ -kV single-phase transformers. One of these transformers is normally in reserve and is equipped with circuit-breakers and isolating switches so that it can be substituted for one of those in service without cutting off the supply. Each of the transformers weigh 151 tons and contains 37 tons of oil. They are 31 ft. long 11 ft. wide and 32 ft. high, and Fig. 1 shows one of the units being erected in its rock cubicle. A 9.3 MVA/16 $\pm$ 30 $\sqrt{3}$ -kV forced oil-cooled regulating transformer is connected to the neutral point of the high-tension side of each main transformer. These transformers, which weigh 19.3 tons and contain 7.9 tons of oil, are 13 ft. long by 8 ft. wide and 17 ft. high. They are also arranged so that they can be disconnected without interrupting the main power supply. The equipment further includes three 40-MVA reactors which, like the main and

Fig. 2. 220 AND 130-KV SYSTEMS AND FIRST 380-KV LINE.



regulating transformers, were constructed at the Ludvika works of Allmänna Svenska Elektriska A.B. A diagram showing the electrical connections of this part of the equipment at Harsprånget is given in Fig. 7, page 750; Fig. 6 is a single-pole diagram for the transformer.

MAIN TRANSFORMERS.

As the main transformers are unusually large and are being operated at a voltage higher than has hitherto been used in practice, it was wisely decided to keep their design as simple as possible and to employ only well-tried methods of construction.* As circuit-breakers were not available to deal with the line current of 12,500 amperes, corresponding to a load of 345 MVA at 16 kV, or with the equivalent short-circuit currents, it was also decided to divide the primary winding into three parts, each of which has the same reactance relative to the high-voltage secondary winding and a large mutual reactance. This necessitated the use of the arrangement shown in Fig. 4, opposite, from which it will be seen that a core with five legs is used, but that the two outer legs have only half the cross-sectional area of the inner three. As will also be seen, the primary winding is divided into three parts, one of which is wound on each of the inner legs and each of which has separate bushings. The relevant phases of one alternator are connected to each winding. The three parts of the high-tension winding are arranged in parallel and are connected to one 380-kV and one 30-kV bushing. The low reactance that is essential has been obtained by a combination of large core diameter with long length of leg, thus providing only a relatively small number of ampere-turns per centimetre of winding length.

* See E. Stenkvist, "The Transformers for the Swedish 380-kV Network," *Conference Internationale des Grands Reseaux à Haute Tension*. Paper No. 138 (1952).

380-KV SWEDISH TRANSMISSION SYSTEM.

Fig. 3. FIRST STAGE OF 380-KV SYSTEM.

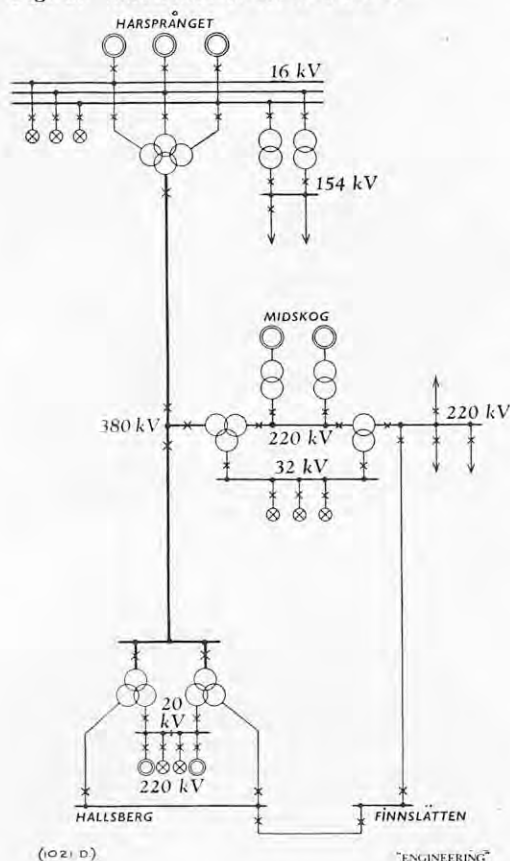
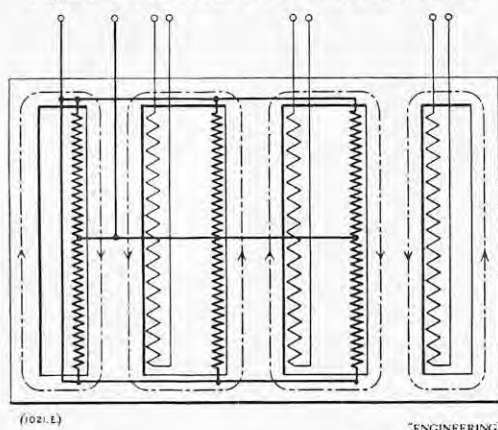


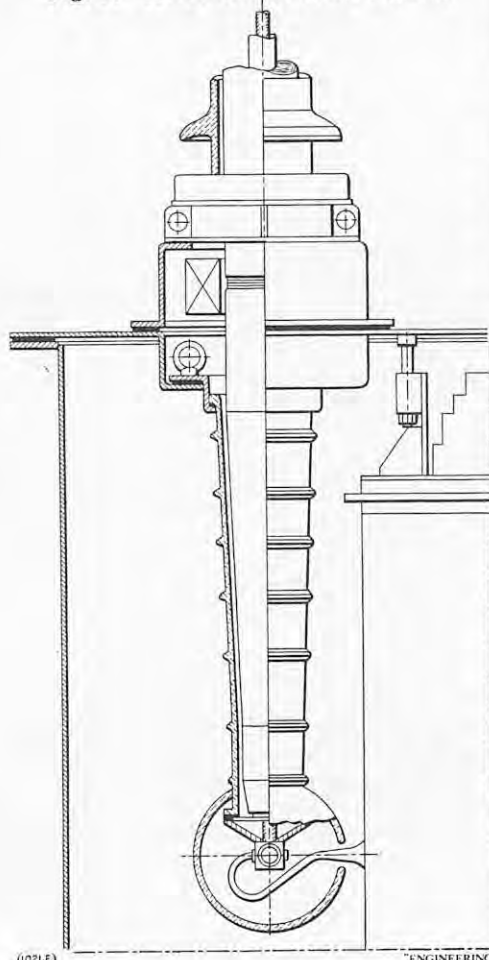
Fig. 4. SINGLE-PHASE 115-MVA TRANSFORMERS.



The windings themselves are conventional disc and helical coils; those on the high-tension side are arranged in two groups connected in parallel, so that the voltage falls as the distance from the yoke decreases. Electrostatic screening rings are placed in suitable positions between the end coils and are connected to the line terminal to provide a protection against surges. The individual coils are separated from each other by insulating material of the highest grade and are also protected by one or more insulating collars. The insulation resistance to earth is more than usually liberal, as is indicated by the fact that on test the bushing always flashed over first.

As can be seen from Fig. 5, the 380-kV bushing, which weighs about $2\frac{1}{2}$ tons exclusive of the current transformer, is of the normal condenser type with protecting porcelains at each end. The lower porcelain forms a separate container which is clamped to the cover of the tank. A seal is inserted between the container and the tank, so that the bushing can be removed from the lower porcelain without lowering the oil. When the bushing is in use the space between its core and the porcelain is, of course, filled with oil and the two chambers are connected. During transport, however, the lower

Fig. 5. LOWER PART OF 380-KV BUSHING.



part was enclosed in a special oil-filled sheet metal tank. The lower end of the bushing is also unusually long in order to bring the high voltage directly to the terminal at the middle of the winding. As will also be seen, the lower porcelain is provided with a large-diameter metal sphere which is insulated with paper in order that the clearance between it and the tank shall be reasonably small. The core of the bushing is solid and for mechanical reasons was made of bakelised paper, a minimum amount of Bakelite being used to facilitate impregnation and to reduce the time required for drying under high vacuum. In order to decrease the dielectric stress, the external diameter of the bushing was made large. As will be seen from Fig. 1, the top cap consists of a large-diameter cage, which is made of galvanised-iron rod 10 mm. in diameter.

When this high-tension bushing was tested at gradually increasing voltages, corona first appeared at the top cap when a value of about 350 kV to earth was reached. At 700 kV, the corona extended for about 18 in. round the bushing, a distance which increased to 10 ft. at about 900 kV. The dielectric losses when the lower part of the core was immersed in oil at different temperatures gave a value of $\tan \delta$ of 0.007 at 400 kV to earth and about 90 deg. C., and did not change after 48 hours. It is interesting to note that the bushing used for the type and acceptance tests is now in service and has been subjected to some 200 surges with amplitudes between 1,200 and 2,100 kV without suffering damage. The transformers have also successfully withstood a number of type and routine tests of various kinds, the results of which are given in the paper to which reference has already been made.*

As the size of the main units gave rise to difficulties, separate regulating transformers had to be used and these, as will be clear from the information given above, are also of considerable size. To

overcome the consequent disadvantages, arrangements were therefore made to reduce the rating of these units by eliminating exciting and series windings and by connecting them directly between the main transformers and earth. As a result of this arrangement, special consideration had to be given to the question of insulation level. This it was found would have to be as high as 525 kV in the lower parts of the high-voltage winding of the main transformer, as well as in the regulating transformer. As, however, it is fairly easy to protect these points by using lightning arresters, a level of 275 kV was chosen at Harsprånget and even this has been found to be more than is actually needed. The regulating transformers are protected by lightning arresters, which are placed both between the regulating winding and earth as well as on the primary side as a check to transferred over-voltages.

The main transformers are protected from flashover at the bushing by arcing rings, which are earthed through ordinary current transformers, the latter being equipped with instantaneously operating devices. Gas-relay, differential, earth-fault and thermal-overload protection are also fitted on each of the single-phase transformers and works in conjunction with auxiliary relays so that the whole group can, if necessary, be disconnected. This system of protection has been designed so that it is unnecessary to switch over the secondary circuits of the instrument transformers or to alter the relay settings when the line conditions or transformer phases are changed.

The low-tension side of each single-phase transformer is controlled by three double-pole air-blast circuit-breakers, which, as shown in Fig. 7, are arranged so that the three breakers belonging to the 'bus-bar system in service can be operated as a triple-pole unit. Moreover, the double-pole circuit-breakers controlling one phase can be operated individually when it is necessary to change over the phases. The isolating switches can be operated in the same way.

380-KV CABLES.

The 380-kV windings of the transformers at Harsprånget are connected to the outdoor switching stations at ground level by cables, which are installed in a shaft about 165 ft. deep, the mouth of which opens into the underground cubicles. Two of these cables were manufactured by A.B. Liljeholmens Kabelfabrik, Stockholm, while the other two were made by Les Cables de Lyon. The Liljeholmens cables consist of an inner core made up of shaped-copper wire which, after stranding, was drawn down to circular cross-section. After holes had been drilled at intervals of 1 ft. in this core, it was wrapped with two layers of strip the edges of which were well-rounded and again drawn through a die to give a finished cross-section of 0.78 sq. in. and an outer surface so smooth that the usual metallised-paper wrapping could be omitted. The core was next covered with very thin and narrow paper tape to a thickness of 1.1 in. These tapes were laid on dry to avoid porosity between the conductor and the lead, the machine used for this purpose being designed so that the tapes could be further dried immediately after they had been applied. As this dry hard insulation could not be wound on small-diameter drums, impregnation was carried out in a tank with reinforced-concrete sides which was specially built to contain a 16 ft. 6 in. drum.

On completion of the impregnation process, the paper was covered with a lead sheath 0.22 in. thick in which channels about 0.08 in. deep had been left to facilitate the flow of oil and thus to prevent the formation of voids during service. A second lead sheath, 0.14 in. in thickness, was then drawn over the first, the two being separated by a bedding of polyvinyl chloride. Over this second lead sheath is an armouring of two soft

* Loc. cit.

copper tapes with a total thickness of 0.28 in. These tapes were laid with a short lay to take up the radial stress caused by the oil pressure and over them were wound 30 hard copper tapes, with a total thickness of 0.48 in., to take up the longitudinal stress. A third layer, 0.26 in. thick, was finally wound with a short lay over the second layer to keep it in position. This triple armouring is covered with a layer of polyvinyl-chloride tape so that the finished diameter of the cable is 4.72 in. and its weight 35 lb. per foot.

The maximum static pressure between the two ends of the cables is 140 lb. per square inch, of which 56 lb. per square inch is due to the oil pressure. This pressure may increase to about 170 lb. per square inch if a short-circuit occurs at a temperature of 32 deg. F. In order to assist the oil flow and to prevent excessive pressure drop, air at a temperature of 54 deg. F. is forced round the cables.

The terminals used on these cables consist of porcelains nearly 12 ft. long, which can be distinguished hanging from the roof in Fig. 1. The oil pressure inside the porcelains, which is about 14 lb. per square inch, is taken up by laminated phenolic paper tubes, 10 ft. long and 9.6 in. internal diameter. Tests have shown that these tubes are capable of withstanding pressures as high as 50 lb. per square inch for long periods without leakage. Before they were inserted in the tubes the lead was removed from the cables and ring-shaped condensers were stacked one on top of the other round the cores. The lowest element in the stack was then connected to the lead sheath and the uppermost one to the conductor. The terminal is surmounted by a corona cage 5 ft. 2 in. in diameter and 35 in. high.

The transport and installation of these cables gave rise to some difficulty as, owing to the size of the drums, they had to be taken from Stockholm to Harsprånget by special train. To facilitate lowering them into the shaft and to prevent oil escaping during installation, the outer end of each length was provided in the factory with a plug which was encased in a tube 13 ft. long. On arrival at Harsprånget, the drums were unloaded near the mouth of the shaft and the length of cable was fastened by straps and twin buckles to a steel wire, so as to distribute the load. The cables were successfully tested both in the works and after installation and the results have been given in a recent paper.*

(To be continued.)

SYMPOSIUM ON BURSTING DISCS.—The Institution of Chemical Engineers, 56, Victoria-street, London, S.W.1, has arranged a symposium on "Bursting Discs," which will take place in London during afternoon and evening sessions on Tuesday, January 13, 1953. According to present arrangements, papers to be presented will include "Bursting Disc Assembly for Alternating Pressure and Vacuum at Elevated Temperatures," by Mr. E. A. K. Patrick; "Design and Operation of Bursting Discs in Isolating," by Mr. F. Molyneux; "Bursting Disc Design and Application in the Chemical Industry," by Mr. D. J. Breeze; "Design and Manufacture of Bursting Disc Assemblies," by Mr. J. M. Pirie and Mr. J. Brown; and "Use of Ductile Metals for Bursting Discs," by Mr. T. B. Philip. Preprints and additional particulars may be obtained from the secretary.

RE-RAILING JACKS FOR BRITISH RAILWAYS.—The re-railing of locomotives, carriages and wagons by means of hydraulic jacks instead of cranes is to be given a trial by British Railways. Equipment recently ordered from Germany for this purpose includes a hydraulic jack capable of lifting a weight of 150 tons through a height of 18 in., also a crank and chain gear to haul the vehicle sideways, after which it is lowered on to the rails by releasing the jacks. If the vehicle is overturned it is first righted by link chains and hydraulic jacks. It is thought that equipment of this type will enable "breakdowns" to be dealt with more speedily than with cranes and without obstructing adjacent tracks. If it is successful additional sets may be built in British Railways' workshops.

* See B. Hansson, B. Bjurström, R. Johansson and G. Axelsson, "A Swedish 380-kV Cable Installation," Conference Internationale des Grands Réseaux Electriques à Haute Tension. Paper No. 205 (1952).

380-KV SWEDISH TRANSMISSION SYSTEM.

Fig. 6. SINGLE-POLE DIAGRAM FOR TRANSFORMER.

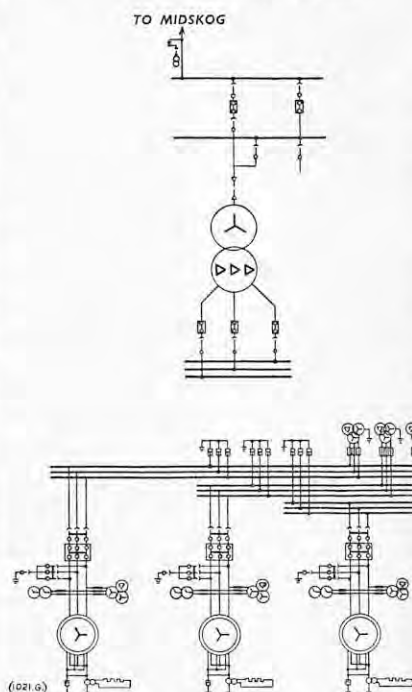
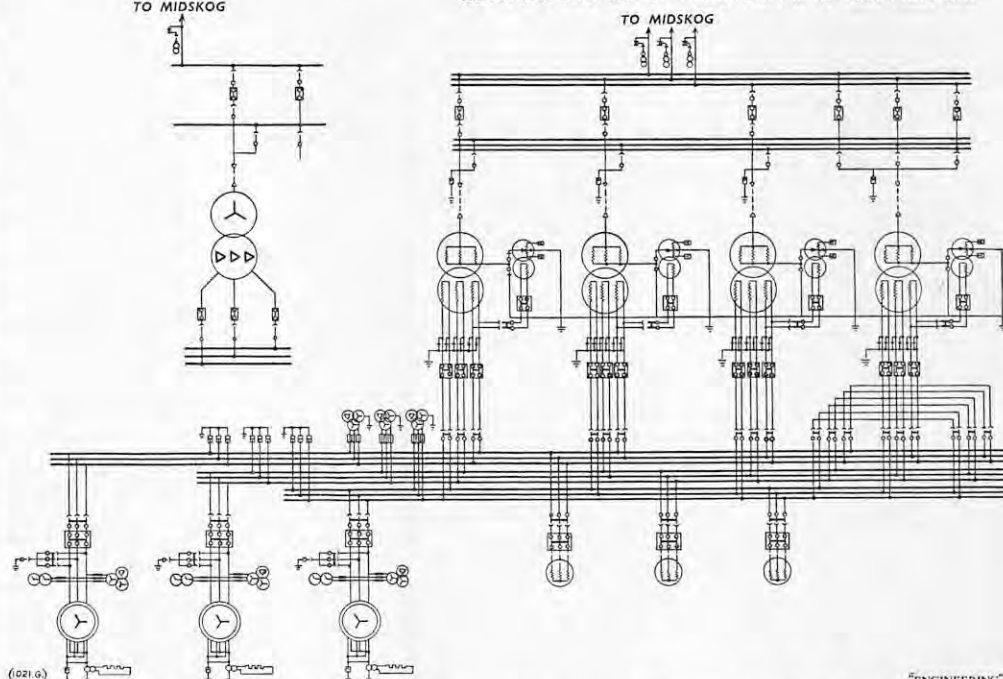


Fig. 7. CONNECTION DIAGRAM FOR GENERATORS, REACTORS AND 380-KV TRANSFORMER AT HARSPRÅNGET.



SYMPOSIUM ON THE PROPERTIES OF METALLIC SURFACES.

(Continued from page 689.)

WE continue below our report of a general meeting of the Institute of Metals, held at the Royal Institution, London, on November 19, to discuss a series of 13 papers on the "Properties of Metallic Surfaces." Seven of the papers, which dealt with methods of examining metal surfaces and with the characteristics of those surfaces, were presented at the morning session of the meeting by Professor A. H. Cottrell, who acted as *rapporteur*. His remarks, in abridged form, were printed on page 689, *ante*, and deal below with the subsequent discussion.

Mr. D. McLean, who opened the discussion, said that, because it was not well known, he would like to refer to an instrument mentioned in Professor Tolansky's paper, the Linnik-Zeiss interference microscope. As mentioned in the paper, this instrument, which was a two-beam interference microscope, could detect steps in the surface of about 250 Å, and the multiple-beam microscope was about ten times as sensitive. When it was realised that 250 Å was practically one-millionth of an inch, it would also be realised that, very often, the Linnik-Zeiss interference microscope would have adequate sensitivity. In addition, it had very considerable operating convenience which derived from its construction. So far, this microscope had not been made in England, but on account of its advantageous features, it was satisfactory to hear that its manufacture in this country was contemplated.

Professor S. Tolansky, who also made some comments about the Linnik-Zeiss microscope, stated that last year, in the United States, he had seen a very simple adaptor which could be screwed on to an ordinary microscope to convert it into a Linnik-Zeiss interferometer. The adaptor was produced by the Bausch and Lomb Optical Company. The whole thing was very small and had the advantage of having a set of three reflectors of different reflectivities which could be brought in for use with specific surfaces. The next speaker, Mr. L. Grunberg, said that the work described by Dr. M. T. Simnad and Dr. U. R. Evans dealt with metal surfaces in contact with electrolytes. In those circumstances, the active patches in the surface behaved anodically; but there were circumstances in which the active patches might show cathodic behaviour, and by "cathodic behaviour" was meant that they might act as a source of electrons. That was evidenced by the

discovery of Kramer, who had found that freshly-disturbed surfaces emitted negatively-charged particles which could actuate a Geiger counter.

Dr. F. Wormwell, in a comment on the papers by Dr. Evans and Dr. Simnad, said that in their work at Teddington they had often, as Dr. Evans had done, emphasised the importance of the surface roughness factors—the physical character of the surface—in determining the corrosion distribution, and possibly, in some cases, the corrosion velocity. The effect of differences in surface condition might, in some cases, outweigh the effects of aeration and of other factors that controlled corrosion distribution. In one paper they had been able to show that by taking two specimens, one with an ordinary machine-turned surface and the other prepared by rubbing with fine emery, connecting them externally in a semi-normal sodium-chloride solution, the rougher surface was corroded and the smoother surface was protected for at least fifty days. Their work was causing them to feel that, in studies of corrosion, and particularly of inhibition, it was absolutely vital to know more about the nature of the surface dealt with. The specimens used in experiments did not have perfectly plain, beautifully-crystalline metal surfaces; turning or machining marks were present, and, incidentally, in their earlier work they had found usually that corrosion tended to work on the crests of the turning marks and not in the troughs. In some cathodic protection work they had also found, in a case in which they were applying a current with a steel anode connected to six separate cathodes, that the current flowing to the individual cathodes varied from one specimen to another. Apparently this was determined by some difference in the surface condition. His colleagues, for the past two years, had been carrying out a study of the mechanism of corrosion inhibition, using active potassium chromates and sodium benzoate. Some of the work had been published. In general, this work, which had been carried out quite independently and without any knowledge of Dr. Simnad's work, had given similar conclusions.

Mr. E. C. Williams said that in reading the papers presented to the symposium, it seemed that metallurgists were only at the fringe of exact knowledge regarding metallic surfaces. Surface conditions were described in terms of the operations performed on the surfaces, such as grinding, polishing, etching; and the best which could be achieved by way of a refined nomenclature was to differentiate between a ground surface and one that was ground under alcohol. On the nature of the surface layer, starting with an etched surface of an annealed polycrystalline metal and putting that through

different amounts of surface working by abrading or polishing, the crystal structure could be gradually distorted and broken up into fragments which were disorientated from the original crystal matrices. It seemed that, in so doing, the surface had been made less heterogeneous. He believed that the Beilby layer was not truly a metallic layer. In fact, it could be described as a mixture of metal and oxygen atoms; in other words, an oxide in not very well defined form.

Dr. W. H. J. Vernon agreed that the near amorphousness of an abraded surface should not be regarded as a metal or as an oxide, but rather as a conglomerate of the two. The difference between abraded surfaces and etched surfaces was that, in the case of the abraded specimens, a thinner surface film was present; more of the oxygen had gone into the mixed region, so that the maximum oxide was present.

Dr. J. W. Mentor said that many of those present would remember the discussion organised by the Institute, in association with a number of other bodies, in November, 1949, on "Metallurgical Applications of the Electron Microscope." A considerable part of that discussion had been concerned with the limitations and merits of replica processes for examining surface topography, and a number of speakers had referred to the advantages to be gained by direct examination of the surface itself in the electron microscope. Since that time, work has been going ahead in a number of laboratories on the development of so-called reflection microscopes for this purpose. Attention should be drawn to the fact that it was possible, by slight modification of a standard commercial instrument available in this country, to obtain very high-resolution reflection images of solid surfaces, and various lines in which it might prove a valuable additional tool for the study of surfaces might be suggested. The illuminating system of the electron microscope was inclined at an angle of 8 deg. to the vertical and the specimen surface at a variable angle less than this. The electrons scattered from the surface were collected by the objective lens and an image was produced by the projection lens in the normal way. Briefly, it might be said that the method was particularly valuable for revealing small asperities or depressions in a surface; it provided high resolution in a direction normal to the surface. High resolution in other directions could, of course, be obtained by rotating the specimen about the surface. Furthermore, combined with electron-diffraction observation on the same area of the specimen, it provided the possibility for chemical identification of surface features and also facilitated the interpretation of many diffraction photographs the character of which depended markedly on the microscopic topography of the surface. Finally, it permitted the carrying out of dynamic experiments on a surface while keeping it directly under observation. For example, in principle, experiments on thermal changes in surface structure, on plastic deformation, scratching, and fatigue, could be carried out. Of course, no method was complete in itself, but the more thorough exploration of this particular technique would add a useful weapon to the metallurgist's armoury for the study of solid surfaces.

Dr. U. R. Evans, F.R.S., stated that the work which Hoar and he had done had been carried out 20 years ago, and it would not unduly worry him if it were found that their results needed some modification now. It was generally agreed that with iron which had been placed in a chromate solution, chromium was produced on or in the surface under some conditions. The question arose, however, whether it was the essential cause of the protection. Quite recently Professor Cecil King and two colleagues had expressed the view that although chromium oxide or chromium compounds were present, better protection was obtained when the protective field was simply iron oxide.

Dr. A. J. W. Moore said that some time ago a colleague and he had carried out some investigations into the relationship between friction and hardness, using as an example copper-beryllium alloys. Their results were, he believed, related to those of Dr. Evans in his investigations into the scratch-corrosion tests. Although, in general, the coefficient of friction was the ratio of the shear strength and the

hardness, it seemed that, on some surfaces, such as chromium plating or tungsten carbide, friction was, in general, less for harder substances. It was, however, difficult to test this experiment because usually harder substances had peculiar zones of oxide films and it could not be ascertained whether a change in friction was due merely to the hardness or to some other change in the surface.

Mr. H. J. Sharp said that he wished to ask a few questions relating to the anodising process. He had found little reference in the literature to the effect of alkaline conditions upon the anodic film. He was very interested in the ability of suitable anodic films to resist corrosion in media having a pH value up to 10, and including a very low concentration of caustic soda. He would also like to have some recommendations concerning film thickness for alkaline environments. Another matter of interest to him concerned reliable non-destructive methods of testing film thickness which would give reliable indications and could be put into a production line. Some hints had been received that methods involving radio-isotopes were being developed, and it would be interesting to have further information on these methods. Another matter of interest concerned the effect of suspended matter in the electrolytes used in commercial anodising plants, and he wondered whether they were to be blamed for lack of continuity in the anodic film, because in certain conditions, quite bad pitting corrosion occurred in anodising aluminium. This might be due to the effect of suspended particles in the bath which became occluded in the film.

Mr. H. R. Wright said that the paper by Dr. Gay and Dr. Hirsch, although of considerable interest, did not throw much light upon the physical processes accompanying the abrasion of metallic surfaces in the presence of oxygen. The conception of the abraded surface as one which consisted entirely of distorted crystallites was somewhat idealised, and it would be better to consider the distorted layers as composed of a mixture of adsorbed gases and oxides together with distorted metallic crystallites and amorphous material. It might well be expected, therefore, that such surfaces would possess a number of interesting and important features not usually associated with a clean unstressed metallic surface. Some work carried out by Kramer in Germany was of special interest in this connection, as he had found that metal surfaces, when abraded, gave rise to electronic emission, and he explained this as being due to the energy released when the surface structure reverted from the so-called non-metallic phase to the metallic state. Slight differences in the magnitude of the emission were also observed for different methods of surface preparation; thus, a specimen which had been abraded with emery paper was more active than one which had been mechanically polished. Of particular interest was the fact that the activity of a bearing surface increased considerably during the "running-in" period. Some of Kramer's work had been repeated at Thorntonhall, Glasgow, in order to try to ascertain the precise nature of the active centres which appeared to be responsible for the emission, especially as they might be of extreme interest in lubrication studies where abrasion and wear were particularly evident. The results obtained had shown that abrasion increased the photo-electric sensitivity of the surface, the threshold wavelength having been increased from the ultra-violet to the blue-green of the visible range.

At this stage, the chairman, Professor A. G. Quarrell, adjourned the proceedings until the afternoon.

(To be continued)

MAGNETIC CRACK-DETECTING EQUIPMENT.—The Magnetic Equipment Co. Ltd., Lake Works, Portchester, Hampshire, have recently added to their range of crack-detecting equipment by producing a machine for the examination of complicated castings and shafts up to 5 ft. long or more. It is made in two types suitable either for current-flow or for current-flow and magnetising testing and comprises two sliding heads. For repetition work one of these heads can be clamped and the other moved and held by an air-operated pressure cylinder, which, like the magnetising circuit, is controlled by a foot switch.

AIRCRAFT ACCIDENT DUE TO WASH FROM AIR LINER.

ON August 1, 1952, a de Havilland Rapide aircraft, operated on a five-minute pleasure flight by I.A.S. (London) Limited, crashed at London Airport as a result of the pilot losing control during the landing approach. The pilot was severely injured and five passengers also received injuries. A report by the Chief Inspector of Accidents on this incident has been issued by the Ministry of Civil Aviation and will be on sale in the near future at H.M. Stationery Office. The pilot requested permission to land after a Strato-cruiser, which was then making its final approach, and was instructed to make a long down-wind leg. After the Strato-cruiser had landed and had reached a point 1,000 yards from the end of the runway, the pilot of the Rapide was given permission to land at his own discretion. He turned towards the runway, keeping well to its right in order to be clear of the Strato-cruiser's slipstream. When the Strato-cruiser was near to the end of the runway, the pilot reduced power and turned to the left to line up for landing. The aircraft was then at a height of about 300 ft. and a speed of 100 m.p.h., slowly losing height.

Almost immediately after starting to turn, the Rapide ran into severe turbulence, and the pilot lost control. After being thrown violently, first to the right and then to the left, it started to lose height rapidly, and as it was near the ground the pilot throttled back and tried to level out. The aircraft started to respond, but before recovery was complete it crossed over the Bath-road and struck a 6-ft. wire fence. It crashed on the aerodrome, wrecking the front of the fuselage, but did not take fire.

As a result of inquiries made during the subsequent investigation, the Chief Inspector of Accidents states that numerous cases have been recorded where light aircraft have been put out of control by the propeller wash of large aircraft, either during take-off or landing approach. In some cases the turbulence encountered has constituted a flight hazard even when the distance between the two aircraft exceeded a mile. In conditions of little or no wind, it is concluded, the turbulence is likely to persist near the ground for an appreciable time.

DISTRIBUTION OF COBALT.—The Manganese-Nickel-Cobalt Committee of the International Materials Conference, Washington, have announced that an improvement in supplies of cobalt has caused the distribution plans for the first quarter of 1953 to be discontinued.

CONFERENCE ON STATIC ELECTRIFICATION.—The Institute of Physics has arranged a conference on "Static Electrification," to be held at Bedford College for Women, Regents Park, London, N.W.1, on Wednesday, Thursday and Friday, March 25, 26 and 27, 1953. There will be an opening lecture by Professor F. A. Vick, O.B.E., and the other sessions will each take the form of an introductory survey, followed by specialised papers and a discussion. The introductory surveys will be given by Dr. P. S. Henry on "General Principles of the Generation and Dissipation of Static Electricity," by Dr. E. S. Shire on "Electrostatic Machines," and by Mr. H. W. Swann, O.B.E., on "Harmful Static Electrification." The proceedings of the conference will be published by the Institute later. Applications should be addressed to the conference secretary, Mr. N. Clarke, Institute of Physics, 47, Belgrave-square, London, S.W.1.

COURSE ON PRESTRESSED CONCRETE AT NOTTINGHAM UNIVERSITY.—The Departments of Civil and Mechanical Engineering, Nottingham University, with the assistance of the Cement and Concrete Association, have organised a course of lectures entitled "Prestressed Concrete—Design Principles and Methods." The course will consist of eleven weekly lectures, held on Wednesdays from 3.30 p.m. to 5.30 p.m., commencing on January 7, 1953. The subjects dealt with will include, design of concrete mixes; control of concrete quality; design principles; the Freyssinet, the Magnel-Blaton, and the Lee-McCall systems of prestressed concrete; the Preload system of prestressing circular structures; and the use of precasting in prestressed concrete construction. The complete syllabus and enrolment form can be obtained from Mr. R. C. Coates, Departments of Civil and Mechanical Engineering, University of Nottingham, Nottingham.

FORGE FOR CONTINUOUS PRODUCTION OF RAILWAY WHEELS.



FIG. 14. MAIN CONTROL ROOM.

FORGE FOR CONTINUOUS PRODUCTION OF SOLID RAILWAY WHEELS AND DISC CENTRES.

(Concluded from page 716.)

AFTER the forged wheel has left the punching press, as described in the previous article, it is passed through a tunnel which is underneath the main control room illustrated in Fig. 14, herewith. Then it is rolled to give it the required rim section, as shown in Fig. 15, and finally it is dished in a press to produce an offset of the hub in relation to the rim, as shown in Fig. 16. If the rim is to be chilled the wheel is passed to a chilling machine, otherwise it is delivered directly to a "lay-down" station. These processes, which are regulated entirely from the main control room, where the operators work in white overalls and comfortable surroundings, are described below, together with the hydraulic and compressed-air plant which makes possible the remote and automatic control which is such a notable feature of the forge.

ROLLING MILL.

The mill loading mechanism is mounted under the main control room, its main supporting frame being pivoted at the mill end and suspended at the other end from a curved track. This arrangement facilitates the alignment of the machine in relation to the mill rolls. A carriage activated by a hydraulic cylinder carries a self-centring grip mechanism which is rotated to enable the grips to clear the wheel forging. A separate oil hydraulic unit, located in the motor room, has a Vickers-Detroit double pump for the grip mechanism and a separate pump for operating the twisting and travelling cylinders. All these cylinders are mounted in the movable carriage and fed through flexible hoses. The travel stroke is arranged to take the forging from the end of the roller table to the centre-line of the mill, where the forging is deposited on forks attached to the roll carriages. The rolling mill is illustrated in Fig. 18, on Plate LVIII, which also shows the operators at their control desk.

The forged rim is reduced in cross-sectional area in the mill and formed to the required shape, as shown in Fig. 19, on Plate LVIII, by driven edging rolls which bear on the front and back faces and on

the inside contours of the rim, and by the load on two pressure rolls which bear on the tread and form the flange. The mill, of Taylor-Kendall design, has also a driven main roll mounted in an adjustable carriage and two guide rolls mounted on a separate carriage but sliding on the same ways as the main carriage. The hydraulic pistons for the guide-roll carriages are attached to the main-roll carriage to give movements relative to that carriage. The mounting arrangement of the guide rolls permits their retraction behind the main roll to facilitate loading and unloading of the mill. The arrangement adopted reduces the handling time at the mill and simplifies the handling equipment. Pressure regulation on the carriages during rolling controls the formation of the section and the rate of expansion of the wheel diameter. Indicating equipment is built into the mill to show the inside diameter of the rim, and mill setting scales are mounted on the side of the main stand for rapid setting-up to suit varying rim widths and roll diameters.

Each carriage has a self-contained oil hydraulic unit comprising large-volume low-pressure pumps for rapid-traverse duties and small-volume high-pressure pumps for maintaining pressure during rolling. The pumps, together with the electrically-operated control valves, are mounted on tanks which contain all the system connections. Only the cylinder piping and remote-control drains are located outside the motor room. Cylinder pressures are remotely controlled at the mill desk by adjusting venting valves coupled to Vickers-Detroit "hydro-cushion" relief valves which are mounted on the operating side of the cylinders.

The top and bottom edging rolls are each driven by a 400-h.p. direct-current motor having a speed range of 690 to 860 r.p.m. These motors, during rolling, are coupled in series across a 480-volt generator. The motors drive through a primary reduction gear and wobbler shafts which are coupled horizontally to spiral-bevel pinions engaging wheels mounted on the roll shafts. The edging-roll shafts are inclined at 35 deg. to the horizontal plane and are mounted in quill castings which also form the bevel-gear casings. At the roll end of the shafts are four-row Timken "balanced-proportion" roll-neck bearings. Steep-angle taper-roller bearings are mounted in a cartridge behind the bevel gears. The input bevels are mounted in the quills on stub

Fig. 15. ROLLING.

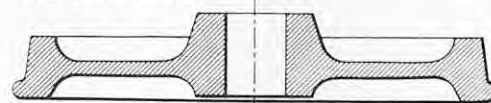
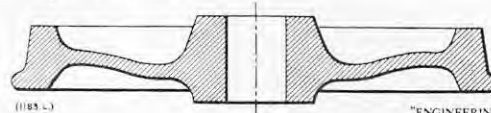


Fig. 16. DISHING.



shafts carried in cartridge-mounted taper-roller bearings. The main roll, which is the only other driven roll, is carried on a tapered extension of a vertical shaft mounted on a Timken two-row "balanced-proportion" roll-neck bearing with a double-row taper-roller bearing at its lower end. A single-helical gearwheel is mounted on the roll shaft and engages a pinion on a vertical intermediate shaft which also carries a spiral-bevel wheel. A bevel pinion is mounted horizontally on a shaft coupled to a 150-h.p. mill motor having a speed range of 460 to 1,150 r.p.m. This motor is fed from a separate generator mounted on the main set and has a "shovel" characteristic to prevent it taking load from the edging-roll drive motors and overloading itself. All driven-roll speeds are independently variable and the overall mill speed is also adjustable to maintain pre-set roll speed ratios, modified to suit the various roll diameters.

The primary gearbox, edging-roll quills and main-roll gearbox are fed with lubricating oil from a De Laval circulating unit made by Denco Engineering Services, Limited, Hereford, and installed in the motor-room basement. The unit is fitted with duplicate gear-type pumps, a motor-driven filter, steam-heating coils and oil cooler. It has automatic control equipment to bring the second pump into operation in the event of loss of pressure and is provided with audible warnings for excessive pressure. The mill-motor controls are interlocked with the lubrication system to prevent the starting of the mill before the lubrication system is operating.

The three roll carriages slide on round ways and are fitted with bronze bushes pressure-fed with grease from a Trabon automatic reversing lubrication system. The bushes are fitted with wiper seals. It is claimed that this method of mounting the carriages facilitates effective lubrication and maintenance of roll alignments, with a consequent improvement in the consistency of product dimensions. Both edging-roll quills are mounted on pivot shafts having an eccentric centre portion for quill adjustment. Rocker bars at the roll end of the quills are connected through adjustable pitman arms to the screw-down cranks. The crankshaft for the lower roll is connected through a wormgear to a 5-h.p. mill motor forming a drive for retraction of the roll. The upper quill is similarly connected to a 20-h.p. direct-current mill motor of 450/1,200 r.p.m. This motor is coupled to a Metadyne set having a 35-h.p. driving motor, a 0.17-kW 0/230-volt generator, a 5-kW 250-volt exciter and a 600-watt 150-volt Metadyne exciter. Controls are provided to give "instantaneous" edging, which produces a parallel wheel web, or "continuous" edging to produce a tapered web by the use of an electronic ratio controller coupled to the wheel-growth dial. A separate controller is provided for manual adjustment of the top screw-down motor. Further information on the mill and screw-down drives is being prepared by the Metropolitan-Vickers Electrical Company, Limited.

2,000-TON DISHING PRESS.

The wheel, on completion of the rolling, is transferred to a flat-topped car by an unloading mech.

FORGE FOR PRODUCTION OF RAILWAY WHEELS.

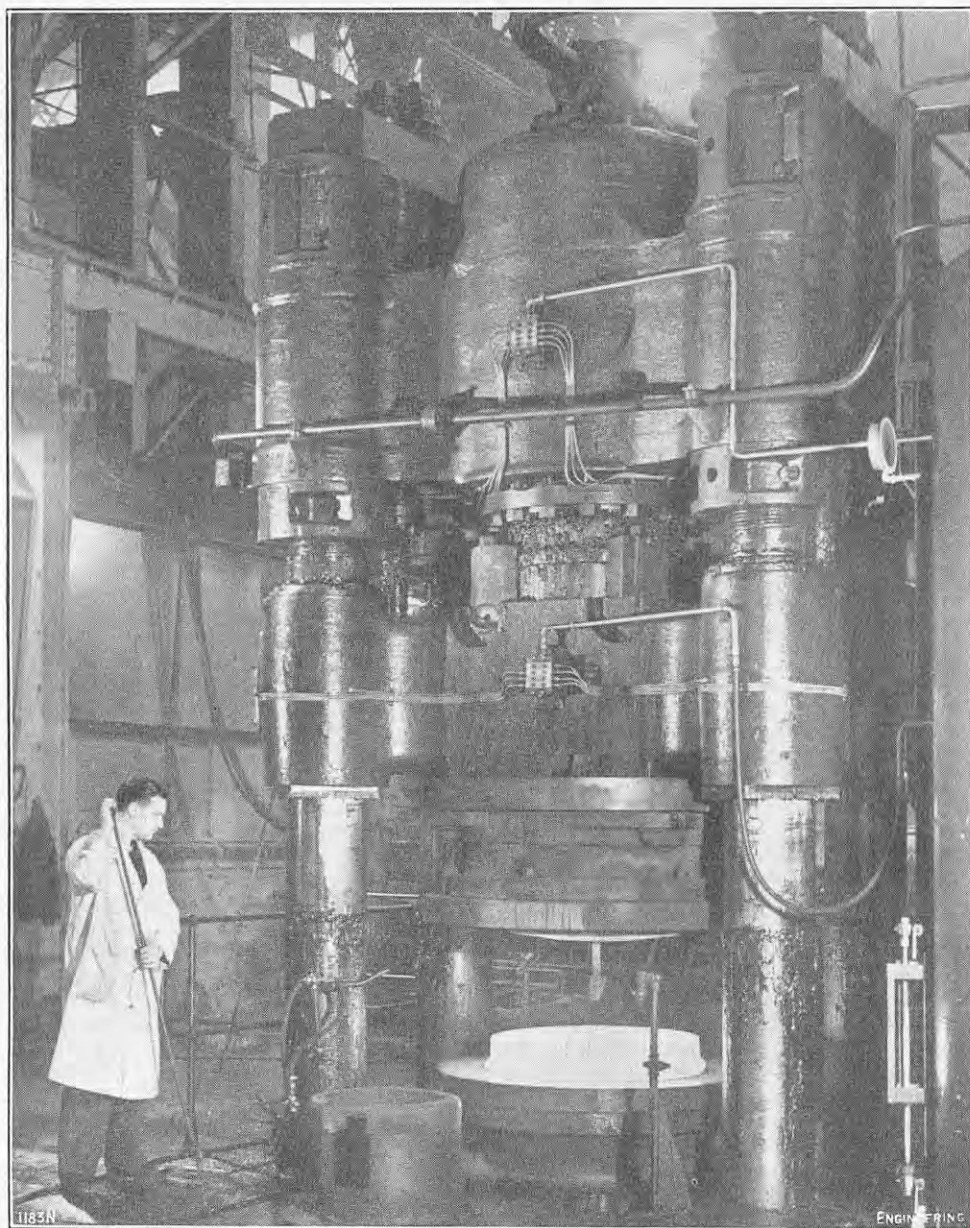


FIG. 17. 2,000-TON DISHING PRESS.

anism similar in design to the one used for loading the mill. This car, which is cable-driven, takes the rolled wheel over the bottom die of the dishing press shown in Fig. 17, above. A swinging arm is brought into position by the dishing-press operator, who then returns the car to the mill end of its track. The car, in returning, slides from underneath the wheel, which is restrained by the stops, and the wheel falls on to the die. The lower sliding table of the press is then moved, bringing the die under the crosshead ready for the next forging operation. The dishing operation changes the web of the wheel from a flat disc to a cone shape and sets the boss offsets, as shown in Fig. 16. The press has a two-piece top die mounted in a holder on the crosshead and has a bottom sliding table having a stroke of 6 ft. on which are mounted the bottom dishing die and a stripping stool. The press has a rated capacity of 2,000 tons at an accumulator pressure of 2,200 lb. per square inch, intensified to 6,000 lb. per square inch on a single ram $31\frac{1}{2}$ in. in diameter with a 2 ft. 7 in. stroke. Hydraulic pull-back cylinders are mounted on bolsters fastened to the top of the press columns. The intensifier has a $19\frac{1}{2}$ in. diameter low-pressure moving ram and a $11\frac{3}{4}$ in. diameter high-pressure stationary ram. The press control system is similar to that used on the 8,500-ton press, except that a pre-fill tank only is provided.

Mounted over the dishing-press table cylinder is a

1-ton hydraulic jib crane with a guided hoist in the form of a box-section column sliding vertically in guides at the end of the jib arm. To the bottom of the column is attached a set of automatic tongs which are adjustable to suit varying wheel diameters. A hydraulic cylinder mounted vertically on the jib mast is coupled to the column by wire ropes and fed with hydraulic oil through a rotary distributor which is mounted on top of the mast. The crane is slewed by a V.S.G. transmission unit driving through a planetary gearbox, the outer case of which is held by a friction brake to prevent damage in the event of fouling the jib arm. The crane is placed in such a way that the automatic tongs may be brought directly over the dishing-press stripping stool, the chiller loading station and a final lay-down station. These three points are at 120-deg. intervals around the 14-ft. diameter circle described by the jib. The slewing controls are arranged to give progressive movements of the jib through 120 deg. in either direction, thus enabling dished wheels to be taken either to the rim-chilling machine and from there to the lay-down station, or directly from the dishing-press to the lay-down station, according to the heat treatment required. Before transfer from the dishing-press stool the wheel is hot-stamped with the cast number of the steel. The stamps are mounted in the jaws of a toggle mechanism operated by an oil hydraulic cylinder, the complete gear

being mounted in a carriage slung under the crane structure and traversed by a pneumatic cylinder. Stamping is carried out when the wheel on the dishing-press stripping stool has been moved from under the press crosshead. Gauging of a wheel after dishing is illustrated in Fig. 20, on Plate LVIII.

RIM-CHILLING MACHINE.

The rim-chilling machine has five chilling stations mounted on an electrically-driven turntable 14 ft. in diameter. At each chilling station is placed a set of three tapered rolls, one of which is driven by an electric motor mounted inside the turntable hood. Box-section spray rings are mounted on the roll housings and coupled to a pump located inside the turntable hood through a solenoid-operated valve. This pump, rotating with the table structure, draws water from an annular tank located around the vertical post which carries the weight of the whole machine. At the centre of each chilling station is a set of loading forks under which is mounted a live-roller centre. At the point of intersection of the spray-ring pitch line and the jib-crane radius a fixed cam is arranged to lift the forks above the level of the live rollers in readiness to receive the wheel from the jib crane. After the wheel has been deposited on the forks the main turntable is indexed one-fifth of a revolution, lowering the forks and leaving the wheel on the rotating rollers. The water-spray valve of that station is automatically switched on, together with the spray timing device which holds the spray valve open irrespective of further movement of the station.

As the first station is carried away from the loading point the fifth station goes into the loading position and the wheel is lifted from the live rolls by forks, ready for transference by a hydraulic jib crane to the final lay-down position. The water from the spray rings runs down the hood at the main turntable structure into an outer annular tank fitted with overflow pipes which act as a return to the main drainage sumps. The outer casing of the chiller dips into the return water tank, forming a water seal, and the underside of the hood is ventilated by a fan mounted on the centre of the main hood structure. This flow of water is used to assist the flushing of scale from the mill and press foundations. The main turntable drive consists of a 10-h.p. motor with a brake, coupled by means of an extension shaft to a wormgear unit mounted underneath the turntable hood, a pinion on the wormwheel extension shaft meshing with a ring gear fastened to the inside of the rotating hood structure. A set of collector rings mounted on the vertical centre column supplies current to the five roll motors, the spray pump and the spray valves. The timers are located in the main control room on the chiller control desk. The latter also carries the turntable rotation controller and the hydraulic jib-crane controls. The final lay-down station consists of a simple turntable carrying three sticking pegs. The pegs, designed to receive five completed wheels, have their upper ends shaped to suit a set of automatic tongs fitted to the overhead crane used for removal of the completed stacks of wheels to the cooling beds.

MOTOR AND PUMP ROOM.

The main pumps and accumulators for the press hydraulics, which are designed to operate up to a maximum working pressure of 2,200 lb. per square inch, are arranged to form two independent systems with separate control gear. The large system comprises five strip-wound air vessels, each with a capacity of 68 cub. ft., and one strip-wound water vessel of a similar capacity. The small system comprises two 68-cub. ft. strip-wound air vessels and one 25-cub. ft. solid-forged water vessel. These vessels are shown in Fig. 21, on Plate LVIII. The ratio of air to water volume is such that a pressure drop of 10 per cent. is allowed over the normal operating levels. The 68-cub. ft. vessels are made

of welded plates covered by four layers of special-section rolled-steel strip. A three-stage Hamworthy air compressor with a capacity of 18 cub. ft. per minute is used for charging the air vessels. The water and air vessels are connected to mercury level-control pots of Vickers-Armstrongs design for control of the pumps and accumulator automatic stop valves. The pumps are unloaded by lifting the suction valves at a predetermined water level. Contacts in the mercury pots shut down the pumps at extra high level to avoid overfilling. Should the pumps fail to meet demands on the systems, further contacts are arranged which close the accumulator automatic stop valves, thus isolating the water vessels from the press supply lines.

The large accumulator system is fed by two three-throw Vickers-Armstrongs pumps, each having a capacity of 400 gallons per minute at 2,200 lb. per square inch. The rams are $4\frac{1}{2}$ in. in diameter, with a stroke of 21 in., and the crankshaft speed is 110 r.p.m. Each pump is driven through single-reduction double-helical gears by a Metropolitan-Vickers 6,600-volt slip-ring motor of 750 brake horse-power at 740 r.p.m. The small accumulator system is fed by a Davy three-throw pump of 160 gallons per minute capacity at 2,200 lb. per square inch. The pump is driven through a single-reduction double-helical gear by a Metropolitan-Vickers 6,600-volt slip-ring motor developing 275 h.p. at 740 r.p.m.

It is possible, by means of the independent accumulator systems, to operate the 8,500-ton press at lower pressures than the punching and dishing presses, and thus to consume less power in the forging of smaller products. The accumulators can be connected together to operate as a combined system, by equalising the air pressures and opening a stop valve in the water lines. The pumps and accumulators are housed in the motor room and the valves are arranged under the vessels in a basement which extends into the main pipe subways and the press foundations.

New 2-ft. diameter supply and return culverts have been constructed between the motor room and the Bridgewater Canal, which forms the south-west boundary of the works, and two Gwynnes centrifugal pumps, each with a capacity of 1,000 gallons per minute, are coupled through Auto-Klean strainers to supply cooling water for the rolls, dies, chilling machine, etc. All waste water is returned to a scale sump through open troughs constructed in the plant foundations. The scale is collected in containers which are lifted out of the main return sump and allowed to drain before being emptied into rail wagons. The return water is lifted from the deep sump to an oil-separator chamber by two float-controlled Gwynnes vertical-spindle pumps, and then returns by gravity to the canal.

An Ingersoll Rand 90 h.p. three-cylinder air-cooled compressor equipped with an after-cooler and air receiver supplies compressed air to the forge for operating the elevator at the furnace discharger. Compressed air is used for operation of the cooling-water valves and the stamper traverse cylinder, and is also piped to convenient points for general service. The motor room is supplied with clean air through a Visco filter at 30,000 cub. ft. per minute by a fan designed to maintain a positive pressure in the room.

The main 6,600-volt switchgear, the 400-volt switchboard and the rolling-mill control board are mounted on a balcony over the oil hydraulic room. The latter is at motor-room floor level but is enclosed from the main room and houses the tank units carrying the Vickers-Detroit equipment and the oil supply tank for the V.S.G. systems. In the basement beneath the oil hydraulic room is housed the mill lubrication equipment, the mill and press greasing equipment and the V.S.G. oil hydraulic pumps. Care has been taken in preparing the general layout to give ease of access to the extensive pipe and cable runs.

THE INSTITUTION OF NAVAL ARCHITECTS' AUTUMN MEETING.

(Continued from page 735.)

CONTINUING our report of the concluding technical session, which was held in Rome, of the joint meeting of the Institution of Naval Architects and the Associazione Italiana di Tecnica Navale, we summarise below, with the discussion, the seventh paper in the programme, which was presented by Dr. Ing. Professor A. Servello. It bore the title, "Principal Characteristics of Warship Design," and had been previously circulated in an English translation.

WARSHIP DESIGN.

The paper was an attempt to facilitate the work of a warship designer in the preliminary stages by formulating certain hull proportions and ratios for basic guidance, deriving these figures by plotting the actual particulars of previously-constructed ships. The author pointed out that the formulation of such approximate rules for guidance presented many difficulties in the case of warships; primarily, because the secrecy surrounding warship construction and performance made it impossible to check any rule derived from purely theoretical considerations, and, he added, "There are many possibilities of error when making speculative researches." He endeavoured, however, to establish, from published data relating to a number of battleships, cruisers and torpedo craft, corvettes, etc., expressions connecting displacement, length, beam, metacentric height, speed, wetted surface, tonnage available for armour protection, etc. In one instance, he stated in the paper, the particulars relevant to his investigation were taken from 75 vessels; which, in view of his remark that homogeneity of type was most important and that, in practice, the number of ships of a given type but of fundamentally different design was limited, suggested that some of the examples studied and included could not be at all recent. The paper was somewhat complicated for the English readers, at least, by the fact that the author used a nomenclature differing from the usual. In a concluding note, he suggested, as "aiming at a standard international method of naming the fundamental coefficients," that the present "block coefficient" should be "prismatic coefficient"; that the present prismatic coefficient should be renamed "cylindrical coefficient"; and that the "displacement-length ratio" which he used in the early part of the paper should be termed the "cubic coefficient."

DISCUSSION.

Dr. Ing. Sergio Marsich, who spoke in Italian, said that the author was trying to define the best design for a warship. The best warship was the one which, for a given endurance, needed the least power. The other factors were armament, protection and speed. Speed, and the capacity to carry useful equipment and stores, were the elements which made an efficient warship. Displacement was concerned strictly with the length and weight of the ship, which were the elements necessary to the preparation of the equation of the displacement itself. The next necessary element was the block coefficient. Those elements having been found, the area of the midship section and the coefficient of that section, which, within certain limits, were not strictly connected with the power, could be found, taking also into account the transverse stability of the ship, which could be determined by a family of curves which gave the stability characteristics as functions of the draught and beam. That was the way in which to prepare a design; not the usual way of starting with stability, which was not the fundamental element of the design for a warship, but something which was determined after the other characteristics were decided. Similarly, the prismatic coefficient could be determined, taking account particularly of the power of the ship, because that was the most important element affecting resistance, and hence the power required.

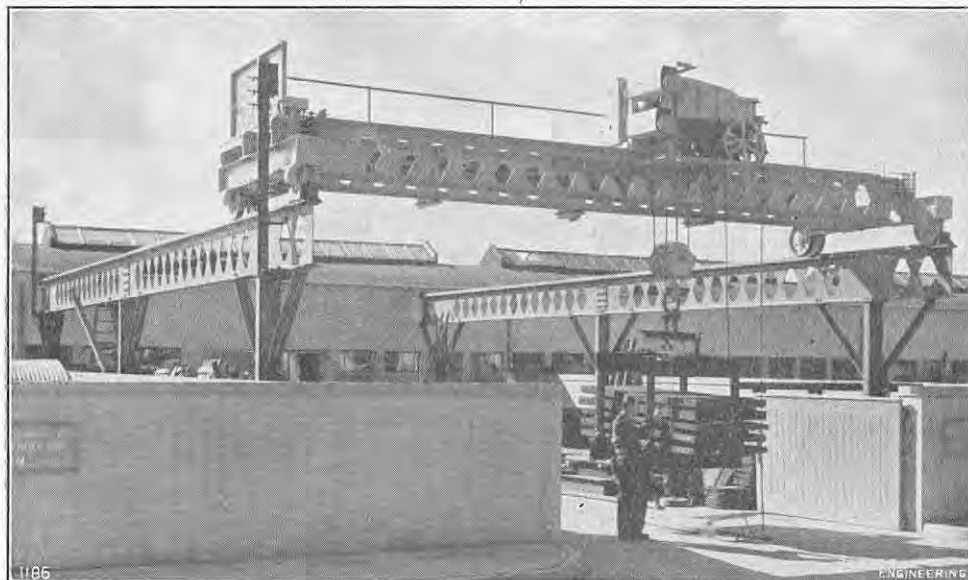
Professor E. V. Telfer thought that the British members who had read the paper must have been a little surprised by the contents, in view of the

title; it appeared that, in choosing the words "principal characteristics," the translator had imported into the English version a meaning entirely different from that usually accepted as the meaning of the words in Italian. He was sure that the author intended to discuss the principal form coefficients of ships, and not the principal characteristics of design; therefore, it might be better if the title were changed, so that future students would not be misled by the English title of the paper. He was rather surprised, too, that the author was using a displacement-length coefficient which went back to A. C. Kirk, who presented in 1893, to the North-East Coast Institution of Engineers and Shipbuilders, an interesting set of papers dealing with ship resistance. That particular displacement-length coefficient was then adopted by Taylor and had been used by the American tank consistently, ever since. In the reading of Italian literature on the subject over many years, however, he had been impressed by the way in which Italian naval architects always used the Froude constants, and thought that much of the author's work would have been greatly simplified if he had used the Froude M value instead of the displacement-length value, which was an inverted form of coefficient which led to reversed thinking. He thought that the inverted presentation had led the author to quite unnecessary difficulties in arranging his statistical matter. About the author's treatment of the wetted surface, using the Denny formula: that particular formula was given by Mumford in 1892 before the Institution of Naval Architects. Mumford started by analysing a systematic series of models to deduce a correction in the Kirk coefficient, and he eventually found the value of 1.7. Nearly 30 years ago, Professor Telfer was investigating Mumford's work, and showed that the Mumford formula could be generalised. The point he made was that the 1.7 was not a constant, but depended on the value for the block coefficient; and as Professor Servello had derived a certain line of argument depending on the ratio of the side area to the bottom area, his argument required qualification as between various block coefficients. The wetted surface was always a minimum when the side area equalled the bottom area, and he would like him to consider what effect on his own conclusions that particular work of his might have.

Mr. V. G. Shepherd, who was unable to attend the meeting because of his official duties as Director of Naval Construction, British Admiralty, made a written contribution to the discussion, which was read by Mr. R. W. L. Gawn. Mr. Shepherd considered the paper to be instructive in giving some idea of the broad trend of change of the principal dimensions of ships of different classes, in relation to the displacement and full speed. The spots for individual ships on the various diagrams, he observed, were generally scattered over a wide field, and, while that did not detract from the general interest, it emphasised that the designer could not expect any real guidance from the statistics in the paper when deciding upon the leading dimensions of a new ship. The author mentioned that individual ships had special requirements, but there were certain fundamental aspects which must be considered. For example, the paper dealt with changes of length relative to full speed and displacement, which were acceptable for merchant ships; but endurance at cruising speed was important for warships, and that requirement was reflected in the design characteristics. Moreover, the design was governed by the space and weight of machinery, armament, equipment and accommodation, which involved much compromise. Strength considerations also played a part, though that had been neglected by the author. Manoeuvring and seaworthiness were qualities the importance of which, in warships, did not appear to have been adequately conceded in the paper. The author's diagrams indicated a wide divergence of beam proportion. One of the features of ships was the growth of relative beam. It would be of interest if he could indicate whether the chronological trend towards wider ships was supported by his analysis. His Fig. 7 was unique in that it was the only diagram in the paper in which the spots for individual ships were close to a mean curve. That

10-TON TRAVELLING CRANE FOR NEW ZEALAND.

VAUGHAN LIFT ENGINEERING, LIMITED, CRAWLEY.



was a tribute to the reasonable validity of approximate formulæ for the area of the wetted surface of a ship. The parameters on that diagram were the significant terms of R. E. Froude's simple and useful expression for the wetted surface.

Mr. J. A. Milne, C.B.E., observed that the author used a mixture of metres and knots in his $\frac{V}{\sqrt{L}}$ proportions, and suggested that he should adhere either to metres or to knots and feet; a $\frac{V}{\sqrt{L}}$ superior

to 3.5 was rather frightening. He endorsed what Professor Telfer had said about the English title of the paper, and suggested that it might be altered to read "Principal Characteristics of Warship Hull Form."

Professor Servello, in his reply, said that he did not presume to claim that the method put forward in his paper was the only way to prepare the design of a warship. He wanted merely to correct the data and to find a way to prepare the design of a ship. When the designer had found the dimensions by that method, he had not achieved the perfect design; he had still to study and compromise on all the elements which entered into the design of a warship. The method, however, did give him a starting point.

(To be continued.)

RECRUITMENT OF STEELWORKS STAFF.—A publication concerned with the recruitment and training of senior staff has been issued by the United Steel Companies, Ltd., 17, Westbourne-road, Sheffield, 10. In it are set out the qualifications required by the firm, the sources of recruitment, the methods of selection of personnel, their training and remuneration, etc. Several photographs of works plant and scenes are reproduced. Inquiries concerning training, and applications for apprenticeship, should be addressed to the chief education officer of the firm at the address given above.

THE PRODUCTION OF TUBES BY ELECTRIC RESISTANCE WELDING.—Among the latest 16-mm. and 35-mm. films made by Ace Distributors Ltd. for Messrs. Stewarts and Lloyds, Ltd., is one illustrating their "E.R.W." process for producing tubes by electric resistance welding. This process, which was fully described in *ENGINEERING* on page 65, *ante*, consists of forming cold-rolled steel strip into a cylinder and then welding the abutting edges by passing alternating current at frequencies up to 500 cycles through them. The film shows the process in detail in an informative manner and ends by indicating various uses of the tubes thus produced. The films are available on loan, without charge, to approved borrowers, and application for them should be made to the nearest branch office of Messrs. Stewarts and Lloyds, or, in the case of overseas borrowers, to the firm's export department, 41, Oswald-street, Glasgow, C.I.

10-TON OVERHEAD TRAVELLING CRANE FOR NEW ZEALAND.

THE 10-ton overhead travelling crane shown in the accompanying illustration is one of two which have been made by Messrs. Vaughan Lift Engineering, Limited, Crawley, Sussex, for use in the storage sheds of the Roxborough power station in New Zealand, to the design of Mr. R. J. Harvey, M.I.C.E., the Government consulting engineer. As can be seen in the illustration, the supporting girders and the cross beams of these cranes are of the Appleby-Frodingham "Castellated" type; they were supplied by the United Steel Structural Company, Limited, Scunthorpe. They are formed by making a zig-zag cut, using an oxy-acetylene burner, down the web of a standard rolled-steel joist and welding together the crests of the resulting "castellations." In this way, the depth of the beam is increased by 50 per cent. without increasing the weight, so that a comparatively light section can be used over long spans, in this case 30 ft.

The load can be raised through a height of 18 ft. at a speed of 16 ft. per minute by a 15-h.p. slip-ring crane-rated motor, manufactured by Brook Motors, Limited, Huddersfield, and driving through triple spur and reduction gearing. The crane can be travelled at a speed of 75 ft. per minute by a 4-h.p. slip-ring motor and moved transversely by the manual operation of a chain, on which a pull of about 7 lb. is necessary. These are the first overhead travelling cranes to be exported from the new town of Crawley.

THE LATE MR. F. W. YOULDON.—It is with much regret that we record the death, on December 7, at his home in Crawley, Sussex, of Mr. Frederick William Youldon, a former superintendent engineer of the Anglo-Saxon Petroleum Company. Mr. Youldon, who retired from the company's service in 1944, served his apprenticeship to engineering with Fletcher, Son and Fearnall, Ltd., Limehouse, and served for many years at sea before being appointed an assistant superintendent of the company with whom he spent the rest of his career. He was a member of the Institute of Marine Engineers and served for various periods on the Council before becoming chairman in 1940. He was elected a vice-president in 1942.

THE BARNSTAPLE STATION OF THE BRITISH BROADCASTING CORPORATION.—The new permanent transmitting station of the British Broadcasting Corporation at Fremington, between Barnstaple and Bideford, took over the West of England Home Service on Thursday, December 11. The equipment comprises two Marconi transmitters, working in parallel to give an output of 1½ kW, which will be switched on and off automatically by a time switch. The station is receiving its programmes over land lines from Bristol and these, as well as the radiated programmes, will be automatically monitored.

STRUCTURAL BEHAVIOUR OF MARINE-ENGINE SEATINGS.

VARIOUS references have been made in the *Transactions* of professional institutions, and in these columns, to the series of full-scale static bending tests carried out by the Admiralty Ship Welding Committee on the dry-cargo ships *Clan Alpine* and *Ocean Vulcan*, the former a riveted ship and the latter welded. While those tests were in progress, the British Shipbuilding Research Association took the opportunity to investigate, in the *Ocean Vulcan*, the structural behaviour of the main-engine bedplate and engine seatings. The results were presented in a paper entitled "The Structural Behaviour of the Main Engine Seatings and Bedplate in a Cargo Ship under Static Bending Tests," delivered on November 14 to the North-East Coast Institution of Engineers and Shipbuilders by Mr. A. J. Johnson, B.Sc.(Eng.), and Dr. J. E. Richards, Wh.Sc.

The bedplate was of the conventional type, as used for many years with reciprocating marine steam engines, consisting of three cast-iron sections bolted together with fitted bolts to form a continuous girder, and mounted directly on the tank top. Each section had two integrally-cast cross-girders, recessed to take the main bearings. The bedplate was secured to the seating by 90 1½-in. non-fitted bolts, with a supporting chock, 1½ in. thick, in way of each bolt. Dial gauges were used to measure average deflections over large distances, and strain gauges (some of the electric resistance type and others of the acoustic type) for shorter lengths and for greater detail. To measure the vertical deflections of the bedplate, dial gauges, attached to a longitudinal "dial-gauge beam" (a steel channel bar, supported at its ends), were arranged to bear vertically on each of the six keep-plates. Longitudinal deflections were measured by dial-gauge distance bars—steel rods, ½ in. in diameter, with a dial gauge attached to one end, located by steel strip springs. To indicate any separation between the bedplate and the tank top, five dial gauges were secured to the lower flange of the bedplate, with their stems bearing vertically on glass pads, cemented to the tank top.

To show the strain distribution through the bedplate girders, Maihak acoustic strain gauges, with a base length of 5 cm., were attached to the bedplate by mild-steel clips on welded studs. The majority were arranged in two longitudinal rows, one along the centre of the top flange and one along the outer wall, as close as possible to the bottom flange. Gauges were arranged to span each of the bolted joints. Similar gauges were attached to the sides of the cast-iron columns of the engine, as near to the bases as they could be placed, to measure the axial and bending strains in the columns. Electric resistance strain gauges of the American S.R.4 type, of 120 ohms resistance, were attached to the bedplate as a check on the readings obtained by other means. A second dial-gauge beam was placed longitudinally on the starboard seating plate, about a foot away from the bedplate, with dial gauges on it in positions corresponding to those on the beam above the bedplate. Eight Maihak gauges were attached to the tank-top plating, together with two long-base gauges (of 100 in. gauge length) to give average strain values.

The tests showed that the bedplate and its seating behaved as a structural entity. The vertical deflections over the length of the bedplate were about twice those estimated on the normal bending of the ship girder over the same length, the additional deflections being due to eccentric loads caused by the discontinuous nature of the double-bottom structure under the engine. At the higher hogging moments experienced, the vertical deflections of the bedplate increased rapidly with increase of bending moment. The cylinder block and the columns were found to have only a small effect on the deflections of the bedplate. The average longitudinal deflections and strains in the bedplate and tank top agreed fairly well with calculations based upon ordinary bending of the ship girder, but it was found that local stresses and strains might differ widely from the average values.

THE SMITHFIELD SHOW AND AGRICULTURAL MACHINERY EXHIBITION.

(Continued from page 725.)

"PLATYPUS" TRACTOR.

A SURPRISING feature of the Smithfield Show and Agricultural Machinery Exhibition, which closes tonight, after having been open since Monday, December 8, is the number of new machines on show for the first time. Practically all the exhibits on the stand of Rotary Hoes, Limited, East Horndon, Essex, for example, are entirely new and include a narrow-width crawler tractor, a trench-digger and pipe-layer, a trailing rotary hoe, a sprayer attachment for their Bantam machine, and a vaporising-oil version of their "Gem" Rotavator. Outstanding among these is the new crawler tractor; this is illustrated in Figs. 7 and 8, on page 760, where it is shown at work in South Africa. It is manufactured by the Platypus Tractor Company, Limited, Basildon, Essex, and is distributed by Rotary Hoes, Limited, who have designed a special hoe for use in conjunction with the machine. Known as the Platypus 30, the new tractor has been designed for working in row-crops, such as sugar cane, coffee, vines, hops, raspberries, etc., but is equally suitable for general-purpose use on large market gardens. It is driven by a Perkins P4 Diesel engine or a standard petrol engine, the tractor on view being fitted with the Perkins engine; this develops 30 brake horse-power on the one-hour rating. From the flywheel, engine torque is transmitted by a 12-in. single-plate clutch to a six-speed gearbox, the clutch being controlled by a pedal situated to the left of the driver. The gearbox is bolted to the engine flywheel housing and is arranged to give three separate speeds in two ratios, that is, in high gear and low gear, the road speed varying from 0.8 miles an hour to 5.1 miles an hour. The gearbox holds 40 pints of oil, which, in addition to lubricating the gearwheels, etc., also serves the hydraulic system, which is fed by a separate gear-type pump. The drive is transmitted from the gearbox to a controlled differential of the epicyclic type designed so that torque is transmitted to both tracks during turns, the differential incorporating the steering-brake drums. Final drive to the track sprockets is through spur reduction gearing, each track sprocket being splined to a tapered axle carried by twin ball bearings.

The standard distance between track centres is 31 in. and the width over the tracks is 39 in. Cast-steel track plates are employed and these have a width of 8 in., the ground pressure being 4.7 lb. per square inch. The weight of the tractor is transferred to the track frames through a transverse axle at the rear and through two leaf springs at the front. There are three bottom rollers to each track frame and they are fitted with bronze bushes. The front idlers are spring-loaded and free to recoil against shock loadings, adjustment of the track tension being obtained by varying the position of the idlers in the normal manner. Steering, as previously indicated, is effected by braking the tracks and the minimum turning radius measured to the centre of the tractor is 39 in. The weight of the complete machine is 4,940 lb., the overall length 91 in., the width 41½ in., and the height 54 in.

As previously mentioned, a special rotary hoe has been developed by Rotary Hoes, Limited, for use with the Platypus tractor. Two types are available, namely, the "D" type with widths of cut of 40 in., 50 in. and 60 in., and the "F" type with a width of cut of 38½ in. For the three "D"-type machines, the depth of cut is 6 in., but for the "F"-type machine this can be increased to a maximum of 9 in., the actual cut possible depending, of course, on soil conditions. In each case, the design of the implement is similar, the drive being taken from the tractor gearbox and transmitted to the rotor of the hoe through a roller chain. The rotor is fitted with a dry-type friction safety clutch which embodies two discs each 10 in. in diameter and ⅝ in. thick. This clutch reduces the risk of damaging the working parts of the

EXHIBITS AT THE SMITHFIELD SHOW.



FIG. 6. FULL TRACK EQUIPMENT FOR FERGUSON TRACTOR; TRACPAK LTD.

Rotavator when operating on stony or stumpy ground. The drive to the Rotavator is controlled by a two-speed pre-selector dog clutch controlled from the driver's seat and the depth of working is adjusted by a wheel.

TRAILING ROTARY HOE.

The trailing rotary hoe introduced by Rotary Hoes, Limited, at Smithfield is illustrated in Fig. 9, on page 760. It is suitable for use with any tractor of up to 35 h.p., provided it is fitted with a rear power take-off, and it is available in two widths, namely, 5 ft. and 6 ft. As indicated, it is driven directly from the tractor rear power take-off, the power being transmitted through a universal coupling and extension shaft to a bevel gear arranged to drive a jackshaft which, in turn, is connected to the rotor through a roller chain. All shafts are fitted with ball bearings, and all bearings, transmission parts, etc., are enclosed in dust-proof casings and operate in oil baths. A mechanical lift is supplied as standard but a hydraulic ram suitable for connecting to the tractor hydraulic system can be supplied. In accordance with the maker's usual practice, the rotor is fitted with a disc-type safety clutch so as to minimise the possibility of damage due to striking hidden obstacles. The length of the unit is 138 in., the width 86 in., and the height, lifted, 52 in. The weight is 14½ cwt. A larger model is available and in this case the working widths are 6 ft. and 8 ft.

TRENCH-DIGGING AND PIPE-LAYING MACHINE.

The trench-digging and pipe-laying machine being shown by Rotary Hoes, Limited, is illustrated in Fig. 10, on page 760. This view, however, shows the trench-digging element only, the pipe-laying attachment not being shown in the illustration for the sake of clarity. The trench digger is an improved version of the Roteho machine produced in limited numbers by Rotary Hoes during the war. It has been designed to cut drainage trenches and lay tiles in one operation and is arranged for fitting to the new Fordson Major Diesel tractor, with which it is supplied as a complete unit. As will be seen from the illustration, it is mounted at the rear end of the tractor and the design is such that it can be raised and lowered by a special hydraulic ram, connected with the tractor hydraulic system, or a winch and cable, the latter being used also to support the unit in the elevated position during

transport. The digging unit consists of a large disc or rotor set in the vertical plane, the periphery of which are attached twelve spade-type blades which are capable of digging to a maximum depth of 3 ft. 6 in. with a width of 9 in. Loose earth left behind by the blades is collected by a scoop-shaped scraper blade which can be adjusted to suit trenches of varying depth. The spoil is deposited beside the trench and is formed into a ridge by an adjustable mouldboard, the sole plate of which acts as the depth control. Top and bottom scrapers are provided to remove the soil from the rotor and a further scraper keeps the rotor face clean.

The rotor is driven from the rear power take-off of the tractor, the transmission group comprising a small shaft, a bevel-gear assembly, a heavy roller chain and spur reduction gearing to the rotor, the spindle of which is supported by heavy ball bearings. A grading system is provided by sighting bars used on the boring-rod system, and to enable the operator to make best use of these provision has been made at the rear of the machine for remote control of the steering, engine clutch and quick-action depth control of the rotor. The tile layer is mounted on the scraper blade and requires the services of a second operator. It consists of a chute down which the pipes slide, the forward end of the base sweeping any small deposits of earth remaining in the trench to the sides. Cheek plates prevent these deposits falling back into the trench until the tiles are laid and the base is shaped so that it forms a groove in which the pipes are deposited. A cast-iron roller is arranged to pass over the pipes as they are laid and thus ensure even bedding down. To give improved traction, the rear wheels of the tractor are fitted with Rotapeds which also reduce the ground pressure. Special front wheels made from cast iron are fitted so as to improve the balance and the steering characteristics, and an additional gearbox built into the tractor transmission assembly gives a reduction of 22 to 1. This gear, however, can be disengaged thus enabling the normal gears to be used when required.

TRACK-LAYING CONVERSION SET FOR FERGUSON TRACTORS.

Tracpak Limited, York-road, Seacroft, Leeds, are showing an interesting conversion set for converting a Ferguson wheeled tractor into a full track-laying tractor. A Ferguson tractor equipped

THERMAL-PROTECTION RELAYS FOR ELECTRIC MOTORS.

CHAMBERLAIN AND HOOKHAM, LIMITED, BIRMINGHAM.

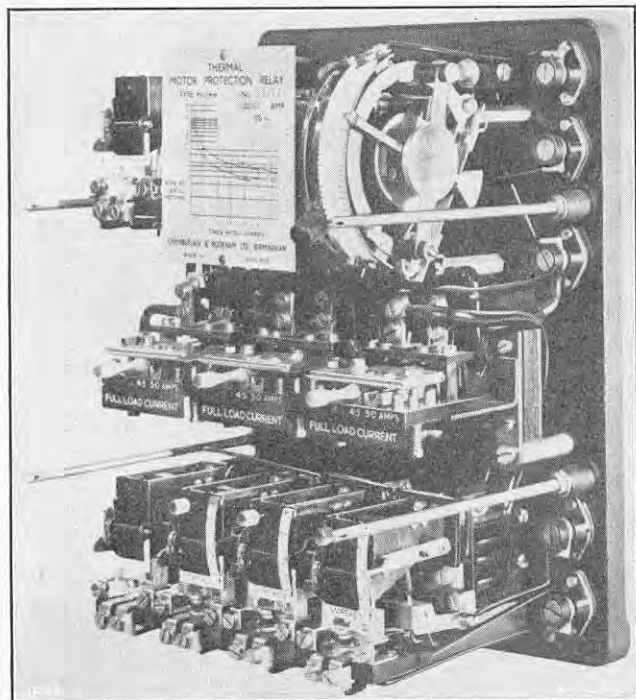


FIG. 1.

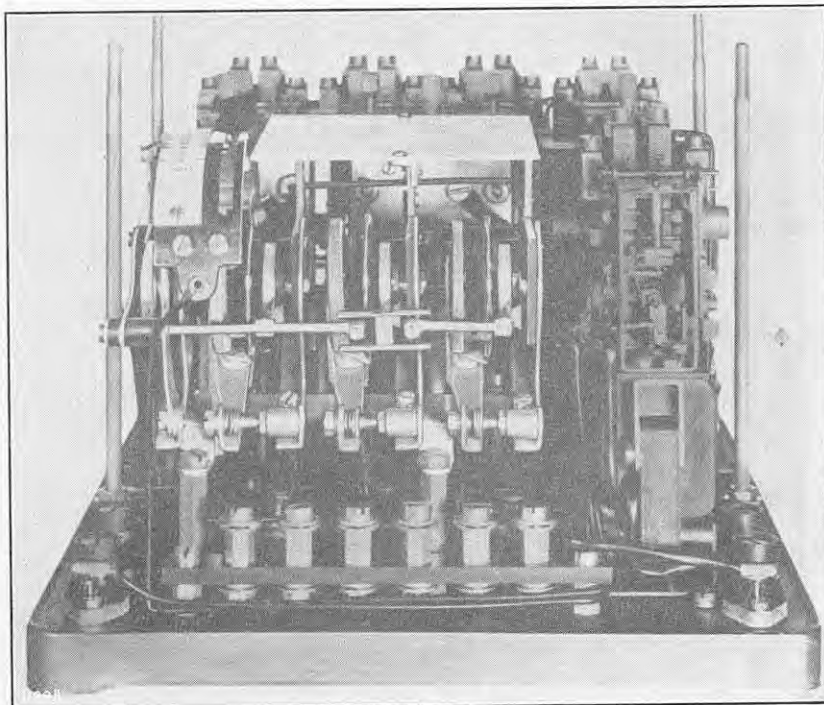
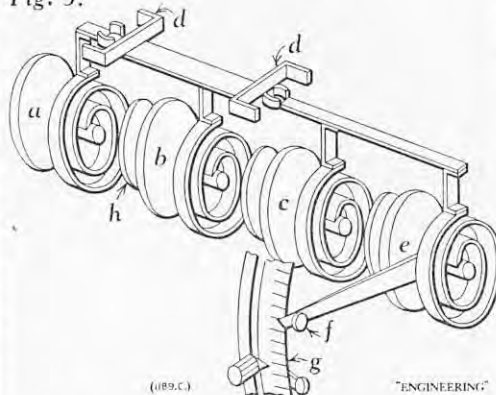


FIG. 2.

with this gear is illustrated in Fig. 6, opposite, from which it will be seen that the conversion adds very little to the overall dimensions of the tractor. Briefly, the conversion is carried out by replacing the rear wheels with open track-driving sprockets, the teeth of which mesh with the track. There is, of course, a pair of track frames and each incorporates three pairs of bottom idler rollers and a front idler held in position by a recoil spring. The two track frames are joined by a cross beam situated below the driving seat of the tractor and each frame is stabilised by a longitudinal beam, joined to the cross beam at the rear and to the tractor front axle at the front. A three-point suspension system is used, with the single point at the front in accordance with usual practice, and the three points of attachment are each fitted with a resilient bush. Each track plate is provided with a tooth on its inner face which engages with the open driving sprocket, and the track pins are lubricated from sealed oil wells formed integrally with the track plates. Steering is accomplished through brakes and the tractor differential, the system being operated by the tractor steering wheel, but the pedal-operated brake control is retained for parking purposes. The track plates are 10 in. wide, the track gauge 48 in., and the length of track in contact with the ground on a firm surface, 38 in. The overall dimensions of the tractor with the tracks fitted are: length, 9 ft. 5 in.; width, 6 ft. 4 in.; and height, to the top of the steering wheel, 4 ft. 6 in. The total weight of the tractor, including the operator, is 4,860 lb. It is claimed by the makers of the tracks that it takes 75 minutes to install the conversion set and under an hour to refit the wheels. All existing mounted implements can be used when the tracks are fitted and the maximum speed at rated engine speed is 6.72 miles an hour.

(To be continued.)

Fig. 3.



THERMAL-PROTECTION RELAYS FOR ELECTRIC MOTORS.

THE protection of induction motors against prolonged overloads by purely electrical methods is not altogether simple, because when they are started against a high inertia load the current rush may open the circuit-breaker. This difficulty, however, can be overcome by utilising the thermal capacity of the motor, as has been done in three types of relay recently developed by Messrs. Chamberlain and Hookham, Limited, Birmingham.

The first of these relays, which is illustrated in Fig. 1 with the cover removed, has been designed to protect three-phase star-delta-connected induction motors against overload and "single phasing" so long as the starting current does not exceed seven times the normal full-load current. It consists of three bimetal spirals, which are illustrated in Fig. 2, above, and the arrangement of which is shown at *a*, *b* and *c*, in Fig. 3. These spirals are fixed at their centres and are heated by three metal grids *h*, which carry currents proportional to the three line currents. The deflection of each spiral bears a direct relationship to the current in its associated heater and to the ambient temperature. On the other hand, the relative movement of the free ends of the spiral is a function solely of the difference between the currents flowing in the three motor circuits. As will be seen, the free end of the central spiral *b* terminates in two forked contacts *d*, the members of which enclose two single contacts which are secured to the other two spirals

a and *c*. The prongs of each fork are spaced so that a difference of 12 per cent. between the currents in the adjacent elements will cause the appropriate single contact to be engaged as the strip expands. The result is that the tripping circuit of the breaker will be closed and the indicator described below will be operated. Thus any phase unbalance of 12 per cent. at full load will operate the protection device.

The relay has a fourth bimetal spiral *e*, but as this is not provided with a heater, it is sensitive only to changes in the ambient temperature. The outer end of this spiral is attached to the free end of one of the heated spirals and its inner end, which is free to turn, to a contact at the end of the arm *f*. The movement of this contact depends solely on the heat supplied to the adjacent heated spiral. The arm moves over a scale *g*, which is calibrated in percentages of full load and is provided with a contact so arranged that it engages with the arm at any pre-determined line current between 50 and 150 per cent. of normal load.

The spirals, which are heat-aged during manufacture and are gold-plated to prevent any change in the surface texture, are calibrated individually. Groups of four with the same constants are then selected for use in each unit. Indicators of the attracted-armature pattern can be connected either in series or in parallel with the trip coil and incorporate a flap which normally covers a plate of the same size. This plate is, however, exposed when the flap is rotated through 180 deg. about one edge, so that its reverse side is exposed.

The second type of relay operates on the same principles as that just described, except that each heater is supplied from a transformer which can be saturated and the time-current curve correspondingly modified. The starting time of the motor is also increased. Heavy currents can be accepted by this type of relay, since the output current is lower in proportion to the input current than in the first pattern. The third model is of similar design to the second, except that it incorporates three instantaneous relays, each of which is connected in series with a saturable transformer. The instantaneous element in this third relay is based on the tripping indicator described above and the settings can be adjusted so that the current at which they operate can be varied. The connections, too, can be arranged to include three over-current elements or two over-current elements and an earth-fault element.

ALMANACS AND CALENDARS.—We have received monthly tear-off wall calendars from the Ateliers de Constructions Électriques de Charleroi, Charleroi, Belgium; the D.P. Battery Co., Ltd., Bakewell, Derbyshire; and Goodwin Barsby and Co., Ltd., Leicester. The first-mentioned contains reproductions in colour of twelve paintings depicting aspects of various crafts and professions in bygone times. In each case, there is a photograph of a modern equivalent. Tear-off wall calendars having two months on each page have reached us from the K.L.M. Royal Dutch Airlines, 196, Sloane-street, London, S.W.1; and Davey, Paxman and Co., Ltd., Colchester.

NOTES FROM THE INDUSTRIAL CENTRES.

SCOTLAND.

PLANS FOR PASSENGER TRANSPORT IN GLASGOW.—The Clyde Valley Planning Advisory Committee have endorsed the main principles and proposals of the Inglis Report on passenger transport in Glasgow and district. They specifically support the proposals for the electrification of suburban railways in and around Glasgow. They have also expressed strong support for the plan to build a traffic tunnel under the river Clyde between Whiteinch and Linthouse, and recommend early representations to the Minister of Transport.

CLYDE NAVIGATION TRUST SCHEDULE RATES.—The Clyde Navigation Trustees, at a meeting in Glasgow on December 2, approved a recommendation by their general purposes committee that the 1929 schedule rates should be increased, on January 1, 1953, by 75 per cent. in place of the present increase of 50 per cent. applied in 1947. There would be excluded from the increase the rates for the Renfrew and Erskine ferries, which were raised in July, 1951, and for the graving docks, the rates for which went up in May of this year.

THE STEVENSON FAMILY AND LIGHTHOUSES.—The resignation of Mr. D. Alan Stevenson, the engineer of the Clyde Lighthouses Trust, which was intimated at the annual meeting in Glasgow on December 3, has severed a family connection of 160 years with the Trust and its predecessor, the Cumbrae Lighthouse Trust. The association of the Stevenson family with the development of the river Clyde and lighthouses goes back to 1792, when Mr. Stevenson's great-great-grandfather was engaged in establishing, on the Little Cumbrae, the oil and mirror lighthouse which replaced the coal beacon on the summit of the island.

THE LATE MR. J. C. WALLACE, M.C.—The death occurred in Glasgow on December 2 of Mr. John Cameron Wallace, M.C., M.A., Fellow of Emmanuel College, Cambridge, a founder director of Metal Industries, Ltd. He was also chairman of George Christie, Ltd. A native of Glasgow, Mr. Wallace took an engineering trip with first-class honours at Cambridge.

S.S. "SIR WILLIAM HIGH" FOR NIGERIA.—The Dundee-Tay ferry steamer Sir William High, built 28 years ago, has been sold to Ojakwo Transport, Ltd., Lagos, for 15,000l.—3,250l. less than the original cost. The vessel will be towed to Lagos, and from there she will travel 400 miles up the River Niger to Onitsha. The Sir William High is to be used to transport passengers and vehicles—mainly lorries carrying groundnuts—over the Niger.

FIRE AT GLASGOW COPPERSMITHS' WORKS.—An outbreak of fire on the premises of George Robertson & Son, Ltd., coppersmiths, Govan, Glasgow, on December 3, seriously damaged the sheet-metal section of the works and destroyed a quantity of machinery. Mr. Robert F. Miller, a director of the firm, said that the section would be out of use for some time, but work would be carried on in the brass and copper departments, although these were also affected.

CLEVELAND AND THE NORTHERN COUNTIES.

INSTITUTION OF MECHANICAL ENGINEERS.—At the annual dinner of the North-Eastern branch of the Institution of Mechanical Engineers, at Newcastle-on-Tyne, Sir George Wilfred Turner, Permanent Under-Secretary of State for War, said that the Newcastle-on-Tyne area contributed not only mechanical equipment for the Forces, but also a much valuable research and atomic-energy development. He urged the Institution to ensure that the equipment produced was properly used by helping to provide and maintain an adequate supply of technically-trained officers and men for the Services. Professor A. Burstall, head of the mechanical and marine-engineering department of King's College, Newcastle, said that the universities were alive to the need for the technical training of Service officers. Other speakers included Dr. C. I. C. Bosanquet, Rector of King's College; Sir D. Pye, President of the Institution of Mechanical Engineers; Mr. B. G. Robbins, secretary of the Institution; and Mr. W. H. Purdie, North-Eastern Branch chairman.

TYNE SHIPBUILDING.—The last launches have been arranged on the Tyne for this year, and provisional figures show that the output will be 26 vessels, including several barges, aggregating 194,000 gross tons, a

decrease of about 45,000 tons on last year and 7,000 tons below the total for 1950. The fall this year is attributed entirely to the slowing down in building due to the steel shortage. Launches in December will include the tanker Caltex Bahrain, under construction at the Hebburn yard of Hawthorn, Leslie & Co., Ltd., for Overseas Tankships (U.K.) Ltd., and due to enter the water on December 16; the motor cargo ship La Hacienda, being built at the Walker yard of Swan, Hunter, and Wigham Richardson, Ltd., for Buries Markes, Ltd., to be launched on December 17; the 13,000-ton tanker Saxonglen, being built by Vickers-Armstrongs Ltd., Walker, for Stavros S. Niarchos, to be launched on December 30; and a coaster of 1,200 tons and a barge, to be launched about the middle of the month at Willington Quay by Clelands (Successors), Ltd.

SEARCH FOR COAL AT SUNDERLAND.—National Coal Board engineers are attempting to prove the existence of extensive coal reserves at Wearmouth Colliery, Sunderland. Mr. H. E. Collins, the Durham divisional production director, has stated that it is hoped to prove the reserves, which there is good reason to believe exist. Until this is done it will not be possible to begin work on any reconstruction scheme at Wearmouth Colliery. Work is already in hand, however, to improve the ventilation, and a new fan and fan drift have been installed. The "A" pit shaft is to be deepened by 200 ft., from the Hutton Seam level to the Harvey Seam.

NEW RESERVOIR AT SCALING.—It is expected that work will begin next spring on a new reservoir, to have a capacity of 330,000,000 gallons, at Scaling, North Yorkshire, for the Cleveland Water Company. The work has been delayed for some time, owing to difficulty in getting Government permission to proceed.

RECONSTRUCTION AT BOLDON COLLIERY.—Work has commenced on a reconstruction scheme at Boldon Colliery, Co. Durham. This involves the deepening of two shafts by about 100 ft., and the introduction of Diesel locomotives and mine cars underground. When the work is completed all the coal mined at the colliery will be picked up on the main locomotive hauling level and the present rope system of haulage will be removed. The new mine cars will each carry between two and three tons, compared with half a ton carried by the small tubs now in use.

THE LATE MR. R. ROBINSON.—Mr. Rex Robinson, general manager of the Tyne and Wear Electrical Co., Ltd., of East Boldon, Co. Durham, has died at the age of 59. He had been with the firm for 20 years and was previously chief engineer at North Biddick Colliery, which is now closed.

IMPROVEMENTS AT HERRINGTON COLLIERY.—The National Coal Board have approved the installation of a new coal-washing plant at Herrington Colliery, near Sunderland. The plant will cost about 400,000l. and will deal with 250 tons of coal an hour. Work is already in hand at Herrington Colliery on underground improvements, including the introduction of locomotive haulage in place of rope haulage.

LANCASHIRE AND SOUTH YORKSHIRE.

ADDITIONAL PIG IRON.—The relighting, on December 5, of the No. 1 blast furnace at the Renishaw Ironworks, Derbyshire, after re-lining in record time, will provide much-needed pig iron in this district. The estimated annual output of the furnace is 50,000 tons. Mr. F. J. Stanier, chairman and managing director of the company, states that it is probably the last time that this furnace will be blown in, as, within two years, a new No. 1 furnace will be completed.

MANAGERS' TRAINING COURSE.—Sheffield industrialists have prompted Sheffield University to experiment in the training for management of selected men, already in industry, who have impressed their employers with their capacity. A trial residential course will be held from March 22 to March 31, 1953. If this is successful it will be followed by a two-year course of one day's attendance a week during the winter, with several residential periods of one to two weeks for more intensive work. The group of chosen students will number about 24.

DONCASTER EMPLOYEES ON SHORT TIME.—Short-time working has been instituted at the Doncaster works of Briggs Motor Bodies, Ltd., affecting about 600 of the 1,000 employees. A four-day week is being worked, and certain departments will be operating for 34 hours a week only. It is understood that re-tooling is taking place in certain sections, and that this may be connected with the production of aircraft parts.

CHRISTMAS BONUS AT A SHEFFIELD WORKS.—It is announced by Sir Harold West, managing director of Newton, Chambers & Co. Ltd., that, in view of the exceptionally good trading results this year, the Board have decided again to pay each employee, at Christmas, a profit-sharing bonus equal to his average week's earnings. There are 4,000 employees, to whom the firm will distribute more than 25,000l.

THE MIDLANDS.

MOTOR-CAR EXPORTS TO JAPAN.—The Austin Motor Co., Ltd., Longbridge, Birmingham, and the Nissan Motor Co., Yokohama, Japan, have entered into an agreement covering the import into Japan of 2,000 Austin A40 motor cars a year. The vehicles will be exported from this country in the fully knocked-down condition, and will be assembled by the Japanese company. Distribution of the cars in Japan will be handled jointly by the Nissan Co. and the Nisshin Automobile Co. of Tokio, who have been Austin distributors for many years.

MINING SUBSIDENCE IN HOUSING ESTATE.—Because subsidence has caused cracks to appear in the walls of four houses in an estate belonging to the Urban District Council of Willenhall, Staffordshire, the Council are being asked to authorise the sinking of exploratory boreholes over the whole estate. The land had been very extensively worked for both coal and ironstone in the past, and some of the pits were abandoned so long ago that there is no record of their extent. Trial boreholes near the affected houses have shown that, at some time, the ground has been on fire.

EXPORTS OF MOTOR CYCLES.—The first arrangement for exporting motor cycles from this country in dismantled condition has been made by the Excelsior Motor Co., Ltd., King's-road, Birmingham, 11. The company are to send complete sets of parts to Ireland, where they will be assembled.

IRON AND STEEL SUPPLIES.—The pressure on the iron and steel trade is still heavy for all its products, though there has been some reduction in the demand for foundry pig-iron. The Midland re-rollers, after a lengthy period of short-time working due to a shortage of semi-finished steel, are now fully engaged, with more orders than they can execute. They expect the position to remain unchanged in Period 1 of next year, provided that the import of billets continues on the same scale. The major shortage continues to be in steel plates.

SOUTH-WEST ENGLAND AND SOUTH WALES.

FURTHER MODERNISATION IN TIN-PLATE INDUSTRY.—Mr. E. H. Lever, chairman of the Steel Company of Wales, Ltd., has announced that the Iron and Steel Corporation of Great Britain have approved further modernisation of the Welsh tin-plate industry at a cost of 40,000,000l. The principal features of the scheme would be a new five-stand cold-reduction mill, similar to that at Trostre, at Velindre, Llangyfelach, between Swansea and Llanelli. It is estimated that this new works would produce about 8,000,000 basic boxes of tin-plates a year. Other developments included in the programme are additional coke ovens, an extension of the sintering plant a fourth blast furnace, four open-hearth steel-melting furnaces, and rolling-mill equipment and ancillary plant, to be installed at the company's three installations at Port Talbot, namely, the Margam, Port Talbot, and Abbey Works.

WELSH COAL TRADE.—Coal production in South Wales, hit during the past month by the operation of the unofficial ban imposed at some collieries on Saturday work and overtime, should begin to improve. The approach of Christmas is partly responsible, but, during the past week, miners in the Rhondda Valley, where production in recent weeks has been down to about 50 per cent. of that for the corresponding period of last year, have unanimously decided to restore normal working. This, in spite of a meeting in Neath, which decided to ask all British miners to join in the ban. In November, owing to the operation of the ban, the South Wales output, at 1,828,000 tons, was 165,000 tons less than that for the corresponding month of 1951.

SHIP BREAKING AT MILFORD HAVEN.—The Italian steamer Ereole, of 5,000 tons, has arrived at Milford Haven, where she is to be broken up by Thos. W. Ward, Ltd. Built at Newcastle in 1907 for an Italian firm, she was sunk in 1944 when she struck a mine off Leghorn. She was salvaged in the following year and repaired, but her boilers have now been condemned. She will provide work for at least 50 men for the next six months. Five French trawlers are also to be broken up at Milford Haven by the firm.

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, December 15, 5.30 p.m., Victoria-embankment, W.C.2. Discussion on "How to Plan a Radio Project," opened by Dr. J. Thomson. **London Students' Section:** Tuesday, December 16, 7 p.m., Victoria-embankment, W.C.2. "Modern Transformer Construction," by Mr. A. J. W. Beckey. **Supply Section:** Wednesday, December 17, 5.30 p.m., Victoria-embankment, W.C.2. "Uses of Earthed Signal Conductors on Transmission Circuits," by Mr. W. Casson. **South Midland Centre:** Wednesday, December 17, 6.30 p.m., Birmingham and Midland Institute, Paradise-street, Birmingham. Joint Meeting with the **Midlands Association of the Institution of Civil Engineers** and the **Midland Branch of the Institution of Mechanical Engineers.** "Factors Affecting the Location, Design and Operation of a Modern Coal-Fired Power Station," by Mr. F. W. Lawton. (Admission by ticket only.)

INSTITUTION OF PRODUCTION ENGINEERS.—North-Eastern Section: Monday, December 15, 7 p.m., Neville Hall, Westgate-road, Newcastle-upon-Tyne. "The Development of Engineering Metrology," by Mr. F. H. Rolt. **Manchester Section:** Monday, December 15, 7.15 p.m., College of Technology, Sackville-street, Manchester, 1. "Materials Handling," by Mr. L. W. Bailey. **Luton Graduate Section:** Monday, December 15, 7.30 p.m., Luton Library, Williamson-street, Luton, Bedfordshire. Short Paper Competition. **Sheffield Graduate Section:** Tuesday, December 16, 6.30 p.m., Royal Victoria Station Hotel, Sheffield. Film Evening. **Birmingham Section:** Wednesday, December 17, 7 p.m., James Watt Memorial Institute, Birmingham. "The Advent of Automatic Transfer Machines and Mechanisms," by Mr. F. G. Woollard. **Coventry Section:** Wednesday, December 17, 7 p.m., Church House, Church-street, Rugby. "Electronics as an Aid to Productivity," by Mr. J. A. Stokes. **Western Section:** Wednesday, December 17, 7.15 p.m., Grand Hotel, Bristol. "New Techniques in Aircraft Production," by Mr. L. R. Benton. **Lincoln Section:** Wednesday, December 17, 7.30 p.m., Staff Canteen, Messrs Ruston and Hornsby, Ltd., Boultham Works, Lincoln. Film Display and Discussion on "Cutting Tools and Tungsten Carbide." **Southern Section:** Thursday, December 18, 7 p.m., Polygon Hotel, Southampton. "Some Interesting Set-Ups on Modern Machine Tools," by Mr. R. C. Fenton. **Glasgow Section:** Thursday, December 18, 7.30 p.m., 39, Elmbank-crescent, Glasgow, C.2. "Methods of Achieving More Economical Production," by Mr. E. V. Graham.

SHEFFIELD SOCIETY OF ENGINEERS AND METALLURGISTS.—Monday, December 15, 7.30 p.m., University Building, St. George's-square, Sheffield, 1. Annual Meeting. "Making It Work," by Professor W. A. Tuplin.

ASSOCIATION OF SUPERVISING ELECTRICAL ENGINEERS.—Bournemouth Branch: Monday, December 15, 8.15 p.m., Grand Hotel, Fivale-road, Bournemouth. Various short papers. **London:** Tuesday, December 16, 6.30 p.m., Lighting Service Bureau, 2, Savoy-hill, W.C.2. "Progress in Electric Lighting," by Mr. W. J. Jones. **Coventry Branch:** Wednesday, December 17, 7.15 p.m., Technical College, Coventry. "Some Electro-Mechanical Equipment for Machine Tools," by Mr. C. Haywood. **South-West London Branch:** Wednesday, December 17, 8.15 p.m., Guild House, 32, Worple-road, Wimbledon, S.W.19. "Responsibility of a Supervisor," by Mr. W. J. Spencer.

INSTITUTE OF REFRIGERATION.—Tuesday, December 16, 5.30 p.m., Institution of Mechanical Engineers, Storey's-gate, St. James's Park, S.W.1. "Factors Governing the Design of Chambers for Very Low Temperatures, Including Those Operating Under Cyclical Temperature Conditions," by Mr. S. H. W. Richards.

CHEMICAL ENGINEERING GROUP.—Tuesday, December 16, 5.30 p.m., Geological Society's Apartments, Burlington House, Piccadilly, W.1. Film Evening.

INSTITUTION OF CIVIL ENGINEERS.—Tuesday, December 16, 5.30 p.m., Great George-street, S.W.1. Unwin Memorial Lecture on "The Development and Functions of the Research Department of the Railway Executive," by Mr. T. M. Herbert.

ILLUMINATING ENGINEERING SOCIETY.—Cardiff Centre: Tuesday, December 16, 5.45 p.m., Offices of the South Wales Electricity Board, Cardiff. "Floodlighting," by Mr. R. O. Ackerley. **Gloucester and Cheltenham Centre:** Thursday, December 18, 6.15 p.m., Cadena Café, High-street, Cheltenham. "The Equipment and Functions of an Illumination Laboratory," by Mr. H. F. Stephenson.

INSTITUTION OF SANITARY ENGINEERS.—Tuesday, December 16, 6 p.m., Caxton Hall, Victoria-street, Westminster, S.W.1. "Introduction to Prestressed Concrete and Its Application to Sanitary Engineering," by Mr. R. C. Blyth.

INSTITUTION OF STRUCTURAL ENGINEERS.—Scottish Branch: Tuesday, December 16, 6 p.m., Ca'doro Restaurant, Glasgow. "Structural Design of Cranes," by Mr. J. H. Huntley. **Yorkshire Branch:** Wednesday, December 17, 6.30 p.m., The University, Leeds. "Unusual Design for a Large Constructional Shop," by Mr. F. R. Bullen.

INSTITUTION OF MECHANICAL ENGINEERS.—Midland Branch: Tuesday, December 16, 6.15 p.m., College of Technology and Arts, Eastlands, Rugby. Repetition of Presidential Address on "The Art of the Practical Engineer," by Sir David Pye, F.R.S. **Yorkshire Branch:** Wednesday, December 17, 6.30 p.m., Grand Hotel, Sheffield. "Economic Plant Sizes and Boiler-Set Groupings on the British Grid," by Mr. B. Donkin and Mr. P. H. Margen. **Southern Branch:** Wednesday, December 17, 7 p.m., The University, Southampton. "Powered Flying Controls: Some Design Considerations," by Mr. F. J. Bradbury and Mr. S. M. Parker. **Institution:** Friday, December 19, 5.30 p.m., Storey's-gate, St. James's Park, S.W.1. "Contemporary Methods of Watch Production," by Mr. R. A. Fell and Mr. P. Indermuhle. **AUTOMOBILE DIVISION.—Scottish Centre:** Monday, December 15, 7.30 p.m., 39, Elmbank-crescent, Glasgow, C.2. "Commercial Vehicles Problems: Their Investigation and Solution," by Mr. G. H. Lee. **North-Western Centre:** Tuesday, December 16, 7.15 p.m., Engineers' Club, Manchester. "Engineering Changes," by Mr. H. Drew. **Birmingham Centre:** Thursday, December 18, 6 p.m., James Watt Memorial Institute, Birmingham. Film Evening.

INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND.—Tuesday, December 16, 6.30 p.m., 39, Elmbank-crescent, Glasgow, C.2. "Textile Finishing Machines," by Mr. K. S. Laurie.

SHEFFIELD METALLURGICAL ASSOCIATION.—Methods of Analysis Group: Tuesday, December 16, 7 p.m., Grand Hotel, Sheffield. "Micro-Chemistry," by Mr. W. N. Nall.

INSTITUTE OF BRITISH FOUNDRYMEN.—East Anglian Section: Tuesday, December 16, 7 p.m., Public Library, Ipswich. Symposium on "Resin Core Binders." **North-East Scottish Section:** Wednesday, December 17, 7.30 p.m., Imperial Hotel, Keptie-street, Arbroath. "Training of Apprentices," by Mr. J. Mitchell.

ROYAL STATISTICAL SOCIETY.—Merseyside Industrial Applications Group: Tuesday, December 16, 7 p.m., Radiant House, Bold-street, Liverpool, 1. "Tolerances," by Professor G. A. Barnard. **North-Eastern Industrial Applications Group:** Wednesday, December 17, 7 p.m., 18, Louvain-place, Newcastle-upon-Tyne. "Economic Statistics," by Mr. E. D. McCallum.

ROYAL AERONAUTICAL SOCIETY.—Graduates' and Students' Section: Tuesday, December 16, 7.30 p.m., 4, Hamilton-place, W.1. "An Introduction to Aircraft Vibration," by Mr. D. J. Mead.

INCORPORATED PLANT ENGINEERS.—Hertfordshire Group: Tuesday, December 16, 7.30 p.m., Peahen Hotel, St. Albans. "Oil Firing, Including Oil Burners and Other Applications," by Mr. G. A. Foster. **Kent Branch:** Wednesday, December 17, 7 p.m., Bull Hotel, Rochester. "Planned Maintenance for the Plant Engineer," by Mr. F. L. Griffiths. **Blackburn Branch:** Thursday, December 18, 7.30 p.m., Chamber of Commerce, Richmond-terrace, Blackburn. Discussion on "Lubrication."

INSTITUTION OF LOCOMOTIVE ENGINEERS.—Wednesday, December 17, 5.30 p.m., Institution of Mechanical Engineers, Storey's-gate, St. James's Park, S.W.1. "Use of Rubber in Railway Engineering," by Mr. S. W. Marsh.

INSTITUTE OF FUEL.—Wednesday, December 17, 6 p.m., Royal Society of Arts, John Adam-street, W.C.2. (i) "Removal of Sulphur Oxides from Flue Gases," by Mr. R. L. Rees; (ii) "Recovery of Sulphur from Flue Gas, by Use of Ammonia," by Dr. S. R. Craxford and others; and (iii) "Concentration of Sulphur Dioxide in South-West London Air," by Mr. S. H. Richards.

INSTITUTION OF HEATING AND VENTILATING ENGINEERS.—Birmingham Branch: Wednesday, December 17, 6.30 p.m., Imperial Hotel, Birmingham. "Thermostatic Controls," by Mr. L. B. Rothwell.

INSTITUTION OF MINING AND METALLURGY.—Thursday, December 18, 5 p.m., Geological Society's Apartments, Burlington House, Piccadilly, W.1. (i) "A Standard Laboratory Procedure for the Evaluation of East African Graphite Ores," by Mr. J. H. Harris; (ii) "Experiments on Formation and Control of Magnetite During Copper-Smelting Operations," by Dr. B. C. Ellwood and Mr. T. A. Henderson; and (iii) "Shaft Pillars and Shaft Spaces," by Mr. G. Hildick-Smith.

CHEMICAL SOCIETY.—Thursday, December 18, 7.30 p.m., Burlington House, Piccadilly, W.1. Various papers for discussion.

JUNIOR INSTITUTION OF ENGINEERS.—Friday, December 19, 7 p.m., Townsend House, Greycoat-place, Westminster, S.W.1. "Some Everyday Problems of Running a Car," by Mr. E. E. Burrage.

PERSONAL.

SIR WALTER BENTON JONES, Bt., has been elected President of the British Tar Confederation, 9, Harley-street, London, W.1, for the year 1952-53. Mr. C. E. CAREY has been elected honorary treasurer, Mr. W. K. HUTCHISON, chairman of the executive board, and MAJOR A. G. SAUNDERS and Mr. R. H. E. THOMAS, O.B.E., vice-chairmen of the executive board.

MR. R. A. HARDING, the general manager of Macrome Ltd., Aldersley, Wolverhampton, has been appointed to the board. He joined the firm in 1945 and was made general manager in 1951.

MR. W. W. STEVENSON, Assoc.Met. (Sheffield), A.M.I.Chem.E., F.R.I.C., F.I.M., of the Central Research Department, Dorman, Long & Co. Ltd., Newport Ironworks, Middlesbrough, has been appointed chief metallurgist to Round Oak Steelworks, Ltd., Brierley Hill, Staffordshire.

MR. R. A. HACKING, O.B.E., M.Sc., F.I.M., has been appointed director of research of R.T.S.C. Laboratories, Aylesbury, the joint research organisation of Richard Thomas and Baldwins Ltd. and the Steel Company of Wales Ltd.

BULSTRODE TECHNICAL SERVICES LTD. and DR. M. A. PHILLIPS AND ASSOCIATES, 14, Western-road, Romford, Essex, both of which organisations are consulting chemists and chemical engineers, announce that they are now working together on a co-operative basis. DR. W. FRANCIS, M.Sc., F.R.I.C., F.Inst.F., has joined Dr. M. A. Phillips and Associates.

We are informed that MR. W. C. FAHIE, M.Sc., A.M.I.E.E., has relinquished his position as consultant to Tinsley Industrial Instruments, Ltd., North Circular-road, London, N.W.10.

MR. E. S. WADDINGTON, F.S.E., Assoc.I.E.E., of Philips Electrical Ltd., Century House, Shaftesbury-avenue, London, W.C.2, has been appointed the representative of the Sheet Metal Users' Technical Association on the British Standards Institution Technical Committee WEE/24, dealing with projection welding in mild steel. Mr. Waddington has also been re-elected vice-chairman of the B.E.A.M.A. arc-welding plant section.

MR. J. D. PROFUMO, O.B.E., M.P., Parliamentary Secretary to the Ministry of Civil Aviation, has appointed MR. W. A. PENN to be his private secretary.

DR. J. L. ASTON, M.A.(Cantab.), has relinquished his position on the staff of the County Technical College, Wednesbury, Staffordshire, to take up the appointment of lecturer in metallurgy at the Institute of Technology, Loughborough, Leicestershire.

MR. J. W. HILL, B.Sc., B.E., A.M.I.Mech.E., has been appointed design engineer with Imperial Chemical Industries of Australia and New Zealand Ltd., Melbourne.

MR. J. H. HUTCHINSON, has been appointed project engineer to the Hymatic Engineering Co. Ltd., Glover-street, Redditch, Worcestershire.

MR. OWEN L. HARRIES, a representative of shipping, has been appointed a member of the Transport Users' Consultative Committee for Wales. MR. W. W. F. SHEPHERD has been made chairman of the Transport Users' Consultative Committee for the North-Western Area.

ELLIOTT BROTHERS (LONDON) LTD., Century Works, Lewisham, London, S.E.13, have transferred their Birmingham branch office to larger and more modern premises at 181, Corporation-street, Birmingham, 4. (Telephone: Central 8313.) The new office, staffed by MR. A. H. ROBINSON, MR. H. J. JOHNSON and MR. G. F. THOMAS, is now the area sales, service and instrument-repair centre for the Midland counties.

A. C. MORRISON (ENGINEERS), LTD., Burton-on-the-Wolds, near Loughborough, have appointed SARDAR UTTAM SINGH DUGAL and Co., LTD., 11, Marina Arcade, New Delhi, to be their agents for N.W. India and Assam, and MR. JOSEPH MULLER, P.O. Box 243, Haifa, to be their agent in Israel.

DIXON HAWKESWORTH LTD., Middleton, Lancashire, have appointed BUCKTON LTD., Ashton-under-Lyne, to be the main distributors for all their plant in the United Kingdom and Eire.

SOUTHERN FORGE LTD., Langley, Buckinghamshire, one of the companies of the Almin Ltd. Group, Farnham Royal, Buckinghamshire, announce that MR. L. E. YOUNG, sales manager, has been appointed a director of the company.

THE FINLAY CONVEYOR CO., LTD., Transporter Bridge, Newport, Monmouthshire, have decided to change their name, as from January 1, 1953, to FINLAY ENGINEERING LTD. The telephone number, Newport 2210, is unaltered, but the telegraphic address is to become: "Finlay Newport Mon."

EXHIBITS AT THE SMITHFIELD SHOW.

(For Description, see Page 756.)



FIG. 7.

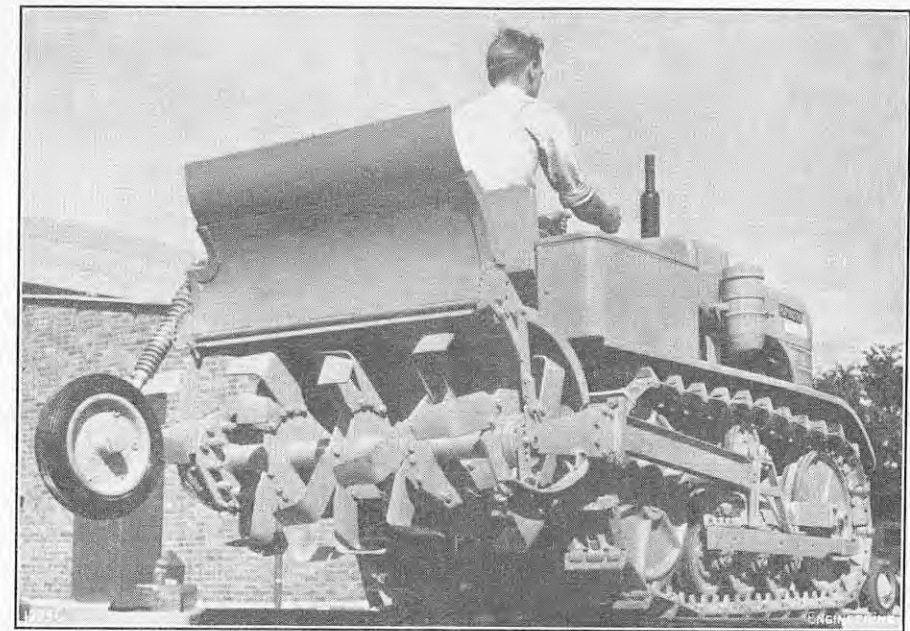


FIG. 8.

FIGS. 7 AND 8. TRACTOR FITTED WITH "ROTAVATOR" ATTACHMENT; PLATYPUS TRACTOR CO., LTD.



FIG. 9. TRAILING ROTARY HOE ; ROTARY HOES, LTD.

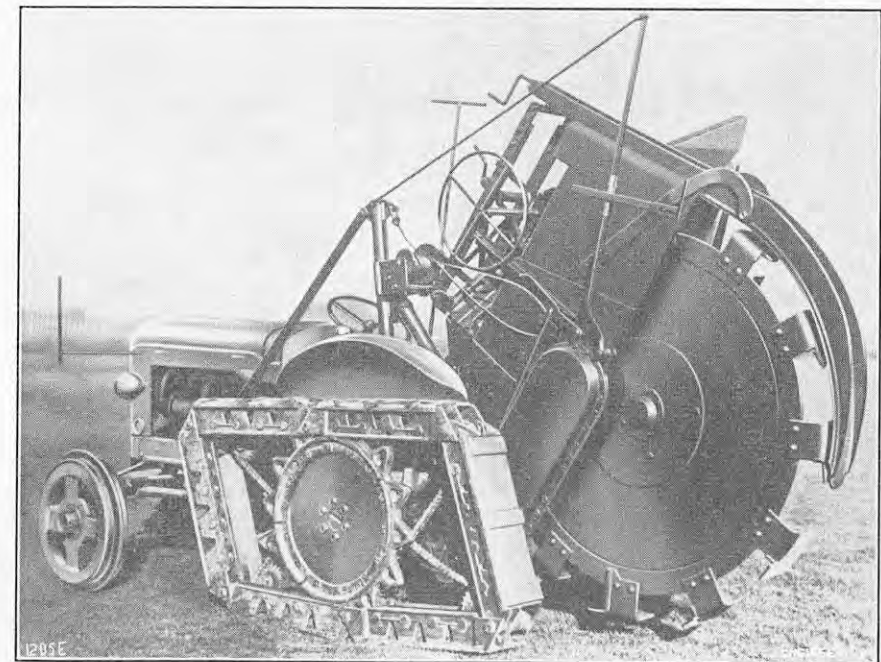


FIG. 10. TRENCH DIGGER ; ROTARY HOES, LTD.

ENGINEERING

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

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

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ENGINEERING, LESQUARE, LONDON.

Telephone Numbers:

TEMPLE BAR 3663 and 3664.

All editorial correspondence should be addressed to the Editor and all other correspondence to the Manager.

Accounts are payable to ENGINEERING Ltd. Cheques should be crossed "The National Provincial Bank, Limited, Charing Cross Branch." Post Office Orders should be made payable at Bedford Street, Strand, W.C.2.

SUBSCRIPTIONS.

ENGINEERING may be ordered from any newsagent in town or country and from railway book-stalls, or it can be supplied by the Publisher, post free, at the following rates, or twelve months, payable in advance:—

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For Canada	£5 5 0

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

ADVERTISEMENT RATES.

Terms for displayed advertisements can be obtained on application to the Manager. The pages are 12 in. deep and 9 in. wide, divisible into four columns 2½ in. wide. Serial advertisements will be inserted with all practicable regularity, but absolute regularity cannot be guaranteed.

The charge for advertisements classified under the headings of "Appointments Open," "Situations Wanted," "Tenders," etc., is 10s. for the first four lines or under, and 2s. 6d. per line up to one inch. The line averages six words and when 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; 12½ per cent. for thirteen; 25 per cent. for twenty-six; and 33½ per cent. for fifty-two insertions.

TIME FOR RECEIPT OF ADVERTISEMENTS.

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

"Copy" instructions and alterations to standing advertisements for display announcements must be received 14 days previous to the date of publication, otherwise it may be impossible to submit proofs for approval.

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

INDEX TO VOL. 173.

The Index to Vol. 173 of ENGINEERING (January-June, 1952) is now ready and will be sent to any reader, without charge and postage paid, on application being made to the Publisher. In order to reduce the consumption of paper, copies of the Index are being distributed only in response to such applications.

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PLATE.

Plate LVIII.—CONTINUOUS PRODUCTION OF SOLID STEEL RAILWAY WHEELS.

ENGINEERING

FRIDAY, DECEMBER 12, 1952.

VOL. 174.

No. 4533.

MACHINERY AND BOILER FAILURES.

THE many works engineers and others concerned with the running and maintenance of engines, boilers and electrical plant should welcome the reappearance of the series of technical reports published by the British Engine Boiler and Electrical Insurance Company. These valuable documents, the first of which appeared in 1922, were originally issued annually, but the intervention of the war resulted in the issue for the year 1938 not appearing until 1948. At that time it seemed possible that this 1938 report would be the last, as it was stated in it that "whether reports in similar form will be issued in future years remains doubtful." Fortunately, the doubt has been resolved in a favourable sense and a further report* has just appeared. Prefatory remarks in the new issue explain that it does not constitute the first of a new annual series. It is expected that, in the future, the average interval between publications will be about two years, the period depending on "the availability of suitable material."

This is an understandable and wise arrangement.

* Technical Report. New Series, Vol. I. British Engine Boiler and Electrical Insurance Co., Ltd., 24, Fennel-street, Manchester, 4. [Price 12s. 6d.]

These reports are not of the type in which an organisation gives, and is required to give, an annual account of its stewardship. The company are under no obligation to publish them. They are voluntary contributions which undoubtedly, in the words of the preface to this latest report, "play a part in advancing the standard of reliability of engineering plant." The fact that biennial publication, or possibly publication at even longer intervals, may delay dissemination of information about some failure and its lessons is, as a rule, of little importance.

Defective material, inexperienced heat treatment, unsound design, and ill-usage arising from carelessness or ignorance are causes of failure which, unfortunately, are likely to constitute permanent factors in engineering practice. It may be hoped that their incidence may diminish in the future; in as far as it does so some credit must be given to these informative reports. It has been remarked in connection with various classes of accidents, those on railways and the roads, for instance, that human failure is a more potent factor than material failure, but it is not certain that, in any direct sense, the same thing applies to the type of accident or failure with which this report is concerned. Indirectly, however, the human factor appears to play a prominent part in failures due to caustic cracking in steam boilers.

Caustic cracking, which is the subject of the longest section of the new report, is frequently referred to as "caustic embrittlement," which implies that the material affected has become embrittled. Actually, the original ductility is not impaired and consequently the term "caustic cracking" is to be preferred. The phenomenon takes the form of cracks, most commonly found in the riveted joints of boilers and occasionally at the attachments of fittings. It has been the subject of much metallurgical research and has been established as due to attack by caustic alkali. Sodium hydroxide acts on iron with the liberation of hydrogen, but the damage found in practice must have been caused by concentrations of alkali far greater than could be tolerated in boiler water. The report considers it to be definitely established that caustic cracking is due to boiler water "entering the cavities invariably present in riveted seams," leakage of water vapour to atmosphere then resulting in such concentration of the dissolved salts within the seams that the point is reached at which attack on the iron takes place. When seams which have failed are taken apart, strongly alkaline deposits are found, except in cases in which leakage of water from the seam has washed them away.

It is clear from this explanation that the composition of the boiler water is a factor in the matter; sodium carbonate, frequently present in feed water, is hydrolysed under the conditions prevailing inside a boiler to form sodium hydroxide, and sodium compounds are used in boiler-water conditioning. It is an important aspect of the matter that a very low concentration of sodium hydroxide will not necessarily ensure that no attack will take place; it may merely extend the time necessary to produce concentration in a seam. Although this consideration is not to be neglected, in the majority of cases investigated by the company the actual, or potential, sodium-hydroxide content has been found to be abnormally high.

This simple explanation of the cause of caustic cracking is a valuable working hypothesis, but the report does not pretend that it covers all that can be said on the matter; it is stated, in fact, that much further work will be necessary before the precise mechanism of the phenomenon is understood. This consideration, however, in no way lessens the value of the large amount of evidence amassed from the wide practical experience of the company. In the majority of cases of caustic cracking which have been investigated, there has been evidence of

unsatisfactory workmanship; burrs have not been removed from the edges of rivet holes; plates have not been properly bedded; rivet holes have been out of line and in some cases have been drifted; or excessive riveting pressure has been employed.

Caustic cracking is intergranular and may be induced by non-uniform stress distribution. Any of the types of poor workmanship listed above may result in both the formation of cavities in which alkali concentrations may build up and in non-uniform stress conditions. By no means all cases of cracking of boiler seams have a caustic origin and the report gives particulars of cracks in a circumferential shell seam of a Lancashire boiler which were traced to poor material and bad workmanship; the plates at the seam had been out of line and were deformed when they were pulled together by the rivets. In another Lancashire boiler, cracks between the rivet holes in the shell angle seam of the front end-plate were found to be due to excessive riveting pressure which had work-hardened the material in the neighbourhood of the rivets to such an extent that it could not stand up to the fluctuating bending stresses to which it was subjected in service. It is clearly important that caustic cracking should be recognised when it is present and the report gives a list of characteristic features which should form a valuable guide for boiler users. Two almost invariable symptoms are the intergranular patterns of the cracks and the presence of scintillating oxide deposits in the seam.

Although cases of boiler defects occupy a large part of the report, they do not monopolise it. The range covered is extensive and even includes accidents to cranes caused by wind pressure. Details of three cases are recorded in which derrick cranes and a sheer legs were blown over and wrecked. These are examples of human failure, as proper anchoring would have prevented them. There were examples of lack of foresight, but some cases are recorded in which mishaps could be traced directly to defective supervision. Three examples are mentioned of steam boilers fitted with automatic controls and serious damage occurred when they were left under automatic operation. Better supervision would have prevented the accidents: in one case accumulation of sediment in the float chamber of the low-water trip switch prevented it from operating. Among other examples recorded are two in which gas-heated bakers' steam-tube ovens were left after work was completed with the gas still burning, resulting in overheating and serious damage. In one case thermostatic control was fitted, but it had been disconnected.

Various cases of shaft failure are dealt with. In one, described in the report as "unusual," the shaft of a 12,500-kW turbine, which was neither inspected nor insured by the company, and was installed in 1931, seized in the high-pressure gland when running-up in 1932. The shaft was found to be bent and was straightened by local application of heat and external loading. In 1947, again when running-up, severe vibration occurred. The shaft was found to be slightly bent and was straightened by the same means. Somewhat similar trouble was experienced in 1950, and the shaft was again straightened in the same way. In 1951, after further vibration trouble, the shaft was removed for further straightening and gradually extended. By 1951, it covered about half the shaft and it is suggested that had it been straightened again and set to work a disastrous accident might have occurred. A warning is issued against straightening shafts in the manner adopted. With the class of material from which this shaft was made, the temperature of a zone heated above the lower critical range may fall, when the source of heat is removed, at a rate sufficient to amount to the equivalent of a local quench and cracking may result.

THE EVOLUTION OF ENGINEERING.

ANYONE who has worked under a senior who was always demanding the impossible will admit that it was a valuable experience, especially if he was submitted to it when he was young. He doubtless jibbed at the time, and he may even have suspected that his master was slightly mad, but in retrospect he realises that it brought out the best in him. His master, it is now clear, had more faith in his ability than he had himself, and if modern civilisation owes much to the discoverers and inventors, it also owes something to those who demanded results. This generation is mindful of Mr. Churchill's power of demanding action, but throughout history, and particularly in the past hundred years, the pace of progress has been quickened as much by the instigators as by the practitioners. To-day the scope for such fruitful partnerships is greater than it has ever been. There is a need, in engineering, not only for a wider vision of potential developments, but also for a deeper understanding of the principles and issues involved. A discussion of this subject was initiated this week by Dr. H. E. Merritt, M.B.E., when he presented a paper on "Research and the Engineering Process, with Particular Reference to the Automobile Industry," at a meeting in London of the Automobile Division of the Institution of Mechanical Engineers. The paper is also to be presented at a number of provincial centres, so the total discussion of it should serve as a valuable review of what mechanical engineers are striving after.

Dr. Merritt could hardly avoid the use of the word "research," but he was evidently thinking of a much wider view of engineering than is implied by a term which, as one speaker rather satirically suggested, evokes visions of "country-mansion" research stations. To him, everything and anything which aims at improving the practice of engineering is the subject for discussion, and the discussion is not to be restricted by the inevitable word "research." "There are," he said, "branches or derivatives of mechanical engineering which necessarily rest on a solid scientific foundation, and these are usually conducted in very large organisations which are adequately equipped for research. But for every one such organisation, there may be a hundred small concerns which have neither time nor money to devote to research, or else have no inclination to do so." They are being helped, in many cases, by the research association movement which, though it has made great strides, has still a long way to go. "It will go farther only as fast as the aim and purpose of a research association are understood and supported by the industry which it exists to serve." Enthusiasm for research, however, should not prevent criticism of particular projects. Much more is heard of the initiation of research than of its abandonment, though this week there has been a report that 22 members of the staff of the Building Research Station have received redundancy notices. The Institution of Professional Civil Servants have protested and the staff side of the departmental Whitley Council has asked the Lord President of the Council to receive a deputation.

The "engineering process" of the title of the paper denoted the sequence of collective activities which combine to produce a design that satisfies a new external requirement or produces some new and worthwhile result. The historical picture of it which Dr. Merritt sketched as a basis for discussion brought out the point that many engineers in the past, and even to-day, work out their designs by the light of mechanical aptitude. They can visualise the way in which mechanisms will behave and they have an intuitive sense of the character of materials. With many engineering products this approach can and does predominate. The

background of experience which it requires is provided by the works of the preceding generation, and a young engineer is successful in proportion as he has the ability to comprehend such works and advance them beyond the stage at which he finds them. The scope for the purely practical engineer, however, is being narrowed. In many cases, development can now only be furthered by applying scientific knowledge, either to point the way to changes in existing practice and design or to refine the raw idea of an engineer. It is here, at the confluence of science and commercial engineering, that some difficulties arise.

It is a question of smooth liaison between the research workers and the engineers, but that is not easy. It requires, as Dr. Merritt said, that the scientific method, or the "research attitude," should be understood beyond the ranks of research workers themselves. The scientific method is the method by which "accurate, organised knowledge is acquired," and engineers generally are trained in it, but not always sufficiently for them to be able to see a problem and express it in the way which scientists require. Conversely, scientists are not always good at expressing their results in a form which engineers can apply. A link between the two sides may be provided by the research associations—Dr. Merritt was concerned particularly with the Motor Industry Research Association—but there are still plenty of opportunities for fruitful collaboration, which can only be initiated by someone who takes the first step of posing the problem. "To know what is wanted," as Dr. Merritt expressed it, was equivalent to an acknowledgment of ignorance, which Socrates described as the beginning of wisdom.

To know what is wanted an engineer must either envisage a potential development—in design, production or any other facet of the engineering process—or he must become acquainted, perhaps accidentally, with a development elsewhere which he can apply to his own work. The two approaches are distinct. To envisage potential developments it is necessary to be for ever posing questions and not to take for granted anything in the established order. The longer an engineer has been on one type of work the harder it is for him to cultivate this habit, unless, of course, as with Leonardo da Vinci, it is his life-long habit. For lesser mortals, however, the problem is, as Dr. Merritt remarked, "to find the time to study all his problems with the care and thoroughness that they deserve—even the time to reflect upon the kind of information that might be available and the place from which it might be obtained."

An observant mind is also the means of becoming acquainted with developments which an engineer can apply to his own work, but for this approach wide reading, and possibly visits to other works, are indispensable. A technical information department and library are valuable for providing references to published literature, but they do not do away with the need for that random reading and observation which are the food of the creative imagination. Scientific and engineering developments are often the result of an intermingling of ideas which no one could foresee or develop logically; even the originator of a new development may be unable to account precisely for the manner in which his mind produced the idea. Though both research workers and engineers require minds that can function in this way, it is often necessary for one to develop what the other conceives, or for one to analyse what the other dimly comprehends. They can go far in this direction by their own efforts, if they will, but a third party—a manager or someone concerned directly with research—can often act as a catalyst. Faith may or may not move mountains in the civil engineering sense, but imagination and contemplation will certainly lead to developments in engineering.

NOTES.

THE INSTITUTION OF MECHANICAL ENGINEERS.

Two papers on metal-working were presented on Friday, December 5, to the Institution of Mechanical Engineers, at a meeting arranged in conjunction with the Applied Mechanics Group of the Institution, and the Industrial Administration and Engineering Production Group. They were on "An Experimental Investigation into the Redrawing of Cylindrical Shells," by Dr. S. Y. Chung, A.M.I.Mech.E., and Professor H. W. Swift, D.Sc. (Eng.), M.I.Mech.E., and "An Experimental Investigation of the Yielding of Strip between Smooth Dies," by Mr. A. B. Watts, B.Sc. (Eng.), S.I.Mech.E., and Professor Hugh Ford, D.Sc., M.I.Mech.E. The chair was taken by Dr. D. Clayton. The first-mentioned paper described a survey of the various methods of redrawing, applied to a first redrawing of cups, 4 in. in diameter, produced from sheet blanks of brass, mild steel and aluminium (two tempers). The conditions examined included the direct and reverse methods of redrawing, the first-stage drawing ratio, inter-stage heat-treatment, punch profile radius, first-stage punch-die clearance, redrawing ratio, thickness of blank, material and temper. Among the conclusions reached, it was found that the significant difference between direct and reverse bending lay in the number of bending operations and the severity of bending; when the severity was the same in both cases, the reverse method gave the better results. The direct method could often be designed to allow of a larger radius of die profile and might afford a better drawing capacity than the direct method. The best drawing capacity was obtained when the largest practicable first-stage blank was used, and could be improved greatly by inter-stage annealing. Metals which gave good results in drawing from flat blanks were not necessarily the most suitable for redrawing. The paper by Mr. Watts and Professor Ford described a series of experiments with two smooth rigid dies, used to impress a flat strip placed between them, in which the ratio of strip thickness t to die width b ranged from 12 to $\frac{1}{3}$. The conditions approximated closely to plane compression between frictionless dies. Where the strip thickness was less than the die width, it was found that the mean pressure over the die surface followed a cyclical variation which reached minimum values very

near to the theoretical values of $\frac{t}{b} = 1, \frac{1}{2}, \frac{1}{3}$, etc.

For wider dies, the authors proposed that strain should be measured by the penetration of the die below the original surface of the metal, expressed as a percentage of die breadth; but the measurements plotted, and given in the paper, indicated that, in the initial period of pressure, the surrounding surface of the strip deformed before actual penetration occurred.

THE EUROPEAN TIMBER MARKET.

The state of the European timber market during the second quarter of 1952 is analysed in the latest issue (vol. v, no. 2) of *Timber Statistics for Europe*, published by the Secretariats of the Economic Commission for Europe and of the Food and Agricultural Organisation. The bulletin reports a continued decline in demand for raw materials during the period under review and that the market for forest products generally followed the same fall. A fall in price of softwoods at the end of May, enhanced by a drop in freight charges, encouraged the recommencement of buying and the return of the market to normal. There was a net increase in the total quantity of timber felled in the first six months of the year, due to a large increase in the felling of pulpwood and pitprops that was partly offset by a decline in the felling of saw logs. The import of pitprops and pulpwoods to all European countries increased markedly. Timber exports by European countries underwent changes similar to those in imports, with the exception of plywood, where exports fell, mainly due to a drop in exports to extra-European countries. Copies of the bulletin can be purchased from any sales agent for United Nations publications.

THE GREAT EASTERN RAILWAY'S "DECAPOD" LOCOMOTIVE.

There have been, from time to time, papers published in the *Transactions* of the Newcomen Society on very early railway locomotives, but the paper presented by Mr. W. O. Skeat, B.Sc. (Eng.), M.O.Loco.E., on "The 'Decapod' Locomotive of the Great Eastern Railway" is the first, we believe, to deal with a locomotive of the present century. Those who attended the meeting, however, were unanimous in agreeing that this unique engine possessed in full measure the combination of historical interest and technical importance that is a *sine qua non* in subjects for Newcomen Society papers. The presentation of Mr. Skeat's paper on December 10 had an anniversary significance, for it was just 50 years ago that this 0-10-0 tank engine emerged from the Stratford shops of the Great Eastern Railway, where it had been built to the requirements of Mr. James Holden, then chief mechanical engineer, the detail designs being carried out in their entirety by Mr. F. V. Russell. The engine was an experiment, intended to prove that steam could equal the performance of electric traction, which at that time threatened to compete with the Great Eastern suburban services out of Liverpool Street station, and the aim was to accelerate a 300-ton train from rest to 30 m.p.h. in 30 seconds. It accomplished the desired acceleration, in fact, with a train of 335 tons. To do this, the Decapod was given as large a boiler as could be accommodated, a working pressure of 200 lb. per square inch, and three cylinders of 18½ in. diameter and 24-in. stroke. The boiler was 5 ft. 4½ in. in diameter and 15 ft. 10 in. long, with 395 steel tubes of 1½-in. external diameter, giving, with the wide Wootton-type firebox, a total heating surface of 3,010 sq. ft. The grate area was 42 sq. ft. At the time, the boiler was the largest yet built in the British Isles, and one of the largest in the world. The wheels were 4 ft. 6 in. in diameter, and those on the third axle were without flanges, to facilitate running on curves. The cylinder axes were horizontal, which entailed the use of a connecting rod like an elongated Y in side elevation, the arms of the Y passing above and below the leading axle, which was slightly cranked. Arrangement drawings of the engine were reproduced in *ENGINEERING* of January 23, 1903 (vol. 75). The Decapod was never used in regular service; in fact, it made only five trial runs, on which the accelerations were recorded electrically—probably the first occasion when this was done. Some years later, it was rebuilt as a 0-8-0 tender engine and as such hauled freight trains until 1913.

THE ANGLO-IRANIAN OIL COMPANY.

Some of the difficulties with which the pioneers of the British oil industry had to contend, and the courage and determination which have led to the world-wide organisation of the Anglo-Iranian Oil Company, Limited, Britannic House, Finsbury-circus, London, E.C.2, were portrayed in five outstanding films, shown in London on Wednesday, December 10, to stockholders and guests of the company. The first film, entitled "Oil for the Twentieth Century," traced the history and growth of the company in Persia from 1901 to 1951, before the regrettable events in Iran brought the work of the Abadan refinery to a standstill. The first pipeline from the Maidan-I-Naftu oilfield to Abadan, brought into service in 1911, had an annual capacity of 400,000 tons. By 1951 this had risen to 32,000,000 tons of crude oil a year. The historical film was followed by a cartoon showing how the oil-carrying ship had developed from the sailing brig of 1861 to the modern tanker. The third film, "Rig 20," perhaps the most impressive, showed the successful combat of the fire which broke out in May, 1951, when drilling oil well No. 20, at Naft Safid, and which raged for five weeks. The fire fighters tackled the fire from beneath a mobile corrugated-iron canopy which had to be continuously cooled by water jets. A special road had to be constructed to give access to the fire, and water supplies had to be laid on. The superstructure and piping, which deflected the fire laterally, were blown up by an explosive charge, leaving a vertical jet of burning gases under high pressure which the

fire-fighters were able to extinguish by erecting and lowering a gate valve on to the jet, closing and then sealing it, an operation of the utmost delicacy and hazard to the men concerned. The next film, "Persian Story," depicted, in Technicolor, the oilfields and the Abadan refinery. Finally, "A Moment in Time," showed some of the activities carried on throughout the world in 1952, and demonstrated that, though the Persian situation constituted a serious setback, it was by no means catastrophic.

ACCIDENT ON A SAW BENCH.

Every operator who suffers as the result of an accident when working a machine may now claim compensation under the Industrial Injuries Act. He can sometimes do more: if he can show that there has been a breach of some regulation made pursuant to the Factories Act, he can make what is called a claim at common law. Normally, whoever brings such an action must prove negligence; but, if he can show that there has been a breach of some regulation, negligence is presumed. Many such cases have been commented upon in these columns. We have now to draw attention to another—*Watson v. British Thomson-Houston Co., Ltd.* ((1952) 2 *Times L. R.* 789)—in which an attempt was made to strain the language of a regulation to the utmost in order to support an allegation that the employer had failed to comply with it. The facts were briefly these. The plaintiff was using a circular saw. A piece of wood which had been cut off a board by the saw, and which normally would have been cleared off the saw bench, became stuck near the edge of the saw next to the riving knife. The plaintiff put his hand on the wood in an attempt to detach it, and, while so doing, involved his fingers, two of which were cut off. It was alleged on his behalf that there had been a breach of the regulations, inasmuch as the radius of the riving knife was too large, having regard to the size of the saw. In fact, the saw in use had originally a diameter of 24 in., but repeated sharpening had reduced the diameter to 19½ in. The radius of the riving knife was 12 in. Regulation 10 of the Woodworking Machinery Regulations, 1922, provides that "every circular saw shall be fenced as follows . . . (b) behind and in a direct line with the saw there shall be a riving knife . . . and . . . (i) the edge of the knife nearer the saw shall form an arc of a circle having a radius not exceeding the radius of the largest saw used on the bench; (ii) the knife shall be maintained as close as practicable to the saw, having regard to the nature of the work being done at the time. . . ." It was proved that the plaintiff himself had made the necessary adjustment; but it was contended that there had been a breach of the regulations inasmuch as the radius of the riving knife exceeded that of the saw at the time of the accident, though it was not even suggested that the accident was due in any way to this condition of things. Mr. Justice Parker, who tried the case, said, in the course of his judgment: "I am satisfied that, wherever the purchase of replacements can be proved, it shows purchases of 24-in. saws, and I think I am entitled to infer, on the evidence, that, when the blades were replaced, they were replaced by 24-in. blades. In the interval between purchases, the blades, no doubt, would be of varying diameters from time to time, going down, as I think they did in this case, from 24 in. to the 19½ in. of the blade at the time of the accident; but it does not seem to me that it can be said that 24-in. saws were not used on the bench within the meaning of that regulation merely because, for a time, they became of less diameter and for another period of time (albeit a long time, owing to market conditions) a 24-in. replacement was not obtainable. Accordingly, I do not think that in this case there has been any breach of the regulations." This decision has been affirmed by a higher Court. In the course of his judgment in the Court of Appeal, Lord Justice Somervell pointed out that, if the condition put forward on behalf of the plaintiff were right, every time "the largest saw" becomes diminished in size by sharpening there would have to be another riving knife fitted—a *reductio ad absurdum* of the plaintiffs' case. Although the regulations concerning circular saws are necessarily stringent, they must be given a reasonable construction.

OBITUARY.

MR. P. E. ERIKSON.

WE regret to record the sudden death of Mr. P. E. Erikson, which occurred at Malmö, Sweden, on Sunday, December 7, at the age of 72.

Per Englebert Erikson was educated at the Royal Institute of Technology, Stockholm, and received a degree in electrical engineering therefrom in 1903. In the same year he joined the Western Electric Company of New York as a shop student and took part in the pioneer work of developing loading coils and balanced toll cables for telephone communication. In 1909, he was appointed transmission engineer for Europe of the Company with headquarters in London and, while holding this position, was responsible for the construction of the first loaded long-distance telephone cable to be laid in Europe, that between London and Birmingham. At the conclusion of the 1914-18 war he became assistant European chief engineer of the International Western Electric Company and had charge of the design of a number of European toll transmission systems. He was also actively engaged, under the direction of Sir Frank Gill, in the work of the International Telephone Consultative Committee (C.C.I.F.), later becoming the delegate of the International Telephone and Telegraph Operating Companies on that body.

In 1928, Mr. Erikson received further promotion by being made assistant Vice-President of the International Standard Electric Corporation and became European chief engineer in 1930. Eight years later he joined the Board of Directors of A.B. Standard Radiofabrik, Stockholm, a subsidiary of the International Telephone and Telegraph Corporation, and in 1940 returned to Sweden, where he acted as liaison officer between the International Standard Electric Corporation and the Scandinavian countries. In 1946, he was recalled to London headquarters as technical adviser to the European commercial department and held that position until his retirement in 1950.

Mr. Erikson was elected a member of the Institution of Electrical Engineers in 1921 and was awarded the Fahie premium of that body for a paper on "Transmission Maintenance of Telephone Systems," of which he was joint author with Mr. R. A. Mack. He was also a Fellow of the American Institute of Electrical Engineers and a member of Svenska Teknologforeningen, Stockholm.

LETTER TO THE EDITOR.

PLASTICS.

TO THE EDITOR OF ENGINEERING.

SIR,—The reference to the air-supported roof in my recent lecture to the Plastics Institute has attracted a certain amount of attention in *The Times* and elsewhere, although, of course, it is quite an old idea. I did not realise, until I heard from Mr. H. V. Lanchester a day or two ago, that the idea was invented by F. W. Lanchester, apparently before the 1914 war. I am very glad that you have put right my omission in your leading article on page 666, *ante*. I took the information on this subject in my lecture from an article by N. J. Stevens (an American), in *Nature* for April 17, 1948, but Stevens did not mention Lanchester.

Yours faithfully,

J. E. GORDON.

Ministry of Supply,
Royal Aircraft Establishment,
South Farnborough,
Hampshire.

November 28, 1952.

[The conclusion of Mr. Gordon's lecture, containing the reference to the air-supported roof, appears on page 770 of this issue. In our leading article in the issue of November 21, the first mention of Lanchester appeared as "Lancaster." We regret the error.—Ed., E.]

THE TREWENT SCHOLARSHIP IN NAVAL ARCHITECTURE.—The Council of the Institution of Naval Architects, 10, Upper Belgrave-street, London, S.W.1, have decided to raise the age limit for the Trewent Scholarship in naval architecture from "under 20" to "under 19."

SCIENTIFIC RESEARCH IN AUSTRALIA.

THE latest report* of the Commonwealth Scientific and Industrial Research Organization, covering the year ending June 30, 1951, is an impressive document of 167 foolscap pages befitting an expenditure by the Australian Government now exceeding 3,000,000L. per annum. During the year under review, technical advice has been given to the Administration of Papua-New Guinea. A new research section for Land and Regional Survey has been formed and separated from the large division of Plant Industry; part of it is to be established to undertake a long-term survey of lands in Papua and New Guinea. Similarly, under the Colombo Plan, the organisation is affording laboratory and field experience in such subjects as forest products, food preservation, fisheries and radio, to research workers from various countries in South East Asia.

Since the activities described are directed largely to the development of agricultural, pastoral and related industries, an important proportion of the investigations entails field work for which branch laboratories and field stations have been established in situations appropriate to the regions under investigation in many different parts of Australia. Long-term studies of concrete have included attention to the properties and utilisation of foamed concrete, in which connection it has been established that fly ash and diatomite are suitable for use as pozzolana if they are pulverised until at least 85 per cent. passes a 300 B.S. sieve. The pozzolanic activity of fly ash is increased by calcination at 1,500 deg. F. The relationships between method of foaming, grading of sand, density, mechanical properties, rate of drying, dimensional changes and water absorption have been investigated on the commercial as well as on the laboratory scale, one important outcome being to show that, on the whole, the properties of factory-made foamed concrete were superior to those of material made by similar methods in the laboratory. The deterioration produced in concrete by expansive reaction between some types of aggregate and certain constituents of the cement exerts a significant influence on the behaviour of massive structures and is being studied extensively by the Cement and Ceramics Section of the Industrial Chemistry Division.

The criteria of failure of concrete were studied by subjecting a short circular cylinder to concentrated compressive loading across a diameter. Under this condition, the concrete fails in tension along the loaded diametral plane. Photo-elastic analysis shows that the distribution of tensile stress is not quite uniform across the diameter, but the numerous systematic tests so far made suggest that the values obtained are closer to the true tensile strength of concrete than those obtained by other methods of testing. Another investigation was designed to determine whether standard concrete test specimens should be cured in ordinary water, renewed every 28 days, or in water saturated with lime, as recommended by the American Society for Testing Materials and the Laboratoires du Bâtiment et des Travaux Publics in France. The results of numerous tests, now being statistically analysed, seem to indicate that the two methods of curing have closely similar effects. A somewhat related research, to ascertain the influences on the ultimate compressive strength of hardened cement paste of the ambient atmospheric temperature and humidity during mixing and setting, exemplifies a variety of work on cement and gypsum plasters, which included microscope studies of the mechanism of setting and of particle-size distribution in relation to the methods employed to burn the gypsum. The susceptibility of fibrous plaster to mould growth on water-paint films, and to staining caused by sulphide gases, is under active investigation. Trouble is also being encountered in the use of plaster containing expanded vermiculite for fire-retardant partitions in buildings and as a light-

weight coating for structural steelwork. Plaster-vermiculite mixes are easily handled by normal plastering techniques, but serious efflorescence due to soluble salts is caused by decomposition of the Australian vermiculite by the gauging water.

As part of a comprehensive examination of the conditions necessary to make concrete floors acceptable in domestic construction, a theory was evolved for calculating the flow of heat between shod feet and a floor. Experimental checking of the theory by observations on human subjects in various degrees of activity, ranging from sitting to brisk walking, have proved inconclusive so far and further tests are to be made during cold weather. Efforts to evaluate the hardness of floor surfaces by measuring the instantaneous pressures on the sole of a walker's foot have proved similarly inconclusive. Studies of the deceleration of a barefooted walking person, however, revealed significant effects of the nature of the floor, and this technique is accordingly being extended to tests on subjects wearing leather shoes.

Other attempts to counter the common objection that concrete flooring is cold include measurements of its surface temperature when surfaced in different ways on top and underneath in direct contact with the ground. No difference associated with the upper surfacing could be detected in the air temperature 2 in. above the floor, and the most effective covering—cork—showed a surface temperature only 1.5 deg. C. different from that of bare concrete. Examinations of the characteristics of the "Taber Abraser," with the view to its use for appraising floor surfaces, has revealed that the machine gives misleading results if floor materials of widely different compositions are compared.

An investigation of the part played by atmospheric humidity, in Melbourne, in promoting dampness in houses, dry rot in floors and mould growth on walls and ceilings has led to the conclusion that under-floor ventilation is often inadequate. Relative humidities of 80 per cent. in summer, rising to 90 per cent. in the autumn and presumably to saturation point in winter, were recorded in the conventionally-constructed under-floor spaces of new houses. Experiments are in progress to determine the minimum under-floor ventilation needed to restrict humidities to those of the ambient air. The more direct preservation of wood, by such methods as chemical impregnation, comes within the research programme of the Forest Products Division of the organisation, where a fundamental study of the problems of liquid and vapour penetration of wood has recently been started. This long-term project seems to have been prompted by a marked increase of activity in the practical aspects of this subject in Australia, indicating that a wood-preservation industry will develop during the next few years. In the search for a successful preservative treatment for eucalypt wood sleepers, the heart-wood of which resists penetration by ordinary treatments, a pilot plant has been built to treat sawn eucalypt heart-wood at impregnation pressures up to 1,000 lb. per square inch. The plant is to be used primarily to confirm, on a commercial scale with railway sleepers and transmission-pole cross-arms, the promising results of previous laboratory-scale experiments. Meantime, field exposure tests are in progress on cross-arms and fencing poles treated with metallic naphthenate, oil-type and various other preservatives.

Considerable attention has been given, during the year, to standard methods of testing the mechanical properties of timber, with special reference to the tests for compression perpendicular to grain, shear, and single-blow impact, for all of which the standard procedures in Great Britain are different from those in North America. The Australian Forest Products Laboratory is studying the alternative forms of test, in the case of the shear test by exchange of specimens and test results with the United States. In the case of the single-blow impact test, the Timber Mechanics Corresponding Committee of the British Commonwealth Forestry Conference have asked Australia to send collated data regarding the two tests to Canada, whence it is proposed to circulate all available information throughout the British Commonwealth and to the United States of America. Other investigations of the mechanical properties of wood in Australia have been concerned with the apparent modulus of elasticity in relation to the

* *Third Annual Report of the Commonwealth Scientific and Industrial Research Organization for the year ending 30th June 1951.* L. F. Johnston, Commonwealth Government Printer, Canberra. [Price 9s. 6d.]

size of a compression specimen; and with the effect of moisture content on the tensile strength of mountain-ash wood. Green mountain ash is also the subject of experiments on the prolonged loading of wood columns; in this connection some preliminary tests have revealed that the orientation of growth rings has no significant influence on the direction of buckling under strut loading. A somewhat related research, including measurements of the release of residual strain in sawn logs, has been prompted by the suggestion that, if the material in a growing tree "creeps" under the self-imposed stresses due to its own weight distribution, there may be some gradual "creep" recovery—as distinct from immediate elastic strain recovery—when the tree is felled.

The advantages offered by the use of wire resistance strain gauges for physical tests of timber have prompted a general investigation into the characteristics of three alloy wires commonly used for these gauges, in the course of which markedly different properties have been noted between Advance and Eureka wire. Plastic-backed gauges are being made in the laboratory for test work, and a technique for using gauges attached to thin metal foil is under development for strain measurements on green timber. Variation of resistance immediately after bonding is still being studied, but a completely satisfactory method of waterproofing, by means of material locally available, has yet to be evolved. Some useful results, nevertheless, have been obtained from tests of a general character to explore the influence of gauge length on the apparent strains measured by electric resistance gauges attached to timber.

An appraisal of the characteristics of electrical resistance moisture-content meters for wood has revealed, in the case of plywood, some interesting effects of the penetration of the glue line by the instrument probes. As an adjunct to this *ad hoc* work, a more fundamental research is in progress to ascertain how the electrical resistances of a range of typical woods vary with differing combinations of moisture content, temperature and grain direction. Other researches, more directly concerned with seasoning techniques, are being actively pursued to assist the Australian wood industry. One of these practical investigations has demonstrated the value of diffuser screens to increase the effectiveness of forced air-circulation drying plants, and of artificially-induced turbulence for air drying the more refractory species of veneer. Vapour drying, similarly, is giving most attractive results as regards reduction of drying time. *Radiata* pine railway sleepers, for instance, have been dried in four to five hours from the green condition to a moisture content low enough to permit adequate penetration and absorption of preservative creosote.

Vapour drying of mountain ash and hoop pine in superheated steam at atmospheric pressure and at temperatures up to 310 deg. F., has shown that the relationship between equilibrium moisture content and temperature over this range of conditions is similar to that between the equilibrium moisture content and ambient wet-bulb depression at temperatures below 212 deg. F. Close attention is being given to the causes of mechanical and physical failure of railway sleepers under service conditions, whence it is hoped to develop economical methods of increasing track life. One such investigation has shown that the load-bearing capacity of rail spikes is greatly increased by using them in combination with shear plates, which effect a considerable reduction in stress concentration within the spikes and enable the combination to support, for the same deflection, far greater loads than the spikes alone can withstand. Another field study is concerned with the changes, under service conditions, of temperature and moisture content of sleepers. The equipment in use for this purpose includes specially prepared electrodes, inserted to different depths in sleepers laid at a range of representative sites. Other engineering aspects of timber research are exemplified by trials of experimental circular saws, in which the energy consumption was measured at various rates of feed for saws with teeth differently shaped and spaced.

Among a large volume of work intended to help the growing Australian plywood industry is an inquiry into the glueing qualities of more than

20 species of Commonwealth timbers, which has revealed that, while the hard, heavy eucalypts produce mechanically good plywoods admirably suited for the manufacture of boxes or packing cases, they are unsuitable for furniture, which gives rise to the major Australian demand for plywood. The reduction in glue strength has been investigated for veneers impregnated with boric acid or borax, and for some classes of veneers for which glueing may be delayed for periods over six months after the material has been planed. Research into the production of adhesives for wood has centred round the fundamental behaviour of protein gels, and, more particularly, the production and properties of casein and similar products; but increasing attention is being given to tannin-formaldehyde adhesives derived from the bark of *Pinus Radiata*.

This last-mentioned research is being carried out by the division of Industrial Chemistry the work of which is directed mainly to the utilisation of those mineral resources of the Commonwealth that are not more specifically the concern of the Mineralogical and Coal Research sections. Comparatively simple treatments have been developed whereby graphite and manganese dioxide from Australian sources now fulfil all the requirements for use in the manufacture of electrical dry cells. The ingenuity of the division is more extended in the conversion, to commercially valuable products, of low-grade deposits, typically exemplified by rare earths of the cerium group. A cyclic fractional precipitation process, for example, has been devised whereby pure cerium and lanthanum compounds can be separated from mixed hydroxides derived from monazite. The rare earths can be separated from thorium by high-temperature chlorination of monazite, under which condition thorium chloride volatilises and the dry molten chlorides of the rare earths remain free from all major contaminants except calcium and magnesium. In the case of zircon, which occurs abundantly in the beach sands of Queensland and New South Wales, two new methods have been developed for separating zirconium from the hafnium with which it is closely associated. From low-grade titaniferous ores found at Radium Hill, in South Australia, uranium is now being satisfactorily recovered by alternative processes, one of which, involving acid treatment of the ore followed by selective solvent extraction of the resulting liquor, is preferred on the score of low operating costs and simplicity of the requisite plant. After exhaustive laboratory testing, this process is now at the pilot-plant stage. At two sites in the Northern Territory, primary uranium ore, containing uraninite, has been discovered for the first time in Australia. The uraninite occurs in small masses and strings, up to 3 mm. in size, which tend to envelop pyrite crystals; or it sometimes appears in quartz or slate between masses of chalcophyrite. The latest discovery of uranium, at Rum Jungle in the Northern Territory, is too recent to receive comment in the present report.

(To be continued.)

SLURRY-FIRED POWER STATION.—A plan for erecting a power station at Barony Colliery, Ayrshire, has been approved in principle by the British Electricity Authority. It will be designed to utilise slurry, of a quality which so far has had no market value, as a fuel without improving it by the admixture of higher grades.

INFORMATION ON ELECTRIC WELDING.—Some 25 years ago, the Lincoln Electric Co. in America originated a bi-monthly magazine called *The Stabilizer*, containing articles on various welded projects and facts about welding in general. It is now announced that this magazine is also to be printed in this country and that each issue will contain items of British and Continental interest. It is being issued free by Lincoln Electric Co. Ltd., Welwyn Garden City.

ELECTRIC TRUCK FOR DIE-HANDLING.—An electrically-driven truck recently introduced by Lansing-Bagnall Ltd., Kingsclere-road, Basingstoke, has been designed to reduce the time required for setting up die-casting and moulding machines and power houses. It is driven by a 2½-h.p. motor, which is supplied from a 48-volt lead-acid battery with a capacity of 99 ampere-hours. The lifting platform, which can take loads up to 20 cwt., and can be raised to a height of 4 ft. 4 in. above floor level, is hydraulically operated, power for this purpose being obtained from a second motor.

THE IRON AND STEEL INSTITUTE.

(Continued from page 722.)

CONTINUING our report of the autumn general meeting of the Iron and Steel Institute, held in London on November 26 and 27, we now deal with the proceedings which followed the presentation of the four papers on the cooling of ingots and mould-temperature measurements on the morning of the first day.

THERMODYNAMICS OF STEELMAKING.

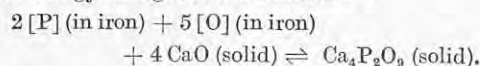
The remainder of the session was devoted to the presentation of ten papers which were to form the basis of a discussion on "The Thermodynamics of Steelmaking," to be held in the afternoon. The first of the ten papers, entitled "Development of Active Mixer Practice at Appleby-Frodingham," was by Mr. A. Jackson, who is deputy general works manager of the Appleby-Frodingham Steel Company. In presenting the paper, Mr. Jackson stated that his company had traditionally used over 75 per cent. of molten iron in their tilting open-hearth steel furnaces during the last 50 years. Following the construction of their third tilting furnace, a first active mixer had been brought into operation about 35 years ago. At present there were, in the works, four mixers ranging in capacity from 400 to 600 tons and one steel furnace-mixer of 300 to 350 tons capacity; records of results and trials had been kept for many years. Changes in the molten iron began as soon as it left the blast-furnace, and, during the last 30 years, active mixers everywhere had been called upon to take a greater part in steelmaking operations than had been expected when they were designed and built. In some of the older mixers the bath was often over 6 ft. in depth, and, aided by small feeds of limestone, limey iron ore, and oxides, the contents often showed a reduction of 40 per cent. of sulphur and up to 30 per cent. of silicon, provided that the molten iron contained over 1 per cent. of manganese and was relatively undisturbed by additions of oxide and limestone during its stay in the mixer.

As a mixer was much cheaper to operate than a steel furnace, ingot costs were a little lower when there was a mixer in the melting shop. Experience showed that when the mixer in a given shop was "off for repairs," the ingot cost changed little, but production dropped to about 75 per cent. of the normal. Direct-metal operation caused much irregularity in production, owing to variation in iron quality, the extra fettling necessitated and other factors, and the rolling mills were thereby greatly inconvenienced. Experience showed that one mixer to three operating steel furnaces gave the best results.

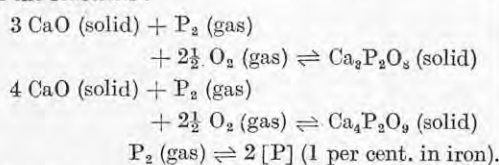
The remaining nine papers, most of which described work carried out for the British Iron and Steel Research Association, were presented by Dr. F. D. Richardson, who acted as *rapporteur*. The first of the nine papers in the series, by Dr. N. C. Tombs and Dr. A. J. E. Welch, was entitled "Thermodynamic Properties of Silicon Monoxide," and described an experimental study of the equilibria $\text{SiO}_2 + \text{Si} \rightleftharpoons 2\text{SiO}$ and $\text{SiO}_2 + \text{H}_2 = \text{SiO} + \text{H}_2\text{O}$. The authors stated that an inert-gas entrainment technique had been used to measure the equilibrium pressures of gaseous silicon monoxide over mixtures of silica and silicon at from 1,200 to 1,650 deg. C. The results had been used to compute standard free-energy changes for the formation of gaseous silicon monoxide from silica and silicon over this temperature range. Even at steelmaking temperatures, silica and silicon monoxide were of comparable stability and it was concluded that the monoxide could not be neglected as a participant in oxidation-reduction equilibria involving silica and silicon.

The second paper in the series was by Dr. J. Bookey, Dr. F. D. Richardson and Dr. A. J. E. Welch and dealt with "Phosphorus-Oxygen Equilibria in Liquid Iron." The authors stated that the thermodynamics of the phosphorus-oxygen equilibrium in liquid iron had been studied by bringing the phosphorus content of liquid iron to equilibrium with a mixture of tetracalcium phosphate ($\text{Ca}_4\text{P}_2\text{O}_9$) and calcium oxide, and a controlled gas atmosphere of water vapour and hydrogen. The

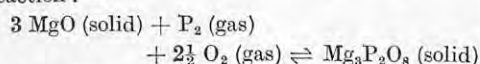
iron was heated by induction in a crucible made from the mixture of the phosphate and lime. The phosphorus content of the iron under these conditions depended only on the temperature and on the oxygen potential of the gas phase. Studies had been made at 1,540 deg., 1,560 deg., and 1,580 deg. C. covering 0.008 to 1 per cent. of phosphorus in the iron. The results had been interpreted in terms of interaction between phosphorus and oxygen dissolved in liquid iron and led to a value of standard free-energy change for the reaction:—



The third paper, by Dr. J. B. Bookey, was on the subject of "the Free Energies of Formation of Tricalcium and Tetracalcium Phosphates." Dr. Bookey stated in his paper that the reduction equilibria of tricalcium and tetracalcium phosphates with hydrogen had been studied in the temperature range 1,250 to 1,550 deg. C., and the results had been used to calculate the free-energy changes of the reactions:



In the fourth paper on "The Free Energy of Formation of Magnesium Phosphate," the author, again Dr. Bookey, gave an account of his studies of the reduction equilibrium of magnesium orthophosphate with hydrogen, in the temperature range 1,000 deg. to 1,250 deg. C. The results had been used to calculate the free-energy change of the reaction:—

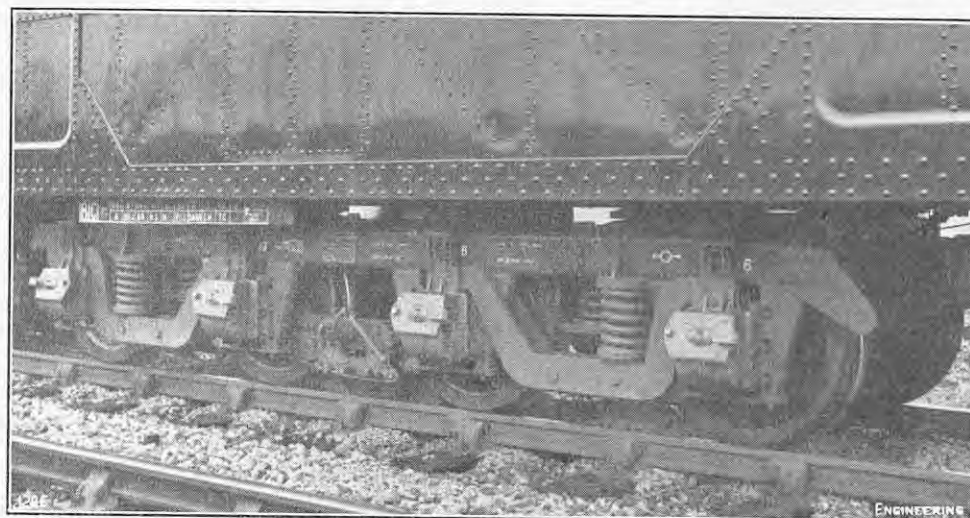


"The Effect of Sodium Oxide Additions to Steel-making Slags: Part II—Dephosphorisation of Steel by Soda Slags" was the title of the fifth paper in the series presented by Dr. F. D. Richardson as *rapporteur*. The authors, Dr. W. R. Maddocks and Dr. E. T. Turkdogan, stated that in Part I of their paper, which had been published in 1949, the effect of soda-slugs, under steelmaking conditions, on the removal of phosphorus at low temperatures had been studied. Further experimental melts had now been made at 1,400 deg. and 1,550 deg. C., and the results had been considered in relation to the earlier data. It had been found that the effect of temperature on dephosphorisation was not so great as had first been anticipated. The soda: silica and iron: silica ratios were the main factors determining the extent of the removal of phosphorus from iron. It had been demonstrated that the composition of the slag should be kept within such limits that the slag was oxidising, and that there was sufficient sodium oxide to combine with the phosphorus pentoxide in the slag.

The sixth paper, which was also by Dr. E. T. Turkdogan and Dr. W. R. Maddocks, dealt with a "Phase-Equilibrium Investigation of the $Na_2O-P_2O_5-SiO_2$ Ternary System." The authors stated that their work had revealed that this was a eutectiferous system with little or no solid solubility. The system had been established by thermal analysis, and specific gravity microscopic and X-ray determinations. On the Na_2O-SiO_2 binary side, there were two stable compounds and one peritectic compound. On the $Na_2O-P_2O_5$ binary side, there were three stable compounds. Within the entire system, one stable and two peritectic ternary compounds existed. Finally, there was an indication of an immiscibility gap in the melts rich in phosphorus pentoxide and silica.

The seventh paper was entitled "The Thermodynamics of Substances of Interest in Iron and Steel Making: III, Sulphides," and was by Dr. F. D. Richardson and Mr. J. H. E. Jeffes. The authors stated that thermodynamic data available for oxides and the compounds between them had been reviewed in Parts I and II of their paper, published in 1948 and 1950, respectively. In the present Part III, equilibrium and thermal data had been employed in deriving the free-energy equations for sulphides and gaseous-sulphur compounds of

RECORDING THE CONDITION OF RAILWAY TRACK.

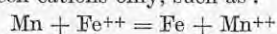


RECORDING THE CONDITION OF RAILWAY TRACK.

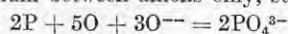
interest in iron and steelmaking. The results had been plotted on free-energy: temperature diagrams, and likely accuracies had been quoted for each substance.

"A Stoichiometric Combustion Method for the Determination of Sulphur in Slags," by Mr. C. J. B. Fincham and Dr. F. D. Richardson, was the eighth paper in the series. In this, the authors described their apparatus consisting of a platinum-wound furnace containing a 1-in. diameter combustion tube through which untreated commercial CO_2 was passed at a rate of $\frac{1}{2}$ litre per minute. The sample of slag weighed usually from 0.5 to 1 gramme and the SO_2 absorbing solution consisted of 100 ml. of distilled water, 5 ml. of 1:4 dilute hydrochloric acid and 1 ml. of freshly-prepared starch solution. The SO_2 was titrated with standard potassium-iodate/potassium-iodide solution of suitable strength. The accuracy claimed for the method was ± 2 per cent. of the total slag sulphur at concentrations above 0.1 per cent., and the time taken for the analysis was 30 minutes for both open-hearth and blast-furnace slags.

The ninth and last paper presented by Dr. F. D. Richardson as *rapporteur* described a research on "The Thermodynamic Calculation of Slag Equilibria," carried out by Dr. H. Flood and Mr. K. Grjotheim at the Technical University of Norway. The authors stated that the equilibrium constant of reactions in molten slags, expressed in terms of ion concentrations, had been found to be frequently influenced by concentrations that did not enter into the formal equilibrium equation. An equilibrium between cations only, such as:



was influenced by the anions present; similarly, an equilibrium between anions only, such as:



was strongly influenced by the cations present. A simple thermodynamic relation had been derived between the equilibrium constant and the concentrations of ions not entering into the equilibrium equation.

After the presentation of the above papers, the President adjourned the meeting for luncheon.

(To be continued).

ELECTRICITY SUPPLY IN SOUTHERN RHODESIA.—According to the latest annual report of the Electricity Supply Commission of Southern Rhodesia, the amount of electricity sold during the year ended March 31, 1952, was nearly 355 million kWh, representing an increase of 36 per cent. over the figure for the previous year. This large increase was partly due to a supply being given in bulk to the city of Salisbury for ten months in the year, although the consumption of the farming industry rose by 41 per cent. and that of the mining industry by 20 per cent. The installed capacity in the Commission's power stations was 82.4 MW, an increase of 7.5 MW. A further 102.5 MW of generating plant is on order or under construction. The length of the transmission and distribution systems was 5,448 route miles.

The problem of recording the condition of railway track by means of a special vehicle has not yet been solved to the complete satisfaction of railway engineers. Apart from the pure mechanics of the problem—which must deal with half-a-dozen or more types of irregularities—it is desirable for the vehicle, and its apparatus, to be designed so that it can be marshalled in a normal train and obtain accurate records in spite of varying train speeds. It is also desirable for the record to reflect the condition of the track under normal axle loads, so that, for example, voids under sleepers are not overlooked. The Matisa-Mauzin track-recording car, which has recently been brought over to this country from France for trials on British Railways, fulfils a high proportion of these requirements, and one of the objects of the trials is to ascertain to what extent it is successful in this respect. British Railways have been investigating the whole problem of track recording for some time, with the object of deciding on the most suitable unit for general use on their permanent way. They are considering the possible trial use of a recording car made by Messrs. Alfred J. Amsler and Company, of Switzerland. The apparatus in this vehicle employs a gyroscopic mechanism to provide the datum to which all measurements of track irregularities are referred.

The Railway Executive emphasise, however, that these special vehicles would not replace but only supplement the other track-recording devices already in use. The Hallade track recorder, for example, has been used for many years. It is a portable instrument which can be placed in any coach (though in practice it is used in a vehicle which is specially maintained in good order), and it gives, in the hands of engineers experienced in interpreting its charts, considerable information about the condition of the track. Its accuracy, however, is limited because the records it produces are affected to some extent by the characteristics of the coach in which it is travelling. The Matisa-Mauzin car gives fuller and more accurate information, and the subsequent "pin-pointing" of defects is simplified. The car and its apparatus were described on page 225 of our issue of August 22. It is a vehicle having, in addition to the two normal four-wheel bogies, an eight-wheel bogie, which is shown in the accompanying illustration. The records of vertical irregularities are obtained from the relative movements of the axles, and records of horizontal movements are transmitted by feeler discs which bear on the rails. The eight axles—all carrying a load of about 6 tons, so that voids are detected—provide the datum by means of systems of cables and pulleys which give the mean position of the axles; the movement of one axle relative to this mean is then transmitted to the appropriate recording stylus.

SPACE-HEATING BY GAS.

CHANDOS ENGINEERING COMPANY, LIMITED, EGHAM.

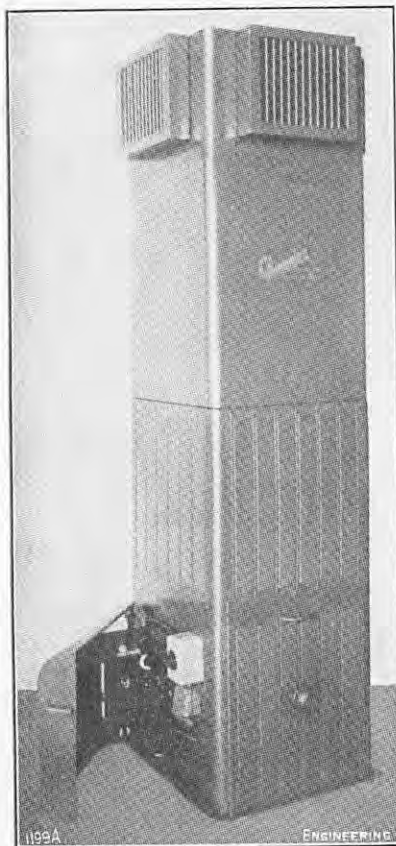
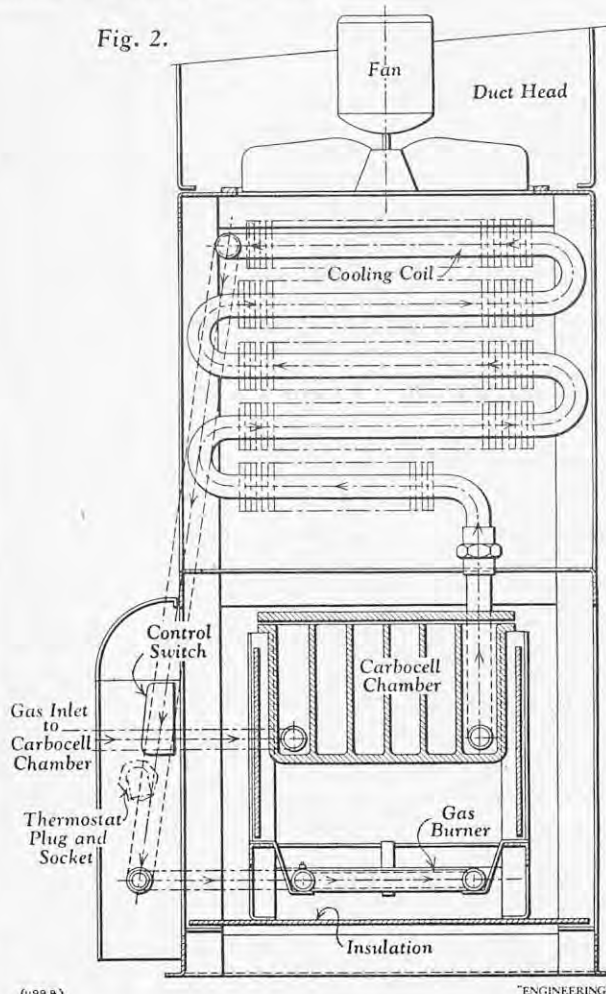


FIG. 1.

On a run from Paddington to Reading and back last week we observed the Matisa-Mauzin car and a Hallade recorder in use. It was remarkable that the rather complex system of cables and pulleys in the French vehicle appeared to follow faithfully the imperfections of the track, even at high speed. It would not have been surprising if the recording styli, oscillating fitfully over the moving paper, had produced a record that differed markedly from a chart recorded on a previous run, but the correspondence between the two charts was extraordinarily close. It is claimed for the Matisa-Mauzin car that it can be used at speeds up to 120 km. an hour, but it would appear likely that the accuracy of recording at high speed is a matter of degree. Thus, it is more probable that the accuracy deteriorates progressively at very high speeds rather than that it suddenly falls off at a particular speed. One of the questions, therefore, which British Railways are studying, is the relationship between accuracy and speed and, as a corollary, the speed at which the degree of inaccuracy becomes unacceptable. It is likely to be a comparatively high speed, but it will need to be since British Railways would wish to use the vehicle in normal trains. They also require to know whether the axle load of 6 tons is, in fact, sufficient to reveal all voids.

ROYAL AIR FORCE GOODWILL MISSION TO LATIN AMERICA.—A reception to welcome the Royal Air Force Goodwill Mission on its return from Latin America was held by Sir George and Lady Nelson at Londonderry House, Park-lane, London, W.1, on Tuesday, December 9. This mission, which consisted of a flight of four English Electric Canberras of Bomber Command, commanded by Air Vice-Marshal D. A. Boyle, left this country on Monday, October 20, and in little more than seven weeks covered some 24,000 miles and visited ten countries. The members were everywhere warmly welcomed and the greatest and sometimes embarrassing interest was shown in the capabilities of their machines, by both officials and the public, at Rio de Janeiro, Buenos Aires, Santiago, Lima, Bogotá, Curaçao and other places. It is satisfactory to be able to record that no operational difficulties were encountered.

Fig. 2.



SPACE-HEATING DIRECTLY BY GAS.

A DEMONSTRATION of a new form of space heating by gas-heated air, organised by the Chandos Engineering Company, Limited, 17, High-street, Egham, Surrey, was held recently in London. In the Chandos system, the gas is purified before combustion and is used directly to heat circulating air, providing, within a very short period, a pleasantly warmed air stream which is free from fumes. The elimination of a heat exchanger results in considerable economy in fuel consumption, and, on account of the automatic action of the heater unit and the cleanliness of the process, the work of operating and maintaining the system is negligible.

Illustrated in Fig. 1 is a compact Chandos Gasanair cabinet heater. Units of this type are available with gas capacities ranging from 100 cub. ft. to 400 cub. ft. per hour, developing from 50,000 to 200,000 B.Th.U., and suitable for heating spaces of from 10,000 cub. ft. to 40,000 cub. ft. Other types of heater developing up to 1 million B.Th.U. are also made. No flues are required, the warm air and gases emerging through the four outlet grilles at the top of the unit, or through suitable ducting connected to the outlets for circulation through a building.

A cross-section through a Gasanair heating unit is reproduced in Fig. 2. It will be seen that the gas is led, through a normal gas cock and governor, to a chamber, constructed in welded mild-steel plate $\frac{1}{8}$ in. thick, containing Carbocell purifying material, a product of the National Smelting Company, Limited, Avonmouth. The Carbocell chamber, located over the burners, is heated to a temperature of about 500 deg. C., and approximately 70 per cent. of the residual sulphur is removed from the gas. It then passes up through an air-cooled coil inside the rear of the cabinet, then down, through a thermostatic control valve and a flame-failure control, to the gas burners at the base of the unit.

The Carbocell chamber, burners and cooling coil are all enclosed in a combustion chamber of heat-resisting construction. The Carbocell chamber is provided with charging doors at the top and emptying doors at the bottom, both of which are fitted with gas-tight gaskets. Recharging the Carbocell chamber is usually necessary only once during the season.

The products of combustion are mixed with many times their volume of fresh or recirculating air, which is drawn by an electrically-driven fan, mounted in the duct head at the top of the unit, through louvres in the cabinet walls. The outer wall of the Carbocell chamber is surrounded by granular-vermiculite heat insulation. The heater lights up automatically when the gas cock and the fan switch are turned on, and requires no further attention other than the periodic renewal of the purifying agent.

LAUNCHES AND TRIAL TRIPS.

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

M.S. "IRISH COAST."—Twin-screw vessel, carrying 242 first-class and 146 third-class passengers, 348 cattle, motor cars and cargo, built and engined by Harland and Wolff, Ltd., Belfast, for the cross-channel services of the Coast Lines, Ltd., London, E.C.3. Main dimensions: 320 ft. between perpendiculars by 51 ft. 6 in. by 19 ft.; gross tonnage, about 3,600. Two Harland-B. and W. ten-cylinder two-stroke trunk-piston Diesel engines. Trial trip, October 15 and 16.

M.S. "NORTH KING."—Single-screw oil tanker, built by the Blythswood Shipbuilding Co., Ltd., Scotstoun, Glasgow, for the Compania Petrolera de Transportes, S.A., Panama. Main dimensions: 530 ft. between perpendiculars by 72 ft. 9 in. by 38 ft. 8 in.; deadweight capacity, about 18,700 tons on a draught of 30 ft. 7 in. Rowan-Doxford six-cylinder opposed-piston Diesel engine, developing 7,300 b.h.p., constructed by David Rowan and Co., Ltd., Glasgow. Speed on trial, 15½ knots. Trial trip, October 18.

S.S. "CALTEX CANBERRA."—Single-screw oil tanker, built by the Furness Shipbuilding Co., Ltd., Haverton Hill, County Durham, for Overseas Tankship (U.K.), Ltd., London, W.1. First vessel of two. Main dimensions: 544 ft. 4 in. overall by 70 ft. by 39 ft. 9 in.; deadweight capacity, 17,100 tons on a summer draught of 30 ft. 4½ in.; oil-tank capacity, 16,470 tons. Steam turbines with double-reduction gearing, developing 7,300 s.h.p. at 100 r.p.m., constructed by Richardsons, Westgarth & Co., Ltd., Wallsend-on-Tyne; and two Foster Wheeler oil-burning boilers. Speed, 15 knots. Launch, October 20.

M.S. "WOKINGHAM."—Single-screw cargo vessel, built by the Caledon Shipbuilding and Engineering Co., Ltd., Dundee, for the British Steamship Co. Ltd. (Managers: Watts, Watts & Co. Ltd.), London, E.C.2. Main dimensions: 435 ft. between perpendiculars by 58 ft. 6 in. by 38 ft. to shelter deck; deadweight capacity, 9,950 tons on a draught of 27 ft. Vickers-Doxford reversible two-stroke opposed-piston oil engine, developing 4,450 b.h.p., constructed by Vickers-Armstrongs Ltd., Barrow-in-Furness. Service speed, 13 knots. Launch, October 20.

M.S. "AVONFIELD."—Single-screw oil tanker, built and engined by William Doxford and Sons, Ltd., Sunderland, for Hunting & Son, Ltd., Newcastle-upon-Tyne. First vessel of two. Main dimensions: 505 ft. by 69 ft. 9 in. by 39 ft.; deadweight capacity, 16,700 tons on a draught of 30 ft. Doxford five-cylinder opposed-piston oil engine, developing approximately 6,450 b.h.p. at 117 r.p.m. and a speed of 14 knots. Launch, October 21.

M.S. "IMPERIAL TRANSPORT."—Single-screw oil tanker, built by the Greenock Dockyard Co., Ltd., Greenock, for the Empire Transport Co. Ltd., London, E.C.3. Main dimensions: 512 ft. between perpendiculars by 69 ft. by 38 ft. 6 in. to upper deck; gross tonnage, 11,400; deadweight capacity, 16,500 tons on a mean draught of 29 ft. 9 in. Vickers-Doxford five-cylinder opposed-piston heavy-oil engine, developing 5,500 b.h.p. at 115 r.p.m. in service, constructed by Vickers-Armstrongs Ltd., Barrow-in-Furness; and installed by Rankin and Blackmore, Ltd., Greenock. Speed, 13½ knots. Launch, October 24.

MODULAR CO-ORDINATION IN BUILDING.

THE case for adopting a recognised unit dimension as a basis of design and standardisation throughout the building industry has been put by Mr. M. Hartland Thomas, O.B.E., M.A., F.R.I.B.A., chief industrial officer to the Council of Industrial Design, in a lecture given to the Royal Society of Arts.* Mr. Thomas began his lecture by suggesting that although the standardisation of the individual elements of buildings, whether for house building or for commercial and industrial purposes, was progressing rapidly, there was no co-ordination between the many trades concerned. Thus, although windows, doors, stairways, lifts and escalators, together with heating, lighting and ventilating equipment, were all being standardised independently, no single basic relationship was employed and difficulties were being experienced in fitting the elements together. The solution proposed by Mr. Thomas was the adoption of a building module, or basic design and manufacturing dimension, that would be recognised by all architects, builders, and manufacturers.

Note was made in the paper of earlier attempts elsewhere to establish such modular co-ordination and many examples were given of firms who had developed such a scheme for their own benefit. Mr. Thomas instanced the several firms who had constructed many hundreds of buildings of varying size built from standard units during the war. Perhaps the most important scheme of dimensional co-ordination so far put into practice had been that devised in Germany in 1939 by Professor Ernst Neufert, which had had the backing of Government regulation. It was based on a large-scale planning grid of 2.50 m. (8 ft. 2 in.) for industrial buildings and 1.25 m. for houses. It had been noted that even after the war, when compulsion to subscribe to the scheme was withdrawn, those concerned did not abandon the scheme.

The development of a system of modular co-ordination had been pursued in this country by various Government departments and other authorities as well as by such organisations as the Royal Institute of British Architects and the British Standards Institution. From the work of these bodies it had been proposed that, for this country, a module of 3 ft. 4 in. should be adopted; the choice of this dimension represented a compromise between many issues, but was related to the human scale by taking the shoulder width of a man and adding tolerances for movement together with constructional thickness on either side of the centre of supports. The dimension of 3 ft. 4 in. was equal to 1.0160 m. and was therefore sufficiently close to 1 m. for it to conform at a later date to the metric system.

A difficulty had arisen from the way various authorities had related details to the design grid. Thus, for example, the majority of authorities had put stanchions and walls centrally about the grid lines, whereas others had taken the grid to be either the inner or outer face of the walls or as a back line of the stanchions. In any case, it had been convenient to consider walls to be 4 in. (0.1 module) thick, any additional thickness of outside walls being accommodated on the outside face. A considerable amount of documented evidence was given in the lecture of the experience which has been gained already in the use of modular co-ordination both by architects and by builders.

In amplifying the advantages to be gained by the acceptance of such a standard, Mr. Thomas suggested that time, and therefore money, would be saved in the drawing office and in estimating, and that tendering would be made easier. Although Mr. Thomas concerned himself only with the adoption of the module for the buildings themselves, it is evident that the recognition and use of such a standard by architects and builders would have a much wider effect and ultimately might influence the dimensions of the machinery and plant to be installed within the buildings.

* The Alfred Bosson Lecture, "Cheaper Buildings: the Contribution of Modular Co-ordination," presented to the Royal Society of Arts, John Adam-street, Adelphi, London, W.C.2, on Wednesday, December 10, 1952.

LABOUR NOTES.

SUGGESTIONS for the setting up of new conciliation procedure, possibly in the form of a national joint industrial council, to investigate disputes arising in the engineering industry, were put forward by officials of the Confederation of Shipbuilding and Engineering Unions at a joint meeting with representatives of the Engineering and Allied Employers' National Federation on December 4. The employers' representatives promised that careful consideration would be given to the unions' proposals, but they also expressed the view that the changes which the men desired to see introduced into the industry's conciliation machinery should be more closely defined. After some discussion, the meeting was adjourned on the understanding that both sides would meet again in the near future to consider the suggestions in greater detail.

It is known that the Confederation has been anxious for a considerable time to secure changes in the disputes procedure set up under the 1922 agreement, and, on various occasions since the autumn of 1950, it has been proposed that the executive council of the Confederation should give the three months' notice required to terminate the agreement. The Confederation is in favour of the formation of a central body, operating on the lines of the joint industrial councils which have been set up in a number of other industries. The membership and functions of these councils are largely based on the constitutions drafted by the Ministry of Labour after the publication of the Whitley reports in the early 1920's.

Many other questions besides the consideration of disputes would normally engage the attention of such a national body as the Confederation proposes. Wages and working conditions throughout the engineering industry would be considered at regular intervals. The new organisation would probably be empowered to initiate many matters which have hitherto been regarded as the prerogatives of the employers in the industry and, if it did not perform such functions, it would, presumably, fall short, to that extent, of what the Confederation intended. For example, the new body might be expected to concern itself with such matters as industrial processes, design, research, statistics, production, employment, and the organisation of the industry generally. For the past three years, the annual conference of the Confederation has passed resolutions asking for the ending of the 1922 agreement and for the establishment of a central organisation. The main complaints put forward against the existing machinery appear to have been that there are delays in its operation.

A voluntary release scheme, aimed at reducing the excessive size of the labour force available at Britain's docks, was announced by the National Dock Labour Board on December 4. The new scheme was put forward because unemployment at the docks is rising and there appears to be little prospect that trade will increase sufficiently in the near future to justify the present total of dock employees. The Board emphasised that the scheme is entirely voluntary. Its success will depend upon whether a sufficient number of men make use of its provisions. These provide that the Board will decide how many men may be spared in each port area and daily employees, up to that number, may then be granted immediate release to enter alternative employment. Each man so released will have his name placed on the dormant section of the dock employment register. If his services are required by a local dock Board during 1953, he will have the opportunity of returning to the active section immediately. If he prefers to remain in other employment, however, his name will remain on the dormant list.

During 1954 the local Board may recall a released docker at any time and, if he fails to return to dock work within six weeks, his name will be removed from the register, unless there are special circumstances. The scheme is due to end at the beginning of 1955. Any man whose name remains

on the dormant section of the register on January 1, 1955, will be transferred to the active list immediately on making application to that effect. Those failing to make application before February 12, 1955, will have their names removed from the register and will forfeit their rights of reinstatement. Released men will be eligible, after the normal qualifying period of three days, for unemployment benefit and national assistance. They will be paid all holiday money due to them.

An announcement by the Board stated that the scheme was introduced only after a careful survey of the future trend of imports and exports had been made, and after consultation with the Minister of Labour and the National Joint Council for the Transport Industry. The men's unions are understood to have been consulted at other levels also. Trade-union members of the Board rejected any attempt at compulsion but apparently considered that many men would avail themselves of the voluntary scheme. During recent months one docker in five has been idle. In the last period for which figures have been issued, from early October to November 22, there was an average of 16,150 men proving attendance each day for whom no work was available. This represented nearly 21 per cent. of the total number of dockers on the register, which averaged 77,860 during the period. The average number of disengaged dockers proving attendance daily during the 11 months ended November 22 last was about 12,000, equivalent to 15 per cent. of the total. It compared with an average of 6 per cent. last year.

The existing situation is partly due, the Board considers to the fact that during 1951 some 11,000 men were recruited to the dock labour force, to handle the increased traffic in that year and to ensure the speedy turn-round of shipping. The new scheme is designed to provide relief for both sides of the industry. For the men, the decreased amount of work available has resulted in lower average earnings. For the employers, there has been the added burden of a rising levy on their weekly wage bills. This levy was increased on November 1 last from 16 per cent. of their total wage bills to 22½ per cent. The money collected by this means is required to pay the "fall back" wage of 4l. 8s. a week due to registered dockers for whom there is no work. It constitutes a serious addition to production costs.

A wage offer by the National Coal Board was considered by the executive committee of the National Union of Mineworkers on December 4, and it was decided to summon another meeting of the union's national delegate conference. According to present arrangements, this will take place in London on December 18, when the Board's proposals will be discussed in detail. It may be recalled that the delegate conference decided at its previous meeting, on November 7, that the executive committee should approach the Board immediately, with a view to obtaining increased pay for the industry's day-wage men. These men earn, on the average, much less than their colleagues on piece-work. The Board are not agreeable to raising the basic rates of all day-wage men, but appear to have made an offer of an increase of 6s. to 7s. a week for the lowest-paid miners in this category. It has been estimated that some 150,000 of those not paid at piece-rates would be likely to benefit.

Unemployment statistics issued by the Ministry of Labour on December 4 show that the number of persons registered as out of work on November 10 last was 406,400, an increase of 8,500 since October 13. Of this total, 36,200 workpeople were only temporarily disengaged and fewer than 149,000 had been unemployed for more than eight weeks. The November unemployment figures represented 2 per cent. of the estimated total number of employed persons in Great Britain. A pleasing feature of the Ministry's announcement was the record that the number of employees in the textile industry had increased by 16,000 during October. Employment in the basic industries, however, declined by 44,000 during the same month.

PNEUMO-HYDRAULIC CLOSING MECHANISM FOR CIRCUIT-BREAKERS.

BRUSH ELECTRICAL ENGINEERING COMPANY, LIMITED, LOUGHBOROUGH.

Fig. 1.

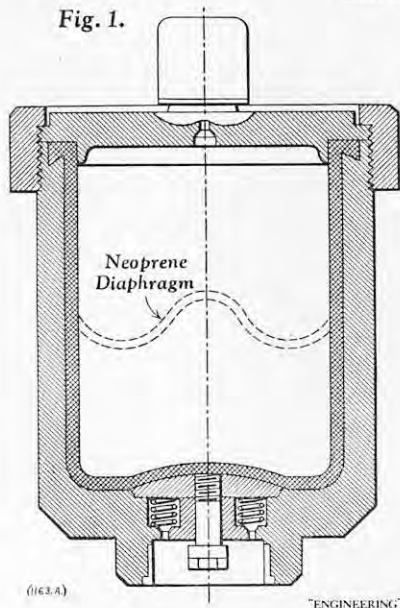


Fig. 2. DIAGRAM OF PNEUMO-HYDRAULIC CLOSING MECHANISM.

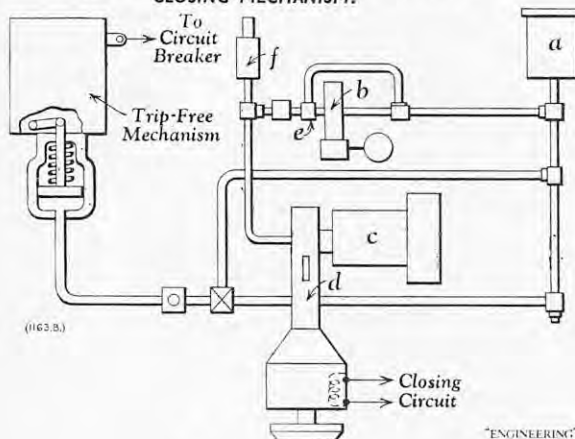


Fig. 4. VIEW IN DIRECTION OF ARROW A.

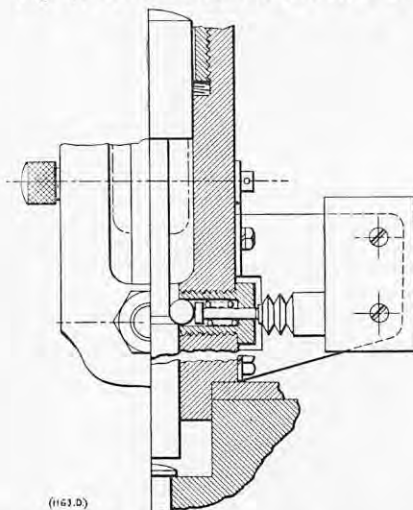


Fig. 3.

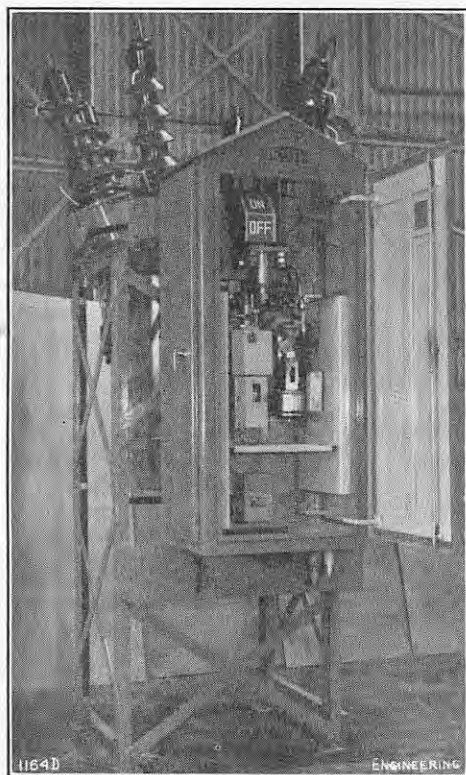
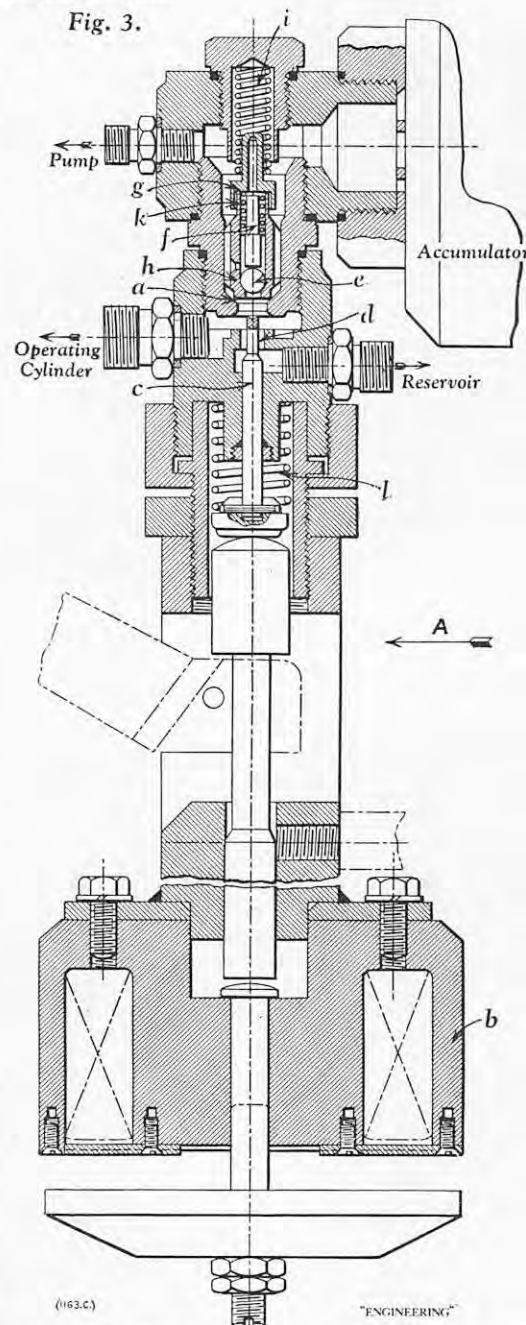


FIG. 5. 33-KV CIRCUIT-BREAKER WITH MECHANISM IN POSITION.

PNEUMO-HYDRAULIC MECHANISM FOR CLOSING OIL CIRCUIT-BREAKERS.

THE 750-MVA 33/38.5-kV outdoor oil circuit-breaker now being manufactured by the Brush Electrical Engineering Company, Limited, Loughborough, is fitted with a stored-energy closing mechanism of unusual design. This consists of a pneumatic accumulator of a type employed for many years for the impulse starting of large Diesel engines, and, as will be seen from Fig. 1, consists of a sealed steel vessel fitted with a neoprene lining. The container is filled initially with compressed air at a pressure of about 2,000 lb. per square inch, so that the neoprene lining bears firmly against the inner wall of the steel container. When, however, oil is pumped into the bottom, the neoprene lining is forced upwards into the position indicated by dotted lines in Fig. 1, to form a diaphragm, and the air above it is compressed to about 4,000 lb. per square inch. This pressure is

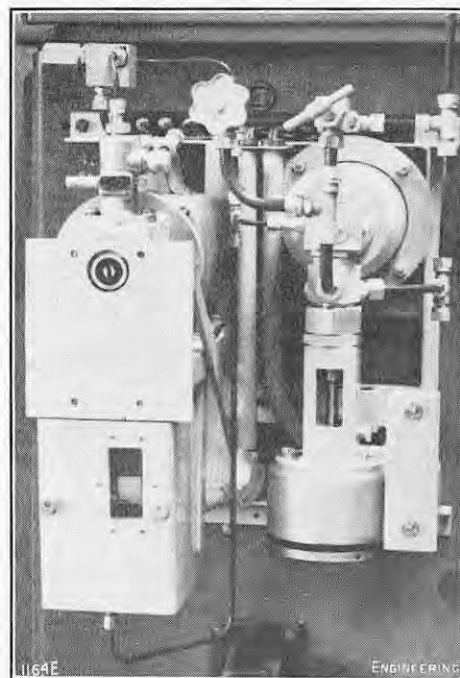


FIG. 6. CLOSING MECHANISM.

used to operate the circuit-breaker when the oil is released in the manner described below. As the container is sealed, re-charging with air is unnecessary and the energy stored is sufficient to effect closure four times before the oil pressure need be restored.

As will be seen from Fig. 2, the oil is drawn from the reservoir *a* by the electrically-driven pump *b* and is forced into the accumulator *c* through the two-way valve *d*. The $\frac{1}{4}$ -h.p. motor driving the

pump, which is of the single-phase capacitor-start type, is set in motion automatically when the pressure in the accumulator falls below a predetermined value and then runs for about 30 seconds, or until a pressure sufficient for one operation of the breaker has been restored. If, however, an excessive pressure is at any time established in the accumulator, a relief valve, shown at *e* in Fig. 2, is opened and the oil is returned to the reservoir through a by-pass. The motor is controlled by a switch, actuated by the plunger-type pressure gauge *f*.

The construction of the two-way valve is shown in Figs. 3 and 4. When it is in the closed position the oil in the system is maintained under pressure from the accumulator as far as the seating *a*, Fig. 3. When, however, the electromagnet *b* is energised the rod *c* is pushed upwards so that its large-diameter portion passes through the orifice *d* and the connection between the operating cylinder and reservoir is closed. As the rod *c* rises still farther the small-diameter portion opens the ball valve *e*, thus permitting a restricted flow of oil into the operating cylinder and taking up any "slack" in the mechanism. Continued upward movement of the rod *c* causes the rod *f* to butt against the face *g*, thus raising the main valve assembly *h* so that the oil flows freely into the operating cylinder. The operating mechanism is bolted to the top plate of the circuit-breaker through an adapter chamber and is arranged to actuate the moving contacts

directly, so that no auxiliary bell-crank coupling is required.

When the electromagnet is de-energised the action is reversed, the main valve being first re-seated by pressure from the spring *i*, Fig. 3, and the ball valve by the spring *k*. Finally, the rod *c* is withdrawn by the spring *l*, the oil being forced back into the reservoir during the last movement by the pressure behind the piston. It may be added that the rod *c* operates a switch, thus ensuring that the electromagnet remains energised until the circuit-breaker has completely closed. A manually-operated valve is provided so that, in emergency, the circuit-breaker can be closed at normal speed; a small hand pump can be fitted for charging the accumulator.

An illustration of the closing mechanism mounted on the front of the circuit-breaker is given in Fig. 5, opposite. In Fig. 6, which is a closer view of the mechanism, the motor-operated pump is visible on the left and below it the pressure switch. On the right are the accumulator and valves with the electromagnet below them. The pressure gauge carries a pointer which moves over a scale. The upper part of this scale is painted red to indicate excess pressure, while the central and lower parts are painted white and green respectively, to show normal and deficient pressures. Tests have shown that as the pressure on the piston is constant, the closing characteristics of the mechanism are good and, as the moving parts are light, the impact on it is small. As regards the circuit-breaker itself, the top plate, on which the internal assembly is carried, is an aluminium-alloy casting of domed section. It is provided with a baffled vent and is machined to ensure accurate alignment. The contact cross-bar of each phase is coupled, by a Permalin insulating link of square section, to a steel guide rod. The bushings of this rod form the end caps of a tubular housing which encloses the accelerating springs and the opening and closing dashpots. The guide rods, in turn, pass through an oil seal in the top plate, where they are coupled by a steel crosshead. This crosshead is connected to the lifting lever mechanism. Each phase is completely separated from the others by insulating lining in the tank.

The fixed contacts each consist of six rose-type finger assemblies, the contact pressure being provided by individual springs. The moving contacts are solid-copper candles and are fixed to the cross-bar in such a way that their positions relative to the rose assemblies of the moving contacts can be accurately adjusted. The arc-control devices are Bakelised paper tubes into which the bottom throat plate is cemented and pegged. The individual splitter plates are clamped into this tube and are arranged so as to give a minimum arc duration. The lower portion of the assembly forms an auxiliary oil reservoir, thus enabling extra pressure to be generated when fault currents of low value are being cleared.

The bushings are of the oil-filled condenser type, the porcelain rain sheds being held in position by springs, so that cemented joints are unnecessary. The current transformers are housed in cast aluminium chambers which are bolted between the top plate and the mounting flange of the bushing.

LOSS OF S.S. ST. RONAN.—The Minister of Transport, the Rt. Hon. Alan Lennox-Boyd, M.P., has ordered a formal investigation to be held into the stranding and subsequent total loss of the steam trawler *St. Ronan*, of Hull, off St. John's Point, Caithness, on October 12, 1952. A further announcement will be made when the date and place of hearing have been fixed.

AUTOMATIC TELEPHONE EXCHANGE FOR THE BRISTOL AEROPLANE COMPANY.—A private automatic telephone exchange, for 1,700 lines, which has been constructed by the General Electric Company, Limited, Magnet House, Kingsway, London, W.C.2, has recently been installed at the works of the Bristol Aeroplane Co., Ltd., Filton, by the Reliance Telephone Co., Ltd. Before the new exchange was installed, the Bristol works was served by three individual exchanges linked together. The changeover to the new system was carried out with an interruption of only 20 minutes to the internal telephone service. The new exchange, employing pre-selectors, first and second group selectors and final selectors, operates on a form-digit dialling system. The ringing machine is mains-driven, as is also the spare. A battery-driven ringing machine is also installed.

THE FUTURE OF PLASTICS IN ENGINEERING.*

By J. E. GORDON, B.Sc.

(Concluded from page 702.)

APPLICATION TO MOTOR-CAR BODIES.

If we take the cheaper end of the scale, say a motor car, then, superficially, the present position appears to be much less favourable. If the cost of a car body is about 4s. per lb., the existing laminates would seem to be out of the market altogether. On the other hand, one is not so much purchasing weight as strength. If we could replace 18-s.w.g. steel by 0.10-in. laminate, then the weight of the body would be roughly halved and we might afford to pay about 8s. per lb. for the finished body. If such a weight could be achieved then reductions could be made in the engine and chassis and an altogether cheaper car might result. While a steel body is relatively cheap, it is heavy, and because it rusts its life may well be shorter than that of the chassis and engine. At 8s. per lb. finished weight, the existing laminates are still too expensive, but if we suppose a suitable cheap material to be available it is interesting to inquire how the job might be tackled.

It is clear that much re-design would be needed. One of the objections which is often raised to the plastic car body is that it would be difficult to repair. However, we might consider such a body as being moulded in comparatively small panels, not more than 2 ft. or 3 ft. square. These panels might be fairly readily detachable and their joints might be concealed by a plated beading. Each panel might 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 might be sold so that a damaged unit could be replaced by undoing a few bolts; this might be a much quicker and cheaper form of repair than the present system of panel-beating followed by re-cellulosing. For the quantities involved the present low-pressure laminating processes are probably not economic and it seems probable that pressure-moulding with metal dies would have to be used.

This raises the question of the curing cycle. Judging by American experience, it is possible to reduce the cure times of the glass-polyester materials in heated dies to a matter of two or three minutes or possibly less. Unfortunately, the glass-polyester materials do not, at the moment, seem to promise low enough material costs. If we want a cheap material we shall probably have to use a phenolic resin. The cure of phenolics by normal methods seems likely to be too slow for a process of this type. At Farnborough, however, we have been developing an electrical curing system which gives virtually instantaneous cure and it seems likely to give production rates equivalent to those attained with steel pressings. Incidentally, I wonder whether wings and bumpers in polyethylene would be practicable. They would be very light and virtually indestructible. Several designers have said that, if they could only obtain a phenolic felted material for less than 2s. per lb. the uses to which it could be put would be virtually unlimited. This, of course, is far less than present prices, but not an impossible target. There is a circle of cause and effect in such matters which is difficult to break. Because there is no cheap material on the market there is no firm demand for it, and because there is no firm demand there is no supply, for such prices can only be attained with large-scale production.

It is at this stage that many people raise the argument about the supply of basic raw materials. It is difficult to be dogmatic, yet it seems to have been the general experience in the past that, if the demand is loud and clear, the raw materials will be found, and often at a surprisingly low price. The difficulty probably lies in the delays which accompany the provision of new plant and equipment. The production of shell structures at low cost is something that plastics can do well, given quite a modest reduction in material costs. It is just this

making of shaped shells that is so difficult and unsatisfactory in metals. Apart from the lighter types of shell structures, there seems to be a potential opening for piping and containers in chemical works, gas works, oil refineries, etc.; and the fact that it is easy to make such shapes may lead to the development of new kinds of products.

I do not see why plastics should not play a part in mechanical engineering. For instance, if we are ever to have really cheap gas turbines for general use in cars and for similar purposes, we must get away from the position where hundreds of very expensive metal blades have to be attached separately to an elaborately machined rotor. We cannot undertake actual turbine blades—we may have to leave these to those cousins of plastics, ceramics—yet the actual turbine is generally less of a problem, economically, than the compressor, especially the axial-flow compressor, in which a moderate improvement in heat resistance may enable us to mould complete rings of blades integrally with their discs. This is an application where the cost of the material is secondary to its performance. Even in established fields there may be an opening; e.g., it should be possible to make road wheels, calendar bowls for the paper and textile trades, and many other devices.

All these applications are in the field of orthodox "rigid" engineering. With plastics we have, for the first time, a really remarkable range of flexible materials and it may be that one of the most interesting prospects will be the opening up of new engineering in flexible materials. There are some obvious uses for flexible piping, etc., but we hardly begin to touch the possibilities of what I might call "pneumatic" structures. We have heard relatively little in this country about the "air-supported roof," though I believe it is being exploited in America. A very large, flexible, and preferably transparent, sheet of plastic is spread out and "pegged down" at the edges. Small fans are then used to blow the sheet up into a saucer-like roof; little pressure is needed. Such domes are quite stable in high winds and can withstand snow loading. If they are successful they will open up quite a new approach to the question of weather protection.

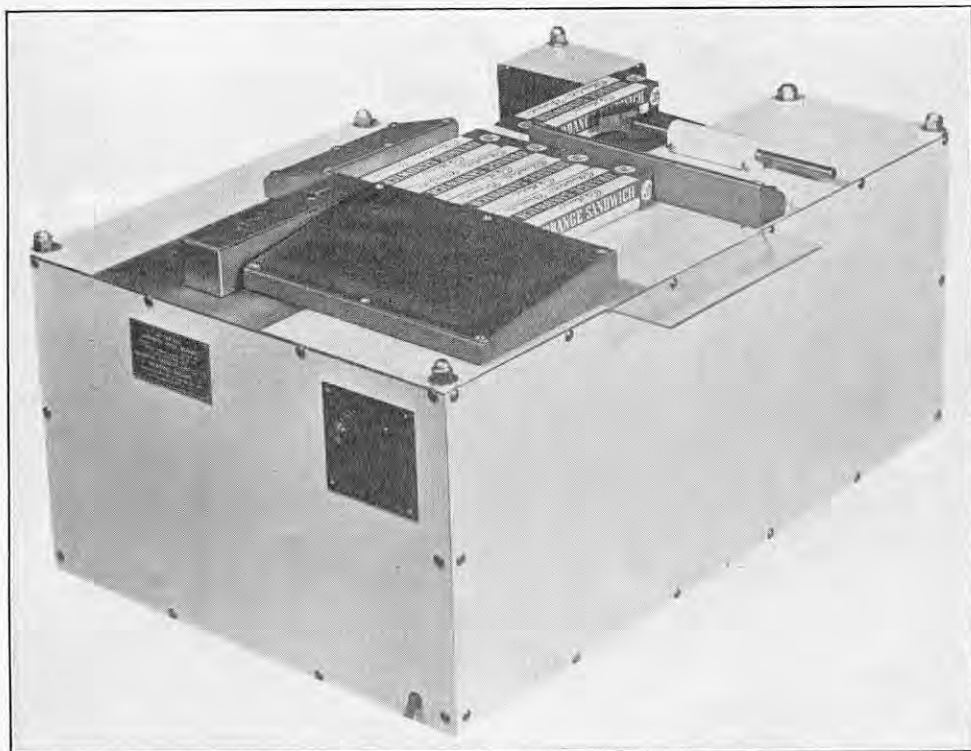
If we look still farther ahead the prospects for the future are bewildering. Consider, for instance, the possibilities of a really satisfactory photocatalysed material. One can imagine that such a material might be set by a process akin to three-dimensional photography. Instead of expensive moulds one might feed the necessary optical scanning data into a machine by means of a punched card and thus obtain any shape we care to demand. Again, there is the possibility of a soft piezo-electric material. An animal can be considered as both soft and infinitely rigid, for it can resist a deflecting force, without displacement, by pushing in the opposite direction, consciously or subconsciously. If we had a material which could be made to expand or contract by a small amount by applying an electrical potential the whole approach to structural engineering would be altered.

It would be absurd to pretend that plastics are ever likely to oust metals completely and it may be that they will always be in a minority as regards tonnage. It must be remembered that enormous quantities of wood are used to-day, perhaps more than metal, and certainly more than was used in 1800. The coming of metals, however, transformed engineering by transforming people's ideas, and we may find plastics acting in a similar way as a catalyst for a new Industrial Revolution. Are we going to take the lead in this process or abandon it to some other nation? We must spend more on development work. Yet money without men is useless; we must seek to attract the right kind of men. Scientists we must have, of course, but I do not think that we need only, or mainly, scientists. The trouble with scientists is that they do not recognise that engineering is not really a science; it would be easy, and rather malicious, to compile an anthology of "howlers" perpetuated by eminent scientists. Engineering development is not a science—at least not in its early stages; it uses science, which is a different matter, just as does medicine. One of the great Eighteenth Century doctors was said to have "found Medicine a Trade and left it a Philosophy." Perhaps we need men who will be both adventurers and philosophers in engineering.

* Fourth annual lecture of the Plastics Institute, delivered on November 13, 1952. Abridged.

CHECK-WEIGHING MACHINE.

INDUSTRIAL PRODUCTS (SPECO), LIMITED, BRENTFORD.



CHECKING THE WEIGHT OF SMALL PACKAGES.

A MECHANISM which will separate packages (or other units) which have a predetermined weight and those which are only very slightly below this weight is incorporated in the check weigher illustrated on this page. Two such mechanisms used in conjunction with each other will also separate packages which are of the exact weight, those which are slightly below the weight and those which are slightly above it. It is quite possible that these mechanisms may be used in a variety of ways, in addition to the use to which they are put in the machine illustrated, and arrangements have therefore been made to supply them separately. The makers are Industrial Products (Speco), Limited, 7, Boston Manor-road, Brentford, Middlesex.

The Hy-Tra-Lec check weigher, as it is called, embodies the mechanism or weighing element of a batch-weighing machine of the same name which the firm introduced in this country a few years ago. This batch-weighing machine is widely used for automatically weighing out small quantities of potato crisps, confectionery and other products which will flow under suitable conditions. It delivers accurately weighed batches at a high rate into bags or other containers. The weighing element employs floats which are partly immersed in oil so that they tend to rise due to their buoyancy. They are prevented from doing so, however, by a stop. Thus, when the package to be weighed is placed on a pan which is connected to the tops of the floats, if its weight is not sufficient to overcome the buoyancy of the floats, the latter will not move; but if its weight is sufficient the floats will be depressed. This movement of the floats is then used to actuate a mercury switch and thereby initiate the required action—deliver the product down a chute in the case of the batch-weigher and push the package in a certain direction in the case of the check weigher illustrated. The construction of the weighing element was described in an article on the batch weigher in *ENGINEERING*, vol. 168, page 586 (1949).

In this country a package for sale must not contain less than its advertised minimum contents, irrespective of the commodity, and since manufacturers have no desire to supply more than is necessary, a machine which will automatically and rapidly check the weights of packages is required. The Hy-Tra-Lec machine checks every package in a flow

line, whereas it has been common in the past to rely on selecting one of a batch for weighing. It will, for example, reject all packages which are one grain or more under-weight on a 9-oz. measure, while accepting all those which are exact weight or more, at a combined rate of 45 to 60 per minute, depending on the shape and size of package. One grain in 9 oz. is equivalent to 0.025 per cent.

The check weigher is installed in the flow line in such a way that the packages are delivered "from the south-east" (in the illustration) on to a transfer plate, whence each is pushed forward by those following it. A pusher which moves forward from the "south-west" corner places each one in turn on the weighing platform; the illustration shows one in this position. If the package is not heavy enough to trip the weighing element, it is then pushed on in a north-easterly direction by the package which follows it, and it is thereby rejected. If, on the other hand, the package reaches the prescribed weight, the weighing element is tripped and operates a pusher which delivers the package in a north-westerly direction, where it continues along the flow line.

If a complete check—over-weight, correct weight and under-weight—is to be made of, say, $\frac{1}{2}$ lb. packages, with an upper limit for "correct" weight of plus $\frac{1}{2}$ gram, two Hy-Tra-Lec check weighers are used. The first is set so that the weighing element trips at $\frac{1}{2}$ lb. exactly. The packages from this unit will then be sorted into under-weight, at right-angles to the main flow line, and all those of correct, or over-weight, in the same direction as the main line. This latter line is then directed to feed the second check weigher, the weighing element of which is set to trip at $\frac{1}{2}$ lb. plus $\frac{1}{2}$ gram. The delivery from this second machine will then be split into correct weight and not more than plus $\frac{1}{2}$ gram delivered at right-angles to the main flow line, and over-weights delivered in line with the main flow. A complete sorting operation has thus been achieved with 100 per cent. control on under-weight at a rate of approximately one package per second, or some 28,000 per eight-hour shift, with no human labour except for supervision.

The machine is made in two sizes: one for weights in the range $\frac{1}{2}$ oz. to 12 oz., and the other in the 12 oz. to 2 lb. range. The weight settings of each model are infinitely variable between their maximum and minimum limits. The Hy-Tra-Lec check weigher has been tested and approved by the Standards Department of the Board of Trade.

TEXTILE ENGINEERING.*

By A. V. PRINGLE, A.T.I.

TEXTILE engineers may claim to belong to one of the oldest branches of the engineering industry, for the history of textiles is nearly as old as that of man himself. It is not proposed here to go back to the days when "Adam delved and Eve span," for, even at the beginning of the industrial era in which we now live, the textile trades were of foremost importance and were directly or indirectly responsible for the development of most of the other industries in the British Isles. The Industrial Revolution may be said to have had its beginning in 1733, when John Kay of Bury produced his "flying shuttle" (British Patent No. 542, 1733). This immediately enabled cloth to be woven more rapidly, yet at less cost, than had previously been possible.

There followed a demand for high-grade yarns at reasonable prices, and many attempts were made to evolve machines capable of producing these to satisfy the greatly increased requirements of the weavers. In 1764, James Hargreaves produced the first satisfactory spinning machine (Patent No. 962, 1770)—his hand-powered "Jenny"—from which the "mule" was later developed by Compton, about 1779. Five years later, Richard Arkwright gave the cotton trade the first power-driven spinning frame, known as the "water frame" (Patent No. 931, 1769). This machine used drafting rollers and flyers for twisting.

The First Flax Machinery.—This early machinery was suitable for wool or cotton. The first machinery which could satisfactorily process flax and other long vegetable fibres was built in 1787 by Kendrew and Porthouse (Patent No. 1613, 1787) and was used in Marshall's Mill in Leeds. It was improved upon in 1790 by Marshall's foreman mechanic, John Murray (Patent No. 1752, 1790). A further important development in machinery suitable for the long vegetable fibres was Archibald Thompson's invention in 1801 of chain-gills (Patent No. 2553, 1801), which greatly assisted in straightening and parallelising the fibres as they were drafted. About this time there was a well-established textile industry in Ireland. This had originally been in wool, but the wool trade had been suppressed and the linen trade fostered in its stead.

The Linen Process.—The production of linen cloth involved the cultivation of flax plants which, after harvesting, had to be retted and scutched to free the fibre from the stem. The fibre was then worked over coarse steel-pinned combs, or hackles, to separate, straighten and parallelise the long fibres and to remove the short fibres and dirt. The hackled flax was then attached to the distaff, from which it was withdrawn by hand, a few fibres at a time, to be twisted together to form a continuous yarn. When very fine yarns were required, the spinning operation might be performed in two stages—a coarse, loosely twisted yarn (or rove) being first formed which was, at a subsequent operation, attenuated or "drafted" by hand to the required degree of fineness before receiving the appropriate amount of twist. The yarns made by the spinner were then interwoven on hand looms to form cloth which was subsequently bleached and finished.

At the beginning of the Nineteenth Century most of these operations were performed by hand in Ireland. Power, usually from a water wheel, but sometimes supplied by asses, was used in some scutch-mills for rolling and beating the straw, and in bleachworks for beetling and other finishing operations.

Introduction of Power Spinning to Ireland.—Since power spinning was applied to cotton some 30 years earlier than to flax, it is not surprising to find that, in the Belfast area, mills for cotton were established before mills for flax. Power spinning, before the introduction of the wet-spinning process, did not attract the attention of the Northern Ireland linen trade, which required fine yarns for damasks, lawns and sheers. The first power mills for flax spinning were established in Ireland in

* Paper read before Section G of the British Association at Belfast on Tuesday, September 9, 1952. Abridged.

1805, when the finest yarns which could be spun by the methods then employed were about 16^s lea (100 grammes per kilometre), so that, even after power mills had been established, there continued to be a steady demand for fine hand-spun yarns. The Napoleonic Wars were largely responsible for these first flax mills being built. In the naval bases in the south of Ireland there was a keen demand for sailcloth and cordage made from the coarser yarns. The Irish Linen Board offered a subsidy of 30s. per spindle towards the cost of establishment of power-spinning mills, and in 1805 eight mills were established, of which five were in the extreme south. The remaining three were in Ulster. The machinery for these was mostly supplied from Leeds. During the next 25 years the number of power mills in Ulster increased gradually, but power spinning only became firmly established in the North after the general introduction of the wet-spinning process in 1825.

Wet-Spinning Process.—Flax is a compound fibre composed of hundreds of ultimate units averaging about $1\frac{1}{2}$ in. in length with a diameter of about 0.0007 in. These ultimate fibres are bound together by natural gums. In dry spinning, the yarns are spun from partly sub-divided fibre bundles. In wet spinning, the gums are softened by passing the rove through water, usually warm water, and the ultimate fibres thus released are drafted away from each other to enable much finer yarns to be spun. The wet-spinning process is another outcome of the Napoleonic Wars. It is said that the Emperor had offered a reward for any invention which would improve the French linen industry.* Philippe de Girard developed the wet-spinning process with the object of qualifying for this award, but, being unable to find in France financial backing for his work, de Girard came to England, where Hall, acting on his behalf, obtained a patent, No. 3855, in 1814. The process was used by Robert Busk of Leeds. The secret of the process was so successfully guarded that it almost became forgotten. It received widespread publicity, however, about 1825 due to a lawsuit regarding the validity of another patent (Kay, No. 5226, 1825), which included wet spinning as one of its claims. From then on, wet spinning became widely practised. The immediate result was that yarns of 40^s lea (approximately 40 grammes per kilometre) or two-and-a-half times finer than was previously possible, could then be spun by power.

Development of Machinery.—The limiting factor in the degree of fineness to which yarns could be spun now became the preparatory and not the spinning process. The need for improved preparing machinery immediately occupied the attention of the engineers, and machinery for the long vegetable fibres developed steadily. About the same time as the revival of the wet-spinning process in the flax trade, Houldsworth, of Manchester, introduced his differential roving frame for the cotton trade (Patent No. 5316, 1826). A few years later, in 1833, Lawson and Westley in Leeds patented the screw-gill drawing frame (Patent No. 646, 1833). These two mechanisms together enabled machine-spun flax yarns to be produced up to 250^s lea (6.6 grammes per kilometre) or finer, so that hand spinning ceased to be essential, although for many years the finer counts could still be bought more cheaply from the hand spinners.† Hand-spun yarns were obtainable until the beginning of the present century. Following the famine period of 1846, when the population of Ireland was reduced by about one-third, the shortage of hand spinners created an increased demand for machine-spun yarns and machinery became predominantly important.

Textile Engineering in Belfast.—It is only natural that the engineers of the period—mostly skilled blacksmiths—who were concerned with the maintenance and repair of the machines, should conceive improvements as they worked, and that some should specialise first on the repair and then on the building of textile machines. Thus, round about 1840, several firms of textile machinists had their beginnings in

Belfast. Some of you have had the opportunity of visiting the works of Messrs. James Mackie and Sons, Limited, one of the firms founded about this time and now one of the foremost textile engineering works in the world. Many other Belfast names are known, wherever flax machinery is used, particularly those of Combe and of Barbour, now combined with the Leeds firms of Fairbairn and Lawson. The engineering works in Belfast were originally concerned only with the local trade, which was the wet-spun flax trade. Cotton spinning gradually died out in Belfast during the Nineteenth Century, the local spinners being unable to compete with their Lancashire rivals. On the other hand, Leeds, the birthplace of flax spinning, eventually ceased to have any associations with the flax trade beyond continuing to supply machinery to mills in other areas. Parts of Scotland became important flax-spinning areas, but specialised on the heavier dry-spun yarns.

Expansion of Belfast Engineering Works.—While the local trade in Northern Ireland continued to thrive and develop, the engineering works in Belfast were kept busy, but when the initial demand had been satisfied it soon became apparent that if the machinery makers were to prosper, or even survive, they must establish markets farther afield. First of all, flax-spinning machinery was exported, chiefly to France and Russia, and then, between the two World Wars, one firm extended its products to include machinery for spinning and weaving all types of long vegetable fibres; this it now exports to all parts of the world. To-day, Belfast exports some 25,000 tons of textile machinery annually, the value of which is about 8L. million sterling. Such a wide range of machinery is bound to include mechanisms which are of interest to the general engineer, and in the remainder of the short time available I intend to select a few of the more interesting for your consideration.

The Drafting Operation.—Reference has already been made to the process of drafting. In mechanical spinning, the fibres are first assembled to form a coarse ribbon or sliver which should be uniform in bulk throughout its length. This sliver is then reduced in weight by drafting or drawing it out in the following manner: the sliver is first gripped by a set of slow-moving rollers, and then by a further set of rollers having a surface speed perhaps ten times greater. The result is that the length of the sliver is increased ten times and its weight per unit length reduced proportionately. The distance between the two sets of rollers, known as the reach, must be greater than the length of the longest fibres in the sliver, so that none of the fibres is gripped at both ends and broken. In line flax the length of the fibres may vary from about 30 in. to 12 in., or less, and the control of the short fibres inside the reach has for long presented a problem to the spinner. Left to themselves these short fibres may sometimes be retained by their contact with the fibres gripped by the slow-moving rollers or at other times drawn forward with the fibres gripped by the fast-moving rollers, so that the drafted sliver is not a reduced replica of the sliver fed into the machine but contains a series of thick and thin portions which are very detrimental to the quality of the yarn.

Gill-Controlled Drafting.—Control of these short fibres is established by the use of gills, which are fine combs made up of steel pins. As mentioned earlier, this arrangement was first used in 1801 by Archibald Thompson. Thompson's machine had two sets of gills, one carried by a slow-moving chain and the other by a fast-moving chain—a principle which is still embodied in the Good's machines used to-day for hard fibre and jute—but, as applied to flax, only one set of gills was used. The sliver was fed by the first set of rollers on to the pins of the gills, which had approximately the same surface speed as the rollers, and the fibres, as their ends were presented to the fast-moving rollers, were drawn out through the pins, which thus helped to straighten the fibres in addition to holding back the short fibres until these had been definitely gripped in their proper turn.

In Thompson's arrangement, the bars carrying the pins formed the links of a chain, and the pins swept round radially as the chain passed the sprockets at each end, so that they actually started

to lose control of the fibres at an appreciable distance from the drawing rollers. The screw-gill mechanism, introduced by Westley and Lawson in 1833, was a big improvement in this matter; in fact, after nearly 120 years, it still offers the most perfect control of any method devised. The gill pins in this case are mounted on flat bars, termed "fallers," which are moved along slides by rotating screws. Two sets of screws are used: one pair to move the bars forward along the top slides and the other to return the bars quickly along the bottom slides. Tappets on the end of each screw knock the bars down at the front and up at the back from one screw to the other, as required. Originally the screws were single threaded, but now double- and triple-threaded screws are used as these allow a greater surface velocity to be imparted to the bars without their being knocked up or down with increased violence.

Many other interesting gilling mechanisms are available, of which the push-bar deserves mention. This had its beginning in 1884 as a hybrid between the chain-gill and the screw-gill mechanisms.* The bars are loose and independent, as are the faller bars, but are moved round in slides by sprockets, the bars pushing each other along in the circuit. Modern push-bar machines may be operated at exceptionally high speeds and are very smooth running.

Rove.—A few spinning frames use gills to control the fibres during the drafting operation, but, generally speaking, during the final drafting on the spinning frame itself the fibres are controlled by a different method. The fibres in a sliver are not twisted together but are merely bound to each other by the interference of slight irregularities in their surfaces: a sliver is consequently easily pulled apart. When a sliver is twisted the fibres become more firmly bound together, because the surface layers press inwards on the other fibres and thus increase the inter-fibre friction. The more firmly the fibres are twisted the less easily do they slip, until a stage is reached when the fibres will break before they will pull apart. Additional twist does not add to the tensile strength of a yarn; in fact it detracts from the strength after the optimum has been reached.

It may be shown simply and geometrically that the important measurement of twist is the angle at which the surface fibres of a yarn lie in relation to the axis of the yarn, but as this angle is not easily measured in practice the twist in a yarn is measured as the number of turns per inch length of the yarn. In different sizes of yarn having the same angle of twist, the number of turns per inch varies as the square root of the count of the yarn. In flax yarns it is found that the optimum strength is reached when the turns per inch of twist is about $1.8 \times \sqrt{\text{lea}}$, or $72.5 \div \sqrt{\text{grammes per kilometre}}$. When approximately only one quarter of this amount of twist is inserted the fibres may be drawn apart without damage, although their cohesion to each other is much more definite than in the case of untwisted sliver. This material is termed rove and it is in the form of rove that the fibres are presented to the spinning frame.

Drafting Rove.—When rove is being drafted, the weight of the rove is decreased as it approaches the drafting rollers and, without the addition or redistribution of twist, the binding of the fibres is consequently less in this region; hence only the fibres actually gripped by the drafting rollers should tend to move forward. In practice it is found that the distribution of twist throughout the rove may be uneven or it may tend to run from place to place within the reach, thus allowing irregular drafting to take place. Control is assisted by causing the rove to bear against flat surfaces to prevent axial rotation during drafting. In the worsted trade, where much thought has recently been devoted to this question of twist control,† sensational results have been obtained, and it is now usual to draft the material to 100 or 200 times its original length in one operation, where previously three or four times was considered to be the limit. Drafts of 1,000 have been used experimentally.

The Roving Frame.—I have tried to show that the production of good rove is essential to the

* See J. G. Marshall's paper read at the Leeds Meeting of the British Association in 1858.

† See memorandum from James Nicholson, of Bessbrook, to Andrew Gray, in 1811, quoted in *Linen Trade of Europe*, by Horner (McCaw, Stevenson and Orr, 1920).

* Barbour, Coombe and Gamble, Patent No. 2545, 1884.

† See Ambler and Hannah, *Jl. Textile Inst.*, April, 1950.

spinning of good yarns, and I propose now to turn to the machine on which the rove is produced, this being possibly the most interesting of all textile machines from an engineering point of view. A roving frame has four distinct actions. It drafts out the sliver in the same manner as it is drafted on any of the preceding drawing frames. It then converts the sliver into rove by adding the required degree of twist. The rove is wound on to bobbins so that this delicate material may be handled without damage on the spinning frames, and at the same time is distributed evenly over the surface of the bobbin in such a manner that variations in tension are avoided.

Nothing more need be said about the drafting operation. The twisting operation is performed by means of rotating spindles, each of which carries an inverted U-shaped fitting, known as a "flyer." The material passes from the drawing rollers to the centre of the flyer, directly above the spindle, and because of the rotation of the spindle becomes twisted on itself and so formed into rove. The rove is then led down one of the tubular legs of the flyer and thence to a bobbin which is mounted freely on the spindle. The bobbin is driven in the same direction as, but at a different speed from, the spindle and flyer. This difference in speed causes the rove to be wound on to the bobbin.

It has been mentioned earlier that the twist in rove is not sufficient to prevent the fibres from slipping over each other. If rove is pulled it stretches, and unless this stretching takes place under controlled conditions it takes place unevenly and causes irregularities. The rove must consequently be wound on the bobbin in such a manner that it is not subjected to strain. The bobbins of a roving frame are driven at such a speed that the difference between the bobbin speed and the flyer speed, when multiplied by the circumference of the bobbin, is equal to the surface speed at which the material is delivered by the drawing rollers; in other words, the winding-on speed is exactly equal to the delivery speed.

The material being wound on the bobbin increases the diameter of the bobbin and the difference between the speeds of the bobbin and the flyer must be decreased so that the winding-on speed is maintained constant. It is also essential that each layer of rove should be wound on the bobbin with the coils neither separated nor overlapping, but just touching each other, so that a cylindrical surface is maintained at all times. The rove is distributed along the length of the bobbin by causing the bobbin to rise and fall on the spindle while the flyer remains at a constant height. The rate at which the bobbins are traversed is progressively reduced for each successive layer to allow for the increase in diameter of the bobbin, and, consequently, the longer time which is required to deliver sufficient material to encircle it. There are thus two parts of the machine for which the speed must be automatically altered by precise amounts each time a layer has been completed on the bobbin. The rate of traverse of the bobbin must vary inversely as the diameter of the bobbin, and the rate at which the bobbin rotates must vary in a similar manner when its speed is considered relative to that of the constantly rotating spindles.

In flax-roving frames the bobbins rotate a lower speed than the spindles. As the bobbin diameter is increased the lag of the bobbins behind the spindles must be decreased and the actual bobbin speed increased. Simultaneously, the rate at which the bobbins rise and fall must be decreased. In the first roving frames these two changes in speed were obtained by using two separate variable-speed drives. Such drives had to be infinitely variable to suit different weights of material, and were consequently friction drives and, being subject to slip, could not be depended upon to produce accurate speeds. Three years after the first roving frames had been made by Cocker and Higgins, of Salford, Houldsworth, in 1826, introduced his "differential" roving frame.

Differential Roving.—The main feature of this machine is the use of an epicyclic or "differential" gearbox to drive both the bobbins and the builder rail on which they are raised and lowered. The main drive is split into two components in the same

manner as that in which the drive is divided between the two rear wheels of a motor car. In a roving frame, as the speed of the builder is decreased the speed of the bobbins must be increased by a proportionate amount. One lightly-loaded variable-speed friction drive is retained to balance the builder speed exactly. The correct bobbin speed automatically results, and the drive to both parts is practically positive. The roving frame, incidentally, pre-dated the motor car by a great many years. Houldsworth's differential is still used in motor cars, but other types, notably those designed by Gibson (Patent No. 22,058, 1909), and Suffern (Patent No. 25,430, 1905), are more generally used in modern roving frames.

Three different types of friction drives are used—cones, discs and expanding pulleys. When cones are used, these must be constructed in pairs so that the length of the belt driving from one to the other remains constant in all positions and, at the same time, the change in speed of the driven cone is inversely proportional to the diameter of the bobbin as the cone belt is moved from one end to the other in equal steps corresponding to equal increases in the diameter of the bobbin. The disc drive consists of two contra-rotating discs driving a leather-face bowl, the position of which is controlled by a scroll cam so that the speed of the bowl varies in the desired manner. The expanding-pulley drive used on textile machinery (Wilson, Patent No. 10,745, 1891) is of interest for it is believed to be the original of that type of variable-speed drive which has now many applications in other fields of engineering.

Machine Hackling.—Differential gearing is applied to some textile machines other than the roving frame, notably to the hackling machine. Hackling is the combing operation to which the flax fibre is first subjected on its arrival at the mill. The object is to disentangle and straighten out the fibre strands, and then to separate and subdivide the strands to produce fine fibres. The operation was originally done entirely by hand, by taking a piece of flax and casting first the root, and then the top end of the piece over the pins of a hackle composed of several rows of strong coarse pins embedded, points uppermost, in a block of wood secured to a bench. Each end was drawn several times through the coarse hackle, then through a finer one, and so on until the work was complete.

In machine hackling the pieces of flax are clamped in holders which are moved along a slide. This slide is raised and lowered. As it descends the free ends of the pieces of flax pass between two sets of pins carried round by belts or sheets, and are so hackled. Each time the slide is raised the holders are moved forward one position, and the pins at each position become progressively finer and more closely set, so that the work proceeds gradually. There are from 16 to 22 positions in each machine, and two machines form one unit—one machine to hackle the root and the other to work the top ends of the pieces. The rate at which the pins pass through the fibres has a marked effect on the standard of the work produced. Normally, this is at times the surface speed of the sheets, at other times the sum of this speed and the speed at which the holders are being raised, and again, at other times, the difference between these two speeds. It is therefore sometimes preferred to drive the sheets through a differential gearbox by means of which the movement of the holders up or down is reproduced in the hackle sheets. The speed of the sheets is thus constantly varied so that their speed relative to the flax in the holders remains uniform. (Metcalf, Patent No. 29,471, 1913, and Barbour, Patent No. 257,692, 1925).

Conclusion.—Textile machines embody many other mechanisms which are certain to prove fascinating to any one who is interested in things mechanical. I can only hope that I have whetted your appetites, and that some, at least, from among you may feel it worth your while to study this subject for yourselves.*

* Suitable books are: Morton, *Introduction to the Study of Spinning* (Longmans, 1949); Pringle, *Theory of Flax Spinning* (Carter, 1949), and *Mechanics of Flax Spinning* (Carter, 1951); Woodhouse and Kilgour, *Jute and Jute Spinning* (Macmillan, 1929).

OPERATING STATISTICS OF THE AIRWAYS CORPORATIONS.

THE Ministry of Civil Aviation have published recently the operating and traffic statistics, for the financial year April 1, 1951, to March 31, 1952, of the United Kingdom airways corporations and their associate companies. In comparison with the previous year, the total available capacity, in short ton-miles, increased by 15.8 per cent., from 212,973,245 short ton-miles to 246,714,898 short ton-miles. Of this capacity, British Overseas Airways Corporation (B.O.A.C.) contributed 186,723,512 short ton-miles—an increase of 18.4 per cent. over the previous year, and British European Airways (B.E.A.) 56,414,506 short ton-miles, an increase of 6.9 per cent. The balance, 3,576,880 short ton-miles, contributed by the associate companies, represents an increase of 42.9 per cent. over that of the previous year.

The actual load ton-miles flown during the year were as follow: B.O.A.C., 122,699,788 short ton-miles, an increase of 30.3 per cent. over the previous year; B.E.A., 36,411,310 short ton-miles, an increase of 19.8 per cent.; and the associate companies, 2,071,932 short ton-miles, an increase of 66.1 per cent. The overall revenue load factors (i.e., the percentage of the total revenue short ton-miles flown to the usable capacity) have improved over those of the previous financial year, in the case of B.O.A.C., from 59.7 per cent. to 65.7 per cent.; in B.E.A., from 57.6 per cent. to 64.5 per cent.; and in the associate companies, from 49.8 per cent. to 57.9 per cent.

The total number of passengers carried rose from 1,197,544 in the year 1950-51 to 1,436,251 in 1951-52, an increase of 19.9 per cent. B.E.A. carried 1,135,579 of these passengers, an increase of 20.9 per cent. over the previous year; B.O.A.C. carried 243,692, an increase of 24 per cent. The number of passengers carried by the associate companies decreased, by 7.3 per cent., to 56,980, but the amount of freight carried by them increased from 6,366.8 short tons in 1950-51 to 19,159.3 short tons in 1951-52—an increase of more than 200 per cent. The freight carried by B.E.A. during the year increased by 22.7 per cent., to 13,915.3 short tons, and that carried by B.O.A.C. amounted to 6,321.7 short tons, an increase of 15.1 per cent. over the previous year.

The average annual utilisations achieved by the national airways corporations were as follow: B.O.A.C., 2,024 revenue hours per aircraft, and B.E.A. 1,527 revenue hours per aircraft. B.O.A.C. achieved a percentage regularity of 98.4 per cent., whereas that of the B.E.A. services was 95.2 per cent. The private companies operating in association with the national corporations achieved a percentage regularity of 98.6 per cent.

UNITED KINGDOM PRODUCTION OF PIG IRON AND STEEL.—The production of steel ingots and castings in this country was at an annual rate of 17,951,000 tons in November, compared with a rate of 17,044,000 tons in the previous month and of 16,437,000 tons in November last year. The November, 1952, total is the highest rate recorded in the history of the industry. Pig-iron production in November was at an annual rate of 10,753,000 tons, against a rate of 10,616,000 tons in October and of 10,194,000 tons in November, 1951.

PROPANE AS FUEL IN VENEZUELA.—Liquefied petroleum gas, in this case propane, is now being pumped through submarine discharge lines as part of a scheme to improve the supply of this fuel to Caracas, the capital of Venezuela. The propane is used mainly for domestic cooking and heating. It has also many applications among local industries. The product is shipped in bulk by tanker from the Shell Petroleum Co.'s Cardon refinery on the Paraguaná Peninsula to a 140-ton capacity storage installation at Catia de la Mar about 10 miles from Caracas. It is here that the cargo is discharged through a 4-in. diameter submarine pipeline, about $\frac{1}{4}$ mile long. Water is pumped through a second pipeline into the cargo tanks of the tanker and so forces the liquid propane out through the discharge line to the storage tanks on shore. An automatic water separator prevents the discharge water from passing through to the storage tanks. From Catia de la Mar, the liquid gas is pumped through a 10 $\frac{1}{2}$ mile, 8-in. diameter pipeline to a storage installation at Caracas which has a total capacity of 280 tons. Here facilities have been installed for putting the propane into steel cylinders.

X-RAY EQUIPMENT FOR RADIOGRAPHY OF WELDS.

Fig. 1. SECTIONAL ELEVATION OF MAIN COMPONENTS.

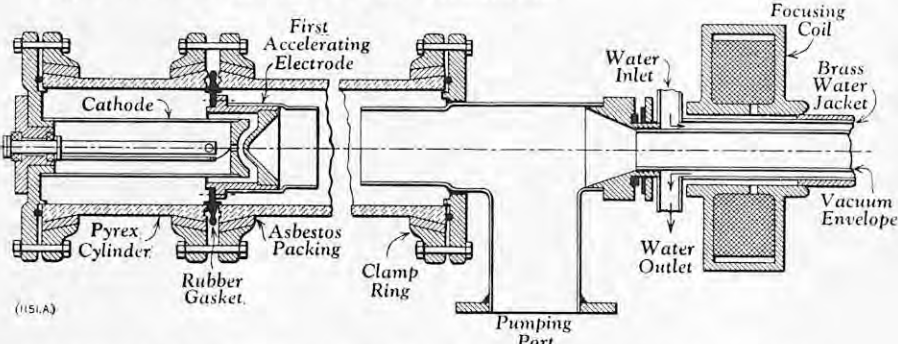


Fig. 3. SECTIONAL DETAILS OF END OF TARGET EXTENSION TUBE.

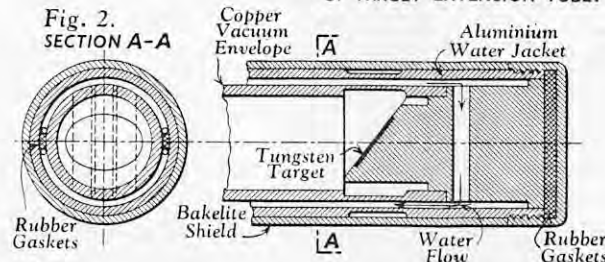
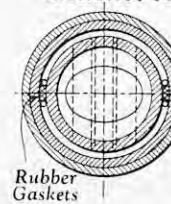


Fig. 2. SECTION A-A



150-KV X-RAY EQUIPMENT FOR THE RADIOGRAPHY OF WELDS.*

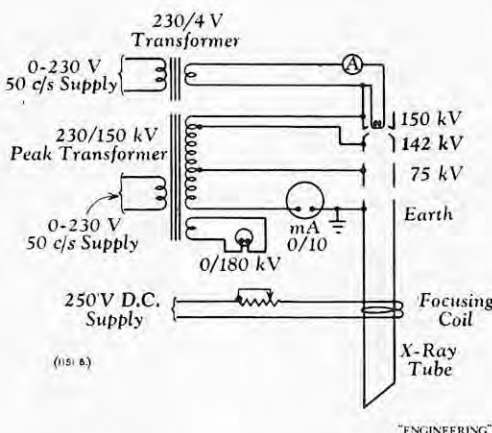
BY F. W. WATERTON.

THE 150-kV 50-cycle continuously-evacuated X-ray equipment described in this paper was constructed to radiograph circumferential welds in a hollow fabricated drum or pipe, into the interior of which radioactive capsules could not be inserted. The anode of the equipment is supported at the end of a jacketed tube, the internal diameter of which is 1 in. and the length 43 in. Gas-turbine rotors up to 70 in. long can therefore be radiographed, since the tube can be inserted from either end through a 1.75 in. hole in the shaft. A complete set of radiographs of a rotor can be produced in two days, compared with two weeks required with radium. There is also a marked improvement in definition and resolution. In order to facilitate delivery, the tube was continuously evacuated. The rated output voltage is 150 kV peak and the mean current is 5 milliamperes. The centre of the tube target is 1.5 in. from the end of the support tube and the focal spot is 4 mm. in diameter and receives about 95 per cent. of the electrons leaving the cathode stage. By subdividing the accelerating voltage, several electron lenses can be used for controlling the size and divergence of the beam and for projecting it over long distances without the loss of a large proportion of the beam current. The tube stability is also improved by reducing the voltage gradients between electrodes and thus increasing the safe working pressure.

Magnetic focusing is used to correct misalignment of the electrodes, to control the divergence of the beam on its passage down the support tube and to provide a small focal spot in the centre of the target. During acceleration, the beam diameter is determined by the voltages applied to the first two lenses, the ratio between them having an optimum value, which should give a parallel beam. The choice of accelerating voltage for the first lens is governed by the necessity of providing adequate current to avoid saturation at maximum tube current; otherwise the beam will spread out and cause overheating of the anode electrode. The contours of this lens give a beam of minimum divergence and uniform intensity. The accelerating voltage of the second lens has been arranged to give minimum divergence and cross section to the beam entering the third lens. The remainder of the accelerating voltage (75 kV) is applied across this third lens, thus producing a small reduction in beam cross section and divergence. By constraining the beam in this way X-ray outputs 25 to 50 per cent. higher than those obtained from the same tube voltage and current in similar multi-stage tubes have been obtained.

The magnetic focusing coil is situated as close as possible to the pumping port, so as to reduce the overall length of the electron path, but at the same time to leave the required length of small diameter anode-support tube for insertion in the rotor. As the tube is excited by alternating current, the direct-

Fig. 4. MAIN CONNECTIONS.



current coil may be used to concentrate the faster electrons in an appreciably smaller area than that of the spot corresponding to the complete electron beam. The beam is fairly sensitive to stray fields in the region between the coil and the target and is shielded by wrapping the anode extension with an overlapping layer of Mumetal tape 1 in. wide and 0.01 in. thick. When the tube is in use, the target extensions are surrounded by a complex steel structure which may have considerable residual magnetism.

The X-ray tube envelope is made up of three main sections—the electrode assembly and major insulation, a pumping section and the anode and supports. As shown in Fig. 1, the high-voltage electrode system is supported on three moulded Pyrex tubes. The cylinders are ground plane-parallel on the ends and also internally at each end to register with a spigot on the steel rings which are used to support the accelerating electrodes. Vacuum tightness is obtained by a 1/8-in. diameter rubber cord, which is inserted in a groove in the steel support and is compressed by internally-tapered cast-iron clamp rings tightened on to the ends of the glass cylinders. A soft packing ring is inserted between the ring and its cylinder to allow for unequal expansion and to enable the clearance between the two, which is necessary during fitting, to be taken up. The cathode is mounted on a separate flange, which is fitted into the steel end plate of the tube to simplify the alignment of this electrode when the filament is replaced. Stress distributors or electrostatic shields are provided over the cathode end and intermediate electrode supports to prevent corona discharge and to shield the filament connection. The pumping section of the tube, which is also shown in Fig. 1, consists of a steel T-piece with a flange supporting the high-voltage electrode system and a reducing piece at the opposite end to accommodate the target-support tube. The pumping port is bolted to the main support plate for the diffusion pump and forms the only support for the X-ray tube.

The extension tube, which is shown in Figs. 2 and 3, has to support the target and also to provide passages for the cooling water. The vacuum envelope in this section consists of a copper pipe with a bore of 1 in. and a wall 1/8 in. thick, which is bored out to a thickness of 1/100 in. for 3/4 in. opposite the target to form an X-ray window.

Two rubber gaskets are fitted into grooves at each end of a horizontal diameter through the tube to form the water feed and return passages between the target support tube and the brass jacket. The water jacket at the target end is formed by an aluminium tube which is turned down to a thickness of 1/100 in. opposite the X-ray window and is joined to the main brass water jacket by a ferrule. The focusing coil is supported from the water jacket on the anode by eight screws, thus enabling the coil to be set so as to bring the focal spot into line with the centre of the target. The winding is insulated from the spool and protected against surges and high-frequency pick-up by a Metrosil disc, which is permanently connected across the terminals. The coil is shielded magnetically by a 1/8-in. steel cover to prevent the concentration of stray flux by the specimen from deflecting the electron beam.

The tube is continuously evacuated by a diffusion pump backed by a two-stage rotary pump. The pumping sequence is completed automatically when the main switch is closed, the electrically-operated tap and pump heater being controlled through a Pirani-type relay by the vacuum conditions. A thermal switch is provided on the diffusion pump to prevent the tube filament from being excited until the heater has reached the required temperature. Relays cut off the high-voltage supply and the pump heater if the water flow is inadequate.

The standard high-voltage transformer was modified by providing taps at 150, 142 and 73 kV, and a voltmeter winding giving 192 root mean-square volts at 150-kV peak is incorporated in the secondary-coil stack near the earthed end. The tank also houses the tube-filament transformer, which consists of the core and winding of a standard 150-kV filament transformer. The filament supply is taken from the secondary of this transformer through the conductor of the 150-kV bushing by an insulated cable, the conductor itself forming the return connection. A separate filament transformer was preferred to a winding on the main transformer as it simplified the remote control of the filament current. The main connections between the transformer and the X-ray tube are shown in Fig. 4.

The equipment is very stable electrically and was run up for the first time to full load in less than 25 min. after the main switch had been closed. Of this time, 20 min. was utilised in warming up the diffusion pump. After the tube has been run up to full load the X-ray output appears to rise steadily for the first 10 min., but subsequently remains reasonably stable. This is probably due to some cleaning up of the gases in the vacuum system owing to the warming up of the electrodes and the target tube. The X-ray output, as measured on open field without back scatter and after the initial warming-up period, is 6.8 röntgens per minute at 50 cm. at 150 kV peak and a mean current of 5 milliamperes. This value was reached in the centre of the beam after the tube had been switched on for 10 min. and remained constant unless the tube was shut down for some hours. The focal spot was about 4 mm. in diameter with a focusing-coil current of 110 milliamperes. The X-ray output varied with the focus, a 20 per cent. change in coil current making a difference of about 10 per cent. The X-ray intensity at right angles to the

* Paper entitled "A 150-kV X-Ray Equipment for the Radiography of Circumferential Welds in Gas Turbine Rotors," read before the Institution of Electrical Engineers on Thursday, November 13. Abridged.

ROAD BRIDGE AT GREAT YARMOUTH.



tube was 75 per cent. of the maximum over an angle of 120 deg. and 50 per cent. over 150 deg. The high-voltage transformer is controlled by a Variac, which is adequate for giving the required working voltage on the tube. The filament supply is also taken through a constant-voltage transformer, in order to obtain a sufficiently steady tube current. The quality of the X-ray beam was estimated by measurements of the half-value layer in copper; it was found to be 0.75 mm.

The equipment has been used with success to radiograph the circumferential welds in the fabricated rotors of gas turbines, the contrast being many times better than when a radium capsule is employed, 2 to 3 per cent. cavities being easily visible. There is also an overall saving in time of about 90 per cent., even after allowance has been made for the fact that three exposures are necessary with the X-ray tube, compared with one for radium, and that the setting-up time is increased. The contrast between the radiographs obtained by the two methods is also noteworthy.

The length of the anode-support tube is slightly more than half the length of the rotor, so that the anode has to be inserted from each end in turn. Since the beam has an included angle of 150 deg. at right angles to the tube, the rotor and tube had to be relatively rotatable and these relative motions had to be obtained by manipulating the rotor, as the tube was fixed owing to the limitations imposed by the pumping plant. A truck was therefore designed to give the necessary motions to the rotor and was mounted on rails fitted to the tube base-plate, so that the rotor could be run on and off the anode. A turntable was provided on the truck to allow the rotor to be turned through 180 deg. A latch was fitted to locate the rotor accurately in line with the rails in both positions. Finally, two bearings were mounted on the turntable, so that the rotor could be turned about its own axis. Owing to the small clearance between the hole in the end of the rotor and the tube anode the axes of the rotor and of the tube had to be within $\frac{1}{8}$ in. of one another in all the required positions. To facilitate the alignment of the X-ray beam and the weld a lamp was provided which shone vertically downwards on to the centre of the tube target. This was sufficient to give the centre line of the X-ray beam, the estimation of the angular spread being left to the operator.

To take a radiograph of a specimen, the equipment is started by closing the mains switch and turning on the cooling water. The pumping sequence is completed automatically and the tube is then run up to full voltage and current. The focusing coil is switched on and set to 110 milliamperes. After allowing about 10 minutes for the equipment to stabilise, the high-voltage control is run down to zero and switched off. The weld and film are then located with respect to the X-ray beam and the high voltage again applied to the tube.

The main disadvantage of the equipment is the large amount of space occupied, although this could be reduced by employing a sealed-off tube. The volume of the transformer could be reduced by 50 per cent. by designing it specifically for exciting

the tube and providing its secondary with a filament winding controlled by a reactor. The space required for the complete head could also be decreased by about 25 per cent. In view of the short exposure required, further development of the equipment on a short-time rating basis would appear to have distinct possibilities. If a beam which made an angle of 75 to 85 deg. with the tube axis could be utilised it could be made to extend over a 360 deg. instead of a 150 deg. arc and by fitting a flat target the time necessary for examining a single weld would then be still further reduced.

CALLENDER-HAMILTON ROAD BRIDGE AT GREAT YARMOUTH.

ONE of the advantages of the Callender-Hamilton system of bridging is that the main deck cross-bearers can be fitted either above or below the bottom chords of the main girders. This feature has been useful in the construction of a road bridge of this type at Great Yarmouth, where the construction depth between road level and the underside of the bridge had to be kept within 2 ft. 4 in. so as to ensure a specified clearance above the water level of the River Bure below. The cross-bearers have been fitted below the level of the bottom chords. The bridge, shown in the accompanying illustration, carries a main road across the river between North Quay and Hele New Road. It has a span of 110 ft., a double carriageway 18 ft. wide and a clear headroom of more than 18 ft. A footway 5 ft. wide is carried on cantilevered supports outside one of the main girders.

The roadway decking is of the type now recommended for use on Callender-Hamilton bridges in Great Britain, consisting of concrete-filled pressed-steel troughing laid longitudinally and butt-jointed to develop continuity of strength. The main bridge steelwork was assembled complete on the shore and moved to a position with the projecting end sufficiently far advanced to enable a barge with supporting scaffolding to be floated in under the penultimate panel point, where, on a rising tide, the weight of the end of the bridge could be supported. With the tail end of the bridge mounted on rollers, the operation of floating the bridge across the river and landing it on the supporting jacks on the two abutments was carried out in 5½ hours. The illustration shows the barge being removed. Completion of the bridge entails the fitting of the side-walk and pressed-steel troughing, and the concreting of the deck surface to connect up with the new road formation, enabling traffic to use the bridge while the old bridge of tubular construction, which has been in use for many years, is dismantled. The old bridge is shown in the background in the illustration.

The main bridge steelwork was fabricated by Painter Brothers, Limited, Hereford, galvanised in accordance with the normal practice for these bridges and delivered to the site "piece small." The pressed-steel troughing, together with steel kerbs, ballast plates and abutment steelwork, was supplied by Dorman, Long and Company, Limited,

Middlesbrough. The contract for the erection of the bridge was undertaken by Carter Horsey (Engineers), Limited, Merebank-avenue, Waddon, Surrey, for the County Borough of Great Yarmouth.

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World Railways, 1952-53.

Edited by Henry Sampson, Sampson Low, Marston and Company, Limited, 25, Gilbert-street, London, W.1. [Price 4 guineas net.]

This is the second edition of a reference book which was first issued about 18 months ago. The information given about each railway includes a map, brief history, track and route length, number of locomotives, signalling and train control systems, amount of traffic carried, gradient profile, notable bridges and tunnels and livery and emblem, the whole being fully illustrated. For ease of reference it is divided into six geographical areas, in which each country is arranged alphabetically; and it consists of 550 pages of text matter and nearly 1,000 illustrations. The real usefulness of such a book, which is inherently great, can only be assessed by employing it, but it is clear that much care has been taken to bring the information up to date. Absolute completeness is, of course, an ideal which cannot be realised; and it is still proving difficult, although the position has improved, to obtain information from a number of administrations. There is evidence that the steam locomotive still maintains its lead as the principal form of motive power, and details are given of a number of new units which have recently been put into service. In the Americas, however, the number of Diesel-electric units is increasing, particularly in the United States, where over 12,000 are now said to be in service. This represents about one third of the total stock, while a considerably higher proportion of the total traffic is being hauled in this way. On the other hand, electrification is being extended in Europe, especially in those countries where a plentiful supply of water power is available. In assessing the position generally, the fact that France is now the leading exponent of the 1,500-volt direct-current system is unaccountably omitted, although excellent illustrations and full data regarding two of the locomotives that are being used are given. The experiments with 50-cycle traction in that country are also noted. Generally speaking, the information given varies considerably from country to country. For instance, data regarding maximum axle load is omitted from the British section, although it is included for some other countries. Such discrepancies are, however, common to many publications of this type, and *World Railways*, being by far the most comprehensive work of reference on this subject, can be strongly recommended.

Select List of Standard British Scientific and Technical Books.

Edited by E. R. McCOLVIN. Fourth revised and enlarged edition. Aslib, 4, Palace-gate, London, W.8. [Price 6s. to members of Aslib, 7s. 6d. to non-members.]

THE Aslib select list, first published in 1937, was compiled at the request of the British Council. Its aim, it is stated in the preface, is to help organisations and individuals in assembling "a representative library of the best books in science and technology" and "in giving the worker in a specialist field a guide to some standard books on an allied subject..." With a few exceptions, it is limited to works in print. The list is arranged under classified headings and subdivisions, and covers the pure sciences, medical science, the main branches of engineering and technology, and allied subjects such as architecture, transport, education, and economics. It is stressed, however, that the list is not intended to be exhaustive, and that is indeed the case. Some of the most widely used and indispensable British engineering and industrial reference books find no place in this list, and it seems possible that the "worker in a specialised field" may find it more profitable to consult directly the lists issued by publishers of technical and scientific books.

The Beama Catalogue, 1952-1953.

Iliffe and Sons, Ltd., Dorset House, Stamford-street, London, S.E.1.

THIS is the second edition of a large volume of over 1,000 pages, which was first published in 1949-50 and is still modestly described as a catalogue. It is really a well-illustrated and informative encyclopædia of the activities of the member firms of the British Electrical and Allied Manufacturers Association and should be of the greatest value in bringing the industry's products to the attention of possible buyers. The descriptive pages are arranged in three main groups, which cover plant required for a modern electricity supply system; equipment used in industry, transport and communications; and domestic and commercial electrical appliances, respectively. In the case of the

larger firms at least, there is therefore a certain amount of repetition, but confusion will be prevented by the complete index. A useful feature, which appears for the first time, is a glossary in five languages—English, French, German, Portuguese and Spanish—which should help a world-wide readership in the book's use of technical terms. A classified buyer's guide lists the range of electrical and allied equipment manufactured by members of the Association. A trade directory gives the addresses of the Beama Export Organisation and Beama committees overseas; the principal addresses in this country of all Beama firms, with their telephone numbers and cable addresses; and the names and addresses of many of those firms' overseas branches, representatives and agents. The catalogue is being distributed privately to buyers and trade commissioners in all overseas countries.

CONTRACTS.

HEAD, WRIGHTSON & CO. LTD., Teesdale Iron Works, Thornaby-on-Tees, have been awarded a contract by John Summers & Sons Ltd., Shotton, Chester, for doubling the pig-iron output of the plant at present under construction. The firm are now completing a plant at Shotton for the anticipated production of approximately 1,000 tons of pig iron a day. This plant covers ore-unloading, crushing, screening and sintering and a complete blast-furnace installation with gas-cleaning equipment and special rolling stock. The new plant now ordered will be a duplicate of that nearing completion.

LEONARD FAIRCLOUGH LTD., Chapel-street, Adlington, Lancashire, are to construct a culvert under the Bridgewater Canal, at Overbridge No. 50 on the Crewe to Warrington line of the London Midland Region of British Railways.

THE COPPÉE COMPANY (GREAT BRITAIN), LTD., Marylebone-road, London, N.W.1, are to commence work early next year on the construction of a coal-washing plant at the Monkton Coke Works, Hebburn-on-Tyne, of the Durham Division of the National Coal Board, at Shotley Bridge, County Durham.

BRAITHWAITE & CO. ENGINEERS LTD., have secured two contracts for port extension works in Africa. Both will be based on the use of the firm's Screwcrete system of piling. One contract involves the building of a new jetty at the port of Tiko, British Cameroons, for the Cameroons Development Corporation. The other contract comprises the construction of new wharves at Kilindini, Mombasa, for the East African Railways and Harbours Administration. The estimated cost of the two contracts is in the region of 2,000,000l.

THE DE HAVILLAND AIRCRAFT CO. LTD., Hatfield, Hertfordshire, have obtained an order from Sweden for a number of Venom night-fighting aeroplanes. They will be fitted with de Havilland Ghost jet engines, built under licence in Sweden.

CRYPTON EQUIPMENT LTD., a subsidiary company of Lancashire Dynamo Holdings Ltd. have received from the Near East an order for items of motor-car service equipment, comprising fast battery chargers, electrical test benches, distributor analysers, portable engine test equipment, and electrical service tools.

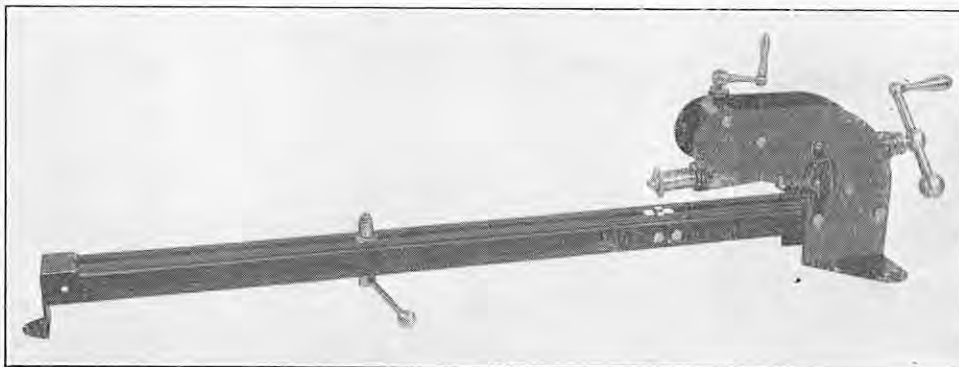
LEYLAND MOTORS LTD., Leyland, Lancashire, announce that a contract for 40 large-capacity single-deck trolleybuses has been placed with **BRITISH UNITED TRACTION LTD.**, by the Transport Board of Auckland, New Zealand. The two-axled chassis will accommodate a body 35 ft. in length and 8 ft. 6 in. in width and the wheelbase measures 18 ft. 6 in. The electrical equipment is to be manufactured by the **BRITISH THOMSON-HOUSTON CO. LTD.**, the traction motor having a one-hour rating of 125 h.p., on 550 volts direct-current. The bodywork will be to the design and construction of **SAUNDERS-ROE (ANGLESEY) LTD.** The door operating gear, supplied by **G. D. PETERS LTD.**, utilises a differential air motor for each doorway. The controls are electro-pneumatic and are operated by push buttons fitted adjacent to the driver's seat.

SHORT BROTHERS AND HARLAND LTD., have concluded a contract with the Government of East Bengal for the supply of two Sealand Mark I amphibian aircraft. They are intended for service with the Provincial Transport Commission and will be employed for furthering the communications of the Commission over the widespread territory under its administration. The Sealands will be equipped to carry five passengers and will be based at Dacca. They are to be fitted with de Havilland "Gipsy Queen" 70-4 engines.

MARCONI'S WIRELESS TELEGRAPH CO. LTD., Chelmsford, Essex, have been awarded, through Marconi (South Africa) Ltd., an order worth 250,000l., involving the provision of nine 20-kW high-frequency transmitters to be centred on one site. The new system will be additional to the existing medium-frequency transmitters already serving part of the Union of South Africa, and the new transmitters will be installed at Paradys, near Bloemfontein.

RING-CUTTING MACHINE.

RICHARD KLINGER, LIMITED, SIDCUP.



BOOKS RECEIVED.

Firing Equipments and Their Fuels. Section I. *Shell Boilers Fired by Solid Fuel.* The Combustion Engineering Association, 6, Duke-street, St. James's, London, S.W.1. [Price 10s. post free.]

National Physical Laboratory. Notes on Applied Science. No. 2. The Industrial Application of Aerodynamic Techniques. H.M. Stationery Office, Kingsway, London, W.C.2. [Price 3s. 6d. net.]

Transactions of the Danish Academy for Technical Sciences. 1952. No. 2. Some Experiments with Sleeve Bearing Metals. By BØRGE LUNN. Akademiet for de Tekniske Videnskaber, Copenhagen, Denmark. [Price 18 kroner.]

Druck-, Zug- und Mengenmessung. Wärmetechnische Lehrblätter, Part 5. Verlag Stahlseisen m.b.H., Breite Strasse 27, Düsseldorf, Germany. [Price 8.50 D.M.]

Ministry of Transport. Railway Accidents. Report on the Collision which Occurred on 21st January, 1952, at Clydebank Station in the Scottish Region, British Railways. H.M. Stationery Office, Kingsway, London, W.C.2. [Price 6d. net.]

Forest Products Research. Kiln Operator's Handbook. By W. C. STEVENS and G. H. PRATT. H.M. Stationery Office, Kingsway, London, W.C.2. [Price 10s. 6d. net.]

Die Tragfähigkeit metallischer Baukörper in Bautechnik und Maschinenbau. By DR.-ING. KARL HELMUT RÜHL. Wilhelm Ernst und Sohn, Hohenzollerndamm 169, Berlin-Wilmersdorf, Germany. [Price 24 D.M. in paper covers, 27 D.M. bound]; and Lange, Maxwell and Springer, Limited, 41-45, Neal-street, London, W.C.2. [Price 42s. in paper covers, 47s. 3d. bound.]

United States National Bureau of Standards. Circular No. 519. Low-Temperature Physics. Proceedings of the N.B.S. Semicentennial Symposium held on March 27, 28 and 29, 1951. The Superintendent of Documents, U.S. Government Printing Office, Washington 25, D.C., U.S.A. [Price 1.75 dols.]

The Beama Catalogue, 1952-53. Hiffe and Sons, Limited, Dorset House, Stamford-street, London, S.E.1. [For private distribution.]

British Express Locomotive Development, 1896-1948. By EDWARD CECIL POULTNEY. George Allen and Unwin, Limited, Ruskin House, 40, Museum-street, London, W.C.1. [Price 21s. net.]

La Traction Électrique et Diesel-Électrique. By PIERRE PATIN. Editions Léon Eyrolles, 61, Boulevard Saint-Germain, Paris (5e). [Price 2,500 francs.]

British Engine Boiler and Electrical Insurance Company, Limited. Technical Report. New Series, Vol. I. Offices of the Company, 24, Fennel-street, Manchester, 4. [Price 12s. 6d.]

Radioisotope Techniques. Proceedings of the Isotope Techniques Conference, Oxford, July, 1951, sponsored by the Atomic Energy Research Establishment. Vol. II. Industrial and Allied Research Applications. H.M. Stationery Office, Kingsway, London, W.C.2. [Price 25s. net.]

Unesco. Agreement on the Importation of Educational, Scientific, and Cultural Materials. H.M. Stationery Office, Kingsway, London, W.C.2. [Price 1s. net.]

Designing by Photoelasticity. By DR. R. B. HEYWOOD. Chapman and Hall, Limited, 37, Essex-street, London, W.C.2. [Price 65s. net.]

High Speed Photography. By GEORGE A. JONES. Chapman and Hall, Limited, 37, Essex-street, London, W.C.2. [Price 42s. net.]

Forty-Fourth Annual Report of the Hydro-Electric Power Commission of Ontario, 1951. Offices of the Commission, 620, University-avenue, Toronto, Ontario, Canada.

Melbourne and Metropolitan Tramways Board. Report and Statement of Accounts for the Year Ended 30th June, 1952. Offices of the Board, 616-622, Little Collins-street, Melbourne, Australia.

RING-CUTTING MACHINE.

A MANUAL machine for rapidly cutting jointing rings up to a maximum outside diameter of 48 in. and a minimum inside diameter of 2 in. has been produced recently by Messrs. Richard Klinger, Limited, Klingerit Works, Sidcup, Kent. Developed in the first place for cutting Klinger jointing materials, on the same principle as the large ring-cutting machines installed in their works, the machine can also be used for cutting cardboard, rubber, cork, felt, and similar materials. A 24-in. diameter ring $\frac{1}{8}$ in. thick can be cut in less than 20 seconds.

The Klingerit ring-cutting machine is shown in the accompanying illustration. The cutting wheel is fixed to a manually-operated shaft supported in a bearing tube which is adjustably mounted so that the height of the cutting wheel can be set as desired by the feed screw. When a ring is to be cut, a centre pin, slidably mounted on the base framework, is adjusted and locked to give the desired cutting diameter, a steel tape being provided with the machine for setting. A circular base disc, $\frac{1}{8}$ in. thick, with a central hole, is then located on the centre pin; a 15-in. diameter disc is supplied with the machine, but larger discs are available if desired. This disc bears on a roller mounted on the base framework immediately below the cutting wheel. A $\frac{1}{2}$ -in. diameter hole is punched roughly in the centre of the material to be cut (a punch being supplied for this purpose), which is then placed on the base disc. The cutting wheel is lowered on to the material, and the cut is made by rotating the large handle seen at the right of the illustration.

TRADE PUBLICATIONS.

Geared Motors.—Geared motors and speed-reduction units are described in a leaflet received from Electropower Gears Ltd., Kingsbury Works, Kingsbury-road, London, N.W.9. The leaflet deals with speed-reducing units for use either with electric motors or separately, which can be coupled together to give speed reductions of the order of 1 to 1,500,000. Reference is made also to the firm's magnetic disc brake, a totally-enclosed unit designed to fit any ball-bearing motor having a suitable shaft extension at the non-driving end.

Heavy Engineering.—A brochure describing the organisation and scope of their group of companies has been issued by Head, Wrightson & Co. Ltd., Thornaby-on-Tees, Yorkshire. The group is divided into ten principal divisions and subsidiary companies, eight of which are situated on Tees-side, one in London and one in Johannesburg. Their activities are mainly largely the production of equipment and components for the industries dealing with coal and oil, iron and steel and non-ferrous metals.

Battery Charging.—Notes on electric battery charging are given in a booklet, entitled "Putting it Back," which has been published at the price of 1s., including postage, by Easco Electrical Ltd., Brighton-terrace, London, W.8.

Instruments for Radio-Isotope Applications.—The Scientific Instrument Manufacturers' Association, 20, Queen Anne-street, London, W.1, have issued, in collaboration with the Atomic Energy Research Establishment, Harwell, a 17-page directory giving brief particulars of instruments and equipment for radio-active assay, radiation monitoring, and other radio-active isotope applications, with the names and addresses of the makers.