THE BRITISH INDUSTRIES FAIR AT BIRMINGHAM—I.

THE British Industries Fair, in Coronation year, is expected to attract an unusually large number of buyers from overseas. It is due to open on Monday, April 27, and close on Friday, May 8. The engineering section—the largest of the whole fair—is again at Castle Bromwich, Birmingham, where 490 firms are showing, but there is also, this year, a new section at Olympia, London, devoted to small craft, as well as a section on caravans, partly at Earls Court, London, and partly at Castle Bromwich. We commence below some brief descriptions of exhibits of engineering interest.

ELECTRONIC WEIGHING SCALE.

Messrs. W. and T. Avery, Limited, Soho Foundry, Birmingham, 40, will exhibit a new electronic scale, shown in Fig. 1, herewith, which is designed to deliver a constant flow of material, measured in pounds per hour. This machine represents a new advance in the mechanisation of industrial weighing. Instead of having to weigh individual quantities by hand, materials can be fed in at one end, and the scale ensures that the correct weight flows out at the other. Once it has been set, the machine is self-correcting. The constant-rate feed scale is designed particularly for the non-stop mixing and blending of granular-type materials—chemicals, baking ingredients, powders, etc.—fed into it by gravity, or by a screw conveyor if the material is not free-flowing. A blanket of material is supplied to a moving belt and balanced against a weigh-box. As long as the correct weight is flowing along the belt the feed stays constant. If there is an error of only three drams, an electronic switch fitted to the scale alters the feed to correct the error. A very wide range, in pounds per hour, can be covered by altering the weights in the weigh-box and by the choice of belt speed. Messrs. W. and T. Avery, Limited, will also exhibit some of their other machines for weighing, counting, etc.

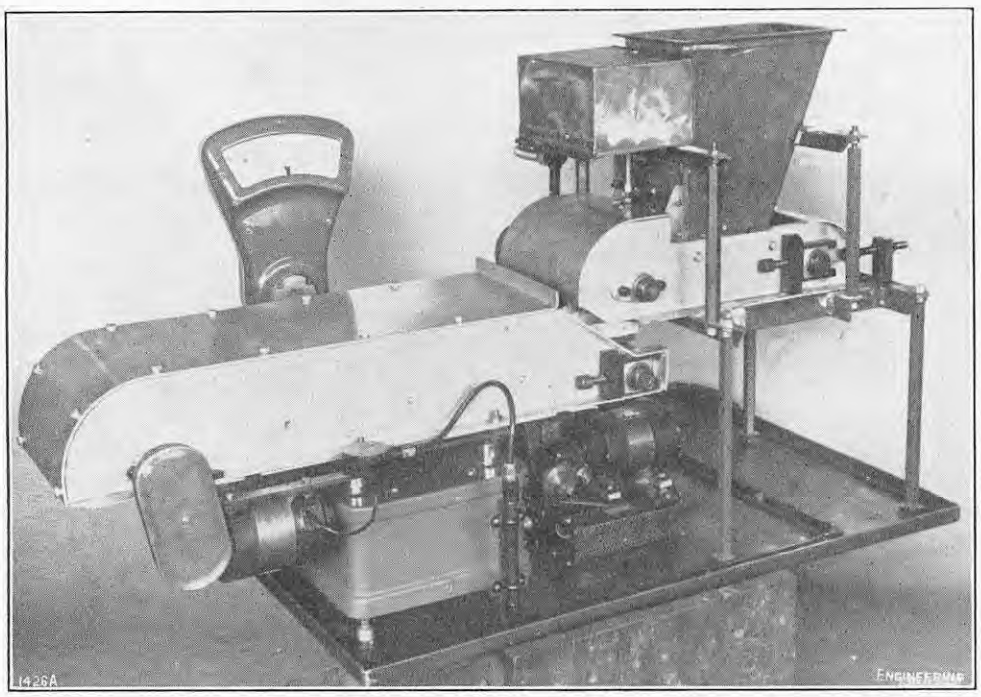


FIG. 1. ELECTRONIC WEIGHING SCALE; W. & T. AVERY, LTD.

PNEUMATIC FORGING HAMMER.

Messrs. Holman Brothers, Limited, Camborne, will show for the first time the air-operated forging hammer illustrated in Fig. 2. It is designed for carrying out a wide range of jobs, including sharpening of pick points, etc., and it can be fitted with dies for the production of light forgings. Among stationary compressors, the TM60R, which is to be shown, represents the most recent development of the firm's well established differential-piston series. This machine has a heat-exchanger incorporated; thus it is independent of any outside source of cooling water and the necessity to use cooling tanks or other devices is obviated where such a source is absent, costly or inconvenient. The Holman "Tractair 13" is shown in its latest form—the new Fordson Major with the air-cooled TA13 compressor mounted on and driven by it. This two-breaker set, now available as well as the smaller-output original Tractair 8, has been widely welcomed by users. Another unit available for use with a tractor, exhibited for the first time, is the "Holpack." This consists, as exhibited, of an ATH8 compressor mounted, with an air receiver, in a frame arranged for attachment to a power lift on the rear of a tractor. For travelling, the Holpack is held in the raised position and, on reaching the working site, is lowered on to the ground. The drive to the compressor is through a telescopic shaft, with a universal coupling at either end, from the rear power take-off shaft of the tractor. When the compressor is not required, the Holpack unit is readily detached and the tractor is free for other employment. The firm will also show a number of other machines from their range.

MULTIPLE TACHOMETRIC RECORDER.

Smiths Industrial Instruments, Limited, Cricklewood, London, N.W.2, will show a recent development of theirs—a multiple tachometric recorder, illustrated in Fig. 3, on page 514. This instrument permits a permanent charted record of rotational speeds to be made. Up to six lines can be taken from Smiths tachometer generators, situated on the machinery under observation, and one glance shows immediate and past happenings at the six sources. A sensitive galvanometer and two synchronous actuating motors are incorporated, the latter taking current from alternating-current mains at 200/250 volts. The unit-construction principle and hinged mechanism facilitate replenishing of ribbons and charts. One chart roll lasts one month at 2 cm. per hour, printing being by ink marks of colours identifying the respective machines.

SPEED CONTROL SWITCH.

The same firm will also exhibit a speed control switch (Fig. 4), which has been designed to provide a very sensitive reaction to in-put speed taken from the machinery to be governed, and as the instrument is fitted with adjustments to provide a predetermined performance of the plant in question, it will be seen that many engineering operations may remain safely under completely automatic supervision. The switch acts by interrupting an electric circuit when the preset speed figure is reached. The switch is intended for flange-mounting and totally resists the entry of water.

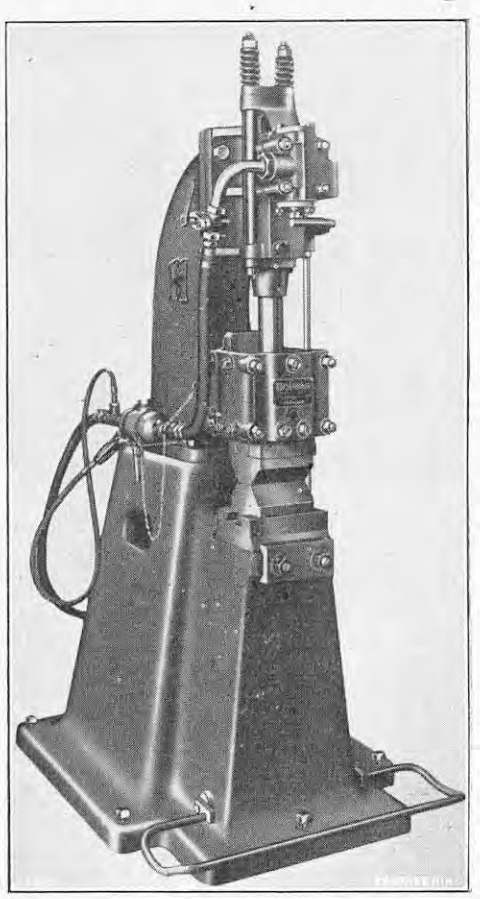


FIG. 2. PNEUMATIC FORGING HAMMER; HOLMAN BROS., LTD.

On removal of the end cover, access may be made to the manually-adjustable contacts which traverse a circular scale indicating maximum and minimum revolution speed. The internal mechanism is simple in design, and this feature has resulted in freedom from trouble due to mechanical failure and also means that the control function is completely reliable. The principle of transmission through magnetic induction obviates wear and ensures predictable response. The low driving torque and the low inertia of the moving parts make the instrument particularly appropriate for certain requirements, such as the conditions met with where input power must not be impeded, in order to measure rotational activity at its true value. The ball races which carry the drive spindle ensure long and smooth running service without lubrication,

EXHIBITS AT THE BRITISH INDUSTRIES FAIR.

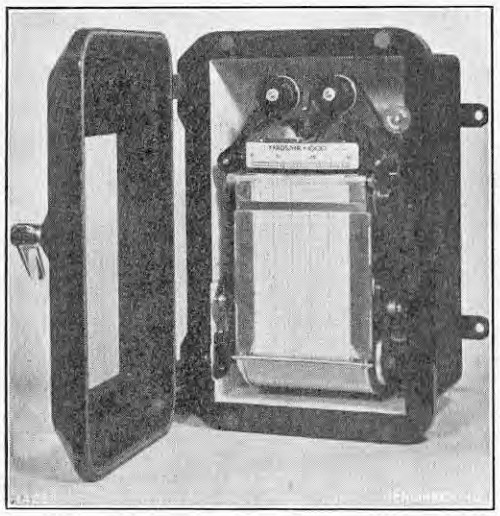


Fig. 3. Multiple Tachometric Recorder; Smiths Industrial Instruments, Ltd.

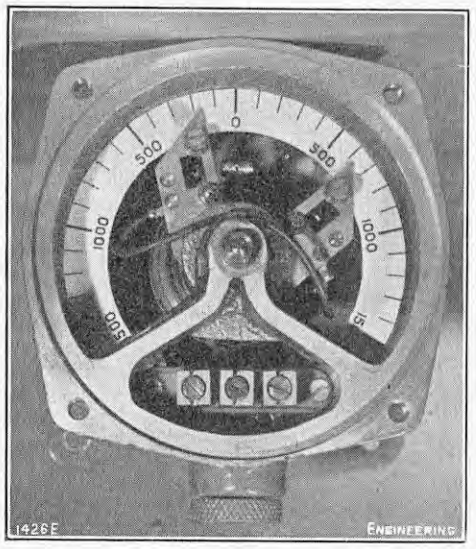


Fig. 4. Speed Control Switch; Smiths Industrial Instruments, Ltd.

and no maintenance is required during thousands of hours. The heavy copper-palladium electrical contacts reduce failures to a minimum. The speed range is from 0 to 4,000 r.p.m., and the instrument is temperature-compensated so that the maximum temperature error between minus 10 deg. C. and plus 80 deg. C. does not exceed 1 per cent.

½-cub. yd. Dumper.

In addition to a wide range of road rollers and constructional equipment, Aveling-Barford, Limited, Grantham, will exhibit for the first time their new ½-cub. yd. dumper (Fig. 5). This is a three-wheel machine driven by a 4·5-b.h.p. single-cylinder petrol engine. It works efficiently over rough and muddy ground and has proved of value for transporting material on building sites. Its ability to operate under adverse ground conditions is due largely to the employment of a positive gear-and-chain drive through a differential to large load-carrying rear wheels. The driver has a full view of the ground in front of him and he rides clear of mud and dust. Control is very simple: one lever starts, stops and reverses the machine, and there are no gears to change. Gravity tipping is employed. The wide low hopper makes hand loading easy and facilitates loading from a mixer. Furthermore, it can be positioned to give a level base for carrying piece loads. An interchangeable deep hopper is available for carrying coke, coal or other light loads, including machine-shop swarf, as shown in Fig. 5. Steering is made easy by a large-diameter handwheel operating through machine-cut reduction gearing to the front wheel. With the standard hopper, the machine carries 1,350 lb. of earth or 7 cub. ft. of wet concrete. The maximum speed is 3¼ m.p.h., both forward and reverse, and the turning radius is 6 ft. 2 in.

Fig. 5. ½-Cub. Yd. Dumper; Aveling-Barford, Ltd.

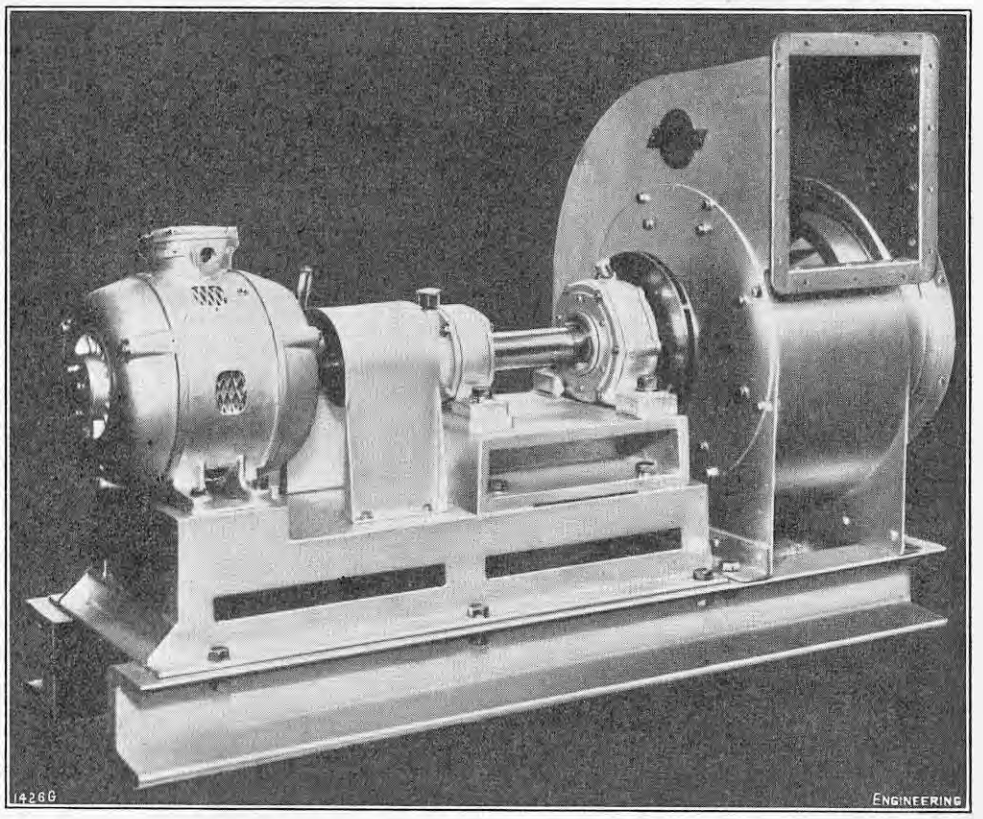


Fig. 6. Centrifugal Fan Unit; Keith Blackman, Ltd.

Centrifugal Fan Unit.

Keith Blackman, Limited, Mill Mead-road, London, N.17, will exhibit a wide range of fans and similar units, including a unit heater, a two-stage blower, an air conditioner, as well as various industrial gas equipments. The "Tornado" No. 12 centrifugal fan unit shown in Fig. 6 is a special arrangement suitable for handling gases at temperatures up to 650 deg. F. Higher temperatures can be accommodated by providing a heat-resisting stainless-steel runner and shaft. A feature of this exhibit is the air-cooled inner bearing, which is mounted on the hollow hub of a cooling fan which in turn is mounted on the drive shaft. Air is drawn through the centre of the bearing, which is not in direct metallic contact with the shaft. The duty for which the exhibit is usually provided is: 900 cub. ft. per minute; 400 deg. F.; 1 in. t.w.g. 1,420 r.p.m., taking 0·29 b.h.p. hot and 0·46 b.h.p. cold. Standard centrifugal fans are made in a range of 17 different sizes and have capacities of from 252 cub. ft. per minute at 1 in. w.g. to 114,000 c.f.m. at 4 in. w.g. They are used for general ventilation, induced and forced draught, mine ventilation, blast furnace and other gases, and fine dust, steam and fume removal.

(*To be continued.*)

LITERATURE.

Handbook of Applied Hydraulics.

Edited by CALVIN VICTOR DAVIS. Second edition. McGraw-Hill Book Company, Incorporated, 330, West 42nd-street, New York 36, U.S.A. [Price 15 dols.]; and McGraw-Hill Publishing Company, Limited, 95, Farringdon-street, London, E.C.4. [Price 107*s.* 6*d.*]

IN revising the first edition of this well-known handbook of applied hydraulics, which was published in 1942, Calvin V. Davis has co-ordinated the experience of a group of eminent American specialists serving private, public and federal undertakings. Although most of the new data are correlated abstracts from the *Proceedings* of the American Society of Civil Engineers, the second edition gives an authoritative review of contemporary practice and hydraulic literature recording important developments over the last decade.

By judicious blending of mathematics, charts and statistics with drawings of actual structures the authors of the various sections provide an introduction to the preliminary design and proportioning of the works used in the main fields of hydraulic engineering. They also concentrate attention on specific problems demanding special allowances or operating experience, thus, with the associated bibliography, providing guidance on research, experience and performance of hydraulic structures which will assist engineers faced with their design and construction. Basic hydraulic principles and graphic analytical methods are confined to two appendices and the main material is arranged so that the common and specialised interests of hydro-electric, irrigation and municipal engineers are served to the best advantage. Differences in practice arising from factors controlling design methods are suitably emphasised in the appropriate sections.

Although it is impossible in the space of a review to compare American and European practice or to examine critically the 25 sections into which the book is divided, a summary may be useful to those interested in specific topics. Section 1, dealing with reservoir regulation, includes brief references to flow characteristics, storage curves, hydrographs, losses and sedimentation in relation to single and multi-purpose projects for water conservation and flood control and their economic value on an annual benefit/cost basis. Sections 2 to 6 concern gravity, arch, buttress, earth and rock-fill dams. They devote much attention to site exploration and to basic considerations concerning loads and secondary forces due to ice, silt, flood and temperature conditions, and to stressing of the structure, foundations and abutments preparatory to detailed analysis. The drawings and tabulated characteristics of actual structures in each class will be valuable in formulating preliminary designs. The technical and practical aspects of constructional problems are adequately treated. They include joints, height of lifts, cooling and foundation treatment in the case of concrete dams. For earth and rockfill dams, materials, slope protection, freeboard, core and cut-off walls, spillway and outlet works are examined. The question of settlement is associated with a statement of the field observations necessary during and after construction and the symptoms preceding failure.

Sections 7 to 9 relate to spillways, crest gates, high-pressure outlets and stream protection works of various types. The descriptive treatment of crest-gate selection, with drawings illustrating structural designs and sealing arrangements, is useful. It is perhaps unfortunate that the opportunity to extend the estimating data provided with a more formal presentation of the hydraulic and structural calculations for these devices appears to have been overlooked. There is need for an up-to-date publication in this specialised field to replace Kulka's *Der Eisenwasserbau*, which was published in 1928. High-pressure gates, including tractor and coaster types, together with butterfly and regulating needle valves, are based on Bureau of Reclamation experience. The data provide capacity curves and formulæ for screen, bell-mouth, transition and conduit losses necessary for outlet design. Section 10 uses an orthodox approach to slope, jump and critical-depth calculations for open-channel flow, and associates them with practical and economic questions concerning location, linings, dimensions, silting and scour velocities, freeboard, conveyance losses and bank stability. Except for a comprehensive study of buried conduits, the technical and economic treatment of tunnels, steel, wood-stave and concrete pipes is conventional but is hardly adequate for hydro-electric penstocks, where the support and anchor block problems are somewhat complex.

Section 11 classifies hydro-electric power stations into forebay and penstock developments from the project planning viewpoint, and refers broadly to indoor, outdoor, semi-outdoor and underground power stations, their sub-structures and superstructures and equipment generally. No reference is made to pumped-storage schemes, though American practice is giving more attention to them, as exemplified by the installation of a large pump/turbine unit at Hiwassee. Section 12 deals with the fundamental principles of turbine and pump operation, as well as their selection and proportions for particular hydraulic conditions in terms of specific speed. While this is satisfactory, the experienced plant engineer may find it disappointing, for although there are references to model tests and scale-effect formulæ, there are notable omissions regarding the conversion of machine characteristics from model tests to the prototype and field methods of discharge measurements. Sections 13 to 16 have been contributed by G. R. Rich in the form of an excellent summary of his book *Hydraulic Transients*. This has already been reviewed in these columns and it is unnecessary to dwell on the value of the material presented concerning water-hammer, turbine-speed regulation, governing and navigation locks. Sections 17 to 18 introduce basic irrigation problems, but since soil analysis, water supply, crop requirements, hydrologic and climatic conditions affecting such projects are so variable, the treatment is largely statistical with emphasis on American experience. The irrigation works chosen to illustrate the principles governing design and construction, therefore, reflect, in the main, Bureau of Reclamation practice. Sections 19 to 21 examine competently questions concerning water-supply sources, consumption forecasts, flow and pressure calculations and distribution-reservoir locations in pipe networks, which, together with comprehensive data on pipes and accessories and flow diagrams illustrating the hydraulic/chemical aspects of water-treatment plants, will be of service to those concerned with water-supply systems.

Sections 22 to 23 are devoted to sewerage and sewage treatment, and, from an examination of methods for estimating sanitary and storm-water quantities, proceeds with the aid of charts and formulæ to the hydraulic calculation of sewer sizes and grades and the structural aspects of their design. Flow diagrams are used to describe sewage-treatment processes so as to elucidate the computations involved in designing and setting the equipment. The value and limitation of scale models are mentioned in Section 24 in connection with spillways, crest gates and high-pressure outlet works. This section develops the laws governing models from the principles of similarity in terms of Froude, Reynolds and Weber numbers for hydraulic structures, as well as river channels with movable and fixed beds and distorted and undistorted scales. Harbour, tidal, ship and turbine models and electrical analogies are briefly considered. There are a few notes on materials, methods used in model construction, measuring equipment and the technique used in their operation. Section 25 is a résumé of flood-frequency analysis methods, supplemented by the use of meteorological, storm rainfall, catchment and other data to determine the form of the hydrograph for use in the design of spillways and other structures concerned with flood control. The 1,200 pages of text are adequately indexed. The book is an excellent introduction to specialised treatises and can be recommended as an acquisition to those engineers whose tasks demand an appreciation of the problems encountered in the design and construction of the hydraulic structures associated with hydro-electric, irrigation, water supply and sewage disposal projects.

Leçons sur les Principes de l'Électrodynamique Classique.

By PROFESSOR ANDRÉ MERCIER. Bibliothèque Scientifique No. 23. Éditions du Griffon, Neuchatel Switzerland. [Price 7·80 Swiss francs.]

IN this book, Professor Mercier provides a purely theoretical exposition of the principles of classical electrodynamics that is both rigorous and concise. The rigour results from a critical consideration of the subject, whereby unjustifiable assumptions have been eradicated. The conciseness is due to the consistent use of vector and tensor methods, and the adoption of an elaborate notation with arrows, straight and curved, with or without attached circles, surmounting many of the symbols. This complicated symbolism could, with advantage, have been explained at the outset instead of halfway through the text. In his preliminary remarks, Professor Mercier gives an explicit statement of the postulates upon which his treatment is founded. The most important of these are as follows. It is essential to employ one specifically electrical dimension in addition to the three mechanical dimensions that were used exclusively until comparatively recently. Only charges at rest or in motion and the fields resulting from their interaction are to be admitted; the magnetic pole is excluded from consideration as having no operational significance. On similar grounds, the electric field and magnetic induction are regarded as physically significant, while electric induction and magnetic field are relegated to the status of auxiliary magnitudes. The enunciation of a law of interaction, such as the law of force between charges, must incorporate a constant of interaction. Such constants of interaction are the sole magnitudes to be determined experimentally, all else being, in theory (though not in practice), a matter of calculation. The field concept avoids the necessity of making any distinction between a charge creating a field and a charge acted upon by a field, while the requirement of two fields is shown to imply two relations between charge and field.

It is on the basis of these postulates that the fundamental equations of Coulomb-Gauss, Ampère-Maxwell, Gauss and Faraday-Neumann are established and their more important properties examined. A section on energy considerations is followed by a discussion on relativity conditions, including the Lorentz contraction, the invariance of charge and the variance of the electromagnetic field. The problem of polarisation is then analysed and shown to involve the introduction of the electric displacement as an auxiliary field, after which the propagation of electromagnetic waves and energy flow in homogeneous media are discussed. In conclusion, Professor Mercier proposes a new set of axioms from which the classical formulation of electrodymanics can be derived. This introduces, among other unfamiliar notions, Clifford's numbers in four-dimensional Euclidean space, with which only mathematical specialists in linear associative algebras and the theory of topological groups are likely to be familiar.

POWER JETS' GAS-TURBINE PATENTS.—II.*

Thrust Augmentation.

The previous section in this series reviewed some Power Jets' patents relating to aero-engine configurations, or component layouts, of the plain turbo-jet and turbo-prop. types. This section is devoted to patents concerned with the augmentation of the thrust obtainable from such configurations.

Ducted Fans.—The ducted fan has for some years been considered as a means of augmenting the thrust, and improving the propulsive efficiency, of a turbo-jet engine, but the practical application of the principle has so far been very limited. Although the earliest Whittle ducted-fan patent relates to the by-pass engine, the first full-scale experiments conducted in this country during the war years were with a simple ducted fan added to an existing jet engine and energising a jet-stream separate from that passing through the jet engine proper. With the general increase of aircraft speeds beyond the range to which the simple ducted fan is best suited and with recent disclosures regarding developments in this country and on the Continent, greatest interest is at present focused upon the by-pass type of ducted-fan engine. In the circumstances, there seems to be no disadvantage in treating this sub-section of the Power Jets patent-holding chronologically, without division into by-pass and non-by-pass classifications.

Pride of place, both chronologically and otherwise, is held by the Whittle patent No. 471,368; this dates back to 1936, but its life was recently extended, in the High Court, by the maximum period of ten years. The patent is concerned with the basic by-pass principle, wherein a compressor (i.e., ducted fan) is employed both to supercharge a jet-producing engine and to provide an additional or by-pass jet stream. A reminder of the basic nature of the patent is given by the fact that, in addition to a drawing illustrating an all-turbine arrangement, the specification contains a figure (reproduced here as Fig. 1) showing an arrangement including a compression-ignition engine 34 driving a compressor 35 which both supercharges the engine (by way of its intake 34B) and delivers air to a turbine 37, by which the ducted fan 31 is driven. In addition to the air from the compressor, the working medium of the turbine includes the exhaust of the engine (delivered as at 34C) and the turbine exhaust is discharged through a propulsion nozzle 39. Some of the output of the ducted fan 31 is used to supercharge the compressor 35, but some of it by-passes the compressor and flows directly to the propulsion nozzle 30B.

Next come two patents for which applications were filed on the same day in 1940. The first, No. 583,111, concerns the basic concept of using energy in one confined stream of fluid (e.g., the exhaust stream of a turbo-jet unit) to drive, through a turbine, a ducted fan whereby energy is imparted to fluid in another confined stream. The illustration reproduced herewith as Fig. 2 is of an arrangement comprising contra-rotating two-tier rotors 20 and 21, having inner turbine-blade portions 20A and 21A and outer fan-blade portions 20D and 21D, respectively; the turbine-blade portions of the two rotors absorb energy from the exhaust stream of a main turbine 9 and impart it, through the fan-blade portions, to an air stream taken in at 24 and added to the exhaust stream in the jet-pipe.

The second of these patents, No. 583,112, is concerned, in part, with a sort of reversal of the ducted-fan principle; this rather cryptic statement is illustrated by the two-tier blade arrangement shown by Fig. 3. In this case, the outer blade portions 8A and 9A act as contra-rotating air turbines

* Part I appeared on page 481, *ante*.

POWER JETS' GAS-TURBINE PATENTS.

Fig. 1.

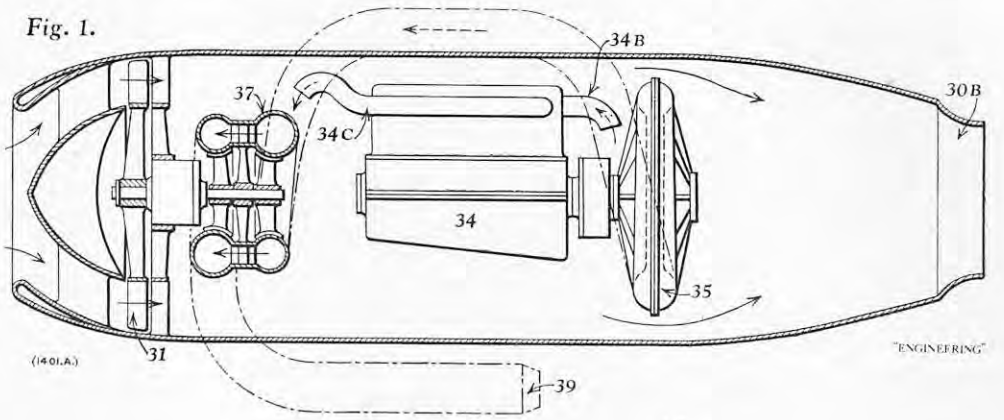


Fig. 2.

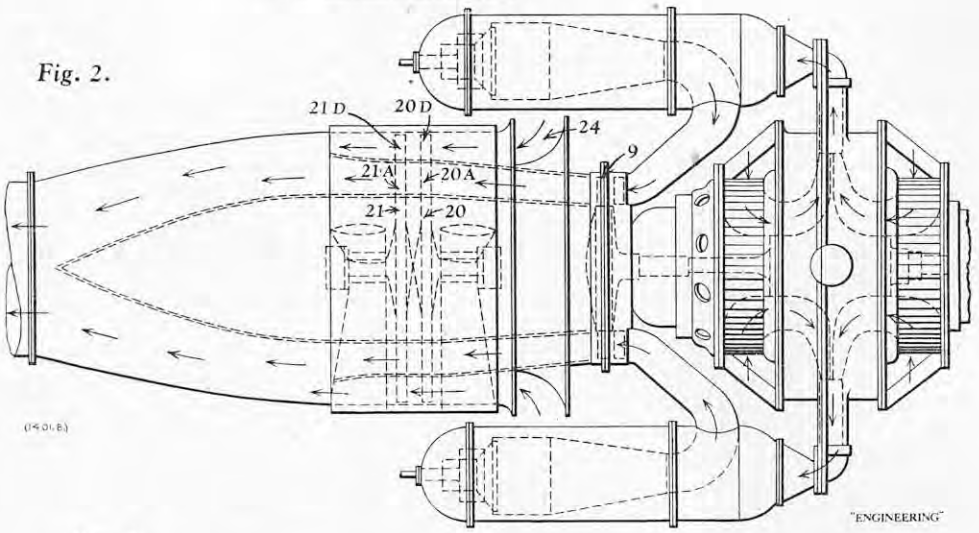
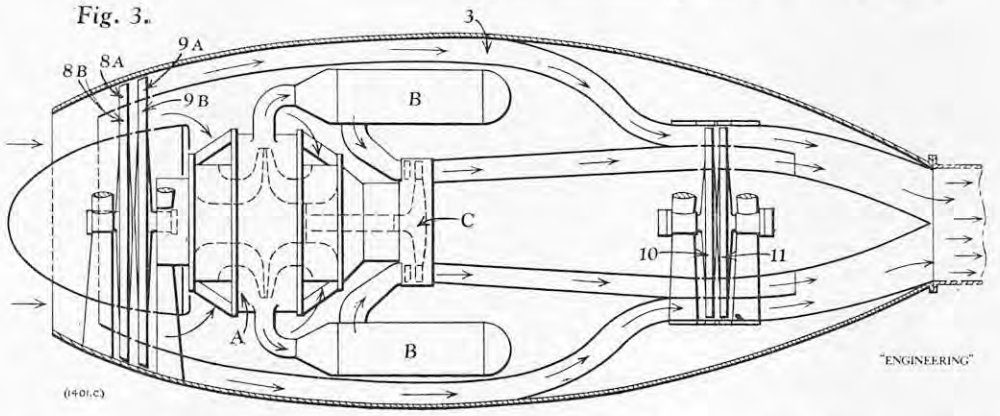


Fig. 3.



deriving energy from the air-flow in the annular duct 3 and imparting it, by way of the associated fan-blade portions 8B and 9B, to the air-flow by which the turbo-jet unit A B C is aspirated; the unit is thus supercharged, as is the prime-mover unit of a by-pass engine. A two-tier ducted-fan arrangement, 10, 11, of the kind described above with reference to patent No. 583,111, is provided to extract energy from the exhaust of the turbo-jet unit and impart it to the augmenting stream flowing in the duct 3.

The next patent, No. 593,403 (which, incidentally, is the last Whittle patent in this sub-section) is concerned with the supercharging of multi-unit, turbo-propulsion systems. While not necessarily incorporating the by-pass principle, the invention is conveniently illustrated by the drawing here reproduced as Fig. 4, opposite, and representing a half section through a propulsion system; in the arrangement shown, turbo-jet units (of which one is indicated at 1) arranged around a common axis are super-charged in common by fan blades 10A, while further fan blades 21A energise an air-stream of which part is inspired by the blades 10A and the rest goes to a by-pass stream 25. Other arrangements illustrated in the specification include the equivalent of that shown in Fig. 4, except that the by-pass arrangement 21A, 25 is omitted. In a suitable installation, the supercharging of a multi-unit system may be effected by an unducted propeller or propellers driven by the system.

The subject matter of patent No. 588,918 is distinguished from the earlier ducted-fan arrangement illustrated by Fig. 2 in that, while the two-tier system of blading is retained, the contra-rotation arrangement is replaced by a construction involving stator blading 21, 21A, co-operating with both turbine- and fan-blade portions of the two-stage rotor, as shown in Fig. 5. An interesting structural feature illustrated by this figure is a system of three or more radial struts 9, which support the rear bearing of the augmentor rotor and are free to slide radially to accommodate thermal expansion.

Although, as will appear below, the first ducted-fan augmentor to be built by Power Jets was in accordance with a patent for which application was filed some eight months later, considerable historical interest attaches to the type of construction illustrated by Fig. 5, opposite. An augmentor on these lines formed part of the power unit which Power Jets built for the Miles M52 project; this, commenced in October, 1943, envisaged a three-stage approach

POWER JETS' GAS-TURBINE PATENTS.

Fig. 4.

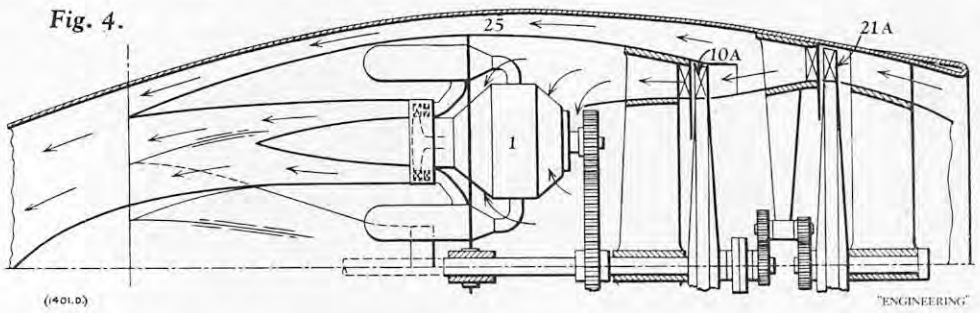


Fig. 5.

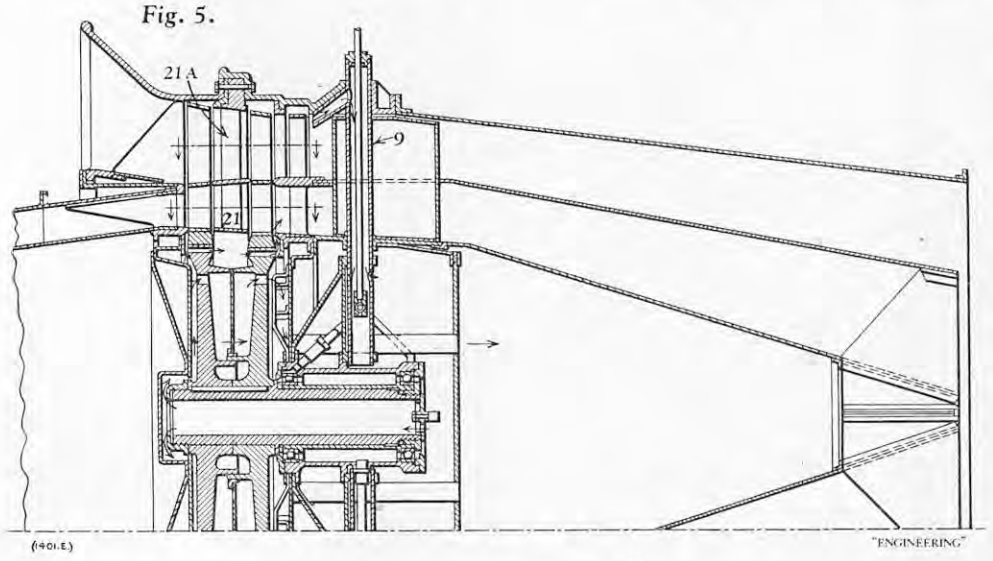
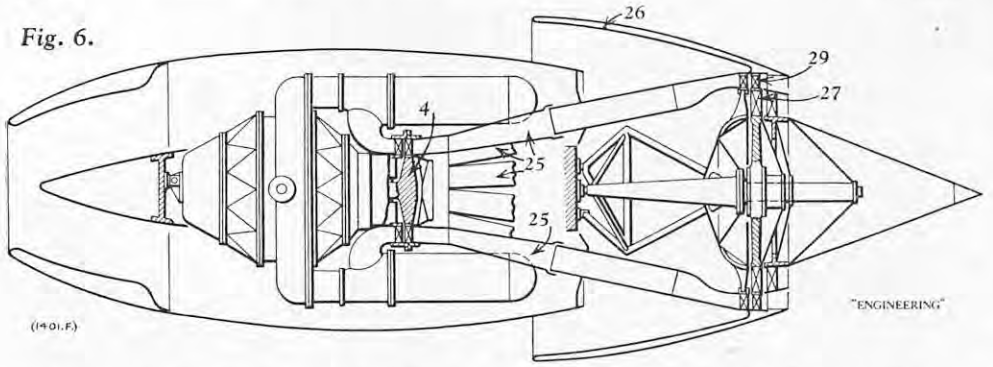


Fig. 6.



to the supersonic aircraft. Stage 1, for which the target speed was 500 to 600 m.p.h., involved the building of a suitable aircraft to be powered by a Power Jets W2/700 engine. Stages 2 and 3, with target speeds of Mach I and 1,000 m.p.h. (at 36,000 ft) respectively, involved the application of thrust augmentation; for stage 3, the project called for the burning of secondary fuel downstream of the ducted fan and for afterburning in the exhaust of the W2/700 engine. The project was abandoned in 1946 (the reason given in the Press at the time being " economy ") but the power unit had reached an advanced stage of development.

The main feature of patent No. 588,085 is the placing of the turbine-blade portions of a two-tiered rotor outside the fan-blade portions, as is illustrated by Fig. 6. In the drawing, the turbine-blade portions of the two-tier rotor are shown at 29, the fan portions at 27; the exhaust from the turbine 4 of the main jet unit is carried to the turbine portions 29 by ducts 25 and the air to be energised by the fan portions is ducted by the fairing 26 to pass between the ducts 25. With this arrangement, the heated portions of the blades are much less stressed than are the corresponding portions in the arrangement illustrated by Fig. 2. Furthermore, the peripheral speed of the turbine portion of the two-tier rotor is higher than the fan portion and it may therefore be possible to arrange for one turbine stage to drive two fan stages. Against these features on the credit side, however, there must be set the ducting problems involved and the potentially higher aerodynamic losses.

The first augmentor to be built and tested by Power Jets incorporated the principle just described. Fig. 7, on page 518, is a rear view of the unit associated with a Power Jets W2/500 engine; features of the augmentor appearing in this view are the blades of the turbine portion of the two-tier rotor, the rear ends of the ducts conveying the exhaust gases to this blading and, around the upstream end of the conical fairing, flow-straightening vanes located downstream of the blading of the fan portion.

The next patent, No. 632,568, concerns the use of a different type of two-tier ducted-fan arrangement. As shown by Fig. 8, page 518, the two-stage turbine 20, which drives the main compressor 9 of the propulsion unit, has no stator, there being provided instead a system of rotating blades 21A which revolve in the opposite direction (on the " Rostat " principle) and drive the augmentor fan blades 5A through the interconnecting structure 22, 23, 24.

Another patent which relates to ducted fans driven on the " Rostat " principle is No. 587,528. No illustration is reproduced here, but it may be mentioned that one of the drawings in the specification shows an arrangement comprising two multi-stage ducted fans, the one driven by the rotating stator of the compressor of the main turbo unit and the other by that of the turbine.

The rearguard of this sub-section is provided by three patents relating to " two-spool " engines. The first of these, No. 588,096, is concerned with the application of the " Rostat " principle to the driving of simple (i.e., non-by-pass) ducted fans associated with double compound engines. In one example (not illustrated here), the augmentor fan blades are driven by freely mounted turbine blades arranged to provide a " rotating stator " for the turbine which drives the low-pressure " engine " compressor; in another, illustrated by Fig. 9, page 518, two oppositely rotating sets of fan blades, indicated generally by the reference 55, are driven by two sets of oppositely rotating turbine blades situated downstream of the " engine " turbines.

The next patent, No. 600,608, returns to the by-pass principle and relates to arrangements in which ducted " by-pass " fans associated with double-compound engines are driven at lower speeds than the low-pressure compressors. An example is illustrated by Fig. 10, page 518, and should not call for special explanation in view of the foregoing.

The final patent in this sub-section, No. 588,097, concerns a rather involved by-pass configuration. As shown by Fig. 11, page 518, the two " engine " turbines 19 and 31 are situated between the two associated compressors 24 and 33 and the ducted fan 53, which both provides the by-pass stream and supercharges the low-pressure compressor, is driven from the latter through reduction gearing. Provision for re-heat between the turbines is indicated at 46 and the reference 47 indicates a duct whereby the low-pressure turbine exhausts into the by-pass stream. Provision for the burning of secondary fuel in this stream is indicated at 48.

Afterburning.—For the purposes of this sub-section, the term " afterburning " is used to refer to the burning of fuel in an exhaust duct to augment the thrust of a jet-propulsion unit.

The first patent in the sub-section, No. 659,793, is concerned with the automatic control of the area of the propelling nozzle for the dual purpose of ensuring maximum propulsion efficiency and of protecting the turbine against excessive temperature rise when afterburning is brought into operation; the main feature of the invention is the linking of the control means for the nozzle with that of the afterburner fuel supply. In the embodiment illustrated by Fig. 12, page 518, the position of an axially adjustable " bullet " 38 is determined by the pressure obtaining in the line 30 whereby fuel is delivered to the afterburner.

The next patent, No. 659,794, is concerned with the problems not only of achieving combustion in the high-speed conditions prevailing in a jet-pipe, but also of preventing extinction at high altitude upon rapid throttling of the afterburner fuel supply. A stabilised flame zone is provided by means of a baffle which is small in relation to the duct cross section and thus creates only local turbulence which does not greatly affect flow conditions as a whole. The illustration, Fig. 13, page 518, is of a " pepper pot " baffle 12 having a ring of fuel jets 15 at its open downstream end, some of the fuel injected from which is carried back into the interior of the baffle by the turbulent, reversed flow which it creates. The " pepper pot " may conveniently be mounted on the apex of an exhaust cone, a portion of which appears in the illustration at 8.

Next comes a patent of the same date, No. 659,859, which requires no illustration, being concerned with the injection of additional fuel into the wake of a flame burning in a stabilised zone, for example a zone formed by a " pepper pot." The invention, like the previous one, is aimed largely at preventing extinction upon rapid throttling of the afterburner fuel supply.

Patent No. 659,795 is concerned in general with the ignition of fuel in combustion systems wherein combustion is to be supported by very high velocity gas streams; the invention, however, was primarily

POWER JETS' GAS-TURBINE PATENTS.

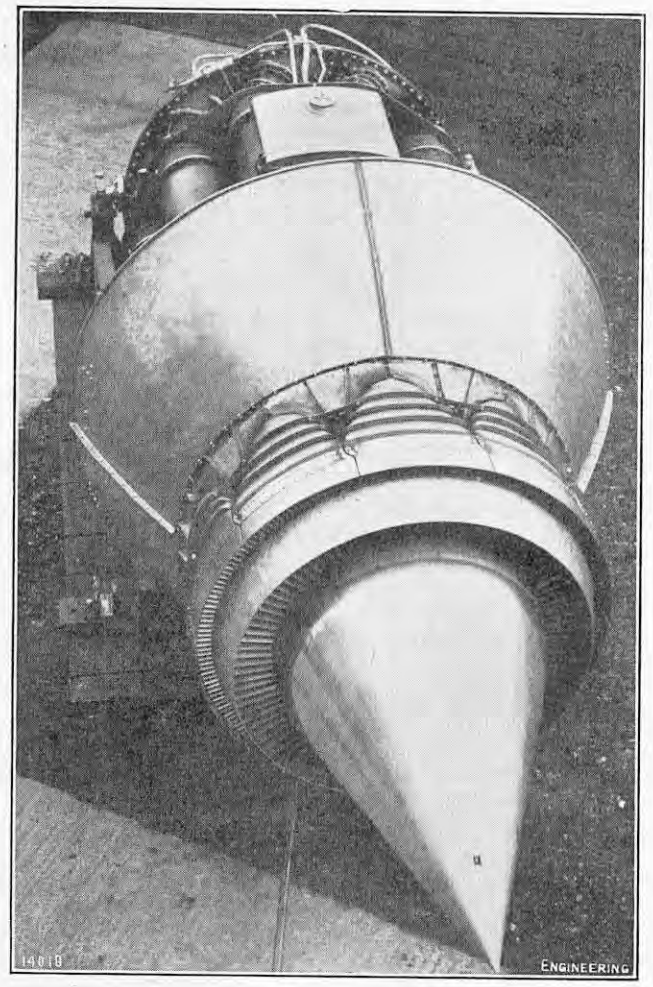


Fig. 7. Power Jets' W2/500 Engine with Thrust Augmentor.

directed to ignition in afterburner systems, where temperature or other conditions may make it inconvenient to provide electrical ignition equipment. The broad concept is to bring about ignition by the introduction into the system, in addition to the normal fuel supply, of fuel or a reagent adapted to ignite spontaneously in the conditions obtaining in the region of introduction; the spontaneously ignitable fuel or reagent may be sprayed into the main gas stream or may be allowed to impinge upon a heated body (e.g., a piece of metal gauze) located in a region shielded from the high velocity gas flow. The specification is illustrated by drawings depicting a system wherein a single burner is used first to inject a slug of pilot fuel and then to commence injection of the normal fuel; there is also, however, the drawing which is here reproduced as Fig. 14. As shown in this drawing, a pilot-fuel injector 4 is mounted upstream of the main fuel injector 2 and a control handle 24 is provided first, by the action of a plunger 25, to inject a slug of pilot fuel and then to open the main fuel valve 33. The pilot fuel may be a gas or a volatile liquid; one example proposed is a mixture of lubricating oil, stearic acid and amyl nitrite.

Patent No. 599,257 is drawn to a system known during the war as "T" scheme and intended both for afterburner combustion and for main combustion, that is to say combustion between a compressor and a turbine. As shown by Fig. 15, opposite, the main feature is the injection of fuel in the upstream direction toward a baffle through which a relatively small quantity of air passes into the inner region of the fuel spray. The outer portion of the fuel spray becomes reversed in direction by the main air-flow, giving the known advantage of upstream injection, namely self-piloting action due to the burning gases being continually carried back past the nozzle or

Fig. 8.

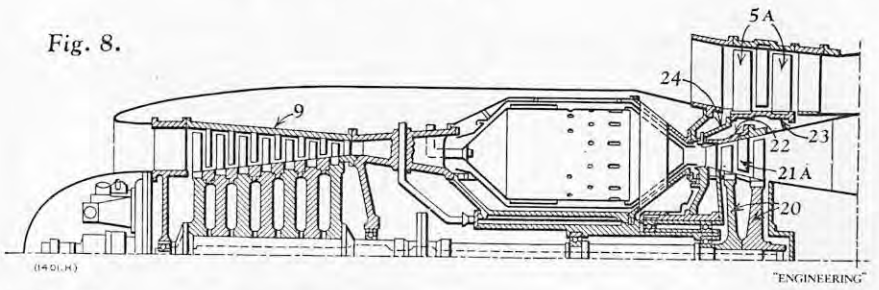


Fig. 9.

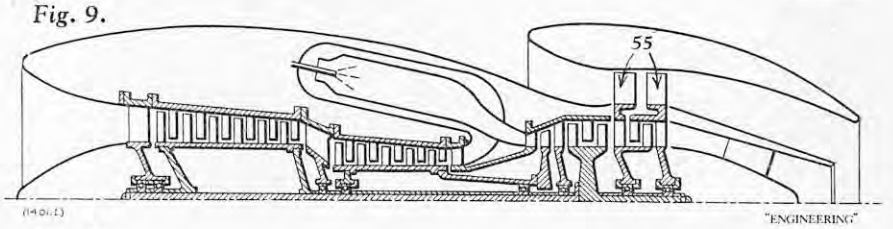


Fig. 10.

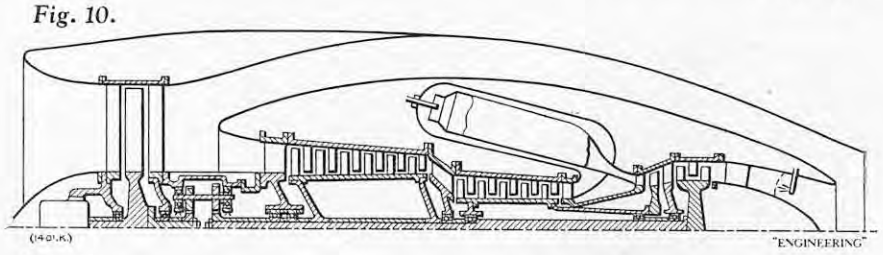


Fig. 11.

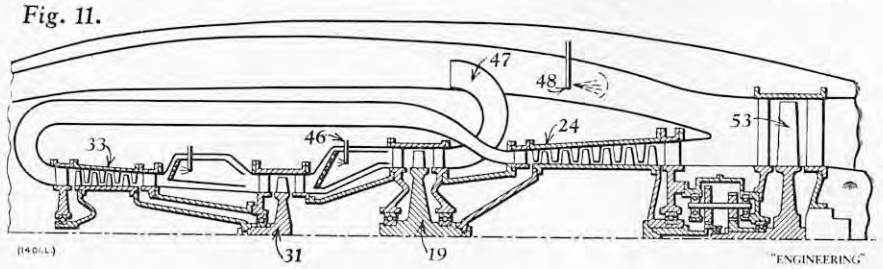


Fig. 12.

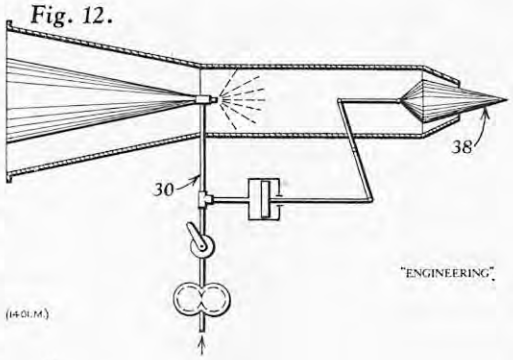
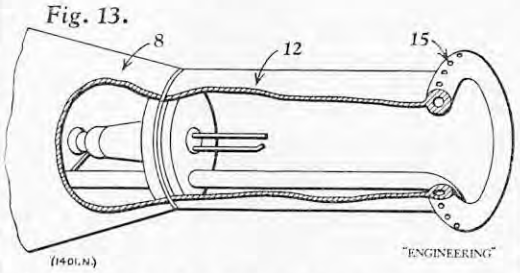
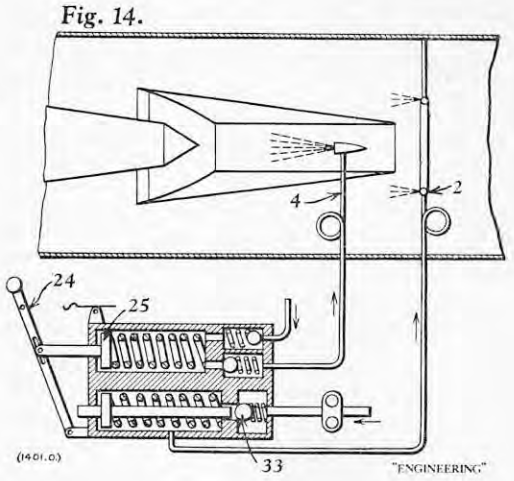


Fig. 13.



other injector; the admission to the centre of the spray of a small quantity of air, itself insufficient to cause reversal, ensures an adequate supply of oxygen at the base of the flame in place of the self-choking effect which may be associated with upstream injection, due to the inherent envelopment of the nozzle by the burning gases or by fuel particles which have been reversed without ignition. In the embodiment illustrated, the conical baffle 25 is provided with elongated slots 20 through which passes air, surrounding that admitted to the centre of the spray by the slits 17 and tending to ensure thorough mixing of air and fuel without concentric stratification of rich and weak mixture.

Fig. 14.



Patents Nos. 665,446 and 670,247 can be illustrated here by a single drawing reproduced, as Fig. 16, opposite, from the second specification. The first patent is concerned with the provision of flame stabilising baffles 10 downstream of fuel injectors 9 which are distributed over a transverse section of an annular diffuser formed by an annular fairing (e.g., exhaust cone) and the exhaust duct wall. The second patent is concerned (*inter alia*) with the problem of maintaining a reasonably low value of the minimum thrust increase obtainable upon afterburning being brought into operation; with this end in view, cylindrical shields 12 or the equivalent are provided to limit the lateral spread of fuel between the injectors and downstream stabilising baffles, thereby enabling ignition to take place with an amount of fuel small in relation to the gas flow in the duct.

According to patent No. 658,294, atomisation of

POWER JETS' GAS-TURBINE PATENTS.

Fig. 15.

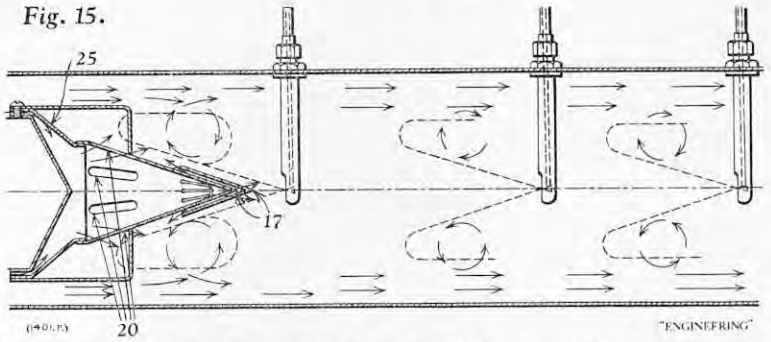
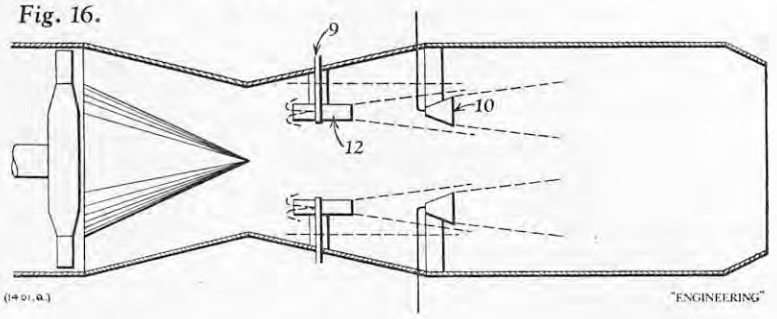


Fig. 16.



fuel in an afterburning system is achieved by directing it, substantially without dispersal, against a resisting medium which subjects it to radial dispersal before flowing downstream to a stabilised zone formed by a baffle. The resistant medium may be a solid body, as illustrated in Fig. 17, or may be formed by an opposing spray of fluid.

As is inevitable in a rapidly developing art, there are patent applications pending relating to afterburning and of which it is not at present feasible to disclose details. Furthermore, there are several patents which relate to the control of afterburner fuel supply or of nozzle area; a selection of these will be reviewed in a later section dealing with the automatic control of gas turbine engines. A still later section dealing with combustion patents in general will include reviews of further patents concerned with both main and afterburning combustion.

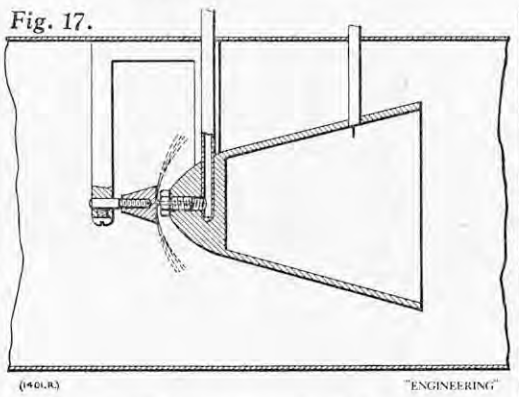
Miscellaneous Methods of Thrust Augmentation.—At the present time there is only one patent worthy of note in this sub-section, namely No. 588,084. The invention, which requires no illustration, consists in the injection of ammonia with the air supplied to a compressor forming part of a gas-turbine plant. Originally, the idea of injecting ammonia into the compressor intakes was conceived primarily to achieve extra power through its coolant effect; early tests, however, showed that an appreciable amount of extra power can be obtained, under boost conditions, by the burning of the ammonia after its passage through the compressor. Tests carried out by Power Jets during the war years indicated a possible thrust increase of 25 per cent., the actual increase obtainable in practice being largely dependent upon the humidity of the atmosphere. Owing to the lethal properties of ammonia, its use calls for certain precautions for the safety of personnel and the use of certain metals, which are subject to attack by ammonia, must be avoided in parts to which the gas may have access.

THE INSTITUTION OF NAVAL ARCHITECTS.

(*Continued from page* 504.)

PROFESSOR E. V. TELFER, the next speaker in the discussion on the paper entitled "The B.S.R.A. Resistance Tests on the Lucy Ashton," associated himself with the congratulations offered to the authors on their paper. Naturally, as his name had been mentioned, he rose at once in his own defence, and proposed to examine those particular data and to demonstrate, in spite of Professor Davidson's remarks, that the Schoenherr line was clearly and unmistakably wrong. It was amazing to him that the authors could see a perfectly consistent set of spots for the low-speed model and deliberately throw them away because they did not fit their idea that the Schoenherr line was correct. They should have taken any of the charts without making any hypothesis at all and should have drawn their curves through the spots, whether or not they were straight. If they had drawn a set of curves through the spots, they would have found that all were remarkably constant. The low-speed end was actually and exactly in the

Fig. 17.



picture as a whole, and that should have made them halt before disposing of those spots. He had recently made some progress towards dealing with the tank-boundary effect correctly, and he hoped to show, in an early paper, how the whole of the results fell into line with the correct tank-boundary allowance. He expressed a word of warning as to the analysis of tests, including appendages. Appendages could be extremely dangerous, and he looked forward with great interest to the next paper by the authors on that subject, feeling sure that many who already disagreed would disagree even more intensely when they came to the next paper.

Mr. John Brown said that, in bringing the full-scale measure of resistance to a common basis for plotting, the biggest single correction was for the wind-resistance factor, which, it was stated, reached the surprisingly large proportion of the total resistance at low speeds of between 10 and 20 per cent. The coefficients used in relating the wind resistance to speed had been determined from model experiments and approximately checked by full-scale work, in both cases with the wind moving across the surface and involving a boundary layer, the depth of which was stated in the paper to be of the order of 4 ft., so that, within that boundary layer, the speed was less than that of the free air surrounding the main part of the model. The main hull of the model was within the boundary layer and was subjected to the lower mean speed, and, consequently, had a lower resistance than in free air. Thus, if the coefficients obtained were used to estimate the full-scale wind resistance, that resistance was under-estimated. It had the consequential effect that the roughness allowance must be reduced at the lower speed. That had a bearing on what other speakers had said, namely, that the roughness allowance seemed to have been assumed as being a steady value, whereas his own suggestion would indicate that it varied with speed even more rapidly than the authors' graph showed. In view of the importance of the work presented, it was desirable that the basis of all the arguments should be absolutely established. There had been reference to accuracies within $\frac{1}{2}$ per cent. Were they sure that the the results presented were accurate to that degree?

Dr. G. Hughes said that, while knowledge of the problem undoubtedly had been advanced considerably by the paper, he must confess to some disappointment that more had not been achieved. That was not the fault of the authors or of the British Shipbuilding Research Association, but was due to the unfortunate interference with the results of the larger models from the tank boundaries. It must be admitted that the results of the six models could not be used, by themselves, to predict the ship result with any certainty, and they were obliged to rely upon an extrapolation based on frictional measurements on plane surfaces. For once, he found himself about 90 per cent. in agreement with Professor Telfer. The authors had shown the results of various methods of extrapolation. He did not think that they had noticed the real trend of the model data, because they adopted the extremely dangerous procedure of arranging for linearity of plot to suit preconceived methods of correlation. In other connections, he had previously pointed out the dangers of that procedure. By its adoption in the paper, the authors had deduced an erroneous compliance with the Schoenherr correlation and they had done less than justice to the Telfer method—which was not to say that he agreed with the Telfer extrapolation. He would like to show (and proceeded to demonstrate) a method of analysis based on the new friction work at the National Physical Laboratory. It was not to be regarded as a criticism of the authors' attempts, for it was based largely on new knowledge, with which the authors were not fully acquainted. In the paper on frictional resistance which he read before the Institution in 1952, he gave preliminary results which showed that, in the model range, the friction line for plane surfaces in two-dimensional flow (i.e., with no edge effect) was lower than, and somewhat steeper than, the Schoenherr line. Moreover, it was indicated that the effect of increasing the length/breadth ratio of the planes was also to increase the frictional coefficient in an approximately constant ratio, independently of Reynolds number, and he had hinted at the end of that paper that that might lead to a very simple application to model results for the treatment of form resistance. Since then the model range had been fully explored with some two dozen sets of tests with completely immersed planes. Those results agreed generally with the earlier indications, but suggested that the basic two-dimensional friction line was a little lower and steeper than was previously shown. Final lines had not yet been drawn, for they were now exploring a somewhat higher range of Reynolds number by means of surface pontoons.

He had, however, applied the results to a number of model hull results at below wave-making speeds. Those results covered a range of block coefficient from 0·35 to 0·81 and a range of half angle of entrance from 0 deg. to 52 deg., that being part of a research into the frictional and form characteristics of model hulls in general. In all those cases, the model resistance curve at below wave-making speeds agreed remarkably well with the basic friction line for plane surfaces when raised by a constant percentage. That percentage was, therefore, a measure of the "form" resistance, using the term "form" to embrace any excess above the resistance for the same length and surface area in two-dimensional flow. Thus it appeared that form effect in model hulls, and length/breadth ratio effect in plane surfaces, behaved similarly so far as dependence on Reynolds number was concerned. In the cases examined, the percentage varied from 13 to 38 per cent., and the model curves were not, therefore, parallel. In view of that good correlation between model and plane results at below wave-making speeds, it was a reasonable assumption that the continuation of the raised friction line would give the friction and form resistance at all speeds,

and that the excess of the total resistance above this line would be the wave-making resistance. He had applied that principle to the analysis of the Lucy Ashton model results and had given the results on a graph. He hoped to deal with that method of analysis more fully in the further paper which he expected to present in a year's time.

Mr. A. Silverleaf said that the Lucy Ashton trials were carried out in a unique fashion and were probably more carefully conducted and analysed than any previous ship measurements. In spite of that, he suggested that an examination of the results would prove that highly accurate ship resistance measurements had not been, and possibly could not be, made in normal open-water conditions. Two essential quantities had undoubtedly been measured with a precision as high as that quoted in the data sheets, namely, speed over the ground and the total resistance, but the corrections necessary to convert those two fundamental measurements into speed through the water and net water resistance were not of the same order of accuracy. The speed measurement corrections contained two doubtful points. First, it was stated that speed calculations had been based on times for the second half mile, as there was often a slight increase in speed over the mile; yet in 55 runs, almost half the total, the speed on the second half mile was actually lower than over the first half. Further, the speeds over the two halves of the course differed on occasion by as much as 3 per cent. either way, and those appreciable variations occurred not infrequently at the higher speeds. Surely, that must markedly influence the resistance coefficients? Secondly, tidal effect corrections had been made by taking a simple mean of two second half-mile runs and so involved measurements in two directions over different stretches of water. Was that not contrary to accepted good practice, especially in a sea inlet like the Gareloch, where tidal currents, although small, were confused? The corrections for the measured total resistance could be divided into two groups. The first comprised two comparatively minor items—corrections for displacement and temperature—which were either directly calculable or were deduced from reliable empirical data, not likely to be subject to significant error. Yet, even there, doubts were possible.

The second group of resistance corrections related to sea and weather conditions, which, he suggested, introduced an almost unavoidable element of approximation. It was not surprising that no use had been made of the ship natural-wind resistance tests. A wind strong enough to give an appreciable pull was also strong enough to set up an appreciable movement of the ship, which affected the load-measuring capsule reading. The wind-tunnel model results were clearly more reliable as well as more comprehensive, but it was a pity, in view of the large wind and air corrections, that the assumption of no scale-effect had to be based on such slender evidence. Again, although the sea conditions were recorded, no attempt was made to correct for any surface ripples or waves. That was understandable, but unfortunate. Comparison of individual measurements as plotted suggested that sea effects existed, although they might be masked by other influences, such as fouling. Because of those doubtful correction factors, he suggested that the mean corrected ship resistance coefficients were unlikely to be within much less than 2 per cent. of the truth.

Captain J. Logan, comparing the Lucy Ashton with the Yudachi, which was used by Hiraga in 1928-29 for full-scale resistance tests up to 27 knots by the towing method, observed that the dimensions of the two were not very dissimilar, but, when their full-scale resistance curves were compared, the differences were quite striking. The Lucy Ashton, although 42 ft. shorter, had about 6 per cent. greater displacement and about 7 per cent. less wetted surface. At low speeds—the speeds where skin friction entered into consideration—the Yudachi showed some 15 to 20 per cent. greater resistance, but at top speed, i.e., 15 knots, her resistance was about 30 per cent. less than that of the Lucy Ashton; the curves crossed at about 11½ knots. At speeds corresponding to a speed/length ratio of unity, the resistance of the Yudachi was still about 20 per cent. lower than that of the Lucy Ashton. From the measured resistances recorded in the trial data sheets, it was noted that they were tabulated to an accuracy of ± 1 lb. Such precision was impressive because, with 10-in. gauges calibrated to 4,000 lb., the circumferential scale, without magnification, was something like 1 lb. = 0·008 in. Would the authors be good enough, perhaps at a later date, to give a sample set of the actual half-minute gauge readings taken during one of the trial runs, and would they also say what vibration or oscillation, if any, was present in the gauge needles? In the corrected data, the high order of precision in the resistance column, to ¼ per cent. at low speeds and to one-fiftieth of 1 per cent. at the top speeds, was no less remarkable, because total corrections of between 5 and 12 or 13 per cent. had been applied to the measured thrusts. At top speeds, the total correction in some cases amounted to more than 1,000 lb. In connection with the allowance for rudder drag, the records showed that the average steady helm angle for the 80 runs at 12 knots and under was 2·4 deg. He would have expected the correction to be appreciably more than the authors suggested.

Professor L. C. Burrill said that no comment had been made during the discussion on the wave-making of the ship and the models, and he drew attention to the fact that all the models showed an appreciable hump at about 11 knots, whereas that was not present in the ship results. He was discouraged to find that, at 8 or 9 knots, the comparison with the Froude procedure normally followed gave such impossible results. He was sure that, prior to those results, the tank experts would have been prepared to test the models at 8 or 9 knots and to have guaranteed the results as accurate. It had been said that the authors were "putting their money" on the Schoenherr extrapolator. He thought that, in British practice, they had backed the Froude extrapolator. The time had not yet come to change to the Schoenherr extrapolator. He would utter a word of caution to those who were exponents of the Schoenherr line, when they talked about accuracy. They might be persuaded, by the fact that they had a figure of 0·0004, that it was accurate; but it was about as blunt and inaccurate as a wooden spade.

Mr. H. Lackenby, in a brief reply, said that Dr. Allan had accused them of putting their money on Schoenherr. That was one thing they had tried not to do in the paper; they wanted to be as dispassionate as possible, and to leave people to draw their own conclusions. It had been pointed out that the roughness allowance varied with speed, and they had to face it. If Dr. Davidson did carry out tests on smaller models, they would like to see how they came out. He was sorry that Professor Telfer's method did not come out so well as he had hoped it would, but the point was that, to fit in the Telfer extrapolator with the model results, they would need a much bigger wall correction than had been applied. Mr. John Brown referred to wind resistance. Above the gunwale bar of the ship there was a forest of angle bars, plates, etc., and he was certain that a great deal of the air-resistance effect was above the gunwale bar. He inclined to the opinion that the effect of the boundary layer below the gunwale was really negligible. Mr. Brown also asked whether they had carried out any checks of model results. They had no reason to doubt the model results obtained at the N.P.L. Some model tests were made in Messrs. Denny's tank and they agreed fairly closely, within 1 or 2 per cent., but there were one or two slight inconsistencies, which arose in the tank comparisons. Mr. Silverleaf made a slashing attack on the accuracy of the full-scale results. In one of the ship conditions, they had repeated the trials; first, they ran the ship naked, then they put on some bossings. They took off the bossings and put on sharp brackets, took them off and ran the ship again in the naked condition. After applying all the different corrections, they got the same answers; they agreed to within about 1 per cent. Professor Burrill mentioned that the curves for the models showed a hump at 11 knots, and said that it was not so pronounced in the case of the ship as on the models. That is a point to be looked into; it might be due to some slight interference between wave-making and skin friction. It did not appear to him, however, to be at all serious.

The discussion of the first paper concluded the business at the opening session. On the evening of the same day, March 25, the annual dinner of the Institution was held at the Connaught Rooms, London, W.C.2.

Annual Dinner.

The President (Viscount Runciman of Doxford) took the chair at the annual dinner, and, on doing so, announced that, because of the death of Her Majesty Queen Mary on the previous evening, a number of important guests were unable to be present; they included the Danish and Norwegian Ambassadors, the Rt. Hon. Lord Leathers (Secretary of State for the Co-ordination of Transport, Fuel and Power) and Field Marshal Viscount Alexander of Tunis, K.G. (Minister of Defence), who was to have proposed the toast of "The Institution." It was felt by the Council, Lord Runciman added, that it would have been wrong to cancel the dinner, even if it had been possible to do so at such short notice.

After the loyal toast had been honoured, the President stated that he had received a letter from Lord Alexander, regretting his inability to attend the dinner and enclosing a copy of the speech that he had intended to make. This was read, at the request of the President, by the secretary of the Institution, Captain (S) A. D. Duckworth, R.N. (ret.). During the 93 years of the Institution's existence, Lord Alexander observed, there had been great changes in the materials used in the construction of ships, but the old skill remained. Throughout that long period of what might be termed a continuous revolution in design, the Institution had been faithfully carrying out the objects of its founders, "The improvement of ships and all that specially appertains to them." As Minister of Defence, he had a special interest in anything to do with shipping. Those who had experienced two World Wars could never forget that the greatest danger to be faced was the cutting of Britain's lifelines by enemy submarines and aircraft. The sacrifice in lives and in terms of shipping during those wars was appalling, and unfortunately, the ordinary man in the United Kingdom did not really appreciate the losses in shipping which were suffered. He would have liked to see the newspapers reproduce a map of the waters round the British Isles, showing where ships were sunk.* Speaking more personally, he would never be able adequately to express his gratitude to that fleet of small ships which rescued, from the beaches of Dunkirk, an army of 300,000 men to win the war another day.

Sea transport had a direct role to play in military operations. Britain's ships must move troops and their supplies all over the world where British forces were operating. Such operations as the landings in North Africa in 1942, the invasion of Italy a year later, and the Normandy invasion were made possible only by the command of the sea. In a future war, it was likely that the danger at sea from submarines, mines and hostile aircraft would be even greater than anything experienced in the past. The minesweepers, frigates and aircraft carriers which were being built to deal with such a menace called for the utmost skill in the art and science of naval architecture. To safeguard Britain's position, it was necessary to press on energetically with research in both ship design and propulsion. It was equally important that the merchant ships should have all the protection they could be given. The Royal Navy and the Royal Air Force would do their best to give that protection, but much could be done by naval architects in designing merchant ships to make the effects of enemy attack less deadly. The Admiralty were always ready to give designers and shipowners any assistance they could in that field.

Since the last war, air transport had made tremendous advances, but no one should be misled into thinking that air transport would, in the foreseeable future, supersede sea transport. Such things as oil, coal and heavy goods would always be carried more easily and more economically by sea. It was not unreasonable to conclude that air and sea transport were not rivals, but, in fact, were complementary. However that might be, the

* This was done after the 1914-18 war.—Ed., E.

tasks to be performed by the Merchant Navy depended ultimately on the efficiency and enterprise of all parts of the British shipbuilding industry. That industry had a magnificent record of achievement. Since the war, British shipyards had turned out shipping to the value of about £1,000 millions. They had work in hand or on order to the huge total of 6½ million tons gross, one-third of it on foreign account. Her Majesty's Government fully appreciated the part which your industry was playing in the struggle to balance external payments, both in rebuilding the British mercantile marine and in building ships for direct export to other countries. It was necessary, however, to recognise that there was serious foreign competition. United Kingdom merchant tonnage at the end of 1952 represented 24 per cent. of the world total in active commercial employment, as against 26 per cent. in 1939 and 42 per cent. in 1913; but shipbuilding abroad had made rapid progress since the war and the tonnage commenced during 1952 had increased by 40 per cent. since the previous year, and now represented 75 per cent. of the world total. Those figures underlined the keen competition which had to be faced in the next few years, and emphasised the importance of constant research in all spheres of naval architecture and machinery design. In that respect, it was satisfactory to know that, in the gas-turbine engine, Britain led the world at sea, as in the air. The ever-increasing *tempo* in the development of new materials and new methods of construction and new types of machinery placed a heavy responsibility on the shoulders of the naval architect, but they could rely with full confidence on the Institution of Naval Architects to continue to play its most valuable part in that work.

The President, in response to Lord Alexander's message, said that the shipbuilding industry was still in the age of shortages—of steel, of skilled labour, of draughtsmen and, looking farther ahead, of cash. In fact, the resources available were too little for the job to be done, and the choice lay between contriving to get the same results at less cost in materials and man-power, or accepting results which are not good enough. The consequences might be very serious. If, for example, a type of small ship was being designed for the Navy and if, in the event of war, ships of that type were required in large numbers, their construction would have to be spread over a large number of yards of differing skill, equipment and experience. The designers would naturally want the lightest possible hull and machinery to carry the largest possible quantity of offensive and defensive equipment, and the temptation was overwhelming to take advantage of the most advanced techniques to gain that end; but if, in so doing, they called for specialised skill and capital equipment, which only a limited number of yards possessed, they might easily find that the type could not be produced in large numbers without re-equipping a number of yards and diverting to them resources in men and machines which would be badly needed elsewhere, so that the very excellence of the design would prove to be its worst defect.

The problem, then, was not merely to design ships of good lines and sea-going qualities, capable of being driven economically by engines which would function for 200 or more days a year for 20 years with the minimum of overhaul, but also, and to an ever-increasing extent, to design those ships so that they could be built with the least possible expenditure of resources. There must be very few men in the shipbuilding industry to-day under 45 or even 50 years of age who had been responsibly concerned with building a ship for a pre-determined fixed price; but no amount of theoretical instruction, of conscientious planning or of creative imagination could quite take the place of the discipline of knowing in advance that, whatever happened, one would not be paid a pound more, but would have to deliver the ship, and a good ship, just the same. It was a hard school, as hard as the school of free competition which went with it; but British shipping and shipbuilding throve under just those conditions in the past, and it could thrive under them again.

The only other toast, that of "The Guests," was proposed by Mr. E. Leslie Champness, M.B.E., M.Sc., and was acknowledged by Mr. Colin C. Black.

(To be continued.)

ENGINEERING DEPARTMENT OF CAMBRIDGE UNIVERSITY.

THE report of the Department of Engineering of Cambridge University for the year 1951-52 has been prepared by Professor E. B. Moullin, who served as acting head of the department during the absence of Professor Baker on sabbatical leave. The report shows that, excluding research students, there were 624 students in residence. This is 27 more than in 1950-51 and the highest figure since 1947-48 when the number was 635. In Part I of the Mechanical Science Tripos, 162 students passed; 29 were classed as first class and four were awarded an ordinary B.A. degree. In Part II of the same Tripos, 35 obtained honours, seven with distinction, and 14 failed. During the year, an average of 542 students were reading for the Tripos and 82 for the Certificate of Proficiency in Engineering Studies. In the course of the year, there was considerable change in the membership of the teaching staff, five members resigning including Sir B. M. Jones, who was the first Francis Mond Professor of Aeronautical Engineering, under whose direction the aeronautical section of the department was built up to its present status. The total teaching staff, consisting of professors, readers, lecturers, demonstrators, and assistant directors of research, amounted to 52.

The Post-Graduate course in Structures and Materials which was held for the first time, extending from October, 1951, to June, 1952, was attended by six students. The course, which is to be repeated each year in the future, was of considerable industrial importance and it may be expected that the number of students will increase as the course and its advantages become more widely known. All the six students were nominated by their employers. They came from the coal mining, chemical, general engineering and shipbuilding industries. Each was encouraged to carry out an investigation on a matter with which he was particularly concerned. Among subjects chosen were the strength of aluminium-alloy welded joints, the rigidity of riveted connections, the collapse loads of tanks under internal pressure and the fatigue strength of fillet welds. The report refers to the greatly improved facilities for study and research furnished by the new five-storey building which was described in our issue of November 21, 1952. The Department has still, however, to carry on some of its activities in huts, although only three of these remain, compared with large numbers in the past. Some huts had been in use for 25 years. The remaining three house the aeronautics, vibration fatigue and mechanics of machines laboratories. None is used as a lecture room.

The report gives brief details of an extensive range of research work carried out and in progress. Here, it is possible to mention only a few selected items out of a list of some 50 or more. A specific figure for the number of researches in progress cannot be given as some necessarily overlap. In the aeronautics section, wind-tunnel experiments to study the influence of distributed suction on the turbulent boundary layer were continued throughout the year; they are giving results which may have a bearing on the control of the flow of fluids in the ducts of compressors and turbines. For these experiments, the porous surface, through which the air is sucked, is of filter paper backed by a flat perforated metal plate with closely-spaced holes of 0·02 in. diameter. The same plate, without its porous covering, is also being used to find whether or not laminar flow can be maintained by suction applied through such a surface, which would be more practicable upon an aircraft than the porous surfaces hitherto used for this purpose. Other work has resulted in the development of a new method by which it is possible to find the skin-friction stress on a surface in a fluid stream of which the boundary layer is turbulent. The method requires only a single measurement of the pressure rise in a small Pitot tube in contact with the surface.

The electricity department reports a long series of investigations and work on new apparatus. The latter includes the development of a scanning electron microscope, a precision electron-diffraction camera, apparatus for the measurement of noise in semi-conductors and a new type of high-power micro-wave amplifier. Work has continued on the measurement of magnetic losses in steel and some data have been established connecting mechanical stress with magnetic loss. Work has also continued on the electronic measurement of relative humidity. Other investigations were concerned with the measurement of the speed of vacuum pumps and the way in which pumping speed is reduced by connecting tubes and baffles, and the use of a transformer bridge as a precision instrument for the comparison of resistances or capacities.

Work on heat engines has included the construction of a test rig to investigate the way in which oil reaches a cylinder past piston rings. This investigation is sponsored by the Motor Industry Research Association. Another research being supported by an outside authority is concerned with scavenge flow in two-stroke engines; financial assistance is being provided by the Mechanical Engineering Research Organisation of the Department of Scientific and Industrial Research. This Department is also supporting the investigation into the combustion of liquid fuels. Work on three-dimensional flow effects in the cascade wind tunnel has continued and a small smoke tunnel has been built to help in visualising the flow around objects placed in a boundary layer. The effect of main stream turbulence on the flow of air through a cascade of axial-flow compressor blades has been studied by means of a hot-wire apparatus and another hot-wire apparatus is being built to study the velocity fluctuations behind a rotating blade row in an axial-flow compressor test rig. Other matters which may be mentioned are an experiment to determine whether a liquid metal can be used as one element of a thermocouple and the construction of a heat pump to investigate the possibility of using the external atmosphere as a source of heat.

The research on the flow of swirling water through a nozzle, in the hydraulics department, has continued to be supported by the Mechanical Engineering Research Organisation. A study is being made of the distribution of pressure and velocity in a nozzle, by means of Pitot tubes and a vaned disc. The examination of the problem of securing a uniform stream of water in an open channel continues to be supported by the British Shipbuilding Research Association, and, in collaboration with Ricardo's Limited, investigations have been concerned with convection effects in a free vortex. The behaviour of a stream of small air bubbles in water having a free vortex motion has been observed and agrees qualitatively with a simple theory. Further work has been done on the investigation of the flow in a centrifugal pump.

Work on the strength of materials has continued for the Admiralty and the Ministry of Supply. The investigations for the Admiralty are concerned with the brittle fracture of mild steel; materials from casualties and plates used in shipbuilding are examined and tested. The research for the Ministry of Supply is concerned with the effects of welding and notches on the strength of light rolled sections. New plant includes 60-ton Schenck and 20-ton Losenhausen fatigue-testing machines. In the stress-analysis laboratory, which was illustrated in our description of the new building, work was continued on the photo-elastic investigation of dynamic stresses in gear teeth. The apparatus used was illustrated in our earlier article. It has been modified to shorten the running time during tests and reduce the influence of wear. This investigation is being supported by the Mechanical Engineering Research Organisation.

In the soil-mechanics laborabory, also previously illustrated, much of the work of the year was concerned with design and layout, but preliminary work of proving the apparatus for measuring the shear strength of soils has been carried out. The results obtained by shearing striped Plasticine samples show remarkable agreement with the predictions of the mathematical theory. The work is being continued with actual soil samples. Various new pieces of apparatus have been designed for the laboratory. These include a torsion-type shear testing machine, a model seepage tank, a variable-humidity sample preparation cupboard, a pug

EXHIBITS AT THE PHYSICAL SOCIETY'S EXHIBITION.

Fig. 8. Electronic Computer; Elliott Brothers (London), Ltd.

Fig. 9. Interior of Computer Cabinet; Elliott Brothers (London), Ltd.

mill for preparing uniform remoulded specimens of clay and an electro-osmosis apparatus. Some consulting work has been carried out in connection with stability and the long-period settlement of the foundations of buildings in the Cambridge area.

In the structures laboratory, work continued on welded connections under impact loading. Modifications made in the machine permitted the testing of larger specimens than was before possible; the design of a much larger machine, using compressed air, is proceeding. Reports on the research undertaken for the Admiralty on the structural behaviour of riveted and welded ships are shortly to be published. Other work for outside authorities includes a research, in collaboration with the Royal Aircraft Establishment, into the alleviation of the transient thermal stresses which occur in high-speed aircraft. Other researches concerned the failure of stanchions bent into the plastic range; the plastic collapse of grillages and plates; and the investigation of stresses in flat plates subjected to surface loads, loads on the edges and restraint of the edges in rotation.

Great activity was maintained in the workshops throughout the year, apparatus and plant being constructed for university departments and research organisations. The supply of materials, the shortage of which has been a source of delays in the past, has slightly improved. The delivery of new machine tools, however, is still subject to delay of up to four years. The funds of the Department were added to during the year by donations from ten industrial firms. The total sum received in this way by June 30, 1952, was 114,144*l*. Gifts of various plant and equipment were also made by manufacturers.

Packaging Materials for United States Defence Orders.—The Federation of British Industries have agreed to act as the British clearing house for inquiries on packaging materials for United States defence orders being placed in Western European countries. They will provide information on standards and specifications, quality control, technique, and the supply of packaging materials to Anglo-American standards. Inquiries about orders for Service packaging materials should be addressed to the Overseas Directorate of the Federation, 41, Buckingham Palace-road, London, S.W.1.

Locomotive for the Talyllyn Railway.—Abelson & Co. (Engineers), Ltd., Birmingham, have presented a locomotive to the Talyllyn Railway, Merionethshire, which is operated by a Birmingham group of light-railway enthusiasts. The railway, which dates from 1865, and has some of its original locomotives and rolling stock, was originally built to serve a slate quarry, but it is now run for passenger transport only. It is of 2 ft. 3 in. gauge, and as the locomotive, which was formerly the property of the Admiralty, is 2 ft. gauge, it is being converted, free of charge, by an Oldbury firm. Another local firm has undertaken to transport the locomotive by road, also free of charge, to Towyn, the terminus of the railway.

THE PHYSICAL SOCIETY'S EXHIBITION.

(*Continued from page* 492.)

The 37th exhibition of scientific instruments and apparatus arranged by the Physical Society closed on Friday, April 17, and in what follows we give a further account of some of the interesting equipment that was on view. Messrs. Elliott Brothers (London), Limited, Lewisham, London, S.E.13, showed a wide range of their manufactures, among which mention may be made of the electronic computer illustrated in Figs. 8 and 9. This machine, which has been developed for the National Research Development Corporation, is designed for solving those mathematical, scientific and engineering problems which are too extensive for desk computing methods. Special care has been taken to increase the reliability of the machine and to make its servicing easy. For that reason, it has been constructed of a number of "packaged" circuits, which can be plugged into the front of the machine, as will be clear from Fig. 9. These circuits are arranged so that faults can be readily located and the defective package immediately replaced.

The machine is built round a magnetic disc store consisting of a wheel near the outer rim of which are eight closely-spaced tracks. Each track carries 128 words of 34 digits each, the binary system being, of course, employed. Single-word magneto-striction delay-line registers are used as accumulators and as multiplier and multiplicand, instruction and general purpose registers, and the machine operates with a "two beat" rhythm; that is, orders are selected and obeyed alternately. The speed of the magnetic disc is controlled by a frequency discriminator. Power for operation is obtained from the alternating-current mains through metal rectifiers, the output of the latter being taken without energy-storing smoothing to series-stabiliser chassis. The main computer assembly consists of seven cabinets the equipment in which is air cooled. The photo-electric input tape reader and the output typewriter are mounted on a trolley, as shown in Fig. 8, from which the machine is controlled. Monitor oscilloscopes and facilities for setting up numbers and orders by hand are provided on a second trolley.

The same firm were showing an auto-balancing three-channel strain bridge. This instrument, which is illustrated in Fig. 10, has been designed for the measurement of strain in wind tunnels and has been constructed to the specification of the Royal Aircraft Establishment. The out-of-balance signal for each bridge is fed into an amplifier consisting of two channels, one of which is connected to the balance meter and the other to the servo-motor fields in the bridge units. The meter channel consists of

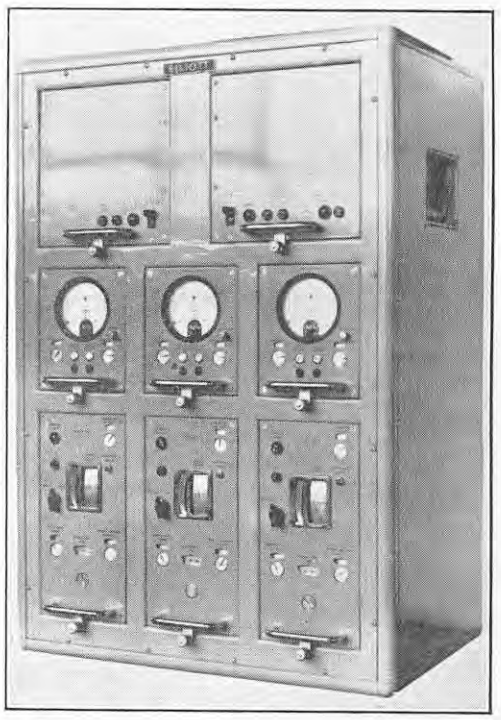


Fig. 10. Strain-Measuring Bridge; Elliott Brothers (London), Ltd.

two stages of alternating-current amplification followed by a phase-sensitive rectifier circuit, the first stage of alternating-current amplification being common to both meters and servo amplifier. The servo amplifier has a total of the three stages of alternating-current amplification followed by a phase-sensitive rectifier circuit and two further stages of direct-current amplification for the operation of the meter fields. Each channel is provided with a gain control and separate balance controls for the motor and servo channels, which are used during the initial setting-up of the equipment. Provision is made to ensure that the quadrature component of the bridge circuit is balanced. The input stabilising of the amplifier is better than 3×10^{-7} volt and the sensitivity better than 0·00001 per cent. strain.

The exhibits on the stand of Mullard, Limited, Shaftesbury-avenue, London, W.C.2, included the very wide-band dummy load illustrated in Fig. 11, Plate XI. This has been specifically designed as a high-precision measuring instrument for use in conjunction with a development project in the field of ultra high-frequency communication. It consists essentially of a short coaxial line filled with carbon tetrachloride and an inner conductor made up of a very thin gold film on a glass rod. This

EXHIBITS AT THE PHYSICAL SOCIETY'S EXHIBITION.

(*For Description, see Page* 522.)

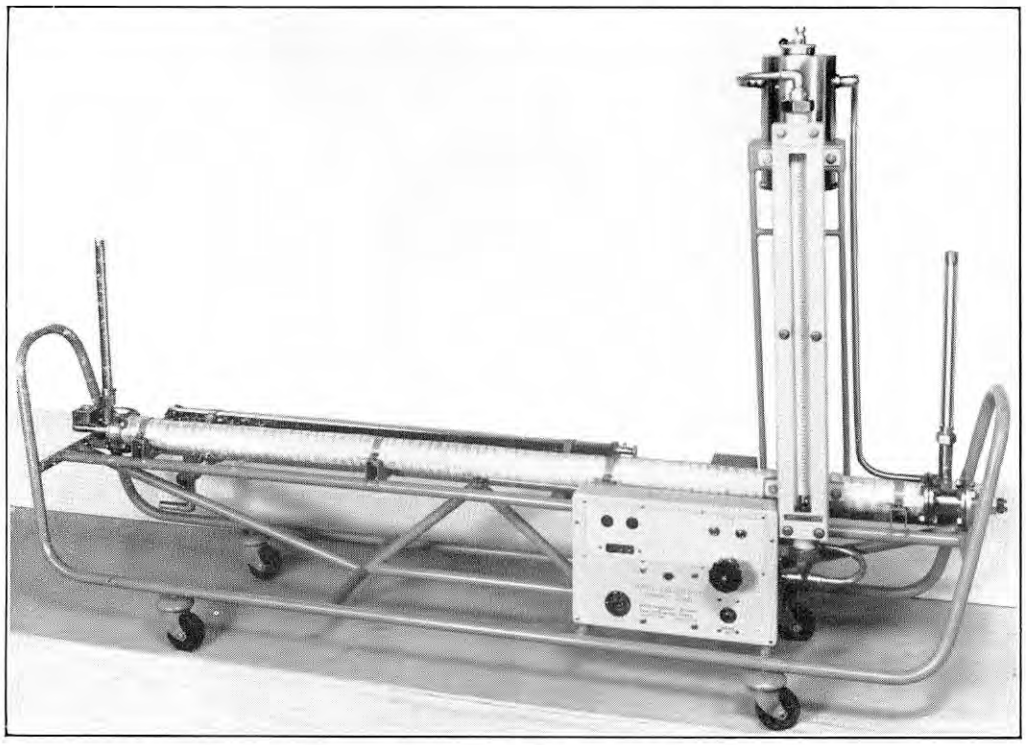


Fig. 11. Wide-Band Dummy Load; Mullard, Ltd.

Fig. 12. High-Speed Cathode-Ray Oscillograph; Ferranti, Ltd.

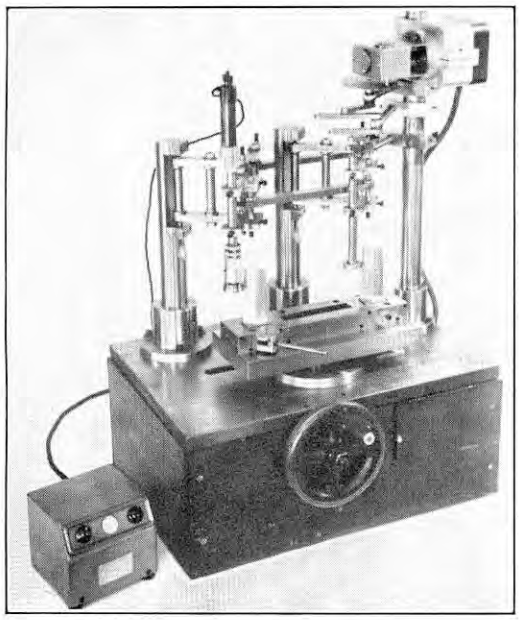


Fig. 13. Apparatus for Inspecting Turbine Blades; Aeronautical Inspection Directorate.

Fig. 14. Ultrasonic Flaw Detector; Solus-Schall, Ltd.

Fig. 15. Stabilised Electronic Power Unit; Boulton Paul Aircraft, Ltd.

Fig. 16. Alternating-Current Test Set; Salford Electrical Instruments, Ltd.

(*To face page* 522.)

THE PHYSICAL SOCIETY'S EXHIBITION.

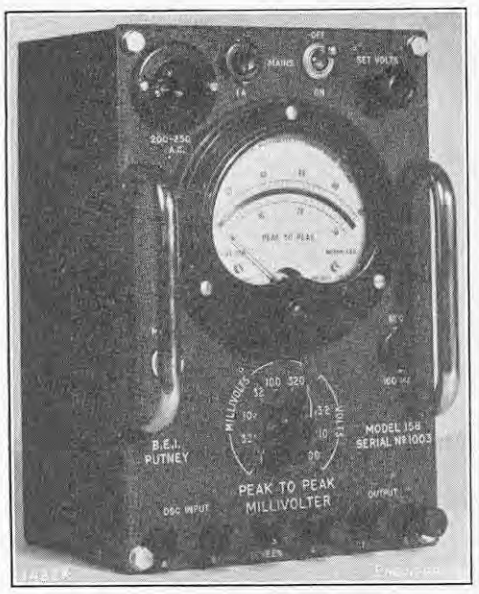


FIG. 17. PEAK-TO-PEAK "MILLIVOLTER"; ALLIED ELECTRONICS, LTD.

arrangement has a purely resistive input impedance of 75 ohms at frequencies of 100 megacycles and upwards. The power absorbed by the dummy load is measured in terms of temperature rise in the carbon-tetrachloride cooling liquid, the circulation of which is regulated by a flowmeter. The maximum power handling capacity of the load is 600 watts and the power measurement accuracy $\pm 1 \cdot 5$ watts, or ± 2 per cent., whichever is the greater.

As regards design, it may be pointed out that the comparatively high resistance of the inner conductor is due less to the specific resistance of the metal film than to its extreme thinness, and thus its very small cross-sectional area. The actual surface area available for cooling is, however, large, and the power-handling capacity under these conditions is unusually high. In order to obtain uniform power dissipation throughout its length, the resistance of the film is graded by constructing the inner conductor of a number of sections of varying resistance. To avoid any kind of discontinuity, due to a change in diameter or in the properties of the dielectric media—the coolant filling the coaxial line—it was necessary to discover a liquid and solid dielectric having as far as possible identical dielectric properties. Carbon tetrachloride and polyethylene were found to satisfy these conditions. As a coolant, carbon tetrachloride offers the further advantages of possessing a specific heat only one-fifth that of water, so that by using it the sensitivity of the instrumen is increased in that proportion.

The same firm were also demonstrating a reciprocating drill operating at an ultrasonic frequency. In this instrument a high-Q magneto-striction transducer is used to generate vibrations at a frequency of about 22 kilocycles per second, and these vibrations are transmitted through a tapered metal strut, which acts as a step-up velocity transformer, to a drilling tip. The amplitudes obtained in this way are large enough to allow the most brittle materials to be rapidly drilled or cut when a paste of carbon abrasive is fed to the tip.

The high-speed cathode-ray oscillograph illustrated in Fig. 12, Plate XI, was exhibited by Ferranti, Limited, Hollinwood, Lancashire. It has been designed for recording transient voltages and the traces can be simultaneously observed and photographed. Both the oscillograph proper and its control gear are housed in a sheet-steel cubicle with interlocked doors, which are arranged so as to facilitate inspection. Both oscillograph tubes are of the hot-cathode glass type and are permanently sealed. The cathode voltage is 15 kV direct-current, the supply being obtained from a unit, comprising a transformer, rectifiers and smoothing condensers, one end of which is earthed.

FIG. 18. GAS TESTER FOR LIGHT ALLOYS; W. EDWARDS & CO. (LONDON), LTD.

Magnetic focusing is employed and a stabilised supply is used for the focusing coils. The colour of the trace on the screen is blue. Two independent sweep circuits are provided, one of which supplies each tube. The two bases, however, are tripped simultenaously from a common tripping circuit, impulses of the order of 100 volts being required for this purpose. The sweep speeds with the first base are 1, 5, 6, 50, 200 and 400 microseconds, and with the second base 6, 50, 200 and 400 microseconds. None of the traces is linear, but the longer ones are almost completely exponential. As the tripping circuit is common, two independent records of the circuit conditions can be obtained from a single applied impulse. Each tube has its own camera, so that they can be used simultaneously for recording purposes.

As regards calibration, a separate valve oscillator is provided for each time base. The switch in one circuit allows frequencies of 5 megacycles, one megacycle, 250 kilocycles and 100 kilocycles to be obtained, while in the other one the last three of these frequencies can be selected. Bias lines can be drawn in the direction parallel to the sweep and, if the supply voltage is maintained constant, the lines will be equidistant within 2 per cent. High stability resistances are used on the bias supply; and the load is arranged so that for all practical purposes it is steady. Apart from the switches already mentioned, there are a double-pole main switch, manual sweep trip, two pre-set switches for the focusing coil current, and controls for the "cut off" bias, pulse voltage and thyratron bias voltage. With the exception of the two tripping thyratrons (one for each polarity of tripping), all the valves (12 rectifiers and 10 pentodes) are of the high-vacuum type. The standard model of oscillograph is arranged for $3\frac{1}{2}$ in. by $2\frac{1}{2}$ in. photographic plates, or $3\frac{1}{4}$ in. by $2\frac{1}{4}$ in. roll film. The lenses used are f 1·9, of 4 in. focal length, the object and image sizes being approximately equal.

Messrs. Ferranti were also demonstrating a demountable cathode-ray unit, which is intended for carrying out experiments on the properties of fluorescent material and the design of electron guns. It is self-contained and is readily evacuated by a silicone diffusion pump backed-up by a rotary oil pump. Accelerating voltages up to 30 kV are obtained from a radio-frequency unit and provision is made for focus, line and frame scan.

The Aeronautical Inspection Directorate of the Ministry of Supply, Harefield, Middlesex, were showing the apparatus for the inspection of turbine and compressor-blade contours which is illustrated in Fig. 13, Plate XI. This consists of a pantograph, which carries a measuring stylus on one side of the frame and a plain stylus on the other. The plain stylus is made to follow the contour of a master blade, its motion being transmitted through the pantograph to the measuring stylus, which responds to pressures applied at any point on its circumference and is in continuous contact with the blade under inspection. Thus the differences between the blade section under inspection and the corresponding section of the master blade are registered. When horizontal pressure is applied to any point on the spherical contact surface of the measuring stylus, the movement is transmitted to a steel ball which can only move in a vertical direction. A rod in contact with this ball registers the movements on a dial indicator or automatic graphical recorder; or, alternatively, operates a light system which is set to indicate acceptance or rejection of the blade. The mechanism is driven by an electric motor and by raising or lowering the platform a blade can be measured at any position to an accuracy of 0·0003 in.

The ultrasonic flaw detector, exhibited by Messrs. Solus-Schall, Limited, 18, New Cavendish-street, London, W.1, and illustrated in Fig. 14, Plate XI, is a more compact edition of a former model. Its operation depends on the production of ultrasonic vibrations by a quartz crystal, the vibrations then being transmitted to the material being tested by direct contact. The vibrations travel through the material and, as they suffer only a small loss in the process, a great distance may be covered so long as there is homogeneity. If, however, a crack, porosity, foreign inclusion or junction of two surfaces are encountered, the vibrations are reflected and only a small proportion of their energy passes on. The echoes thus set up travel back to the crystal where they are converted into electrical impulses and registered on a cathode-ray oscillograph. The oscillograph then indicates two or more peaks in the scanning trace. The first of these is produced by the initial transmitting pulse and the second by the reflected wave. The presence of third and other peaks show that a discontinuity or defect exists between them. The same crystal serves as both transmitter and receiver, thus enabling the instrument to be operated by one hand, leaving the other free for adjusting the apparatus and camera thereby increasing the speed of inspection. A range of frequencies between 1 and 6 megacycles can be used, allowing a choice for sensitivity and penetration. Electronic noise is reduced to a minimum by the provision of a dual sensitivity operated either by the amplifier gain or the output of the impulse generator, the result being that flaw discrimination is increased. The apparatus is provided with a control which allows the scale to be directly calibrated for metals other than steel.

Boulton Paul Aircraft, Limited, Wolverhampton, were showing the stabilised electronic power unit illustrated in Fig. 15, Plate XI. This is mainly intended for laboratory use or for production testing where a highly stable direct current is required. The electronic circuit gives a low output impedance at all normal frequencies and a stabilised direct-current supply is provided at all pressures between 200 and 400 volts with either the positive or negative earthed. A switch is fitted to permit the use of an unregulated supply which can deliver a maximum load of 150 milliamperes at 530 volts. There is also an unregulated supply for the heaters. The controls and terminals of the unit are readily accessible and the output voltage and current are continuously monitored by the instruments visible in the illustration. The primary voltage can be adjusted by a switch so as to avoid unnecessary overloading of the valve heaters when excessive fluctuation of the mains voltage occurs.

The same firm were also exhibiting a combined voltage integrator, timer and counter, which illustrates how high-speed cold-cathode tubes can be used for accurate timing and counting purposes. It incorporates four Dekatron decade tubes and an electro-

magnetic three-stage counter, so that a maximum count to seven significant figures is obtainable. Time intervals can be measured in steps of one millisecond, and the count can be stopped either mechanically or electronically. For counting purposes, the internal frequency source is disconnected and voltage pulses are fed into the unit from outside. The integrator may be employed for obtaining the definite integral of any periodic or non-periodic function of time that can be converted to a voltage. For this purpose, the Dekatron counter receives pulses which are developed within a frequency generator and shaping unit, the interval between successive pulses being inversely proportional to the amplitude of the fraction to be integrated. The pulse rate varies linearly with the input voltage from 50 to 500 pulses per second and integration can be performed with great accuracy over time intervals from 1 second to about 10 minutes.

The principal exhibit on the stand of Salford Electrical Instruments, Limited, Peel Works, Silk-street, Salford, 3, was a self-contained alternating-current test set, which has been designed for the measurement of current, voltage, power and power factor in single and polyphase circuits. This test set, which is illustrated in Fig. 16, Plate XI, is portable and, as will be seen, carries four $3\frac{1}{2}$-in. dial instruments with $7\frac{1}{2}$ in. scales. The appropriate current transformers, resistances, chokes and switches are also housed in the case. The instruments provided are an ammeter, voltmeter, a double-element induction wattmeter, and a three-phase unbalanced-load power-factor meter. They are arranged in such a way that they can be read simultaneously. Three switches enable the voltage range to be changed and the voltmeter and ammeter to be inserted in each phase. The instrument has ranges of 5, 25 and 125 amperes; 150, 300 and 600 volts; and from 1 to 100 kW. The accuracy in voltage and current is within 1 per cent., and in power 2 per cent., of the full-scale reading. The power-factor meter gives an accuracy of 2 deg. of phase between unity and 0·5 power factor. In testing single-, two- and three-phase apparatus, such as motors, transformers and generators, the instrument may be connected in the line at a terminal box or fuse board. Only three connections to the source of supply and three to the load are necessary, as the rest of the wiring forms a permanent part of the instrument.

The exhibits on the stand of Allied Electronics, Limited, 28, Upper Richmond-road, London, S.W.15, included the peak-to-peak "millivolter" illustrated in Fig. 17, on page 523. This has been designed to meet laboratory and workshop requirements for an accurately-metered source of alternating-current voltage for various calibrating and measuring operations and provides a continuously-variable alternating-current voltage from 0·1 millivolt to 100 volts at a frequency from 50 cycles to 15 kilocycles for oscillograph and amplifier work. It includes a valveless circuit which responds to the peak-to-peak value of a signal within wide limits regardless of wave form or form factor. The output of this device can be balanced or unbalanced, as desired, and its impedance is so low that its accuracy is unlikely to be affected by any circuit to which it is connected. The instrument incorporates a ten-step attenuator calibrated in peak-to-peak volts with an accuracy within $\pm$ 1 per cent., a double-screened and balanced transformer and a meter, and its voltage is sufficiently high to permit the deflecting plates of a cathode-ray tube to be directly calibrated.

The meter has two scales in the ratio of $\sqrt{10}$ (3·16) to one so that any voltage in the above range can be read directly with a deflection of one-third scale or more. A further advantage of this ratio between the scale markings is that in electro-mechanical investigations it is often necessary to express readings in microvolt-seconds. In the case of a 50-cycle calibration of an integrator, this would involve the factor $10/\pi$, or 3·18. Conversely, the calibrations of a differentiator under the same conditions would involve the factor $\pi/10$, or 0·314. As the ratio 3·16 is within 1 per cent. of both figures, it is possible to read volts on one scale and microvolt-seconds on the other to within $\pm$ 1 per cent. The instrument can be supplied from the alternating-current mains if an output at mains frequency is required. Alternatively, if an output frequency between 30 cycles and 15 kilocycles is necessary, an oscillator input may be applied. In either case, the power consumption is 2 watts.

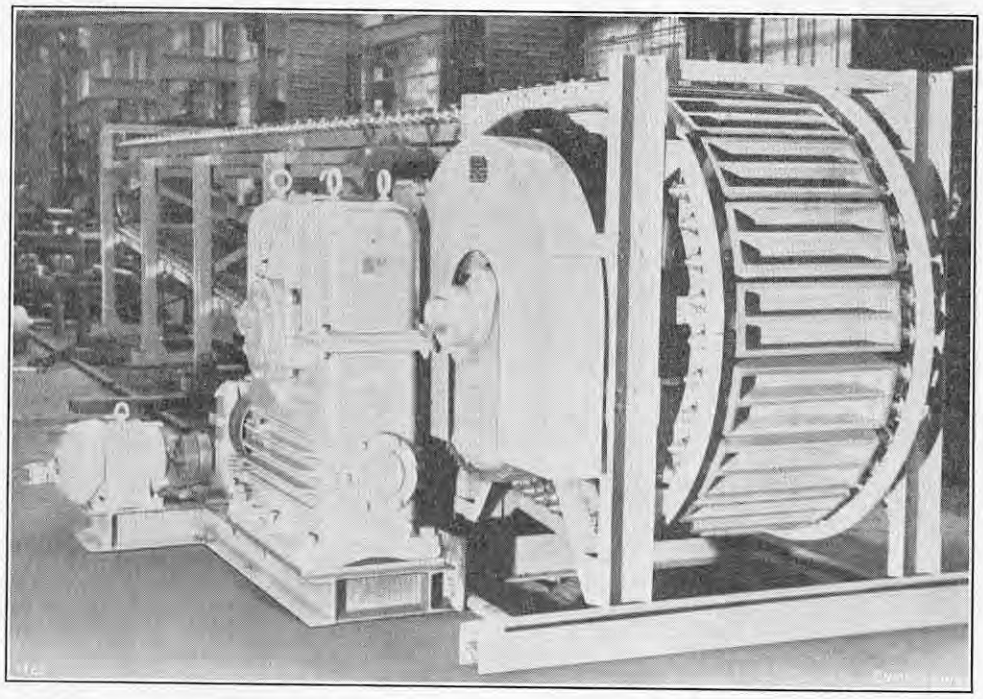
Fig. 18, page 523, shows a gas tester for light-alloy melts, which was exhibited by Messrs. W. Edwards and Company (London), Limited, Worsley Bridge-road, Lower Sydenham, London, S.E.26. Its operation depends on the fact that light alloys form tenacious oxide films which are only slightly permeable to gas dissolved in the metal. Moreover, aluminium-based casting alloys form a pasty mixture of solid and liquid metal when freezing from the molten state. Under these conditions, if a sample of molten metal is subjected to a pressure of about 20 mm. of mercury, the trapped gas forms bubbles which inflate to a greater volume than they would occupy at atmospheric pressure and tend to break explosively as the sample cools. The apparatus exhibited consists essentially of a vacuum-tight chamber, the pressure in which can be measured and which can be evacuated by a pump at the desired rate. The sample, which can be observed in the test chamber through a hard-glass window, is contained in an uncoated iron cubicle which is supported on a fireclay triangle. As regards operation, the crucible is preheated by washing it in a test melt and a sample of the liquid is taken. The crucible and sample are then placed in the vacuum chamber, which is exhausted. During this operation, the absence or presence of bubbles is an indication of the soundness or otherwise of the casting and generally provides a sufficient estimate of the amount of gas in the melt.

In addition to the Talyrond soundness measuring instrument, which has already been described in Engineering, Messrs. Taylor, Taylor and Hobson, Limited, Stoughton-street, Leicester, were exhibiting a datum attachment for their Model 3 Talysurf machine. This enables convex and concave surfaces to be traced by a guiding link of adjustable radius. This link generates a path of sufficient accuracy to hold the profile graphs of curved surfaces on the chart of the machine, so that the primary texture of ball race tracks and gear teeth, and other closely-spaced irregularities, can be examined. The attachment can also be used for examining the profile of parts with a nominally straight cross-section against a straight datum which is independent of the surface of the part. This enables secondary texture of spacing up to about $\frac{3}{8}$ in. to be taken into account.

(To be continued.)

CONTINUOUS LEAD-CASTING MACHINE.

FRASER AND CHALMERS ENGINEERING WORKS, ERITH.



CONTINUOUS LEAD-CASTING MACHINE.

The Fraser and Chalmers Engineering Works, Erith, of the General Electric Co., Ltd., have designed and installed recently an electrically-driven continuous lead-casting machine in a chemical factory in Cheshire. The machine, which is seen from the driving end in the accompanying illustration, has an overall length of 32 ft. 3 in., and is 6 ft. 2 in. in height; the total weight is 9 tons. The framework of the machine is built up of mild-steel channels and angles, which are riveted and bolted together and carry a driving sprocket for a pair of chains, to which the moulds are attached, as will be clear from the illustration. The framework supports the rails upon which the moulds run; the distance between the centre of the driving sprocket and the centre of the radius of the rails at the discharge end is 28 ft. Each of the 88 moulds is capable of holding two 56-lb. pigs or 1 cwt. of lead per mould. The rails along which the moulds travel have a downward gradient of $\frac{1}{16}$ in. per foot towards the discharge end of the machine, this arrangement reducing slightly the power required from the driving motor. The moulds are not connected in any way and each travels on four bushed track rollers fitted with a grease nipple for lubrication. Except for a space which occurs at the discharge end, the moulds form a continuous train around the track of the machine. Lead is poured from a melting furnace at a temperature of between 400 and 420 deg. C., the flow being controlled manually. The machine is run at a speed of 2·52 ft. per minute and during its passage from one end of the machine to the other the lead cools and solidifies sufficiently to be easily detachable from the moulds. When each mould comes to the vertical position at the discharging end, the lead pig is thrown out by gravity, assisted by a bump from the following mould.

After discharge, the moulds return by gravity along the lower track to the driving end. The machine is operated by a 5-h.p. motor driving two double-worm gears in a gearbox. The output shaft is fitted with a pinion driving a spur gear, which is coupled to the driving sprocket engaging with the inner side of the track rollers. The method of propelling the moulds is for the sprocket to engage the track rollers at the driving end and traverse them around the inner radius of the rails, the actual drive being transmitted by each mould pushing the one immediately in front of it. The designed capacity of the machine is 10 tons per hour.

EXTENSIONS TO JOHN SUMMERS'S STEELWORKS.

FIG. 1. PANORAMA OF NEW WORKS.

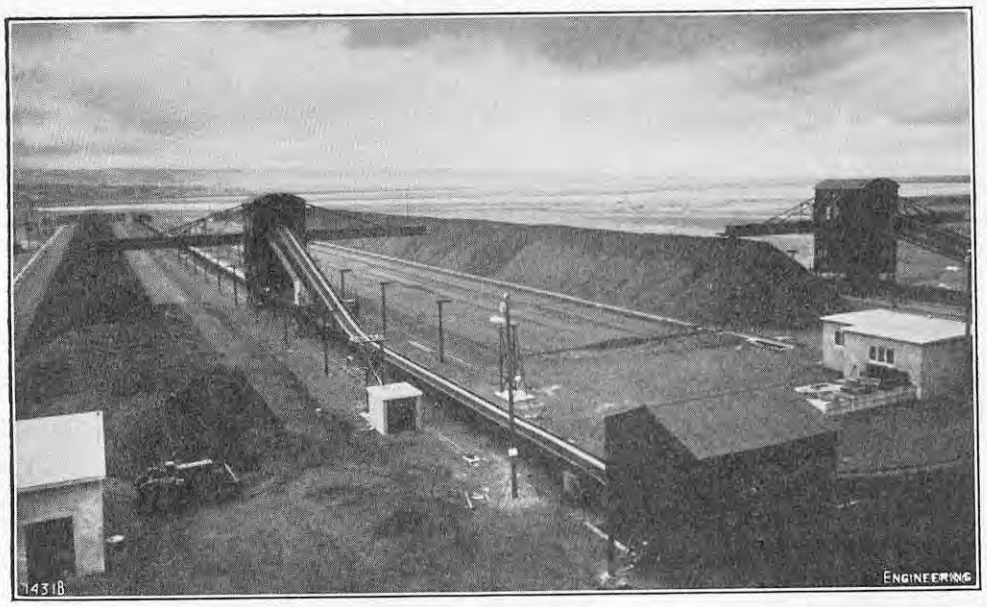


FIG. 2. STOCKING AND MIXING PLANT FOR COKING COAL.

AN INTEGRATED IRON AND STEEL WORKS.

THE Duke of Edinburgh is to visit, on April 29, the new iron and steel works of John Summers and Sons, Limited, at Shotton, near Chester. The works is a complete plant for the production of steel for hot and cold rolled strip from the raw materials—iron ore, lime and coking coal—and its design presents several novel features. The marsh-land of the Dee Estuary on which the works has been built—shown in the foreground of Fig. 1—was reclaimed for this purpose several years ago by pumping sand from the Estuary, thereby raising the ground level by between 12 ft. and 15 ft. The new works, roads, etc., cover an area of 283 acres. The plant comprises a coal-stocking plant, coke ovens and by-product plant, an ore stock yard, a blast furnace (at present believed to be the largest in Europe), open-hearth furnaces, a pig-casting plant, a power station and blower house, and ancillary equipment.

The coal-stocking plant, shown in Fig. 2, is of unusual design in that it is based on a principle, similar to that sometimes used for ore-stocking, which ensures that the actions of laying the coal in the stocking area and picking it up, as required, for the coke ovens, also have the effect of thoroughly mixing the coal. As a result, the coal delivered to the coke ovens is uniform in quality in spite of any variations in the coal as delivered by rail at the works. The new iron and steel works as a whole has been designed for using imported ore, and also for using an increased proportion of iron, compared with scrap. The extension plans formulated in 1946 were based on the fact that scrap was in limited supply throughout the world. Moreover, it was felt that, if the existing hot and cold continuous-rolling mills, installed in 1939, were to be utilised to full capacity, it was desirable to have a complete iron and steel plant which would keep the mills supplied. The new works is, in fact, a fully integrated plant which should improve the economics as well as the techniques of making steel sheet at Shotton.

The plant which the Duke is to see represents the first stage of the whole scheme, and it has been brought into production during the past few months. The second stage will involve duplicating the blast-furnace plant and erecting a further 88 coke ovens and associated by-product plant. The new melting shop, now in use, has eight basic open-hearth furnaces, each with a capacity of 150 tons, and provision has been made for a further four furnaces if they are required at a later date. The blast furnace has a hearth 27 ft. in diameter and is fitted with a Head Wrightson-McKee improved-type distributor, with the large bell 15 ft. 6 in. in diameter. Provided suitable iron ore is available, it is expected to produce about 8,000 tons of pig iron a week.

The steel strip produced at Shotton is generally of deep-drawing quality, with low sulphur and phosphorus contents. Nearly 40 per cent. of it is supplied for motor-car bodies, the remainder being used for oil drums, containers, refrigerators, cookers, office furniture, etc. In future issues of ENGINEERING we hope to describe the main parts of the new works in a number of articles.

THE DE-SALTING OF BRACKISH WATER.—Under the auspices of the O.E.E.C. (the Organisation for European Economic Co-operation) a working party was set up last year to study the de-salting of brackish water. De-salting is a world-wide problem and concerns many countries where water supplies are short or are likely to become so. They include the Netherlands, South Africa, the West Indies and Pakistan. The working party has appointed a group of technicians to study four processes which were considered to merit further investigation. They are ion-exchange, separation by freezing, electrolysis, and vapour compression distillation. From the information which is supplied by the group, the working party will be able to decide which process or processes call for work on the development scale. The group of technicians is now drawing up its report for presentation to the working party. Waters of 1,000, 5,000 and 20,000 parts per million of chloride content have been considered. Those interested in the progress of the work may apply for further information to the Department of Scientific and Industrial Research, 5-11, Regent-street, London, S.W.1.

LARGER VERSIONS OF "BRITANNIA" AIRCRAFT.—The Bristol Aeroplane Co., Ltd., Filton, Bristol, are developing three new versions of the Britannia propeller-turbine transport aircraft—the Mark 200 freighter, Mark 250 mixed freight and passenger aircraft, and the Mark 300 passenger airliner. The all-up weight of all three versions has been increased to 155,000 lb. (the Britannia Mark 100, now in production for British Overseas Airways Corporation, has an all-up weight of 140,000 lb.), and the fuselage will be 10 ft. 3 in. longer. Power will be provided by four Bristol Proteus 750 propeller-turbines each delivering 4,150 equivalent horse-power. The Bristol company have given the following particulars for the Britannia Mark 300 airliner: span, 140 ft.; length, 124 ft. 3 in.; height, 36 ft. 8 in.; wing area, 2,055 sq. ft., giving a wing loading of 75·5 lb. per square foot; landing weight, 125,000 lb.; capacity payload, 30,000 lb. (i.e., 19·4 per cent. of the all-up weight); fuel capacity, 6,800 Imperial gallons. The estimated performance figures are as follows: maximum range with full tanks, 5,100 statute miles, carrying a payload of 20,000 lb.; range with capacity payload, 3,940 statute miles; maximum cruising speed, 389 m.p.h. The company expect the aircraft to be available for delivery by 1956-57.

NOTES FROM THE INDUSTRIAL CENTRES.

SCOTLAND.

Iron and Steel Output Statistics.—A very slight decline occurred in Scottish steel production last month from the improved level attained recently, the weekly output of ingots and castings in March being 47,260 tons, compared with 47,450 tons in February. In the corresponding month last year output averaged 41,560 tons. The average weekly output for the first quarter of 1953, at 46,130 tons, contrasted sharply with 37,760 tons last year. The pig-iron weekly output, in March, averaged 17,310 tons, against 16,870 tons in February and 17,440 tons in March, 1952. The weekly output for the first three months averaged 16,950 tons, compared with 16,690 tons in 1952.

Shipbuilding Activity in Glasgow.—The Royal yacht Britannia, launched by Her Majesty Queen Elizabeth II, was one of five vessels aggregating 55,000 tons launched on the Clyde in three working days last week. The others included the twin-screw pilot vessel Wyuna, built by Ferguson Brothers, Port Glasgow, on which the British Shipbuilding Research Association are to carry out special tests when she goes on trials. The Diesel-electric machinery has been supplied by the English Electric Co. Ltd., and all main machines are fitted on resilient mountings to isolate machinery noise. The Wyuna is for service in Australian waters. The remaining vessels comprised two tankers and a passenger liner. Five more launches, due in April, will make the total 110,000 tons for the month.

Glasgow Sugar-Machinery Works Changes Hands.—An offer by Tate & Lyle, Ltd., and associated companies to purchase the whole of the issued share capital of A. & W. Smith & Co., Ltd., sugar-machinery manufacturers, Glasgow, has been accepted by the shareholders. Founded in Paisley in 1837, A. & W. Smith are one of the oldest firms in this business. Their works were transferred to the Tradeston district of Glasgow in 1855.

Fire at the Carron Ironworks.—Carron Ironworks, Falkirk, was the scene of a fire early in the morning of April 16. Two brick buildings, situated in the centre of the works, were affected and it took the combined efforts of the Falkirk and Grangemouth brigades to confine the outbreak. One of the buildings was burned out.

Dual-Purpose Ships on the Clyde.—Announcing arrangements in preparation for new dual-purpose vessels coming into service on the Clyde later in the year, Mr. L. E. Marr, manager of the British Railways Clyde Steamer Services, stated on April 14 that Dunoon pier is capable of taking vehicles up to a gross laden weight of 7½ tons. The new vessels are planned to carry loaded lorries and omnibuses to Dunoon.

CLEVELAND AND THE NORTHERN COUNTIES.

Tile-Making at Consett.—The Marley Tile Co., Ltd., are building a new tile-making factory at Whittonstall, near Consett, County Durham, and the official opening will be performed on May 5. The works, stated to have cost 100,000*l*., comprise a factory having a floor space measuring 400 ft. by 100 ft. When work is in full swing 130 tons of tiles will be turned out daily. The number of employees will be 60, rising to 120. The factory was erected at Whittonstall as the site is near easily-obtainable high-quality sand. Owing to the present house-building programme, a ready market for the factory's output is expected.

Extensions at Sunderland Shipyard.—Plans have been approved for extending the crankshaft and oil-engine shop at William Doxford & Sons' shipyard, Sunderland. At present, good progress is being made on extensions to the firm's engine works, which will increase their capacity by 50 per cent. and the number of employees by about 500.

Hebburn Cable-Making Firm opens Canadian Factory.—The Pyrotenax Co., Ltd., which began operations at Hebburn-on-Tyne in 1937, have built a factory of 55,000 sq. ft. in area at Trenton, Canada, at a cost of about 300,000*l*. The factory will be officially opened on May 4 by an official of the Canadian Government. Sir Brograve Beauchamp, chairman of the Pyrotenax Co., and Mr. F. W. Tomlinson, managing director of the firm, have left England to attend the opening ceremony. The Pyrotenax Co., manufacturers of mineral insulated cables, have built the new Canadian factory to meet the growing demand for the firm's cable in Canada and the United States.

Trade on River Wear.—During the first two months of this year, coal shipments from the River Wear amounted to 568,030 tons, an increase of 66,000 tons over last year but 195,692 tons below the 1938 figures. In January and February, 1953, shipments overseas were 183,790 tons, against 102,665 tons last year. Imports of iron ore, at 74,716 tons, were 1,472 tons higher than in 1952, and other large imports included 24,964 tons of petroleum.

The Late Sir John S. Barwick, Bt.—Sir John Storey Barwick, Bt., of Crowborough, Sussex, and formerly of Northallerton, Yorkshire, whose death occurred recently at the age of 76, was associated with several North-East industrial concerns. He was a director of Broomhill Steamships, Ltd., Easington Coal Co., Ltd., Seaham Harbour Dock Co., Ltd., South Hetton Coal Co., Ltd., and the Weardale Steel, Coal & Coke Co., Ltd.

Lord Nuffield and Lord Adams Honoured by Cumberland.—The Freedom of Whitehaven has been conferred upon Lord Nuffield and Lord Adams for their services to Cumberland. Before the war, the Nuffield Trust gave financial assistance to mines in West Cumberland and Lord Adams has for many years played a prominent part in the industrial development of Cumberland.

LANCASHIRE AND SOUTH YORKSHIRE.

Increased Steel Production.—Additions to steel-melting plant in Sheffield, notably by the installation of larger electric-arc furnaces than hitherto employed, have built up Sheffield's output of steel ingots and castings to much higher levels. March production averaged 4,500 tons a week more than in March last year, and over the first quarter of the year the average weekly production of 48,600 tons a week was nearly 4,000 tons more a week than in the first quarter of 1952.

Long-Service Employees.—Sheffield steel and engineering firms have adopted the practice of making presentations to employees of long standing. The directors of the Sheffield Forge and Rolling Mills Co., Ltd., have marked their appreciation of the continuous service of two employees who have served the company for 50 years. Mr. Fred Heald, a billet-stock labourer, who started work with the firm at 12*s*. a week, and Mr. John Connor, foreman of the rod mills, whose first wage at 12 years of age was 6*s*. a week, have each received an inscribed gold watch.

Proposed Public Transport Inquiry.—The Sheffield Tramways Development Association are concerned about the financial position of the Sheffield transport undertaking and suggest that a public inquiry should be held. The President of the Association, Mr. W. B. Pickering, in commenting on the fact that the Transport Committee have been compelled to seek financial help from the City rate fund to the extent of more than 131,000*l*., states that while this is a heavy burden, it was only twice the loss of last year's motor-omnibus operation, at high fares, on existing city routes. It is pointed out that during the year ended March, 1952, the omnibuses lost 66,789*l*., while the tramways made a profit of 12,609*l*.

Course on Fuel Efficiency.—A refresher course for works and plant engineers on fuel efficiency as an aid to production has been held in Sheffield. It was arranged by the Sheffield University department of extramural studies in co-operation with the North-Eastern regional joint education committee of the Ministry of Fuel and Power and the Institute of Fuel. A team of twelve local and national experts on fuel was selected to impart theoretical and practical knowledge of fuels and the best way to use them.

Rapid Retort Emptying at N.W. Gasworks.—The time occupied in emptying retorts at the Hyde Gasworks, Cheshire, of the North-Western Gas Board has been reduced by 25 per cent. by the use of hand-operated tippers designed and made at the works and mounted on Brush electric trucks. Fifteen times every 24 hours, a truck, with one change of batteries, is emptying 28 retorts and delivering the coke to the grader in 45 minutes, against the 60 minutes formerly taken by a petrol vehicle. The cost of the motive power—i.e. charging the batteries—is only 2*s*. a day against 25*s*. a day for fuel for the petrol vehicle. The tipping pan holds 8 cwt. of coke. The electric trucks were manufactured by Brush Coachwork, Ltd., Loughborough, Leicestershire, and were supplied through the Lancashire-area distributor, Jewsbury's Motors, Ltd., Chapel-street, Manchester, 3.

THE MIDLANDS.

Employment in the Midlands.—The Birmingham and Black Country area, after possessing the lowest unemployment figure in the whole country for some time, has now fallen to second place, the lead having been taken by North Staffordshire. The percentage of unemployed persons in relation to the insured population of the Midlands, on March 16, was 1·3, whereas the figure for the North Midlands, at the same date, was 0·8. The increase is attributed to a number of causes, the principal one being the prolonged strike at the Longbridge works of the Austin Motor Co., Ltd.

Australian Factory for Wolverhampton Firm.—The Villiers Engineering Co., Ltd., Wolverhampton, have purchased a 20-acre site at Ballarat, about 70 miles from Melbourne, Australia. A factory with full manufacturing facilities is to be erected there, but meanwhile the company propose to use temporary buildings for the assembly of components imported from Wolverhampton. Manufacturing is expected to start in about three months. The initial output of the new factory will be small internal-combustion engines for pumping, operating milking machines, and for various other purposes connected with agriculture.

Fuel Efficiency Panel.—The newly-constituted Fuel Efficiency Panel set up in Wolverhampton by the Midland Regional Board for Industry, has appointed a group of experts to act as a consultative committee. The committee consists of:—Mr. E. Coupland, chief engineer of Rubery Owen & Co., Ltd., Darlaston, who is chairman; and Mr. L. Raven (Midlands Electricity Board), Mr. F. A. Reynolds (West Midlands Gas Board), Mr. A. H. Pinder (Ministry of Fuel and Power), Mr. B. Marks (John Thompson Water Tube Boilers, Ltd.), Mr. C. Nelson (F. H. Lloyd & Co., Ltd., Wednesbury) and Mr. W. Smethurst (Goodyear Tyre and Rubber Co., Ltd., Wolverhampton). Advice will be available, free of charge, on all aspects of fuel economy, and the panel will concentrate on methods of improving the efficiency of existing plants, though it will also be prepared to advise on the question of new equipment. Inquiries should be addressed to the Wolverhampton Fuel Efficiency Panel, Midland Regional Board for Industry, C.M.L. Building, Great Charles Street, Birmingham, 3.

Spring-Works Developments.—George Salter & Co., Ltd., West Bromwich, Staffordshire, have purchased land and buildings in the adjoining town of Smethwick, and are transferring part of their production of springs there. The company, which was founded in Bilston in 1760, moved to West Bromwich in the early years of the nineteenth century, and the works have remained there until the present time. They are now bounded by roads and buildings, and there is no room for expansion. The new buildings, to which additions will be made, will enable the company to introduce flow production methods.

SOUTH-WEST ENGLAND AND SOUTH WALES.

Redundancy in West Wales Steel Trade.—Col. J. M. Bevan, chairman of the Briton Ferry Steel Co., Ltd., told the annual meeting of the Neath, Briton Ferry and District Chamber of Trade that there was a danger of redundancy in the steel trade of West Wales. He pointed out that more steel scrap was used in West Wales than in East Wales or England. There was not enough scrap in this country to meet the needs, with the result that they had to depend upon imports. It was doubtful whether enough scrap to keep going could be obtained, hence the danger of redundancy.

South Wales Trade Union Election.—Mr. Will Crews has been elected general secretary of the South Wales area of the National Union of Mineworkers. Mr. Crews is miners' agent for the Bargoed and Caerphilly area, and, in 1947, was elected vice-president of the area, a position he maintained in subsequent elections. When, 18 months ago, however, the election for a successor to the late Mr. Alf. Davies as President was held, Mr. Crews was defeated by Mr. Will Paynter, whom he had consistently beaten in the elections for vice-president.

Proposed New South Wales Motor Road.—A scheme to construct a new 24-mile spur motorway, with improved approach roads, to Newport, Cardiff and Swansea has been suggested by the Monmouthshire Federation of Trades and Labour Councils. The scheme is estimated to cost 10,000,000*l*., and it is contended that the new road would benefit not only South Wales, but the country as a whole, and help the local ports.

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 THE RUBBER INDUSTRY.—*Manchester Section:* Monday, April 27, 6.15 p.m., Engineers' Club, Albert-square, Manchester. Annual General Meeting.

INSTITUTION OF ELECTRICAL ENGINEERS.—*London Students' Section:* Monday, April 27, 7 p.m., Savoy-place, Victoria-embankment, W.C.2. "Teleprinter Automatic Switching," by Mr. P. J. MacMahon. *Measurements and Supply Sections:* Tuesday, April 28, 5.30 p.m., Savoy-place, Victoria-embankment, W.C.2. Joint Meeting. "Meter Problems and Consumers' Load Characteristics," by Mr. L. B. S. Golds and Dipl. Ing. P. Schiller. *Supply Section:* Wednesday, April 29, 5.30 p.m., Savoy-place, Victoria-embankment, W.C.2. "An Assessment of the Impregnated-Pressure Cable," by Dr. L. G. Brazier, Mr. D. T. Hollingsworth and Dr. A. L. Williams. *South Midland Centre:* Monday, May 4, 6 p.m., James Watt Memorial Institute, Great Charles-street, Birmingham. "Telemetering for System Operation," by Mr. R. H. Dunn and Mr. C. H. Chambers. *North-Western Centre:* Tuesday, May 5, 6.15 p.m., Engineers' Club, Albert-square, Manchester. Annual General Meeting. "Design Features of Certain British Power Stations," by Mr. S. D. Whetman and Mr. A. E. Powell. *North Midland Centre:* Tuesday, May 5, 6.30 p.m., Offices of the Yorkshire Electricity Board, 1, Whitehall-road, Leeds. Annual General Meeting. *Utilization Section:* Thursday, May 7, 5.30 p.m., Savoy-place, Victoria-embankment, W.C.2. Lecture on "Research in the Electrical Manufacturing Industry," by Mr. L. J. Davies.

INCORPORATED PLANT ENGINEERS.—*West and East Yorkshire Branch:* Monday, April 27, 7.30 p.m., The University, Leeds. Various short papers. *South Yorkshire Branch:* Thursday, April 30, 7.30 p.m., Grand Hotel, Sheffield. Film and discussion on "Making of Glass." *London Branch:* Tuesday, May 5, 7 p.m., Royal Society of Arts, John Adam-street, Adelphi, W.C.2. "Running a Hotel," by Mr. E. C. S. Price. *South Wales Branch:* Wednesday, May 6, 7.15 p.m., South Wales Institute of Engineers, Park-place, Cardiff. Discussion on "Modern Electrical Control Systems." *Southampton Branch:* Wednesday, May 6, 7.30 p.m., Polygon Hotel, Southampton. "Pumps and Pumping," by Mr. J. B. Scivier.

INSTITUTE OF ROAD TRANSPORT ENGINEERS.—*Scottish Centre:* Monday, April 27, 7.30 p.m., Institution of Engineers and Shipbuilders in Scotland, 39, Elmbank-crescent, Glasgow, C.2. Annual General Meeting. *North East of England Group:* Tuesday, April 28, 7 p.m., Royal County Hotel, Durham City. Annual General Meeting and Film Display.

INSTITUTION OF CIVIL ENGINEERS.—*Road Engineering Division:* Tuesday, April 28, 5.30 p.m., Great George-street, S.W.1. "The Design of Motorways," by Mr. T. E. Hutton. *Railway Engineering Division:* Tuesday, May 5, 5.30 p.m., Great George-street, S.W.1. "The Design and Equipment of Modern Mechanised Marshalling Yards," by Mr. R. E. Sadler. *Midlands Association:* Thursday, May 14, 6 p.m., James Watt Memorial Institute, Great Charles-street, Birmingham. Annual General Meeting.

INSTITUTE OF FUEL.—Tuesday, April 28, 5.30 p.m., Institution of Mechanical Engineers, Storey's-gate, St. James's Park, Westminster, S.W.1. "Refractory Recuperators," by Mr. F. H. Cass, Dr. N. L. Franklin and Professor A. L. Roberts. *South Wales Section:* Friday, May 1, 6 p.m., South Wales Institute of Engineers, Park-place, Cardiff. Annual General Meeting.

INSTITUTION OF HEATING AND VENTILATING ENGINEERS.—*Scottish Branch:* Tuesday, April 28, 6.30 p.m., Engineering Centre, 351, Sauchiehall-street, Glasgow, C.2. "The Heating and Mechanical-Service Equipment of the New Factory for Rolls Royce, Ltd., East Kilbride," by Mr. I. C. Kirkwood.

SOCIETY OF INSTRUMENT TECHNOLOGY.—Tuesday, April 28, 7 p.m., Manson House, 26, Portland-place, W.1. "A New Method of Electrical Recording Suitable for Multi-Channel Working," by Mr. S. S. Carlisle.

INSTITUTION OF PRODUCTION ENGINEERS.—*London Graduate Section:* Tuesday, April 28, 7.15 p.m., 36, Portman-square, W.1. "The Factories Act as It Affects the Production Engineer," by Mr. A. Stockbridge. *Luton Section:* Tuesday, April 28, 7.15 p.m., at W. H. Allen, Sons and Co., Ltd., Queen's Engineering Works, Bedford. "Rolling-Mill Equipment and Practice," by Dr. L. P. Underwood. *Shrewsbury Section:* Wednesday, April 29, 7.30 p.m., The Walker Technical College, Oakengates, Shropshire. "Incentives," by Mr. B. M. Sixsmith. *Birmingham Graduate Section:* Tuesday, May 12, 7 p.m., James Watt Memorial Institute, Birmingham. "Mechanised Inspection," by Mr. J. Loxham.

INSTITUTE OF BRITISH FOUNDRYMEN.—*Coventry Students' Section:* Tuesday, April 28, 7.15 p.m., Coventry Technical College, Coventry. "Castings for Internal-Combustion Engines," by Mr. C. R. van der Ben. *Southampton Section:* Wednesday, April 29, 7 p.m., Southampton Technical College, St. Mary-street, Southampton. Annual General Meeting. "Diecasting in the United States," with film, by Mr. C. J. Williams. *London Branch:* Wednesday, April 29, 7 p.m., Waldorf Hotel, Aldwych, W.C.2. Annual General Meeting, and Film Display presented by Mr. F. Hudson.

IRON AND STEEL INSTITUTE.—Wednesday, April 29, 9.45 a.m. and 1.45 p.m., 4, Grosvenor-gardens, Westminster, S.W.1. Special Meeting on "Boron in Steel." Thursday, April 30, 9.45 p.m. and 2.30 p.m.; and Friday, May 1, 10 a.m. and 2.30 p.m., 4, Grosvenor-gardens, Westminster, S.W.1. Annual General Meeting. For programme, see page 470, *ante*.

ROYAL SOCIETY OF ARTS.—Wednesday, April 29, 2.30 p.m., John Adam-street, Adelphi, W.C.2. Pope Memorial Lecture. "The Scientist's Place in the Services," by Dr. O. H. Wansbrough-Jones.

ROYAL METEOROLOGICAL SOCIETY.—Wednesday, April 29, 5 p.m., 49, Cromwell-road, South Kensington, S.W.7. Symons Memorial Lecture. "Lightning," by Dr. T. W. Wormell.

INSTITUTION OF LOCOMOTIVE ENGINEERS.—Wednesday, April 29, 5.30 p.m., Institution of Mechanical Engineers, Storey's-gate, St. James's Park, Westminster, S.W.1. Informal Discussion on "Operating Problems on Colonial Railways."

ILLUMINATING ENGINEERING SOCIETY.—Wednesday, April 29, 6 p.m., Lighting Service Bureau, 2, Savoy-hill, W.C.2. Discussion on "Lighting of Pedestrian Crossings," to be opened by Mr. A. J. W. McIntosh. Tuesday, May 12, 6 p.m., Royal Society of Arts, John Adam-street, Adelphi, W.C.2. Annual General Meeting.

INSTITUTION OF STRUCTURAL ENGINEERS.—*Lancashire and Cheshire Branch:* Wednesday, April 29, 6.30 p.m., College of Technology, Manchester. Annual General Meeting and Film Display.

ROYAL STATISTICAL SOCIETY.—*Birmingham Industrial Applications Group:* Wednesday, April 29, 6.45 p.m., Chamber of Commerce, 95, New-street, Birmingham, 2. Annual General Meeting. "Statistical Quality Control and Analysis of Variance," by Mr. V. E. Gough. *Sheffield Industrial Applications Group:* Thursday, April 30, 6.30 p.m., Grand Hotel, Sheffield. Annual General Meeting. "Productivity of a Number of Machines in the Care of One Operative," by Mr. W. N. Jessop.

CHEMICAL SOCIETY.—Thursday, April 30, 7.30 p.m., Chemical Society's Apartments, Burlington House, Piccadilly, W.1. "The Scientific Problems of Surface Catalysis," by Professor H. S. Taylor, F.R.S. Thursday, May 7, 7.30 p.m., Chemical Society's Apartments, Burlington House, Piccadilly, W.1. Various short papers for discussion.

INSTITUTION OF MECHANICAL ENGINEERS.—Friday, May 1, 5.30 p.m., Storey's-gate, St. James's Park, Westminster, S.W.1. "An Experimental Single-Stage Air-Cooled Turbine." Part I.—"Design of the Turbine and Manufacture of Some Experimental Internally-Cooled Nozzles and Blades," by Mr. J. Reeman and Mr. R. W. A. Buswell. Part II.—"Research on the Performance of a Type of Internally Air-Cooled Turbine Blade," by Mr. D. G. Ainley.

BRITISH INSTITUTION OF RADIO ENGINEERS.—*London Section:* Wednesday, May 6, 6.30 p.m., London School of Hygiene and Tropical Medicine, Keppel-street, Gower-street, W.C.1. "Recent Advances in the Application of Electronics to Chemical Instrumentation," by Mr. G. I. Hitchcox. *Merseyside Section:* Thursday, May 7, 6.45 p.m., Electricity Service Centre, Whitechapel, Liverpool. Annual General Meeting. "The Development of the Radio and Electronics Industry in India," by Mr. G. D. Clifford.

JUNIOR INSTITUTION OF ENGINEERS.—*Midland Section:* Wednesday, May 6, 7 p.m., James Watt Memorial Institute, Great Charles-street, Birmingham. "Some Notes on the Technique of Casting Aluminium Billets by the Semi-Continuous Process," by Mr. E. Mitcheson.

ROYAL SOCIETY.—Thursday, May 7, 4.30 p.m., Burlington House, Piccadilly, W.1. Bakerian Lecture. "Dislocations, Plastic Flow and Creep in Metals," by Professor N. F. Mott, F.R.S.

LEEDS METALLURGICAL SOCIETY.—Thursday, May 7, 7.15 p.m., Chemistry Department, The University, Leeds. Annual General Meeting. Various papers by junior members.

ROYAL INSTITUTION.—Friday, May 8, 9 p.m., 21, Albemarle-street, W.1. "The Civil Engineer in the Laboratory," by Professor A. J. Sutton Pippard.

SOCIETY OF CHEMICAL INDUSTRY.—*Corrosion Group:* Wednesday, May 13, 6.30 p.m., Chemical Society's Apartments, Burlington House, Piccadilly, W.1. Annual General Meeting.

PHYSICAL SOCIETY.—*Acoustics Group:* Thursday, May 21, 10 a.m. and 2.30 p.m., Institution of Mechanical Engineers, Storey's-gate, S.W.1. All-Day Joint Meeting with the ROYAL AERONAUTICAL SOCIETY on "Aeronautical Acoustics."

PERSONAL.

SIR HARRY PILKINGTON has been elected President of the Federation of British Industries, 21, Tothill-street, London, S.W.1, in succession to SIR ARCHIBALD FORBES, who had retired after holding the presidency for two years.

DR. DENIS REBBECK, C.B.E., M.A., M.Sc., J.P., who has been a director of Harland and Wolff Ltd., Belfast, for several years, has been appointed deputy managing director. MR. H. C. MACEWAN, the electrical manager, and MR. W. H. PARK, J.P., shipyard manager and head of the steel constructional department, have been elected to the board.

MR. VERNON L. FARTHING, M.I.Mech.E., M.I.Mar.E., M.Inst.Pet., was inducted into the presidential chair of the Liverpool Engineering Society on April 15.

COLONEL SIR RONALD E. L. WINGATE, Bt., C.M.G., C.I.E., O.B.E., has been appointed a director of the Imperial Continental Gas Association.

MR. G. C. D. RUSSELL, A.F.R.Ae.S., has been appointed assistant managing director of Handley Page Ltd. and of Handley Page (Reading) Ltd. MR. G. R. VOLKERT, C.B.E., F.R.Ae.S., has been appointed technical director of Handley Page (Reading) Ltd. MR. J. H. S. GREEN, A.C.A., has been appointed secretary and chief accountant of Handley Page Ltd., and secretary of Handley Page (Reading) Ltd. Other appointments to Handley Page Ltd. are those of MR. R. S. STAFFORD, F.R.Ae.S., as director of the technical department, DR. G. V. LACHMANN, F.R.Ae.S., as director of scientific research, MR. C. F. JOY, A.F.R.Ae.S., as chief designer, and MR. G. H. LEE, A.R.C.Sc., B.Sc., D.I.C., F.R.Ae.S., as deputy chief designer.

MR. T. H. WOOD, M.I.Mech.E., A.M.I.E.E., chief generation engineer (construction), South Wales Division, British Electricity Authority, is to retire on April 30.

MR. F. V. PEARSON, a director of Vandome and Hart Ltd., North London Ironworks, Wenlock-road, N.1, has been appointed general manager of the company.

MR. S. SCOTT HALL, C.B., has been made head of technical services, British Joint Services Mission, Washington, U.S.A., in succession to SIR ALWYN CROW, C.B.E. Mr. Hall will take up his appointment early in June.

MR. E. MORGAN, B.Sc., A.M.I.E.E., has been appointed senior liaison engineer of the components division, the Plessey Co. Ltd., Ilford, Essex.

MR. R. J. SHAWYER has been appointed general manager, Newman Industries (Australia) Pty. Ltd., the recently established subsidiary company of Newman Industries Ltd., Yate, Bristol. MR. R. F. SHEARMAN has been appointed technical representative for the firm in the United States.

MR. R. C. BENSON, M.C., has been appointed a special director and MR. J. DUTHIE a director, of the Darlington Forge, Ltd.

The Ministry of Materials announce that MR. R. F. RUCKER has been appointed Director of Non-Ferrous Metals as from May 1, in succession to MR. C. A. JAMES, who has resigned as from April 30.

MR. E. A. NORRIS, home sales manager of R. H. Windsor Ltd., Chessington, Surrey, has retired and has been appointed technical sales consultant. MR. G. T. WINDSOR has become home sales manager.

MR. A. E. TATLER has been made personnel manager, Dunlop Rubber Co. Ltd., St. Mary's Mills, Leicester.

The overseas reception office of BRITISH INSULATED CALLENDER'S CABLES LTD. has been transferred to 11, Bedford-square, London, W.C.1. (Telephone: MUSeum 1600.)

A METALOCK INTERNATIONAL ASSOCIATION LTD., and two new national companies have been formed, namely, METALOCK (IRELAND) LTD. and a company with headquarters in Wellington, to serve industry in New Zealand. To develop the new international organisation, MAJOR E. C. PECKHAM is resigning his position as managing director of Metalock (Britain) Ltd. His place is being taken by MR. H. A. PAGET, formerly sales director of the British company.

THE VACUUM OIL CO. LTD. and CHARRINGTON GARDNER LOCKET (LONDON) LTD. have come to a joint arrangement whereby the latter undertake the inland marketing of fuel oils now being produced at the Vacuum Oil Co.'s new refinery, Coryton, Essex.

A new overseas company has been formed by the Brush ABOE Group. It is BRUSH ELECTRICAL (AUSTRALIA) PTY., LTD., with head offices in Sydney, N.S.W. The chairman and managing director is MR. V. J. CHALWIN, who is also chairman and managing director of British Oil Engines (Australasia) Pty., Ltd.

THE MOTOR GEAR AND ENGINEERING CO. LTD., Essex Works, Chadwell Heath, Essex, have taken over the manufacture and marketing of the Swift "Motogear" and worm reduction gears from B. & P. SWIFT, LTD.

TAKORADI HARBOUR EXTENSIONS.

(*For Description, see Page 532.*)

FIG. 1. MAIN WHARF EXTENSION.

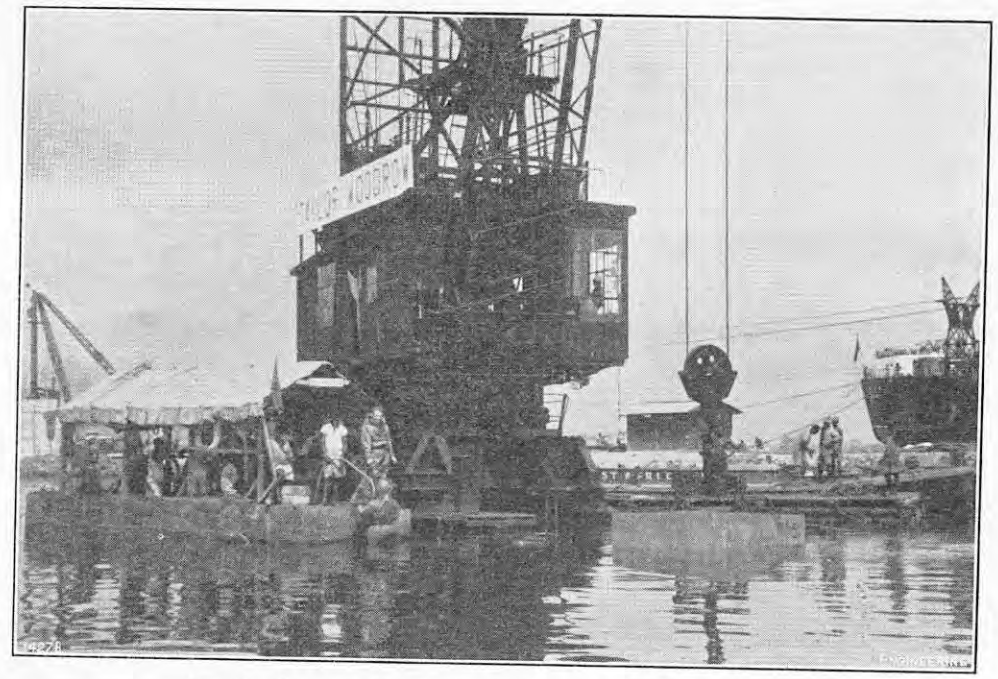


FIG. 2. PLACING PRE-CAST BLOCKS FOR WHARF EXTENSION.

FIG. 3. TIMBER FENDERING TO WHARF EXTENSION.

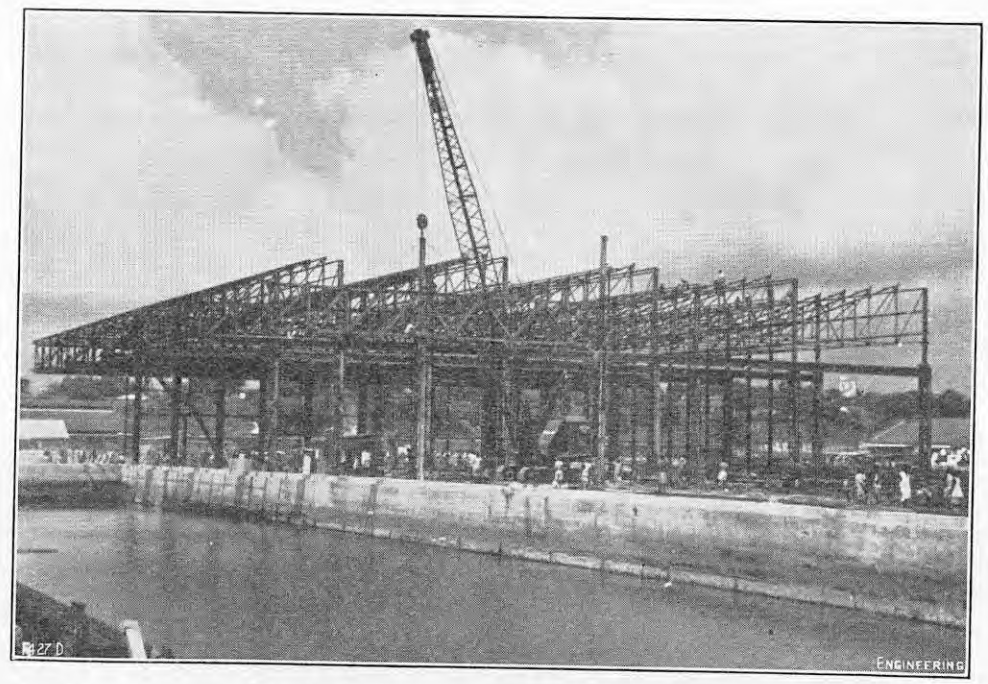


FIG. 4. STEELWORK FOR NEW TIMBER SHEDS.

ENGINEERING

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TEMPLE BAR 3663 and 3664.

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

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Terms for displayed advertisements can be obtained on application to the Manager. The pages are 12 in. deep and 9 in. wide, divisible into four columns 2¼ in. wide. Serial advertisements will be inserted with all practicable regularity, but absolute regularity cannot be guaranteed.

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

TIME FOR RECEIPT OF ADVERTISEMENTS.

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

"Copy" instructions and alterations to standing advertisements for display announcements must be received 16 days previous to the date of publication, otherwise it may be impossible to submit proofs for approval.

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

CONTENTS.

ENGINEERING

FRIDAY, APRIL 24, 1953.

VOL. 175. No. 4552.

MILITARY INFLUENCES ON CIVIL AIRCRAFT.

UNTIL quite recently, advances in the construction and performance of civil transport aircraft have been largely the result of the efforts devoted to the search for more effective military weapons. To-day, with military aircraft attaining transonic speeds, the gap between military and civil needs is wider than it has ever been before, and many aeronautical authorities believe that the time has now come when, in the words of Sir Harry Garner, "Those responsible for the development of civil aircraft will no longer be able to rely, as they have done in the past, on picking up the crumbs that fall from the rich military man's table." This view is not, however, entirely shared by Sir Frederick Handley Page, who recently delivered the 11th Brancker memorial lecture before the Institute of Transport in London. The subject of Sir Frederick's discourse was "The Influence of Military Aviation on Civil Air Transport," and it is his view that the increasing importance of military transport by air may foster a closer relationship with commercial air transport, to the benefit of both.

Before discussing the future trends of commercial air transport development, Sir Frederick outlined its evolution, from the converted bombers of the first World War. He demonstrated that the high speeds which are the transport aeroplane's chief asset mean that a relatively small number of aircraft can carry a large volume of traffic. The capital invested in civil aviation is therefore limited, and the industry "has had to rely for the development of its equipment on the large sum devoted to military research." If, however, commercial aviation continues its rapid post-war expansion, the balance between military and civil requirements may change.

It was, in fact, a long time before the air-transport industry realised fully that with higher speeds the operating costs would be lowered. Thus, in 1930, the Hannibal class aircraft had a cruising speed only 20 m.p.h. higher than that of the O/400 bomber aircraft constructed 15 years earlier. The development of monoplane bombers in 1931 led to the appearance in 1933 of the Douglas D.C.1 air liner "which revolutionised air transport by being some 50 per cent. faster than its contemporaries," and thus had a considerably greater earning capacity than its biplane competitors.

Shortly before the beginning of the second World War, several British aircraft companies had projects for four-engined air liners which had to be abandoned on the outbreak of war. The American industry, however, was able to produce a number of modern transport aircraft before it became directly involved in hostilities, and, as a result of the policy adopted during the war that the United States should provide transport aircraft for the Allies, 85 per cent. of the aircraft on scheduled routes to-day are of American manufacture. During the war, military air transport was developed on a vast scale, and many new routes were opened up which became available for civil transport after the war. Radio and radar developments led to improved navigational aids for civil aircraft, and airfields and bases were constructed all over the world; many of which, however, were unsuitably sited for civil use. The greatest technical advance in aeronautics during the war—the development of the gas turbine—has led to the introduction of the Comet jet air-liner and, more recently, the Viscount propeller-turbine air-liner on scheduled routes of the British national airways corporations.

Considering the question whether future military developments are likely to have any commercial application, Sir Frederick expressed the opinion that much basic research was still applicable to both bomber and transport aircraft. He cited the crescent wing, developed for the long-range bomber; power-operated control systems; landing gear; cabin pressure systems; and fuel and electrical systems. The high subsonic-speed long-range heavy and medium jet bomber aeroplanes now coming into service, he suggested, were capable of adaptation to commercial needs. The next generation of bombers would probably be capable of short periods at supersonic speed, and would be much more expensive to produce on account of the design problems arising from the increased drag. For this reason, Sir Frederick shares the general belief that "civil aircraft will be limited for a number of years to subsonic speeds of the order of 500 to 600 m.p.h. at operating altitudes of 35,000 ft. to 45,000 ft." To outweigh the higher costs of the supersonic transport aircraft, the next speed advance would have to bring the cruising speed to about 900 m.p.h. Sir Frederick did not concern himself with speculations on whether, in the more distant future, the piloted bomber, as it is known to-day, may be replaced entirely by the pilotless guided weapon, eliminating many of the complications, and the associated development work, of the man-carrying machine.

The role of military transport aircraft has become increasingly important and it is this, Sir Frederick considers, that may lead to a closer and more fruitful link between civil and military aviation. Civil transport aircraft have only recently started freight-carrying on any scale; the freight market is, however, expected to increase rapidly within the next few years, and specially designed freighter

aircraft would be required. The higher structure weight of such aircraft renders them uneconomical for passenger carriage. If the long-range military transport aircraft were replaced by two kinds of aircraft, the passenger-carrying machine and the freighter, for both military and commercial use, the Service and the civil transport operators would both profit by the reduced costs made possible by a greater production run. There was also, he said, a civil market for the " tactical " military transport aircraft, designed for dropping supplies and parachute troops, as a short-range freighter capable of operation from small airfields and easily loaded and unloaded.

With the contracting of large-scale air trooping to civil air-transport companies (in the United Kingdom, largely by the independent operators), a new relationship has arisen between military and civil aviation, analogous to that which has always existed between the Royal Navy and the Merchant Service. To maintain a large fleet of the most efficient and up-to-date aircraft is beyond the resources of the independent airlines. To finance the purchase of turbo-jet airliners, Sir Frederick suggests that a finance corporation should be established which would place orders for new aircraft with the manufacturers, and would lend the aircraft to the operators on hire-purchase terms. In the event of operators being unable to continue the hire agreement, the aircraft would be at the disposal of the Air Ministry to form part of Transport Command. If such a scheme could be put into operation, it would solve the difficult problem of fleet replacement which will soon confront many of the independent operators at present operating war-surplus machines purchased at low cost; and it would provide a reserve of aircraft for troop-carrying which could be available immediately in the event of war, while being usefully and profitably employed during peace time.

INDUSTRIAL STANDARDS.

When, in 1901, the Institutions of Civil, Mechanical and Electrical Engineers, the Iron and Steel Institute, and the Institution of Naval Architects co-operated in setting up the Engineering Standards Committee, the immediate object was to reduce the very large numbers of different varieties of rolled sections for which there was no industrial justification and which involved unnecessary costs both for producer and user. One of its earliest activities was to reduce the number of types of tramway rail from 75 to 5. The value of the work of the Committee, and the status it early attained, resulted in the extension of its interests to a wider engineering field and, in 1918, it was reconstituted as the British Engineering Standards Association. The importance of the work done for the engineering industries made it clear that similar procedure might be of value in other branches of work, and in 1931 the organisation underwent its second transformation and became the British Standards Institution, the activities of which now range from rolled sections to household furniture and boots and shoes.

Although the Engineering Standards Committee was the first body set up to introduce some degree of uniformity of type in widely-used industrial products, the importance of industrial standards had been brought out very clearly by Whitworth's work on screw threads. The idea of standardisation, however, dates from long before the days of Whitworth; it is probably as old as civilisation. The Romans laid down standards of weight and introduced Roman coinage, although it is probable that the standard of accuracy of the individual coins, both in dimensions and weight, was far from that of modern practice. The Roman example was followed throughout subsequent history, standards, however, largely being of local application only and frequently rather indefinite. The present English yard was not officially determined by Act of Parliament until 1878. The Weights and Measures Act of that year established standards of legal status which must be complied with in commercial transactions; an Act of 1897, however, legalised the alternative use of metric measures.

There is a distinction between national standards legally enforceable and the industrial standards drawn up by the British Standards Institution. The latter are permissive, although some individual examples have been adopted and incorporated in Government regulations. In general, however, users may ignore them if they wish. There is a British Standard for concert pitch, but nothing will happen to any conductor who chooses to ignore it. The result is, however, by no means the same with many, possibly most, industrial standards. Unless they are specified in a contract on which he is engaged a manufacturer may depart from them, but this is not to say that nothing will happen to him. In very many cases, he will be involved in extra expense. It is the saving in manufacturing and store-keeping costs which forms the main justification for the drawing-up and adoption of manufacturing standards, with, however, the important additional advantage that a buyer purchasing a standard article, or material, knows that it is based on a specification laid down by the authoritative members of the particular industry concerned. It is estimated that 95 per cent. of the steel now produced in this country is manufactured in accordance with a British Standard, so that a purchaser, by consulting the appropriate document, knows exactly what he is getting.

The success of the example set by the Engineering Standards Committee has, in one sense, been something of an embarrassment. Its activities and those of its successors have been copied so widely that there are now some thirty corresponding bodies spread throughout the world. As different nations may, and do, have different ideas about desirable standards, the practice of one country may not be acceptable in another. A prominent case of this kind was furnished in connection with the export of electrical goods to Canada. Canadian standards run more closely to those of the United States than to those of this country, and British goods were found not to meet requirements. As is generally known, this particular difficulty was overcome by means of an arrangement by which the British Standards Institution acts as agent for the Canadian Standards Association and approves goods before they are shipped. In most other Commonwealth countries, the majority of British standards are accepted. As far as the rest of the world is concerned, contact is maintained with the International Organisation for Standardisation, the International Electrotechnical Commission and the Organisation for European Economic Co-operation, but it is not likely, even with these and the various other international bodies which now flourish, that world industrial standards will ever be agreed on.

In the course of an interesting survey of the work of the British Standards Institution, under the title " The Contemporary Role of Industrial Standards," which he delivered to the Royal Society of Arts on March 18, Mr. H. A. R. Binney, the Director of the Institution, stated that the sale of British Standard Specifications was now approaching the rate of one million per year. Than this, nothing could more clearly indicate the acceptance by industry generally of the value of the work of the Institution. Of the range covered, 60 per cent. is concerned with the engineering and metal trades, which were responsible for inaugurating the whole movement; 30 per cent. is concerned with chemicals and buildings; and 10 per cent. with textiles and various miscellaneous industries. As an example of the industrial value of standardisation, Mr. Binney quoted " a very prominent firm " to the effect that although now employing 200 draughtsmen, it would require 50 more were it not for the fact that various electrical components could simply be indicated on drawings by the appropriate British Standard Specification number.

A matter both of interest and importance in connection with international-standards co-operation arises in the English-speaking countries. This concerns the meaning to be attached to certain scientific and technical terms and phrases. Mr. Binney stated that at international conferences his delegation had frequently been asked if various United States papers could be translated into English. He surmised that some American delegates desired the same thing, the other way round, about English papers. This matter has been discussed with the American Standards Association and it has been agreed that attempts shall be made to harmonise differences as far as possible. Some British Standard specifications include definitions of terms, and in view of the importance of the attempts being made to increase the sale of British products in America, it might be worth while for the British Standards Institution to pay attention to the practice of some British motor-car manufacturers, who export to both Canada and the United States. For the convenience of customers in two markets, both the British and transatlantic forms of technical terms are given in their instruction books.

NOTES.

THE JAMES CLAYTON LECTURE.

In delivering the James Clayton Lecture to the Institution of Mechanical Engineers last Friday, Mr. James R. Bright, M.S., M.A.S.M.E., expressed the thoughts of many engineers when he said that " the cream has been skimmed off a good many production techniques." The one technique which was still not explored to anything like its full potentialities, even in the United States, was, in his opinion, materials handling, and this was the subject of his lecture, on " How American Industry is Attacking the Problem of Materials Handling." Seldom has a lecture been of such universal significance to industry generally. Mr. Bright, who is chief editor of the American periodical *Modern Materials Handling*, covered the subject in great detail, and his lecture, which occupies 30 of the Institution's pages and has 71 illustrations, will be an invaluable guide to all managers and engineers who wish to apply the basic principles of the subject to their plants. Mr. Bright dealt with the neglected field of " short-range transportation "—a phrase which embraces the techniques of movement other than normal transportation by sea, rail, road, etc., and moving things within arm's reach (which is covered by motion study). He established the case for more intensive study of short-range transportation by a few well-chosen statistics. Thus, for example, the materials for a certain aircraft component were in the works, from receipt to dispatch, for 240 hours, but only slightly more than 10 hours of this time were devoted to actual processing. Various studies and numerous estimates had shown that materials handling costs varied from 30 to 90 per cent. of total production costs. In another factory, it was found that for every ton of finished products dispatched, 50 tons of materials entered the plant. Mechanised handling techniques were essential to the realisation of the full potential of much high-speed machinery. They could be used to reduce unit production costs, to increase the capacity per unit area of plant, to increase the safety of personnel, to reduce damage to materials and to improve the saleability of the product. Britain's annual wage bill for manufacturing industries was, he said, about 2,500*l.* million. Of this, about 30 per cent., or 800*l.* million, was spent on materials handling, and this 30 per cent. could itself be cut by, say, 30 per cent., thereby reducing costs by 200*l.* million or 300*l.* million.

BRITISH STEEL FOUNDERS' ASSOCIATION.

Speaking at the opening session of a "Customer-Founder Convention" held in London under the auspices of the British Steel Founders' Association, from April 15 to 17, Mr. T. H. Summerson, chairman of the Association, stated that the purpose of the Convention was to let their clients know the steps they were taking to give them better products and a better service. At the same time, the Convention provided a forum which would allow the products of the industry to be discussed and suggestions made for their improvement. These were the primary purposes of the Convention, but to add to its usefulness, two exhibitions, one devoted to the metallurgy and design of steel castings and the other to their application, had been arranged. The Convention and the exhibitions were declared open by the Rt. Hon. David Eccles, P.C., M.P., Minister of Works. In a brief speech, he emphasised the importance of such meetings in that they provided a common platform on which producers and users could discuss their problems and thus make a mutual contribution to the improvement of steel castings. During the two subsequent days, April 16 and 17, the papers presented and discussed comprised, "Steel Castings and their Application," by Mr. F. Rowe, managing director of K. and L. Steelfounders and Engineers, Limited; "Customer Experience with Steel Castings," by Mr. A. C. Annis, of the Metropolitan-Vickers Electrical Company, Limited, and Mr. R. A. Riddles, C.B.E., member of the British Railways' Executive; "Quality Control and Inspection as a Part of the Manufacturing Process," by Dr. John Rait, of Hadfields Limited; "Research as it Affects the Customer," by Mr. J. F. B. Jackson, director, British Steel Castings Research Association; and "Policy Making and Fact Finding," by Mr. T. H. Summerson, the chairman. Steel castings of a wide range of size and type were on view at the two exhibitions.

DISTRIBUTION SCHEME FOR STEEL PLATE.

Speaking in the House of Commons on Monday, April 20, Mr. Duncan Sandys, the Minister of Supply, said that, for some time, the steel industry had been taking action to increase the supplies of steel plate. A year ago production was running at a rate of over 40,000 tons a week but it had now risen to nearly 47,000 tons. It was anticipated that the output for 1953 would total upwards of 2,400,000 tons. This represented an increase of 200,000 tons over the production for 1952, and it was hoped to increase the output by a further 100,000 tons, or more, during 1954 and 1955. This, he had been assured, was the utmost obtainable from the existing rolling-mill plant. Recently he had approved a scheme for the extension and modernisation of a plate-rolling mill on the North-East Coast and this, which should come into operation in 1956, would produce an extra 100,000 tons a year. Plans for other extensions were being made, and, in addition, there was the possibility of importing more steel plate from abroad. Nevertheless, there was still a likelihood of a marginal shortage of steel plate for some time, and, as a result of discussions with the steel industry, it had been decided to introduce a steel-plate distribution scheme, to be operated on voluntary lines by the industry with guidance from the Government. An inter-departmental committee of officials had been set up to keep under review the needs of plate-using industries and to consider any adjustments in the pattern of production and deliveries which might be desirable. Mr. Robert Marshall, a director of Colvilles Limited, and a part-time member of the Iron and Steel Corporation of Great Britain, had agreed to act as technical adviser to the committee. On their side, the steel industry had appointed a group of plate-makers to act as a clearing house for the requirements of consumers.

ECONOMIC USE OF STRUCTURAL MATERIALS.

At a meeting of the Institution of Structural Engineers held in London on Thursday, April 16, the President, Mr. Ernest Granter, introduced three speakers who had been invited to explain and illustrate some of the matters raised in the report issued by the Works Directorates of the Ministry of Works and the Service Departments on the "Economic Use of Building Materials." The opening speaker was Mr. G. A. Gardner, O.B.E., a former member of Council of the Institution and recently retired from the post of Chief Structural Engineer, Ministry of Works. He explained that, as an engineer speaking to engineers, he had no need to advocate an accepted principle of policy but that he had responded to the President's invitation in order to lead the discussion on detailed methods of implementing it. The only fundamental economy, he said, was that of human energy, and this, of course, was not necessarily commensurate with the use of a minimum amount of material in any particular case. Mr. Gardner was ably supported by Mr. R. Morton, Deputy Civil Engineer-in-Chief, Admiralty, and Mr. L. B. Creasy, Deputy Chief Structural Engineer, Ministry of Works. During the discussion, examples were given of possible theoretical savings (due to higher stresses and smaller load-factors) being more than offset by the increased costs of design and supervision necessarily incurred with higher technical standards. Reference was made to the very light weight of the tension-braced roof truss typical of the wrought-iron era, and examples were given of modern roof construction needing some three times the weight of steel for a given area covered for corresponding span lengths. This was a challenge to engineering enterprise which was not being met by the development of light-weight trusses formed of steel tubes with welded connections. Winding up the discussion for the Institution, Mr. Walker Andrews, Past-President, said that whether or not materials were rationed, controlled, or in short supply, the ultimate yardstick of economic efficiency must be price.

CRITICAL-FREQUENCY PROBLEM FOR A COMPUTING MACHINE.

There are several common problems in engineering analysis which might profitably be arranged for solution on an electronic computer. One of these, the determination of the critical frequencies of an unbranched shaft system in torsional oscillation, has recently been programmed for the Manchester University computing machine. It is assumed that the actual physical system can be replaced by an idealised system, consisting of a set of heavy discs connected by light uniform cylindrical shafts. If this is done, the data required for the solution of a given problem consist of three sets of numbers—the moments of inertia of the discs, and the lengths and diameters of the interconnecting shafts—together with the modulus of rigidity of the shaft material. The programme will deal with systems with up to 32 deg. of freedom, and in order to feed a problem into the machine it is merely necessary to punch the three sets of numbers on a piece of paper tape. On feeding this into the machine the natural frequencies and associated normal modes will be printed out in order, starting with the fundamental. The time for the complete calculation varies with the number of degrees of freedom of the system and the number of modes and frequencies required. A shaft system of 16 deg. of freedom was recently solved on the machine, and in that particular case the fundamental frequency and mode were calculated and printed out in 65 seconds, the other frequencies following at roughly equal intervals. The method used by the programme is the well-known one due to Holzer. Further information about the programme may be obtained on application to the Computing Machine Laboratory, The University, Manchester.

THE INSTITUTE OF FUEL.

The total membership of the Institute of Fuel is now more than 4,000; actually the figure, on December 31, 1952, was 4,120, compared with 3,949 at the end of 1951. It is stated in the report of the Council of the Institute for the year ended December 31, 1952, presented at the annual corporate meeting held in London on April 22, that the work of the Institute's education committee, together with the various committees of the City and Guilds of London Institute, during the year, reached a stage at which it was possible to publish the complete syllabuses for Intermediate and Advanced Grade examinations under a new scheme. The syllabuses and regulations have been circulated to leading technical colleges. The Intermediate Grade examinations are being held for the first time next month, while the Advanced Grade papers will be set for the first time in May, 1954. The recognition of the examinations as part qualification for the associate membership of the Institute has been considered by the Council and regulations on the subject have been issued. A major development announced by the publications committee is the change from two-monthly to monthly issues of the *Journal*, beginning with the July number. The format is also to be changed; the page size will be reduced slightly and the size of the type increased to improve the ease of reading. The revenue account shows that the income of the Institute for the year ended December 31, 1952, totalled 15,406*l*., and that the net surplus of income over expenditure was 2,477*l*.

MANUFACTURE OF STREET LIGHTING FITTINGS IN THE UNITED STATES.

An interesting report on the operations of firms manufacturing street lighting "luminaires" (*anglice* fittings) in the United States has been prepared by the Productivity and Technical Assistance Division of the Mutual Security Agency, Washington. Copies can be obtained in this country from the British Institute of Management, 8, Hill-street, London, W.1, at the price of 5*s*. The market for such equipment is, of course, mainly restricted to municipalities and electric power companies. One result of this is a demand for individual designs, although 50 per cent. of the value of the output in the industry is accounted for by the lantern type of luminaire, which is suspended from the lamp post with the light course pointing downwards. Such fittings are manufactured by about 10 companies, a feature of whose organisation is the design department, in which the best combination of components is chosen to provide the distribution of light desired by the customer. In fact, in one firm with a total of 75 employees, 25 are engaged in the design department. The greater part of the man-hours are, however, expended on component and final assembly, on which line methods are largely employed. At present the manufacturers of this equipment are engaged in standardising the size of parts so that reflectors, hoods and glassware shall be fully interchangeable regardless of the firm by which they are produced. This will enable large quantities of such components to be assembled for stock. Although mass-production methods can be, and are, largely employed, manufacturers have to be prepared to supply variations from standard design, and these, where necessary, are usually turned out on a special production line. It has been stated that 100,000 different combinations of components are possible. The report contains a detailed analysis of the man-hour requirements for every component sub-assembly and for the final assembly, while information on plant characteristics, design practices and a brief account of the industry are also included.

DIESEL ENGINE USERS ASSOCIATION.

The principal guest at the luncheon of the Diesel Engine Users Association, held in London on Thursday, April 16, was Mr. W. R. Cook, C.B., Chief of the Royal Naval Scientific Service. Immediately after the luncheon the President, Mr. Gerald Fox, M.I.Mech.E., presented the Percy Still Medal, awarded annually for the best paper read before the Association during the year, to Mr. C. H. Bradbury, M.I.C.E., M.I.Mech.E. This was followed by the toast to the guests, proposed by the President in a short speech in which he made reference to recent progress in Diesel engines. Mr. Cook, who proposed the toast of the Association, said that he had never worked on Diesel engines, but in his association with the Admiralty he was made aware of their importance to the Royal Navy. Because he worked for the R.N.Sc.S. he thought some might wonder where engineers came in. It was his opinion that engineering was a

science, and he said that his Service did not distinguish between scientists and engineers. He thought that the demands of the user were often pitched too high, but a clever engineer was always determined that such demands should be met. On the subject of development he asked that some thought be given to reducing the noise level of Diesel engines, and suggested the supercharger might be tackled first. Submarine propulsion produced many problems and engines that were more economic in the use of air were most necessary. Heat loading was a major problem and a study of the use of oil-in-water emulsions was being made, aimed at removing more heat and yet retaining the necessary lubricating qualities. Work, he said, was being carried out on the subject of heat transfer from surfaces in moving contact, and it included piston rings and liners, under conditions closely simulating those in an actual engine, and some tests were being made on the old idea of sodium-filled valves. He thanked the Association for the part they played, which he said was of great value to the country.

BRITISH CHEMICALS AND THEIR MANUFACTURERS.

The Association of British Chemical Manufacturers, 166, Piccadilly, London, W.1, have recently issued a little handbook of 76 pages entitled "Press Guide to British Chemicals and Their Manufacturers." This, it is stated, has been prepared expressly to assist journalists, broadcasters, lecturers and others who may be writing or speaking on chemical subjects and who need speedy references to sources of reliable information. The book is divided into three sections, all alphabetical, the first being a list of firms, the second a list of products and the third a list of proprietary and trade names. A simple numerical code identifies the companies likely to be able to provide authoritative information on particular chemical products or fields of work and the name, and office and home telephone numbers of the official authorised to answer inquiries is given "to provide a positive contact and obviate delay." We are informed that some 2,000 copies of the book are being distributed, in the first instance, to the editors, news editors, library and scientific correspondents of the national, provincial and technical Press, but persons who are likely to make regular use of the handbook should communicate with the manager of the Association at the above address.

LETTER TO THE EDITOR.

CORROSION OF SHIPS' PROPELLERS IN POLLUTED ESTUARIES.

To the Editor of Engineering.

Sir,—A fresh example of the injurious effects which may result from the pollution of estuaries has recently come to light.

It was reported to the British Shipbuilding Research Association that the bronze propellers and gun-metal sleeves on propeller shafts of certain vessels using a polluted estuary were subject to excessive corrosion. It was also reported that measurements of the potential difference between the propeller shafting and the hull, when a vessel was moving at full speed, showed that the shafting was normally about 250 mV more positive than the hull, but that, as the vessel entered the estuary during the summer, the sign of the potential became reversed. This reversal was not observed during the winter. The potential of the shafting was governed by the potential of the propeller and the gun-metal sleeves which completely covered the section of the shafting exposed to the water. As it was thought that these phenomena were probably connected with the condition of the water in the estuary, the Water Pollution Research Laboratory was consulted.

Experiments made by the Laboratory have shown that the potentials of gun-metal and phosphor-bronze electrodes are more positive than mild steel when immersed in aerated estuary water, but become more negative when sulphide is present in the water. Some values of the potentials, for various metal rods, after immersion for one hour in flowing estuary water, are given in the following table. The salinity of the water was 21·35 grammes per 1,000 grammes, and the *p*H value was 7·4.

Metal.	Potential (Saturated Calomel Scale), mV.	
	Aerated Water.	Water containing Sulphide (7·1 parts per million as S).
Mild steel	—669	—752
Gun-metal	—175	—778
Phosphor bronze ..	—203	—779

It is known that, during the summer, sulphide is present in the water of the estuary concerned, and it is concluded that its presence is responsible for the reversal of potential and might cause the excessive corrosion of the copper alloys.

Yours faithfully,
A. B. Wheatland,
A. Laird.

Water Pollution Research Laboratory,
103, Langley-road,
Watford, Herts.
April 14, 1953.

OBITUARY.

MR. H. A. LINGARD.

We regret to record the death of Mr. H. A. Lingard, which occurred at Ewell, Surrey, on Saturday, April 18, at the age of 70. He was well known for his long association with the lamp-making branch of the electrical manufacturing industry, in which he did good work in bringing about its organisation on a sound basis.

Herbert Arthur Lingard received his technical education at the Derby Technical College and served as a pupil with the firm of Sir Alfred Haslam and Company in that town. He joined the staff of the British Thomson-Houston Company in 1904 and was at first engaged on work connected with the supply of electric power. He transferred to the staff of the Canadian General Electric Company in 1908, but after five years in their service was obliged to return to this country on account of ill-health. In 1915, he again joined the British Thomson-Houston Company and served in the export department, his duties including visits to many foreign countries. In 1928, he became general manager of the lamps and lighting department and three years later was appointed a director of the company. He retired in 1948, although he continued to act in an advisory capacity.

Mr. Lingard had been a member of the Council of the Electric Lamp Manufacturers Association since 1928 and had on more than one occasion served as chairman. He was also a member of the Illuminating Engineering Society and a director of the Hotpoint Electrical Appliance Company.

Iron and Steel Production in United Kingdom.—The production of steel in the United Kingdom during March averaged 351,400 tons a week, equivalent to an annual rate of 18,272,000 tons. This compared with a weekly average output of 352,400 tons in the previous month (annual rate, 18,325,000 tons) and 320,200 tons (annual rate, 16,648,000 tons) in March, 1952. Pig-iron production in March was at a weekly average rate of 215,700 tons, or an annual rate of 11,216,000 tons, against an average of 213,500 tons (11,104,000 tons) in February, and 201,700 tons (10,490,200 tons) in March, 1952.

Model Engineering Exhibition.—The Birmingham Society of Model Engineers, which was formed some 17 years ago, has arranged to hold a model engineering exhibition in the Bingley Hall Annexe, Birmingham, from Monday, May 4, to Saturday, May 9, both dates inclusive. It is claimed that the exhibition will be one of the largest to be held outside London. The Society anticipates that there will be at least six hundred exhibits on view, including a 4-ft. long model of a radio-controlled bridge-laying Churchill tank. Altogether, about 20 model engineering societies in the Midlands are contributing to the exhibition. Further particulars may be obtained from the organisers' representative, Mr. M. D. Picknell, 254, Reddings-lane, Birmingham, 28.

TAKORADI HARBOUR EXTENSIONS.

With the general increase in trade that is occurring throughout tropical Africa, vast developments are having to be undertaken in communications, particularly roads, railways and harbour facilities. Among the harbour works, one of the most important extensions to be completed, so far, is that of Takoradi, on the Gold Coast, through which passes a volume of traffic that is fast approaching 2,500,000 tons each year; it includes timber, manganese, bauxite, precious stones and cocoa. The first jetties at Takoradi were built during the period 1895 to 1900, but the need for a deep-water harbour was apparent even then. Controversial arguments concerning the best site for the proposed harbour, either at Takoradi or at Sekondi seven miles along the coast, caused the project to be held in abeyance until the mid-twenties. Between 1924 and 1928, a main wharf, 1,500 ft. long, was constructed, together with a curved protecting breakwater nearly 1½ miles long, to the leeward, enclosing a basin of 220 acres. Extensions were first considered in 1937, but had to be abandoned with the outbreak of war, although a small temporary wharf for handling timber had to be built outside the protection of the breakwater during war-time.

After the war, Rendel, Palmer and Tritton, the consulting engineers who had been responsible for the existing harbour, undertook the design of the extensions. The contract for the new work was let to Taylor-Woodrow (West Africa), Limited, 10, Park-street, London, W.1, and work began in 1949; the major construction work, described below, has now been completed and the harbour extensions are being opened today, April 24, by Sir Charles Arden-Clarke, G.C.M.G., Governor of the Gold Coast.

The largest single item in the reconstruction work was that extending the main wharf by 1,400 ft., to nearly double the accommodation for ocean-going vessels, there now being six berths instead of three, all with between 30 ft. and 33 ft. of water at low water, ordinary spring tide. A general view of this work is shown in Fig. 1, on page 528, which also shows the original breakwater in the background and the new bauxite-loading berth on the left. The method of construction employed consisted of placing a mass-concrete foundation between temporary sheet-steel shuttering (40,000 cub. yard of 1 : 2 : 4 concrete were used for this purpose). Above this foundation pad, about 6,000 pre-cast concrete blocks, the largest weighing 15 tons, were used to raise the walls of the wharf to a level of 2 ft. above low-water; the work of placing these stones in position is illustrated in Fig. 2. Two new two-storey transit sheds have been built on the extended wharf, one of which has been designed for the accommodation of passengers in transit and their baggage.

The new bauxite berth, shown on the left of both Figs. 1 and 3, and its resiting required the provision of a new aerial ropeway along which the ore will be transported to the quay-side. The new alignment of the ropeway, along a more direct route than previously, runs across an area of 49 acres that has been reclaimed from the sea. The spoil used for the reclamation work was obtained by the removal of Cox's Fort Hill, a local landmark that was about 80 ft. high and covered some 22 acres. About 1,500,000 cub. yards of laterite and shale were excavated from the hill by blasting, and deposited in the reclaimed area. The shale—containing a high proportion of sulphur—weathered badly, although it proved stable when placed below water, and care had to be taken to ensure that the shale was dumped below the water line and recovered by the laterite. Most of the area where the hill once stood is now used for a railway marshalling yard which extends on to the reclaimed territory. Among the extra rail facilities that have been provided at Takoradi are the railway marshalling yards, cargo platforms and a locomotive yard with sheds, turntable and servicing plant. A new wide approach road to the town from the northern hinterland has also been built and this has involved the construction of a new road bridge spanning the railway.

High priority was given to the establishment of new facilities for handling of timber. Of the 1951 exports, the value of logs sold amounted to 3,000,000*l.* and that of sawn timber (a more economical cargo) to 1,000,000*l.*, but the output of the sawn timber is expected to be raised by more than 50 per cent. from the new saw-mills. The new depot (the steelwork for one of the sheds is shown, during the course of erection, in Fig. 4, page 528) has been built at the north-east corner of the harbour area. The arrangement and equipment installed in the sheds is recognised as among the most up-to-date in the world; new road and rail connections have been made to service the sheds, two new docks each 500 ft. long have been laid down for handling timber alone and electric cranes installed for transferring the logs on to the ships. To supply power for the saw mills, and for other industries located in the area, three electricity sub-stations have also been constructed during the past four years.

Of local materials used during the work, the granite was obtained from quarries at Sekondi, where a new modern plant was installed for the purpose; sand was available from the local beaches and timber from the hinterland. Local *kussia*, a hardwood, was used extensively for the heavy fendering that has been placed along the new walls; this fendering is to be seen in Fig. 3. Otherwise, the greater part of the materials, in particular, cement and steel, were obtained from the United Kingdom, as was the greater part of the contractor's plant. The cost of the main harbour improvements has been assessed at 3,250,000*l.* Accommodation for the staff was provided in some of the 2,000 houses, together with roads and services, that have been built under a separate contract for the development of the municipality of Takoradi. During the course of the work, both in the harbour and in the town, much use has been made of local labour and the Africans have been instructed in the operation of the whole range of plant employed on the works, and this instruction is expected to prove of great value in the development of the Gold Coast Colony.

QUALITY IN LIGHT-METAL CASTINGS.*

ONE of the striking features in the field of metallurgy during the past 15 years has been the very considerable increase in the output of light metals. The impetus was provided, of course, by the necessity for building large numbers of aircraft, for which lightness and strength were prime requisites. These twin requirements had to be fulfilled with certainty and precision—there was no room for guesswork or approximation; hence materials were described and defined by standard specifications. Peace-time uses of light metals, as a rule, do not call for the highest strength : weight ratio, either on technical or economic grounds, but it is none the less essential to insist upon consistent quality in materials to be used for any engineering purpose. In 1945 the British Standards Institution issued, for the Ministry of Supply, the BS/STA7, "Services Schedule of Aluminium and its Alloys," which was widely used as a work of reference until the publication, in 1949, of a series of British Standards covering aluminium and aluminium-alloy products for general engineering purposes.

Though the benefits of standardisation apply to all products, we are here concerned only with light-alloy castings, and an enumeration of the main objects in the standardisation of castings, in particular, may not be out of place. The aims to be sought are: to restrict excessive variation of alloys for the convenience of founder, finisher and user alike; to provide a generally-accepted common reference in the multiplicity of proprietary names; to enable the client to appraise the nature of the materials offered, and satisfy himself that they are suitable for the purpose for which they are required; to define methods of inspection and testing, and to specify the chemical composition and property values appropriate to each alloy; and to establish, in advance, an agreed procedure to be followed in the event of dispute. B.S. No. 1490 : 1949 provides the means of attaining all these objects. By careful consideration, a series of specifications has been drawn up to cover a range of alloys that will satisfy all normal engineering requirements. It includes not only the strongest available alloys, used extensively and successfully in aircraft and wherever lightness has to be accompanied by high strength, but also the more common materials that possess adequate strength for lightly-stressed articles and are less costly to produce. It also includes alloys which are specially suitable for particular types of service, as for example, materials capable of resisting corrosion, of retaining their strength at elevated temperatures, or of receiving a decorative finish.

The existence of a series of specifications makes it easier to ensure that the alloys used are suitable for the purpose which the castings are to serve. The importance of choosing the right alloy is now generally appreciated; but this was not always the case. For instance, a year or two ago an investigation was held into the failure of aluminium-alloy components of public-service vehicles built prior to 1939. Nearly all the cast specimens analysed were found to conform to no British Standard regarding composition, or to contain excesses of certain constituents detrimental to performance. Such haphazard ordering of castings would be unusual, and inexcusable, now. With standardisation firmly established, the light-metal industry in Great Britain is more fortunate than those in some other countries. It would be highly regrettable if this advantage were lost under the pressure of competition. In the present trade recession there is a temptation to buy in the cheapest market, with less insistence on quality. Within the last twelve months buyers of industrial goods—materials, semi-finished products, plant and equipment—have become much more price-conscious. The world-wide shortages of both capital- and consumer-goods have now been made up as far as ability to pay for them will allow; with more goods available, the client is able to exercise discrimination and, with less money with which to pay for them, he will assess values very carefully. This makes it all the more important not to sacrifice quality to cheapness, because we cannot afford to disregard the tradition of good workmanship that has been earned by British goods.

How, then, can competition be successfully met? Only by careful estimating and accurate costing. The smaller the margin of profit the more vital it is to know exactly what the position is. It would be foolish to take chances with materials, when unsuspected defects could upset the most carefully calculated transaction. In the field of castings, especially, the existence of accepted standards provides means of avoiding unnecessary risks. The meticulous control necessary to ensure conformity with specifications cannot be exercised without expense to the supplier, who has to employ qualified and experienced supervisory staff, and equip them with costly instruments and apparatus. There are many ways in which the cost of castings could be reduced: by using lower-grade metal, by relaxing control of melting and pouring temperatures, by less frequent sampling, and less vigorous inspection and testing. To the client who does not check the quality of castings—and not all are equipped to do so—the deterioration may not at once be apparent, but it will almost certainly be discovered sooner or later with, possibly, dire consequences.

The Light Metal Founders Association exists to maintain, by the free interchange of technical information and by friendly co-operation, a level of quality in light-alloy castings worthy of a progressive industry. Its members realise that only by doing so will they be able to develop and enlarge the fields of application of light alloys. Skimping is recognised to be short-sighted and detrimental to real progress, however keen price competition may be. For the individual founder it is far better to lose an order than to win it at the expense of reputation, and for the industry as a whole, gains made in the invasion of markets hitherto held by ferrous, or other non-ferrous, metals cannot be consolidated if they have been won by reckless tactics. To some extent, however, founders are in their clients' hands, and, if no value is set on the control of quality, the pressure of competition may force its abandonment.

* Communication from the Light Metal Founders Association. Abridged.

GAS FIRING IN THE POTTERY INDUSTRY.

ON a recent visit to Stoke-on-Trent, organised by the Gas Council, we saw something of the progress made in recent years in the gas firing of pottery. The first gas-fired kiln was installed in the Potteries in 1932, and for several years steady progress was made, but with an inevitable falling-off during the war period. Since 1945, however, the number of gas-fired kilns in use has risen greatly, and last year there were 229 kilns in the area, consuming gas at a rate of 4,760 million cub. ft. per annum. The greater part of the gas is supplied by the West Midlands Gas Board's works at Stoke-on-Trent, but a certain amount of producer gas is also used, made by the firms concerned on their own premises from gas-works coke. The change from the traditional "bottle" kilns, fired with raw coal, to the continuous tunnel-type gas-fired kilns, has brought about a considerable reduction in atmospheric pollution, and has also reduced to a minimum the spoiling of ware during firing, which, as a result of dirt contamination and fluctuation of temperature, was a common feature of the old method.

Gas firing is now used for continuous tunnel kilns, with mechanically-propelled cars carrying the ware, and varying in length up to about 400 ft., according to requirements. In firing pottery, there are three main temperature ranges. For "biscuit" ware, i.e., ware in the unglazed condition, the temperature required is from 1,050 deg. C. to 1,250 deg. C. Firing the ware when it has been dipped in glaze (or "glost" firing), calls for a temperature of 1,020 deg. C. to 1,150 deg. C., and for "on-glaze" decoration the range is from 700 deg. C. to 750 deg. C. Continuous gas-fired tunnel kilns, both of the open-flame type and the muffle type, are used for all three kinds of firing. The kilns are fully instrumented, with pyrometer points at each of the various temperature zones, and operate continuously, with a time cycle from cold, through maximum heat to cold again, of a duration which may be up to 54 hours or more, according to the nature of the ware.

Gas firing found its first application in the earthenware branch of the pottery industry, but it has spread to factories producing floor and wall tiles, electrical porcelain, china, and sanitary ware. Since 1949, it has begun to be used in the firing of refractory products. A typical kiln (used in this case for firing domestic earthenware) is 300 ft. long, and is operated day and night. Recording pyrometers provide a permanent record of the temperatures in the various zones of the kiln. A rail track extends the length of the kiln, and is provided with traversers at each end to transfer the cars on to a track running parallel with that passing through the kiln. This track is in the shop alongside the kiln, and is used for loading and unloading the cars, before and after firing. A pendulum tray conveyor from the pottery-making shops extends for the whole length of the track, and from this conveyor workers can lift the ware, already in "saggars," or fireclay containers, and build up the load on a car. Full cars are then transferred to the intake end of the kiln, and passed into it through double doors. At the discharge end of the kiln the cars are removed, the ware unloaded, and the cars sent back to the track for re-loading. The work of loading and unloading is done on the day shift; only two men are required during the night.

The use of gas is not confined to the actual firing of pottery. There are numerous processes requiring heat in the pottery industry, and in all of them gas has made progress. Before any kind of clay ware can be made, a considerable amount of preparation of the raw material is necessary. In some branches of the trade—electrical porcelain, for example, where dimensional accuracy of the finished product is essential—the raw clay is dried completely, as part of the preparatory process. Gas-fired driers are used for this purpose. Other raw materials, such as bone, have to be calcined, and certain ingredients for glazes require melting; in both these operations gas is used. Extensive use is also made of gas for the preliminary drying of shaped ware before it is fired.

THE INSTITUTE OF METALS.

(*Concluded from page* 503.)

Two concurrent technical sessions were held on March 25 during the annual general meeting of the Institute of Metals. We have already reported session "A," which took the form of a discussion on the "Control of Quality in Melting and Casting Non-Ferrous Materials," and we deal below with the proceedings of session "B." Dr. L. B. Pfeil, F.R.S., occupied the chair at the morning meeting, at which five papers were considered.

Corrosion of Alloys.

The first three of the five papers presented related to the corrosion of alloys and were considered jointly. The first was entitled "The Effect of Cold Work on the Microstructure and Corrosion-Resistance of Aluminium-5 per cent. Magnesium Alloys Containing 0 to 1 per cent. of Zinc." It described work carried out at the Royal Aircraft Establishment, Farnborough, and the authors, Dr. P. Brenner and Mr. G. J. Metcalfe, stated that their investigation had shown that the presence of zinc had little effect on the mechanical properties. The alloy containing 1 per cent. of zinc, however, showed pronounced precipitation after ageing at 70 deg. C., and the corrosion attack was greater than was the case with the 0 to 0·5 per cent. zinc alloys, which showed an incomplete grain-boundary network after ageing. Small amounts of cold work reduced the corrosion-resistance of the alloys appreciably, but heavy cold work, both of aged and unaged materials, resulted in a corrosion-resistance as high as that of unworked material. The maximum corrosion attack at about 30 per cent. cold work, was associated with the presence of continuous grain-boundary films formed on ageing.

The second paper described work carried out at the Fulmer Research Institute, Stoke Poges, by Mr. G. J. Metcalfe. It was entitled "Atmospheric Corrosion and Stress-Corrosion of Aluminium-Copper-Magnesium and Aluminium Magnesium-Silicon Alloys in the Fully Heat-Treated Condition." The author stated that the corrosion behaviour of the alloys in the extruded form had been determined in the stressed and unstressed condition by exposure to sea-water, river water, and various natural atmospheres. The corrosion attack had been assessed by visual and microscopical examination and by tensile tests on the corroded metal. The most severe attack of both alloys had resulted from exposure to the industrial atmosphere of Sheffield, where the average loss of strength after two years of exposure had been approximately 11 per cent., which was equivalent to a loss of thickness of 0·012 in. There was no indication of stress-corrosion failure of either of the alloys at any of the exposure sites. The rate of loss of strength of both alloys exposed at Sheffield and of the aluminium-copper-magnesium alloy exposed to a marine atmosphere, had been found to decrease with time, apparently exponentially.

"Intercrystalline Corrosion in Cast Zinc-Aluminium Alloys" was the title of the third paper. It was by Mr. C. W. Roberts, of the research department, Imperial Smelting Corporation, Limited, Avonmouth, who stated that to determine the susceptibility of zinc-aluminium alloys to intercrystalline corrosion in an air : water-vapour atmosphere at 95 deg. C., and to examine the effect of the presence of other elements on this form of corrosion, alloys of various compositions within the range : aluminium 0 to 22 per cent., copper 0 to 1·5 per cent., magnesium 0 to 0·09 per cent., lead, tin and cadmium 0 to 0·030 per cent., bismuth 0 to 0·016 per cent., and manganese 0 to 0·050 per cent., had been prepared and tested in the as-cast condition. The main conclusions drawn from the work were that : (*a*) intercrystalline corrosion was confined to the α (zinc-rich) phase, although attack was more severe when the β (aluminium-rich) phase was also present, as a result of the larger surface area of the α grains in the two-phase alloys ; (*b*) the severity of the attack was greatly increased by the presence of small percentages of lead, tin, cadmium, and bismuth ; (*c*) the addition of a small amount of magnesium greatly reduced the severity of the corrosion, whether impurities were present or not, provided conditions were such that intermetallic compounds of magnesium with the impurity elements were not formed ; and (*d*) the presence of copper increased the resistance of two-phase alloys to intercrystalline attack.

High-Temperature Oxidation of Alloys.

The last two papers of the five presented were on the subject of "High-Temperature Oxidation of Alloys" and were considered jointly. The first was by Professor A. Preece and Dr. G. Lucas, of King's College, University of Durham, and dealt with "The High-Temperature Oxidation of Some Cobalt-Base and Nickel-Base Alloys." The authors stated that they had examined the oxidation characteristics of alloys in the temperature range 800 to 1,200 deg. C. A simple apparatus had been designed to supply an atmosphere similar in composition to that produced in gas turbines, paraffin containing 2 per cent. of sulphur being used as fuel. The effects of a number of minor alloying elements on the oxidation of a cobalt-32 per cent. chromium alloy had been investigated. Several elements increased the resistance to oxidation, in particular, thorium and silicon. Vanadium and boron, on the other hand, were highly deleterious, owing to the formation of oxides of low melting point.

The second, and last paper of the morning session was by Dr. J. P. Dennison and Professor A. Preece and was entitled "High-Temperature Oxidation Characteristics of a Group of Oxidation-Resistant Copper-Base Alloys." The authors stated that they had examined the influence of small separate additions of aluminium, beryllium, chromium, magnesium, and silicon on the high-temperature oxidation of copper. These alloying elements had been chosen because their oxides had a high electrical resistivity. The composition and microstructure of the scales formed had been studied and correlated with the rates of oxidation. The effectiveness of the additions in conferring oxidation resistance was in the decreasing order : beryllium, aluminium, magnesium, silicon and chromium.

Creep and Plastic Deformation.

The whole of the afternoon was devoted to a general discussion on "Creep and Plastic Deformation." It was based on 16 papers previously published in the *Journal* of the Institute. The first was by Mr. W. A. Rachinger, of the Aeronautical Research Laboratories, Melbourne, Australia, and dealt with "The Effect of Grain-Size on the Structural Changes Produced in Aluminium by Slow Deformation." The author stated that X-ray diffraction and metallographic methods had been used to study the internal derangement of aluminium polycrystals of various grain sizes after slow deformation at elevated temperatures. Previous work had shown that, for a given grain-size, the deformation markings were influenced by both the temperature and the rate of deformation. The present work indicated that, for a given temperature and rate of straining, the effect of an increase in grain size was roughly equivalent to a decrease in temperature or an increase in strain rate.

The second paper entitled "Stress-Recovery in Aluminium" was by Dr. W. A. Wood and Mr. J. W. Suiter of the Baillieu Laboratory, University of Melbourne, Australia. The authors stated that previous work had shown that when annealed aluminium was slowly deformed at elevated temperatures, the grains broke down into a substructure, the size of which tended to an equilibrium value typical of the temperature and rate of deformation. In the present work the changes in strength and structure had been observed during the deformation of aluminium in which the grains had already been broken down to a fine substructure by previous straining. It had been found that growth of the fine substructure could be initiated within the grains, and that this could be controlled by suitably altering the temperature and the rate of strain. Further, the growth produced by such simultaneous heating and straining was greater than that obtainable by heating alone and was sometimes termed "recovery." The new effects were therefore termed "stress-recovery." Finally, the strength of the metal under particular conditions of deformation was inversely proportional to the size of the substructure.

The third paper was by Mr. D. McLean, of the National Physical Laboratory and dealt with "Creep Processes in Coarse-Grained Aluminium." He stated that a specimen of super-pure aluminium had been extended under a constant load of $\frac{1}{2}$ ton per square inch, at 200 deg. C., to fracture. This had occurred, at 65 per cent. extension, in 850 hours. Observations had been made of slip-band and grain-boundary movements and these had been measured mainly by means of an interference microscope. It had been concluded that, under the conditions of the experiment, creep had occurred by coarse slip, fine slip, and grain-boundary displacement.

The fourth paper, like the previous one, was a communication from the National Physical Laboratory and was by Mr. J. Trotter. It was entitled, "Electron-Microscopic Studies of Slip in Aluminium During Creep." Mr. Trotter stated that he had studied the slow deformation of a specimen of 99·98 per cent. aluminium, at 200 deg. C., by means of the electron microscope, using the plastic-replica process. It had been found that the slip zones did not consist of bundles of long parallel slip lamellæ but of intimate segments of primary and cross-slip.

The fifth paper, on "Boundary Slip in Bicrystals of Tin" was by Mr. K. E. Puttick and Mr. Ronald King and dealt with work carried out in the Royal Aircraft Establishment, Farnborough. The authors stated that specimens of tin consisting of two crystals meeting in a straight boundary had been stressed in shear to cause relative movement of the crystals at the boundary. The behaviour of the crystal boundary had been found to be analogous to that of a viscous liquid. The physical character of the boundary depended on the nature of the impurities present in the tin. Boundaries in cast specimens of two samples of tin of similar total impurity content, but differing in the relative amounts of impurities, were of different appearance. Straining and annealing produced similar boundaries in the two types of tin.

The sixth paper also described work carried out at the Royal Aircraft Establishment, Farnborough, on "X-Ray Diffraction Studies in Relation to Creep." The authors, Dr. G. B. Greenough, Mrs. C. M. Bateman and Mrs. E. M. Smith, stated that they had examined two aluminium-silver alloys, one a solid solution and the other containing a precipitate. While the former behaved in a manner identical with pure aluminium and showed marked cell development during creep, the latter exhibited no traces of such cells. Experiments had also been carried out on the recovery of specimens quickly pulled at either 20 deg. or 300 deg. C. It had been confirmed that whereas annealing at 300 deg. C., in the absence of stress caused little recovery, cell development occurred if the specimens were allowed to creep at this temperature.

"Relative Grain Translations in the Plastic Flow of Aluminium" was the title of the seventh paper ; it was by Mr. W. A. Rachinger of the Aeronautical Research Laboratories, Department of Supply, Melbourne, Australia. He stated that he had investigated the geometry of plastic deformation in the interior of a polycrystalline aggregate by means of a grain-counting technique. The respective contributions of grain elongation and relative grain movements to the deformation, had been determined for various conditions of temperature and strain rate. At higher temperatures and lower rates of deformation the grains did not elongate in conformity with the aggregate, but tended to remain equiaxed, the external deformation being due to the relative movement of the grains. In addition, the behaviour of the surface regions of a polycrystal subjected to high-temperature creep conditions had also been studied.

The title of the eighth paper was "The Recovery of Polycrystalline Aluminium." The author, Mr. J. A. Ramsey, of the Baillieu Laboratory, Melbourne, said that X-ray examination had shown that only a few grains in a polycrystalline specimen of aluminium recovered to a great extent ; the majority recovered only partly. Microscopic examination had revealed that recovery depended on the presence of "kink" bands, the degree of

recovery in a given grain being contingent on the closeness of packing of the kink bands. If the bands were sufficiently closely packed, the interband material, as well as the bands themselves, recovered.

Work conducted in the Department of Metallurgy, of the University of Manchester, by Dr. S. Bhattacharya, Dr. W. K. A. Congreve and Professor F. C. Thompson, was described in the ninth paper, which was entitled "The Creep : Time Relationship under Constant Tensile Stress." The authors stated that work had been carried out at constant stress on copper, zinc, tin, cadmium, lead, aluminium, and the lead-tin eutectic. All the results were consistent with the equation $\sigma_t = \sigma_0 + at^k$, where σ_t and σ_0 were, respectively, the total and the initial strain, t was the time and a and k were constants. Creep during the primary stage could also be expressed by a corresponding equation $\sigma_p = a' t^{k'}$, where σ_p was this primary extension. Once the primary stage was completed, the creep strain $\sigma_c = at^k$, was a relationship that was not affected by the space lattice in which the metal crystallised, temperature, applied stress, or pre-strain. The results were in accord with the constant-temperature relationship, $\sigma = bS^\alpha$, where S was the stress and b and α were constants. Combining the two relationships, it would appear that metals obeyed the Nutting-Scott Blair equation, $\sigma = At^k S^\alpha$, which also described the flow of many non-metallic substances. Since, over the range examined in the present work, the rise of direct elongation or of natural strain gave curves in close agreement, the creep equation, if desired, could be expressed as :—

$$l_t = l_0 \exp C \left(\frac{t}{t_0}\right)^k \left(\frac{S}{S_0}\right)^\alpha + \sigma_0,$$

where l_0 and l_t were, respectively, the original length and that after time t, and t_0 and S_0 were some standard time and stress. Such an equation satisfied all dimensional requirements.

The tenth paper was a communication from the Mechanical Engineering Research Laboratory, East Kilbride, entitled "The Temperature Dependence of Transient and Secondary Creep of an Aluminium Alloy to British Standard Specification No. 2L42, at Temperatures between 20 deg. and 250 deg. C., and at Constant Stress." The authors, Dr. A. E. Johnson and Mr. N. E. Frost, stated that the effects of temperature on the various phases (transient and steady-state creep) of forward creep, and on creep recovery had been investigated for a 2L42 (R.R. 59) aluminium alloy, by means of creep tests in pure torsion on thin-walled tubular specimens at a constant stress of 2 tons per square inch, and at 50 deg. C. intervals over the range 20 deg. to 250 deg. C. It was concluded that, for this alloy, no current fundamental theory adequately described the transient creep between 20 deg. and 250 deg. C.

The eleventh paper, on "Crystal Slip in Aluminium During Creep," was a communication from the National Physical Laboratory by Mr. D. McLean. He stated that he had made a study of the types of slip band formed in pure polycrystalline aluminium undergoing creep strain at 200 deg. C., in order to ascertain how much of the total strain was due to each type of slip and to determine the influence of grain-size and stress upon the phenomena. Two types of slip band had been observed, namely, prominent slip bands and fine slip lines. Broadly speaking, the number of prominent slip bands and the mean displacement at these bands increased with increasing grain-size and perhaps slightly with stress. In no case, however, was it more than half the total strain.

"Plastic Deformation of Coarse-Grained Aluminium" was the title of the twelfth paper ; it was by Mrs. V. M. Urie and Mr. H. L. Wain, of the Aeronautical Research Laboratories, Melbourne. The authors stated that a fine grid, photographically reproduced on the specimen surface, had been used to measure local elongations in the individual grains of deformed specimens. In agreement with previous investigators, it had been found that the elongation varied from grain to grain and within the individual grains of the aggregate. The elongation was generally restricted in the vicinity of grain boundaries, and the form of the restriction appeared to depend on the orientation between neighbouring grains.

The 13th paper dealt with the "Deformation of Magnesium at Various Rates and Temperatures." The authors, Mr. J. W. Suiter and Dr. W. A. Wood, of the Baillieu Laboratory, University of Melbourne, stated that X-ray and metallographic studies had shown that polycrystalline magnesium, when deformed, behaved in a manner similar to aluminium and zinc, in that, at both elevated temperatures and slow strain rates, a sub-grain or cell structure was formed within the grains. The research, however, had brought out a new feature, namely, that it appeared necessary to postulate the formation of crystallite "debris" at the grain boundaries in order to correlate the X-ray and metallographic observations.

The 14th paper was also a communication from the Baillieu Laboratory, Melbourne. It was entitled "The Sub-Grain Structure in Aluminium Deformed at Elevated Temperatures" and was by Mr. J. A. Ramsey. The author stated that metallographic and X-ray examination had shown that sub-grain structures in coarse-grained aluminium deformed at elevated temperature were associated with bands similar to kink bands. A marked resemblance thus existed between these sub-grain structures and those resulting from heating after straining at room temperature.

The 15th and 16th papers were both by Mr. D. McLean of the National Physical Laboratory, and dealt with "Crystal Fragmentation in Aluminium during Creep" and "Grain-Boundary Slip during Creep of Aluminium." In the 15th paper Mr. McLean stated that seven specimens of super-pure aluminium having grain-sizes of 1 to 9¼ grains per millimetre, had been made to creep at 200 deg. C., under loads varying from ⅓ to ¾ ton per square inch ; the extensions produced ranged up to 50 per cent. Observations and measurements had been made relating to the sub-crystals formed. These were consistent with a polygonisation model for secondary creep and had permitted a quantitative check of this model to be made. In his paper on "Grain-Boundary Slip during Creep of Aluminium" Mr. McLean described further work on the seven super-pure aluminium specimens. He said that the curves of grain-boundary displacement plotted against time resembled the corresponding extension : time curves. The fraction of the total extension due to the grain-boundary displacements had been calculated. At a constant load of ½ ton per square inch, this increased with decrease in grain-size from about one-fiftieth for 1 grain per millimetre to about one-sixth for 9¼ grains per millimetre.

On the last day of the meeting, Thursday, March 26, two programmes were again available, one of which took the form of an informal discussion on "Liquid Metals" arranged by the Metal Physics Committee of the Institute, while the other comprised visits to the laboratories of the British Non-Ferrous Metals Research Association, Euston-street, London, N.W.1, and to the works of the Pyrene Company, Limited, Brentford ; Hoover Limited, Perivale ; and Vickers-Armstrongs Limited, Weybridge.

Discussion on Liquid Metals.

For the informal discussion on liquid metals the chair was occupied by the President, Professor F. C. Thompson. In an opening address, Dr. V. Kondic stated that the trends of progress in the knowledge concerning liquid metals had been marked in two major directions. These were measurements of the properties of liquid metals and a theoretical attack on the nature of the liquid state. The main developments in these two fields would be reviewed in the course of the general discussion, and allusion would be made to recent results concerning viscosity, surface tension, conductivity properties and the structure of liquid metals and alloys. In the course of a second opening address, Dr. B. R. T. Frost dealt with the significance of the physical and thermodynamic properties of liquids ; the structural analysis of liquid metals by the X-ray, neutron diffraction, and other experimental methods; the general principles and theories involved in melting and the liquid state ; and the stability of liquid metals.

FORTHCOMING EXHIBITIONS AND CONFERENCES.

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

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

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

MODEL ENGINEERING EXHIBITION, BIRMINGHAM.—Monday, May 4, to Saturday, May 9. See page 532.

CONFERENCE ON COLD EXTRUSION OF STEEL.—Tuesday and Wednesday, May 12 and 13, at the Royal Empire Society, Northumberland-avenue, London, W.C.2. Organised by the Sheet and Strip Metal Users' Technical Association, 49, Wellington-street, London, W.C.2. (Telephone : TEMple Bar 3951.) See also page 403, *ante*.

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

INCORPORATED PLANT ENGINEERS, ANNUAL CONFERENCE.—Wednesday, May 20, to Friday, May 22, at the Palace Hotel, Southport. Applications to the general secretary, Incorporated Plant Engineers, 48, Drury-lane, Solihull, Birmingham. (Telephone : Solihull 3021.)

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

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

BRITISH PLASTICS EXHIBITION.—Monday, June 8, to Thursday, June 18, at Olympia, London, W.14. BRITISH PLASTICS CONVENTION.—Monday, June 8, to Wednesday, June 17, at Olympia. Organised by *British Plastics*, Dorset House, Stamford-street, London, S.E.1. (Telephone : WATerloo 3333.) See also our issue of October 10, 1952, page 462 ; and page 466, *ante*.

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

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

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

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

ROYAL HIGHLAND SHOW.—Tuesday, June 23, to Friday, June 26, at Alloa. Organised by the Royal Highland and Agricultural Society of Scotland, 8, Eglington-crescent, Edinburgh, 12. (Telephone : Central 6106.)

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

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

INDUSTRIAL CO-PARTNERSHIP ASSOCIATION, SUMMER CONFERENCE.—Friday, July 10, to Monday, July 13, at

Somerville College, Oxford. Apply to the secretary of the Association, 36, Victoria-street, London, S.W.1. (Telephone: ABBey 3342.)

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

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

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

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

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

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

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

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

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

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

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

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

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

EIGHTH NATIONAL INSTRUMENT EXHIBIT.—Monday, September 21, to Friday, September 25, at the Sherman Hotel, Chicago. Organised by the Instrument Society of America, 921, Ridge-avenue, Pittsburgh 12, Pennsylvania, U.S.A.

AMERICAN SOCIETY OF AUTOMOTIVE ENGINEERS: NATIONAL AERONAUTICAL MEETING, AIRCRAFT ENGINEERING DISPLAY AND AIRCRAFT PRODUCTION FORUM.—Wednesday, October 7, to Saturday, October 10, at Los Angeles, California. Apply to the secretary of the Society, 29, West 39th-street, New York 18, U.S.A.

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

ENGINEERING INDUSTRIES ASSOCIATION; LONDON REGIONAL DISPLAY.—Tuesday, Wednesday and Thursday, October 13, 14 and 15, at the Horticultural Hall, Vincent-square, London, S.W.1. Apply to the secretary of the Association, 9, Seymour-street, Portman-square, London, W.1. (Telephone: WELbeck 2241.)

LABOUR NOTES.

RETURNS recently issued by the Ministry of Labour and National Service show that there was only a slight fall in the total working population of Great Britain during February last. It amounted, in all, to 9,000 persons, of whom 4,000 were men and boys, and 5,000 women and girls. At the end of the month, the number of persons, aged 15 and over, who were working for pay or gain in Great Britain, or who had registered themselves as available for such work, numbered 23,276,000, of whom 15,870,000 were men and boys, and 7,406,000 were women and girls. Of that total, 22,015,000 persons were engaged in civil employment (industries, commerce and services of all kinds), a decrease by 2,000 during the month. The size of the armed Forces at the end of February was 873,000, comprising 848,000 men and 25,000 women. The total compared with 872,00 at the end of 1952, and with 852,000 at the end of 1951. Ex-service men and women on release leave seeking employment at the end of February numbered 8,000. There were also 420,000 registered unemployed at that date. Some 40,000 of these, however, were only temporarily out of work.

Persons employed in the basic industries, comprising mining, quarrying, agriculture, fishing, gas, electricity, water, transport, and communications reached a total of 4,022,000 at the end of February. The decline in this group of industries during the month amounted to 4,000. In the manufacturing group of industries, 8,694,000 people in all were at work at the end of February, a decline by 5,000 during the month. The end-of-the-month totals were 2,549,000 for the engineering, metal-goods and precision-instrument industries; 1,113,000 for the vehicle industry; 552,000 for the metal-manufacturing industry; 486,000 for the chemicals and allied trades; and 2,508,000 for the clothing, textile, food, drink and tobacco industries. The remaining industries in this group gave employment to 1,486,000 persons.

Of the remaining persons engaged in civil employment at the end of February, no fewer than 3,941,000 were employed in professional, financial and miscellaneous services of various kinds. The distributive trades gave employment to 2,622,000 men and women, and the building and contracting industries to a further 1,412,000 workpeople. A total of 1,324,000 persons were engaged in public administration, comprising 599,000 in the service of the Government and 725,000 in the service of local authorities.

The Amalgamated Union of Foundry Workers records that the official side of the Admiralty Industrial Council has agreed to the staggering of annual leave for the 1953-54 leave year, subject to the condition that not more than 15 per cent. of the total number of workpeople in each establishment shall be on leave, whether paid or unpaid, at any one time. Sick leave is not to be taken into consideration in working out this percentage. Arrangements are to be made for the application of the percentage to particular shops, gangs, departments, trades and grades, to be adjusted by the management concerned in accordance with the balance of work likely to be in hand at various times during the year. This concession will mean the spreading of leave over a prolonged period, and the union points out that its operation will require the fullest support of personnel concerned.

Equal pay for both sexes in the Civil Service was discussed at some length at a meeting of the National Association of Women Civil Servants, held in London on April 20. Various complaints were put forward regarding the Government's long delay in putting the principle of equal pay into effect, and the delegates gave unanimous approval to a resolution claiming that the Government's lack of action in this respect was indefensible.

Mainly owing to increases in the prices of coal and vegetables, the interim index of retail prices rose by one point to a new high level of 140 for all items on March 17 last. This compared with a figure of 139 at the close of the previous four-weekly period on February 17 last, and with one of 133 on March 11, 1952. The index measures the average changes, month by month, in the prices of the goods and services which enter into the expenditure of working-class households in the United Kingdom. It was commenced on June 17, 1947, the level at that date being taken as 100.

A scheme for the training for skilled status of employees in the heavy-chemicals, plastics and fertiliser industries is making good progress. The Transport and General Workers' Union reports that officials of the City and Guilds of London Institute have agreed to make provision for these workpeople, and that the syllabus and examination papers in connection with a course for them are in active preparation. It is hoped to bring the scheme into operation in September next.

The employment of elderly persons is to form the subject of a voluntary Departmental inquiry. In answer to a Parliamentary question on Monday last, the Minister of National Insurance, Mr. Osbert Peake, informed the House of Commons that an inquiry was about to be made through the local offices of the Ministry, on a sample basis, to see what information could be obtained about the reasons which led people either to retire or to continue at work, after reaching the minimum pensionable age. The inquiry would be entirely voluntary and was being undertaken in consultation with the National Advisory Committee on the Employment of Older Men and Women, set up by the Ministry of Labour. It was hoped that persons approached for information would agree to co-operate and thus enable the Ministry to obtain worthwhile information. Personal details supplied by individuals would be treated as strictly confidential.

An unofficial strike of tugmen at Southampton, which began last Friday and caused some dislocation to the Queen Mary and other passenger vessels using the port, came to an end on Monday. At a four-hour meeting on that day, the 140 men concerned decided, by a small majority, to resume work immediately They accepted an offer by their employers of an increase of 2*d*. an hour for tugmen and 3*d*. an hour for masters and engineers. They had previously asked for an extra 3*d*. an hour all-round, and for payment for a minimum of seven hours, instead of four hours, when called out at night. The claim in respect of payment for night work is to go to arbitration. The men's pay claims, but not their decision to strike, had the full support of their union.

Efforts were made last Friday to settle the strike of vehicle builders at the Longbridge works of the Austin Motor Company, Limited, at Birmingham. At the commencement of that day's proceedings before the court of inquiry, Mr. W. T. Wells, representing the National Union of Vehicle Builders, stated that, in substance, the offer of the union's general secretary to a representative of the company on March 27 still stood. This offer was that if the union's secretary was given an opportunity to call a meeting of the strikers on March 30, he would instruct them to return to work immediately.

After an adjournment, Sir Godfrey Russell Vick, representing Messrs. Austin, stated that the company was anxious, in the national interest, to resume full production as soon as possible. It was estimated that the company would require to take on 450 representatives at once, 300 about a week later, and from 200 to 300 in the following week. The men would be engaged through the employment exchange. Mr. Wells pointed out that these numbers were far fewer than the 1,583 men on strike. After a second adjournment, Sir Godfrey informed the court that the company, after taking on the 1,050 referred to above, would be prepared to take on a further 300 at the end of a further week. He suggested that the union should take a secret ballot among the men out of work on the company's proposals. The hearing of witnesses before the court then continued.

FIRE-ENGINE WITH SELF-SUPPORTING ESCAPE LADDER.

MERRYWEATHER & SONS, LTD., GREENWICH.

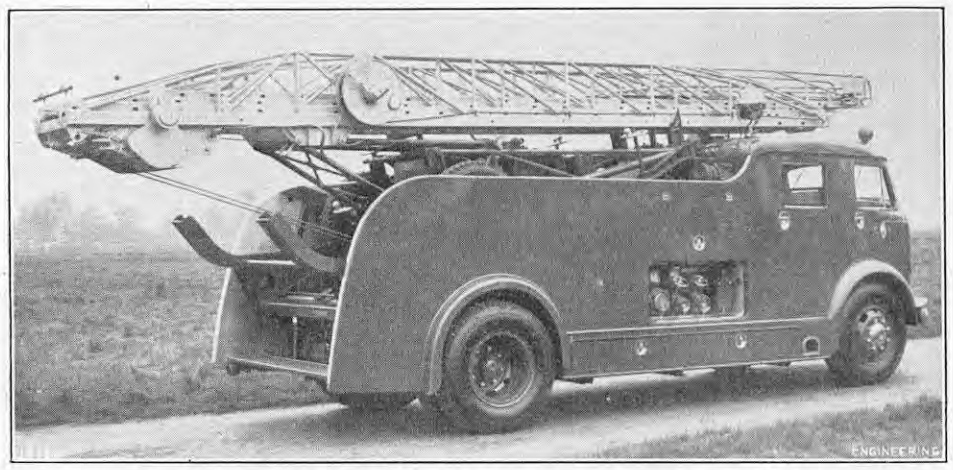


Fig. 1. Ladder in Carrying Position.

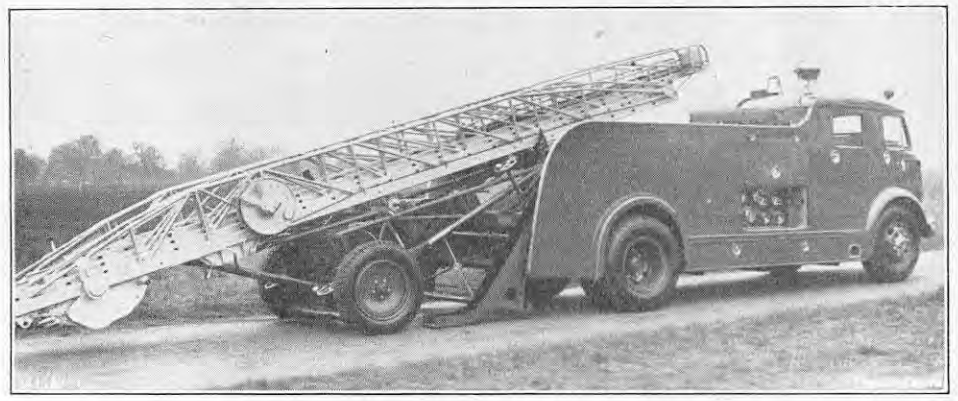


Fig. 2. Cradle Ramp in Lowered Position.

Fig. 3. Escape Extended.

FIRE-ENGINE WITH SELF-SUPPORTING ESCAPE LADDER.

The fire-engine with self-supporting escape shown in Figs. 1 to 3, above, has been designed by Messrs. Merryweather and Sons, Limited, Greenwich High-road, London, S.E.10. It is one of a number of similar machines made to suit the requirements of a Scandinavian fire brigade. A feature of the fire-engine is the wheeled self-supporting ladder, which is made in accordance with Continental practice and replaces the wheeled escape more common in this country. An advantage of this type of ladder is its very low height, which enables it to be wheeled through low doorways. The transporting vehicle is based on a Commer chassis. It has left-hand drive and is of the forward-drive type. The power unit is a six-cylinder 109 brake horse-power petrol engine. The enclosed body has accommodation for four firemen and a driver and officer. Behind the crew's compartment is a 500/800 gallons per minute single-stage centrifugal fire pump with suction inlet. Delivery outlets and controls are placed on both sides of the body. Above the pump unit is a large stowing compartment for hose and other equipment. A specially designed ramp which assists in raising the escape is mounted at the rear, as shown in Fig. 2.

The escape is similar in design and construction to the turntable ladder escape made by Merryweather's. It reaches a height of 72 ft. 3 in., and a separate auxiliary ladder is provided for increasing the overall height to 79 ft. There are four ladders, each fabricated from steel tubes with side lattice-work for strength and rigidity, and the rungs are rectangular-section sheet steel with non-slip covering. The bottom ladder is carried by two tubular steel links on each side. The links opposite each other are held by cross-bracing. The carriage of the escape is also constructed from tubular steel. Two 6·50-in. by 20-in. pneumatic tyres are fitted at the rear. At the front end is a castoring wheel with a solid rubber tyre; it is mounted on a shaft passing through the front member of the carriage which is attached to the towing handle. The escape is designed for manhandling into the required position when in use. Four jacks are provided for anchoring the escape. The front two are on arms which swing outwards to increase the width of the base and give stability. The movements of the escape are controlled by two electric starter motors, each with a maximum output of 3 brake horse-power. The current is supplied by 24-volt heavy-duty batteries mounted on the carriage of the escape. The motors operate winches, for elevating and extending the escape, through a gear and chain drive. A hand crank is provided for use on both these winches as an emergency measure. A plumb bob and calibrated segment for showing the correct height and angular setting of the ladder are mounted on the side, adjacent to the controls. At the minimum angle of 30 deg. an extension of 12 m. will carry one man, and 10 m. two men. The maximum angle is 75 deg. with a height of 22 m. for one, and 20 m. for two. Red and white lights indicate that the ladder is safe for use, or whether it is suitable for lowering. The two motor control levers each operate a brake and starter button, and are arranged so that sudden releasing of the lever stops the motor and immediately applies the brake to the winch.

The ramp at the rear of the engine, which carries the escape, comprises two steel channels bent into a crescent shape with a chord of approximately 4 ft., and held by pivot arms which enable it to swing up from ground-level into the rear of the vehicle. It is drawn up by a hydraulic jack which actuates a rope and pulley. The hydraulic jack and control lever are mounted on the nearside instrument panel, and the jacking lever is detachable. A small channel is placed in the centre in the rear of the vehicle body to carry the centre wheel of the escape and a clamp anchors this wheel in position after the two ramps have been raised. The ramps may also be locked in position.

When the escape is required for action, the front clamp is released and a valve in the jack is opened. With the release of hydraulic pressure the ramp carrying the escape is lowered gently to the ground. The speed of descent is governed by the extent to which the valve is opened. When the escape is to be elevated the movement of the appropriate control lever releases the automatic brake and starts the motor driving the elevating winch; this draws the heel of the ladder towards the carriage. The escape, pivoting on the two swinging links, gradually raises its head until the required angle of elevation is reached. A similar one-lever action also controls the extension of the ladders. Automatic pawls hold the ladder with the rungs in alignment. The ladders can be housed by freeing the pawls and allowing them to run back under the control of a friction brake. Limit stops and safety devices are provided. To mount the ladder on the fire-engine, the front wheel is made to engage the centre channel at the rear of the body. The rear wheels of the escape are then run on to the ramp runways at each side. The hydraulic system is operated to draw the ramp and escape up; it is then moved slightly to reduce overhang, and secured by the locking device. A crew of four men is sufficient to perform this operation. The total weight of the escape is approximately 35 cwt. Other features of the fire-engine include a searchlight, twin amber flashing lights, and carillon bell. A telephone is fitted to the base of the escape and a metal drum carries the cable; this is automatically paid out as the escape is extended, the other end being attached to a loud-speaker at the head of the escape.

North-East Metallurgical Society.—At the first annual dinner, at Middlesbrough, of the North-East Metallurgical Society, it was stated that the Society had quickly developed and had a membership of more than 170. Mr. P. Walker, chief metallurgist of the Cargo Fleet Iron Co. Ltd., proposed the "Guests" and Mr. A. Dorman and Mr. W. W. Stevenson replied. Dr. J. W. Jenkin, research director of Tube Investments Ltd., proposed "The Society" and Mr. T. Bushell, of Lloyd's Register of Shipping, replied.

3½-IN. HIGH-SPEED CENTRE LATHE.

MYFORD ENGINEERING CO., LTD., NOTTINGHAM.

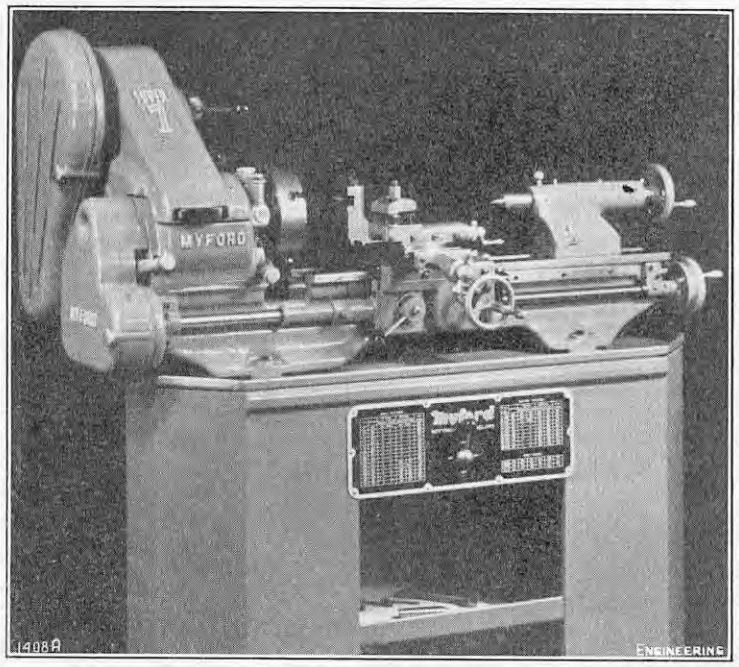


Fig. 1. Lathe and Cabinet Stand.

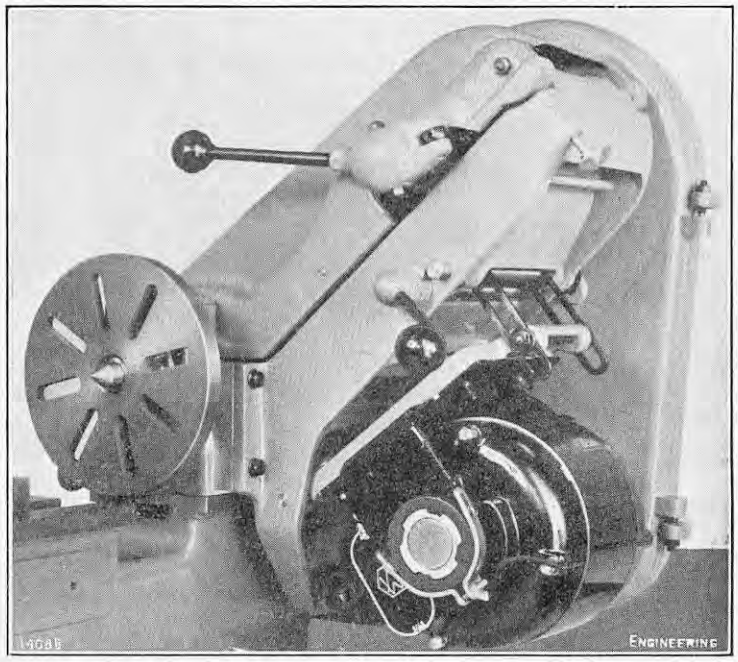


Fig. 2. Headstock Driving Arrangements.

3½-IN. HIGH-SPEED CENTRE LATHE.

The 3½-in. centre lathe shown in Fig. 1 is made by the Myford Engineering Company, Limited, Beeston, Nottingham, and was displayed by them at the recent Factory Equipment Exhibition. It is known as the "Super Seven," and is designed to meet the needs of firms engaged in instrument work where high spindle speeds are essential. There are six speeds from 25 r.p.m. to 130 r.p.m., with gears, and eight speeds from 200 r.p.m. to 2,150 r.p.m. without gears, when used with a 1,420-r.p.m. standard motor. The backgear reduction is 7·8 to 1. There is a long cross-slide which carries a tool post at the rear and a graduated top slide at the front. The lathe has a swing over the bed of 7 in. diameter and will admit 19 in. between centres. The swing in the gap is 10 in. diameter and, over the cross slide, 4⅛ in. diameter. A 6¾-in. diameter faceplate is supplied with the lathe and this allows 1½ in. in front of it when it is required to swing in the gap.

The bed has a flat top with a narrow guide and is of the square-shear type. It is in the form of a box section casting designed to eliminate deflection. The narrow guide ensures that the cutting thrust acts on the solid fast-angle of the saddle. An advantage of this type of shear is that, when it becomes necessary to re-adjust the bed surfaces, the operation is simplified because each set of faces can be treated individually. The leadscrew brackets at the ends of the bed are fitted with "Oilite" oil-impregnated bushes and oiling nipples. The leadscrew is extended at the tailstock end and fitted with a graduated handwheel. The change-wheel studs have one nut only at the outer end, which locates the change-wheel bush and secures the stud to the change-wheel quadrant. A facing is provided on the rear of the bed for a taper-turning attachment. The headstock is secured to the bed by four cap screws and has a tenon on the underside for accurate alignment. The spindle is bored throughout 19/32 in. in diameter and the nose has a No. 2 Morse taper. It runs in a tapered journal bearing at the front and two angular-contact ball bearings at the rear. The clearance provided on the front bearing before the lathe leaves the factory is for a speed of 2,150 r.p.m. If the lathe is to be operated as an ungeared machine at speeds in excess of 2,150 r.p.m., this clearance requires increasing. Lubrication of the front bearing is by a drip feed, oil being fed from the reservoir above the bearing through a sight-feed chamber and entering the bearing at the bottom. The drip

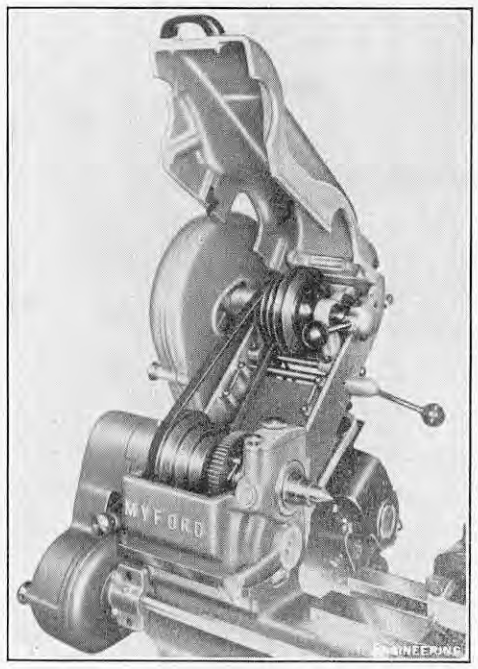


Fig. 3. Belt-Drive Cover Opened.

control valve is arranged with a sensitive adjustment so that a very low rate of feed can be set. The back gear is placed below the main spindle to bring the back-gear lever to the front of the headstock and also permit the total enclosure of the gears.

The saddle is the narrow-guide type with the fast-angle bearing on the rear edge of the front shears and a long gib strip on the front edge of the front shears. It is held to the bed with flat plates, provided with laminated shim adjustment, which project under the front of the front shear and back of the rear shear. A saddle clamp, for use when surfacing, is arranged so that it clamps the saddle down on the headstock side to receive the travelling steady.

The cross slide is longer than usual and has a large area for a lathe of this size. It is of the boring-table type and has five ⅜-in. T-slots running traversely. Its length of travel is 5⅛ in. The end plate, which acts as the bearing for the feedscrew, take the form of an extension bracket and permits the top slide to be fed inwards far enough for the boring of small holes without the necessity for setting the top slide in from the front of the cross slide. The cross slide is of such length as to permit the mounting of the rear tool post without interfering with all normal turning. The feedscrews used for both the cross slide and top slide are screwed 10 threads per inch. The micrometer dial divisions of the cross slide are 0·001 in. and of the top slide, 0·002 in. The top slide has a travel of 2⅜ in. and, together with its base, may be removed from the boring table, thus leaving the latter clear for fitting special attachments. The tool-clamp stud is long enough to accommodate a four-tool turret and the top slide is drilled and tapped for this purpose. Both the cross slide and top slides are fitted with an adjustable index dial of the friction-setting type.

The tailstock is clamped to the bed by a cam which is lever operated, and the base is provided with an adjustable gib which can be set when in position on the lathe bed. The top of the tailstock is tenoned to the base and it is fitted with screws for adjusting the angle of set-over at the front and rear to assist in obtaining lateral alignment. The set-over of the tailstock is 7/16 in. to the front and 3/16 in. to the rear. The barrel is bored No. 2 Morse taper and has 2¾ in. of travel and is 1⅛-in. diameter. It is fitted with a replaceable bronze nut and operates in a long barrel housing and is locked in the usual way. The driving-motor unit is mounted on the back of the lathe bed, behind the headstock, as shown in Fig. 2, on a bracket with a swing-head countershaft and a lever-operated cam release for speed changing. A slotted base for the motor pivots on the bottom of the bracket, and is held at the top by slotted arms which allow movement of the bottom pivot for adjustment of the belt tension. The tension of the secondary belt can be adjusted by means of a thumb screw. Both the belt guards are hinged, as shown in Fig. 3. The guard over the headstock drive is also provided with a spring plunger which automatically secures it in the raised position. The countershaft runs in needle-roller bearings and is equipped with a lever-operated clutch. This clutch is useful where repetition work is concerned and serves to protect the motor against possible overload due to repeated starting at high spindle speeds.

The cabinet stand available with the lathe is fabricated from 16-gauge sheet steel and is of octagonal form. The overall length of the lathe is 3 ft. 10½ in. and the width is 2 ft. 3½ in. It weighs 225 lb., and, with the cabinet-type stand, the total weight is 320 lb. The standard equipment with the lathe includes a backplate, 14 change wheels, an oil gun and a set of spanners.

NEW MATERIALS AND METHODS FOR AIRCRAFT CONSTRUCTION.

THE possibilities of using, for the primary structure of aircraft, asbestos-based and glass-based plastics, Redux-bonded aluminium alloys, machining techniques in place of riveted or bonded stiffening, welded magnesium-zirconium alloys, and titanium, were discussed, with particular reference to processes and experiments carried out by the Bristol Aeroplane Company, Limited, Filton, Bristol, by Mr. H. J. Pollard in a lecture entitled "New Materials and Methods for Aircraft Construction." The lecture was presented before the Royal Aeronautical Society in London on Thursday, February 27. A large proportion of the weight of an aircraft structure, said Mr. Pollard, was determined by the stability of the structure in compression. In such cases, over the lower loading ranges, the weight of the optimum structure might vary inversely as $E^{\frac{1}{3}}$ divided by the material density, rather than inversely as the specific strength or stiffness. On this basis, the asbestos plastic materials were superior to aluminium alloy, as indicated in Table I, which gives the strength and stiffness properties for the materials under consideration; the plastic materials also had the advantage of a smooth exterior surface and low final cost.

TABLE I.—PROPERTIES OF AIRCRAFT STRUCTURAL MATERIALS.

—	Specific Gravity.	Design Tensile Strength, lb. per sq. in.	Young's Modulus, E, lb. per sq. in.	Specific Strength, lb. per sq. in.	Specific Stiffness, lb. per sq. in.	$\sqrt[3]{E}$ / Specific Gravity.
Asbestos phenolic plastic, Grade 1	1·6	24,000	$2·8 \times 10^6$	15,000	$1·75 \times 10^6$	88·0
Asbestos phenolic plastic, Grade 2	1·6	15,000	$2·4 \times 10^6$	9,400	$1·50 \times 10^6$	83·7
Woven glass polyester laminate	1·7	40,000	$2·2 \times 10^6$	23,500	$1·29 \times 10^6$	76·5
Resinated paper	1·25	10,000	$0·8 \times 10^6$	8,000	$0·64 \times 10^6$	74·2
Aluminium alloy	2·87	68,000	$10·5 \times 10^6$	23,700	$3·66 \times 10^6$	76·3
Magnesium-zirconium alloy	1·8	40,000	$6·3 \times 10^6$	22,200	$3·50 \times 10^6$	102·6
Titanium	4·4	190,000	$15·5 \times 10^6$	42,500	$3·52 \times 10^6$	56·7
Steel	7·85	100,800	$28·0 \times 10^6$	12,800	$3·57 \times 10^6$	38·7

ASBESTOS PLASTICS.

Mr. Pollard then described some of the pressure-moulding methods for asbestos phenolic plastics developed at the Bristol Aeroplane Company, Limited. He showed an illustration of the bottom half of a moulding tool for a half-wing, in which strips of asbestos felt could be laid in slots in the die representing the skin stiffeners; more felts were laid over the surface of the die, and under pressure and heat, bonded to the stiffeners. The closed die was fed into a hydraulic press, and hot water under pressure was circulated through the die during the curing period. After curing, the moulding was cooled by circulating cold water through the die before it was removed from the press. The raw material could also be supplied as flock, which, when cured, had a lower strength than when moulded from felt, but in most cases was adequate for skin-stiffening members; this enabled an improved production technique to be employed, whereby asbestos felts were laid in the die to form the skin surface and the resin-impregnated flock was injected under high pressure along the slots in the closed dies. In both cases, assembly was completed by gluing two half-wing sections together, using a hot glue.

Components such as fuselages could be moulded in a pressure vessel, on the inside of which were laid the felts and ribs, together with metal laminates and attachment fittings. A rubber bag of suitable shape was inserted in the pressure vessel, and the ends were closed. The rubber bag was inflated to the required pressure and the whole vessel was heated in an oven or by infra-red lamps. For large components, an autoclave could be used, inside which was placed a cradle on which the felts were laid and sealed, so that air could not penetrate between the felts and the cradle wall. Heating elements were disposed round the cradle, and the inside face was connected to a vacuum to ensure that a proper seal had been made.

For non-structural components, such as air ducts, fairings, etc., the "no-pressure" method developed by the Royal Aircraft Establishment was used, in which the felts were laid on a pattern and cured by heating without pressure. The resulting parts were lighter, by 25 to 30 per cent., than high-pressure mouldings. The vacuum-moulding technique, also developed by the Royal Aircraft Establishment, gave better strength and consolidation and smoother surface finish than the no-pressure method.

GLASS LAMINATES.

Mr. Pollard then considered glass-fibre plastics, which, on lightly-loaded structures, were slightly inferior to asbestos-phenolic plastics in buckling strength but were stronger in tension. It was more difficult to produce a composite member from metal laminates and resined glass than from asbestos plastic. Glass-fibre plastics were first considered by the Bristol company for radomes, on account of their excellent electrical transparency. They had also been adopted for air-conditioning ducting, having a superior fatigue-resistance than the 24-s.w.g. light-alloy ducting originally used for this purpose.

Glass fibre, not a natural product, could be drawn down to a diameter of 0·0002 in. or smaller, the strength of the fibre increasing rapidly as the diameter decreased. It should ultimately be possible to orientate the fibres in the woven-glass laminate to suit the designer's purpose. There were also good reasons for believing that the value of E could be increased to about three times its present value. If that were achieved, aircraft design and construction would be revolutionised. Improved values in the stiffness and strength of asbestos might also be possible. Comparing glass laminates with asbestos plastic, the former were greatly superior to impact loads. Series production of asbestos-plastic components was cheaper than that of glass plastics, and such components, when produced by the "no-pressure" technique, were lighter, though when strength was a requirement, there was little difference in the weight. A prototype component could be produced more quickly in glass laminate, since it could be cold-set without elaborate tooling.

LIGHT ALLOYS.

The Redux metal-to-metal bonding process, extensively used in the Comet and fairly extensively in the Britannia, saved weight and cost and enabled good finish to be obtained. To ensure satisfactory joints, the surfaces to be bonded must be in good contact along their whole length before cure. This might cause difficulty when bonding thick plates to reinforcing members of comparable thickness, and the problem would have to be overcome of determining the correct temperature and pressure at the glue line if either the skin or the stiffeners were tapered in thickness.

The necessity for machining wing surfaces from thick aluminium alloy plates might arise with high-speed aircraft with very thin wings, requiring thick root plating heavily tapered and adequately stabilised. Once the costly equipment for integral machining was installed, this technique should show great savings in time and cost compared with the bolted and riveted structure. The maximum sizes of light-alloy slab available at present in the United Kingdom were not sufficiently large for the production of an efficient integral-machined construction.

At the Bristol Aeroplane Company, an investigation had been carried out on fabricating and determining the properties of a structure in welded magnesium-zirconium alloy (Mg, 96 per cent.; Zr, 0·7 per cent.; Zn 0·3 per cent.). At present, the fatigue life of the thicker plates in this material was not entirely satisfactory, and a reduction in notch sensitivity was also desirable. The method of assembly was far cheaper than riveting. In the wing structure, magnesium-alloy T-section extrusions were automatically and continuously butt-welded. Transverse or chordwise welds followed. The thicker plate at any chordwise abutment was machined down over a width of about $\frac{1}{2}$ in. to the thickness of the thinner adjoining plate. When all the welding was finished, the exterior weld beads were milled off and each completed surface was bent to contour, under heat, between shaped blocks in a drop hammer. Shear bracing was attached through bolted or riveted fishplates. Welding was carried out in an inert atmosphere. Probably 90 per cent. of the riveting used in a conventional structure could be eliminated by this technique.

The lecturer referred only briefly to titanium. He suggested that massive steel attachment fittings with bolts and nuts could be replaced by titanium alloy fittings with a saving in weight. Weight could also be saved in power plant installation by using titanium alloy instead of stainless steel for heat-resisting bulkheads and fairings. The weight economy in jet pipes, shrouds and internal gas turbine parts, where corrosion and erosion resistance was required, should be substantial.

SUPPORTING A TUNNEL ROOF BY LONG BOLTS.

A SATISFACTORY method of preventing roof falls, by the systematic use of roof bolts, has been developed during the construction of the East Delaware Tunnel for the City of New York Board of Water Supply. In driving this tunnel, which was cut 13½ ft. in diameter through shale and sandstone, about 124,300 roof bolts, each 6 ft. long, have been used successfully to support the roof of more than 65,000 linear ft. of tunnel, so effecting safer working conditions, a great saving in steel and a higher speed of construction than could have been expected had other expedients been adopted. A full description of the work has been given in a report published by the United States Bureau of Mines.*

The purpose of the tunnel, which connects the reservoirs of Pepacton and Rondout, situated approximately 50 miles north of New York City, is to increase the water supply to the city. In 1950, New York had a population of 7·9 millions, and the daily demand for combined domestic, municipal and industrial uses was 1,160 million gallons (equivalent to 2,100 cusecs). The *per capita* water demand in the city has been increasing steadily since the beginning of the century, and the population is likely to reach 8½ millions by 1960. Water-supply and conveying facilities are being planned and constructed to meet these expanding needs and included among the more recent extensions is the East Delaware Tunnel, which has a length of 25 miles. During the early stages of construction the roof of the tunnel was supported by conventional steel-rib sets, but, during the spring of 1951, when about 35 per cent. of the tunnel had been driven, the specification and roof designs were revised and, for the remainder of the work, the roof was supported entirely by the roof bolts. The tunnel itself has been driven from both ends and in both directions from two intermediate shafts; all the headings were about 13½-ft. diameter and the completed pressure-type tunnel will be concrete-lined to have a clear diameter of 11 ft. 4 in. The portal of the inlet is 1,143 ft., and the portal of the outlet 840 ft., above sea level; the greatest depth of the tunnel below the ground-surface level is 1,680 ft. and the average cover about 1,060 ft. The headings have been driven through Devonian shales and/or sandstones of the Catskill series; considerable cross-bedding and numerous lenses were encountered during the construction of the tunnel, and where such conditions occurred the nearly horizontal and uniform stratification has been disturbed. The normal dip of all formations is less than 5 deg. to the south-west (the line of the

* *Roof Bolting the Delaware Aqueduct*, Bureau of Mines Information Circular 7652, U.S. Department of the Interior, November, 1952. [Gratis.]

tunnel is almost truly from north-west to south-east with a fall of about 1 in 350). The shales were frequently finely bedded and were easily fractured, deteriorating where the exposed surface came into contact with air and/or water. The sandstone was less friable and generally unaffected by exposure.

Following some experimental roof-bolting near the outlet of the East Delaware Tunnel, where some isolated bolts with small bearing plates were used to hold the roof because space was otherwise restricted, schemes were prepared for making sole use of this method for supporting the tunnel soffit. The accepted scheme that was finally put into practice called for the systematic use of bolts, but replaced the small bearing plates by 9-ft. long tunnel ties running parallel to the longitudinal axis of the tunnel and each fixed by two bolts. These tunnel ties were pressings of 5½-in. overall width with a deformed central section 1 in. wide by 1 in. deep, and with two holes burnt in the web about 1 ft. from each end. In each 9-ft. length of tunnel, four such ties were installed at approximately 30-in. centres across the tunnel roof; in order to avoid weakening the roof the longitudinal position of the bolts was staggered. The form of bolt chosen was 6 ft. long, 1 in. in diameter, with a rolled thread for 6 in. at one end and slotted at the other to accommodate the wedge anchorage. All collaring and drilling were done wet, the hole being drilled not more than ¼ in. oversize. It was thought to be sufficient to sound the back of each hole manually with a probe to determine whether or not the formation was adequate to effect a good anchorage for the bolt. The bolt was inserted into the hole slot first, with a steel wedge, 6 in. long, located in the slot; by forcing the bolt into the hole, the wedge backed up against the head of the hole and was thereby pressed into the slotted bolt, so causing the ends to splay out to make the anchorage in the body of the rock strata. With the bolts in position, the tunnel ties were located on the bolts and nuts threaded on and tightened with pneumatic torque-wrenches. When a length of 50 to 100 ft. of tunnel had been bolted in this manner, this section of the roof was gunited to a thickness of ¾ in. in accordance with the installation specification. All the work of drilling, both at the working face and in the tunnel roof, was done from track-mounted jumbos carrying two batteries of percussion drifters with automatic feeds, hole spotter and double-action piston motor; the forward battery with four drifters was used for cutting into the working face, the other battery, with two drifters mounted on an elevated platform, being used for work in the roof. The overall length of the jumbos was approximately 31 ft. (excluding the forward drill booms) and the travelling width 4 ft. 9½ in. By raising the side wings to make additional area for the working platform, the width could be increased to 11 ft. 6 in.

Figures for materials and labour, comparing the conventional methods involving rib-type steel sets with those required when roof-bolting was adopted, were given for a typical 100-ft. length of tunnel. The deadweight of steel used was reduced from 34,500 lb. to 5,000 lb. and the man-hours required to install this steel reduced from 125 to 112. Furthermore, since the working face has to be drilled before blasting, high capital charges were not involved in putting the equipment for drilling into the headings. The rate of advance with roof bolting finally reached 48 ft. per day, a rate that was achieved by a well co-ordinated working cycle of drilling and roof bolting, blasting, scaling, mucking and track-laying for the jumbo, each cycle gaining an advance of 8 ft. and two such cycles being completed in each shift.

Further advantages were found when placing the concrete lining to the tunnel. With arched ribs, removing the lagging and wedges from behind the ribs and scaling the loose material proved a hazardous undertaking whereas, with roof bolting, no further preparatory work was found to be necessary and about ½ cub. yd. of concrete was saved in every foot of tunnel where roof bolts were used. Two other advantages, not so far mentioned, proved to be easier supervision and inspection and the much smaller storage yards that were required for materials.

SHAPING MACHINE FOR TURBINE BLADES.

A. V. ROE CANADA, LTD., MALTON, ONTARIO.

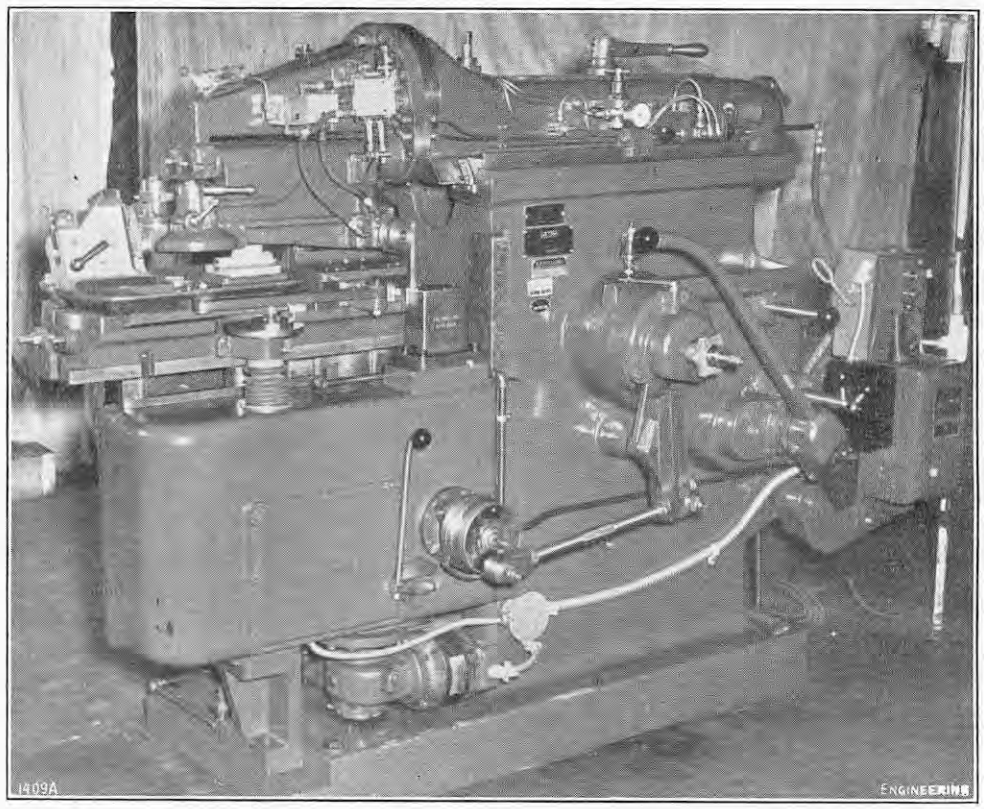


FIG. 1.

PATTERN-CONTROLLED SHAPING MACHINE FOR TURBINE BLADES.

A NEW type of shaping machine for aircraft turbine and compressor blades has been developed by Messrs. A. V. Roe Canada, Limited, Malton, Ontario, and is in use at their Malton plant. The new machine, it is claimed, reduces the production time of the blades by about 20 per cent., compared with conventional machining technique using a single reciprocating milling cutter, and, moreover, provides a better surface finish, requiring less final buffing. The patent rights of the machine have been assigned to Canadian Patents and Development, Limited, Ottawa.

The machining of thin blades of aerofoil section, often highly cambered, and twisted axially, presents difficulties, particularly since they are usually made of steel containing a percentage of nickel and therefore have a low machinability rate. In the new machine, which is illustrated in Fig. 1, two single-point cutters are used, one on each side of the workpiece, so that bending stresses in the workpiece are reduced to a minimum. The cutters are guided by tracers disposed on opposite sides of a pattern. The tracers are mechanically linked to the cutters, and are held pneumatically in close contact with the pattern. During the backward stroke of the tracers, the cutters are hydraulically disengaged from the workpiece. Automatic vertical indexing is provided between the cutting strokes so that, for each succeeding stroke, the pattern and workpiece are located slightly higher in relation to the tracers and cutters. One of the disadvantages of the conventional shaper has been that, owing to the twist of the blades, the incidence of the tracers to the pattern surfaces and of the cutters to the workpiece might change on successive cuts, giving rise to "chatter" and unsatisfactory cutting action. In the new machine, this disadvantage has been overcome by swivelling the supports for the workpiece and the pattern to provide the desired incidence.

The operation of the machine may be understood by reference to Figs. 2 and 4. In Fig. 4, some of the elements are simplified to show certain of the transmitting mechanisms more clearly. Fig. 2 is a horizontal section through the brackets supporting the cutters and tracers. Referring to Fig. 4, the cutting head 1 is mounted on the forward end of a horizontal ram 2 which reciprocates in the machine frame 3. A vertically-indexing knee 4, mounted at the front of the frame 3, carries a table 5 which can be adjusted longitudinally on guides. In the example depicted in Fig. 4, a compressor-blade workpiece, the root platform is not perpendicular to the longitudinal axis of the blade; to enable the cutters to machine as close as possible to the root platform, therefore, the table 5 is automatically indexed on its guides after each cutting stroke by a cam, not shown in the illustration. The means for indexing the knee are conventional, and consist of a first gear 6 driven by the ram-driving mechanism and a second gear 7 to which a shaft 8 is connected eccentrically by a pin. The shaft 8 drives, through a pawl, a ratchet wheel 9 mounted on a shaft 10 which drives a lead-screw mechanism for elevating the knee.

Three supports 11, 12, 13, for the workpieces and the two pattern elements, respectively, are pivoted on trunnions 14, 15, 16 on the table 5. Connecting rods 17 on each side of the workpiece-mounting support 11 link the three supports together, so that they may be swivelled in unison; the arrangement may be seen more clearly in Fig. 2. The swivelling is provided by a cam 18, which engages with a follower on the support 11; the follower is kept in constant contact with the cam by a spring anchored to the table 5. The camshaft is driven through a flexible coupling from reduction gearing, housed in the knee, which in turn is driven from the shaft 10 by bevel gears. Thus, swivelling of the supports 11, 12 and 13, is co-ordinated with the indexing of the knee, since both motions are driven by shaft 10.

The workpiece 19 is mounted in a clamp and centre on the support 11, directly over the trunnion 14, with its longitudinal axis substantially parallel to the ram axis. Two pattern elements 20 and 21 are mounted respectively on supports 12 and 13, also directly over the trunnions, so that minimum translation of the workpiece and elements occurs when their supports are rotated on the trunnions.

The cutters 22 and 23 are carried on brackets 24 and 25 mounted on horizontal hinges in the head. The rear ends of the brackets support tracing

PATTERN-CONTROLLED SHAPING MACHINE FOR TURBINE BLADES.

A. V. ROE CANADA, LTD., MALTON, ONTARIO.

Fig. 2. HORIZONTAL SECTION THROUGH CUTTER SUPPORT BRACKETS.

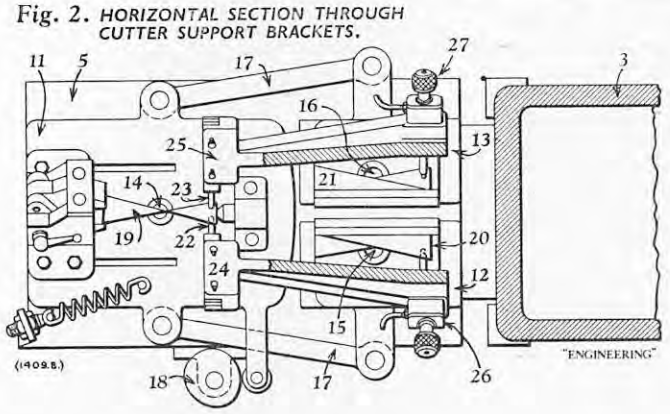


Fig. 3. TRACER MECHANISM.

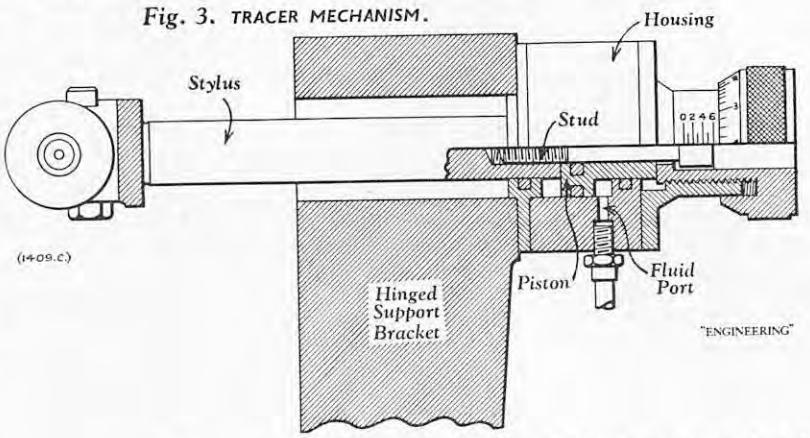
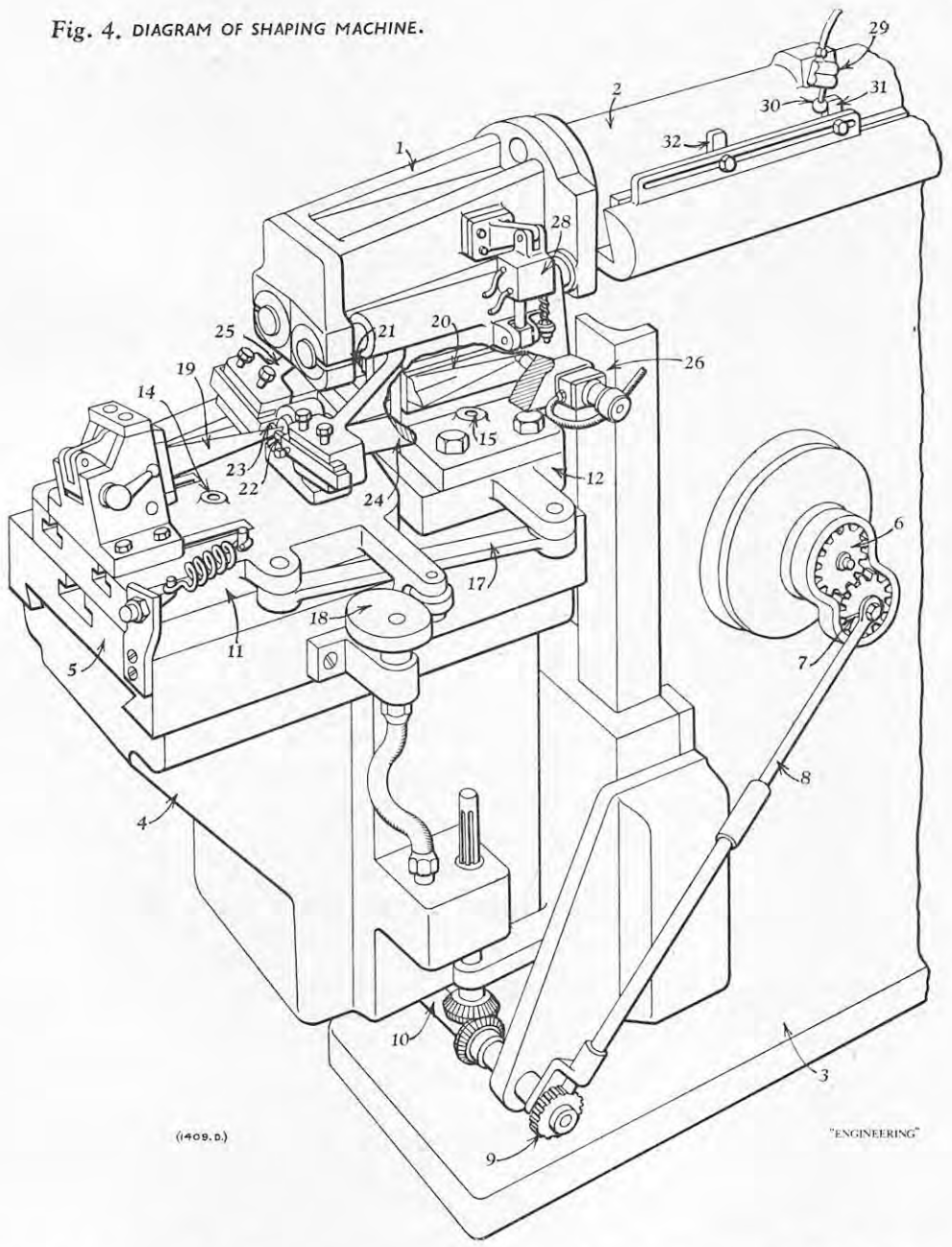


Fig. 4. DIAGRAM OF SHAPING MACHINE.



mechanisms 26 and 27. The tracers are held in contact with the control surfaces of the pattern elements partly by gravity forces acting on the support brackets and partly by pneumatic pressure; the housing 28, pivoted on the head, contains a pneumatic cylinder and piston. The piston rod, pivoted to the support bracket, exerts a downward force on the latter. For inspecting or removing the cutters, it is possible to swing the support brackets clear of the pattern elements by diverting air pressure to the lower side of the cylinder. Also within the housing 28 is a hydraulic damper controlling the rate of movement of the bracket. As the head travels forwards, the tracers travel over the control surfaces of the pattern elements and cause a corresponding movement of the cutters. On the return stroke of the ram, the cutters are held clear of the workpiece.

One of the tracing mechanisms is shown in detail in Fig. 3. A piston housing is rigidly secured at one end to the support bracket. At the other end it carries a micrometer sleeve on which is threaded a micrometer thimble. The stylus is secured by a stud to the micrometer thimble. Forward movement of the stylus is limited by a collar on the stud coming into engagement with a shoulder on the thimble. Within the housing is a piston fitting tightly around the stud. A rearwards extension of the piston limits the backward movement of the stylus by engagement with the thimble shoulder. Movements of the piston within the housing are controlled by hydraulic fluid admitted and withdrawn through a port.

To follow the operation of the tracer mechanism, it is necessary to refer again to Fig. 4. On the ram 2 which drives the cutting head is mounted a three-way valve 29 controlling the flow of hydraulic fluid to and from the port in the tracer-piston housing (Fig. 3). This valve is controlled by a lever 30 operated by two adjustable stops 31 and 32 on the frame. Thus, at the end of a forward stroke of the ram, the three-way valve is operated so as to admit fluid to the tracer-piston housing, extending the stylus relative to the support bracket and moving the cutter out of engagement with the workpiece during the return stroke of the ram. At the end of the return stroke, operation of the three-way valve causes fluid to be withdrawn from the housing, and the support bracket returns to its original position in relation to the stylus, thus re-engaging the cutter. The position of the stylus relative to the bracket can be altered, without changing the travel of stylus, by adjusting the micrometer thimble, which can then be locked.

DEVELOPMENTS IN ELECTRICAL INSULATING MATERIALS.

(*Concluded from page* 511.)

THERMOSETTING AND OXIDISING VARNISHES.

AT the meeting on Wednesday afternoon, March 18, a paper on "Thermosetting and Oxidising Varnishes Used as Impregnants under Oil," was presented by Messrs. R. Newbound and R. T. Rushall. Thermosetting varnishes, based on oil-modified phenolic resins, appeared to have certain advantages over the conventional oil varnishes for the treatment of coils which operated under oil. These advantages were associated with their heat-hardening characteristics and the absence of metallic driers. Oxidising oil varnishes dried and hardened by oxidation; hence when applied as a thin film they hardened satisfactorily. If they were applied thickly only the surface hardened and the varnish underneath remained fluid indefinitely.

Laboratory tests were therefore made to compare the effect of small coils when untreated, treated with thermosetting varnishes and treated with conventional oil varnishes, on the sludging and general properties of the mineral oil in which they were immersed. The effects of conductor covering, the presence of air and the susceptibility of the oil to deterioration were also taken into consideration. The tests were made at temperatures between 75 deg. and 80 deg. C., and the normal period of heating was about ten weeks. The results indicated that thermosetting varnishes were superior to oxidis-

ing varnishes for use under oil. Their greater oil resistance eliminated direct contamination and the permanency of the varnish coating effectively suppressed the potential catalytic activity of the copper in causing oxidation. There were also indications that thermosetting varnishes inhibited the oil-oxidation process. On the other hand, there were equally definite indications that, unless adequately dried, conventional oil varnishes were liable to accelerate the formation of sludge and the development of acidity in the oil. Nevertheless, it was evident that treatment of a coil in one of the more oil-resisting grades of such oxidising varnish was preferable to leaving the coil in an unvarnished condition. The result of the subsidiary tests confirmed the effectiveness of a coating of tin or enamel on the copper as a barrier to the catalytic activity of the metal. They also demonstrated the marked influence of the inherent characteristics of an oil upon the manner and progress of its subsequent deterioration and of the predominating effect of oxidation in the process of oil deterioration.

Mr. P. Popper presented a paper on "Ceramic Dielectrics and their Application to Capacitors for Use in Electronic Equipment." The available ceramic dielectrics, he said, fell into two groups: non ferro-electric materials, which were suitable for capacitors requiring low losses and high stability, and ferro-electric materials which had very high permittivities and higher losses and were not so stable. These had considerable advantages for coupling and decoupling capacitors owing to their small physical size. A large variety of shapes could be produced by different processes.

Silicone Resins, Fluids and Elastomers.

A paper by Messrs. W. J. Renwick and J. R. Reed was entitled "Silicone Resins, Fluids and Elastomers in Insulation for Use at Power Frequencies." Silicone resins, it was pointed out, possessed a moisture resistance at least equal to, and in many ways better than, that of conventional organic resins and varnishes. The property, common to insulation incorporating them, of rapidly drying out from wet conditions and regaining high values of insulation resistance was regarded as of particular importance. The contention that silicone materials possessed at least a 50 deg. C. advantage over the analogous Class-B materials was justified by tests. This did not, however, facilitate their classification or make the fixing of permissible temperature limits a straightforward task.

Silicone resins, in conjunction with mica, asbestos or glass-fibre insulation and silicone elastomers, had recently been designated Class-H insulation in the United States. This classification was, however, made before the widespread use of such materials as woven glass fabric and many of the synthetic resins and oil-modified synthetic resin varnishes. Consequently, it was open to many objections. For example, silicone-varnished glass fibre insulation and silcone bonded glass-backed mica were specified as being capable of working at the same temperature, irrespective of the function either served. It would be unfortunate if, because of an arbitrary classification, the temperature had to be limited to such a value that the capabilities of some of the materials were never utilised. It was therefore suggested that the class be split into two parts: one in which all the main insulation consisted of built-up mica products with a silicone resin or similar bond and where the primary purpose of other materials was that of spacing circuit elements at a relatively small potential difference; the other, in which materials, such as silicone-varnished glass or asbestos and silicone elastomers were called upon to act as dielectric barriers. While the temperature limit of 180 deg. C. would seem reasonable for the latter, the former could be permitted to work at a maximum spot temperature of 200 deg. C.

A logical extension would be a similar splitting of Class-B insulation; those systems in which the main insulation consisted of built-up mica employing, for structural purposes, such materials as glass fibre, asbestos and possibly Terylene, being permitted to work at temperatures higher than the existing maximum hot-spot limit of 130 deg. C. For different fields of application, it would then have to be decided which parts of the system constituted the main insulation, forming the dielectric barrier, and which the secondary, acting chiefly as a spacer.

A paper on "Electrical Ceramics," by Messrs. W. G. Robinson and E. C. Bloor, described the ranges of composition and general nature of porcelain, modified porcelains, cordierite ceramics, normal and low-loss steatite, alumina and zircon porcelains, sintered alumina and other oxides, as well as the semi-conducting ceramics and the dielectric materials based on titania and other oxides. The methods of forming insulators or capacitors from such mixes, and the limitations of manufacturing methods and firing temperature were also detailed, as were the relationship between the type and amount of glassy phase in the insulating ceramics.

Submarine Power Cables.

The remaining paper presented on Wednesday afternoon was by Mr. H. B. Slade and was entitled "High Voltage Rubber-Insulated Submarine Power Cables." The author said that submarine power cables in the United States were frequently made with rubber insulation for voltages up to 35 kV phase-to-phase, the choice being governed by physical and chemical conditions rather than cost. The handling, storing and laying of such cables were extremely rough operations, not well suited to inelastic materials; and the twisting, pulling and bending stresses applied required the utmost in physical resistance or elastic yielding. Rubber insulation best satisfied these requirements and by the use of water-resisting insulations, which eliminated the necessity for lead sheaths, many problems were overcome, including corrosion and fatigue cracking. It was hoped to raise the present upper limit of 35 kV and at the same time to eliminate weaknesses in the lower-voltage cables. All cables for use above 10 kV three-phase were being electrically measured continuously for concentricity. Inch-by-inch measurement of ionisation level on rubber cable before shielding was also undertaken where experimental runs showed that it could find weaknesses which were not detectable by routine tests on reel lengths.

Classification, Specification and Testing.

At the final meeting of the symposium on Wednesday evening, March 18, the subject was classification, specification and testing. Dr. L. Hartshorn was in the chair, while the *rapporteur* was Dr. T. E. Allibone, who said that the three papers presented at that meeting showed how careful and how critical it was necessary to be in order to devise acceptance tests with any real meaning. Paper insulation, no matter how well impregnated or protected externally by a varnish fill, still absorbed moisture, in some cases at a high rate. This moisture content, in the past, had been determined by measuring the power factor and capacitance on site and comparing the results periodically with the corresponding values taken at the time of manufacture. As such tests were insensitive, as the results were masked by other dielectric losses, Dr. Mole had suggested that they should be made at both 50 cycles and at either five cycles or one cycle, so as to reveal the presence of moisture more dramatically. He also suggested that the insulation should be tested at increasing voltages from a pure sine-wave generator and that the value of the third harmonic, which was generated between the current through the insulation and the voltage across it, should be recorded, as its magnitude was very sensitive to moisture absorption.

Messrs. H. E. Rees and F. S. Edwards concluded from their study of both oils and compounds that there was no way of reconciling the conflicting requirements of a short test and a reliable result. The same authors pointed out that the breakdown of solid dielectrics depended on the concentration of stress at the electrodes. For this reason, short-time tests yielded far higher electric strengths than long-time tests during which the insulation had been partly destroyed. Long-time and short-time tests on filling compounds placed between electrodes of different shapes could yield results at variance with one another.

In dealing with standard tests for measuring the resistance of insulating materials to tracking, Messrs. V. E. Yarsley and G. C. Ives recommended one of the contaminant type in which an electrolyte was spread over the surface of the insulating material. This material was then stressed to a fixed potential so that the water evaporated, leaving partly dried-out areas across which the discharge eventually took place, thus degrading the surface. Such a test, the authors argued, brought out the differences which could be expected in service when the insulating materials had been contaminated by industrial precipitants.

Improved Methods of Testing.

A paper on "Improved Methods of Test for Insulation of Electrical Equipment" was presented by Dr. A. G. Mole, who said that laboratory and field investigations had shown that the measurement of dielectric dispersion over a frequency range of 0·5 to 50 cycles or over a time range of 3 to 300 milliseconds was a more critical method of detecting moisture in paper insulation than existing low-voltage tests. A direct-reading portable instrument, termed a dispersion meter, had been developed for making routine tests on installed equipment. This instrument measured the dielectric dispersion in terms of the variation of the instantaneous capacitance with the time of application of a square wave. A charge voltage of 200 volts was employed and the voltmeter was coupled to the specimen through a cathode follower. By using diodes for switching, it was possible to measure dispersions down to 1 per cent. for specimens of capacitances from 0·2 picofarads to 0·2 microfarads. It was visualised that, by using a two-stage cathode follower, it would be possible to test individual orifice insulators or bushings on a 'bus-bar system without disconnecting them.

As a result, the dispersion values to be expected from paper-insulated bushings, 'bus bars, transformers and cables in their normal state of dryness had been established. Further experience, however, was needed before it would be possible to establish values which would be regarded as indicating the presence of a damaging amount of moisture. An experimental investigation had shown that the determination of non-linearity in the current/voltage relationship formed an absolute and sensitive method of detecting moisture in paper insulation.

In a paper by Messrs. H. E. Rees and F. S. Edwards, on "Variations in the Electric Strength of some Industrial Insulating Materials," an attempt was made to show the variable and even misleading results which could be obtained from tests normally carried out on insulating materials. Coefficients of variation of 10 per cent. on the same specimen were frequent and were often exceeded, while the mean results on different specimens of nominally identical materials might vary in the ratio of more than 2 to 1. Long-time tests under conditions approximating to those in service gave results which were very much lower than those on short-time tests. Differences in electrode arrangement, which had little or no effect on a short test, might place materials in an order of merit which was completely altered on a long test. Practical considerations severely restricted the duration of a routine test, but, provided that its limitations were fully recognised, a short-time test could be usefully applied for the purpose of ensuring consistency of successive assignments.

A paper on "Testing Insulating Materials for Susceptibility to Tracking" by Messrs. V. E. Yarsley and G. C. Ives described the tests which had been proposed for extending the susceptibility of an insulating material to tracking. Such tests fell into two classes: those in which an arc or spark discharge between electrodes was caused to play on the surface of the clean untreated insulation and those in which a current was passed through a layer of conducting material placed on the surface. There could, however, be no single test which would completely evaluate the tracking behaviour of an insulating material. A contaminant or salt-water test, in which an electric current at 200 to 250 volts was passed through a film of electrolyte solution placed on the surface of the insulating material, however, closely simulated normal service conditions; and was therefore proposed as a standard method. The water was evaporated by the current and sooner or later discharges took place across partly dried-out areas, resulting in degradation of the insulating surface.

"ARCON" SYSTEM OF PREFABRICATED BUILDINGS.

FIG. 1. "ARCON" STORAGE BUILDING UNDER CONSTRUCTION.

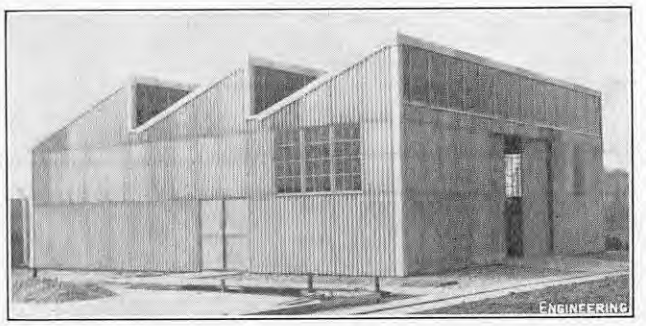


FIG. 2. BUILDING WITH SAW-TOOTH ROOF.

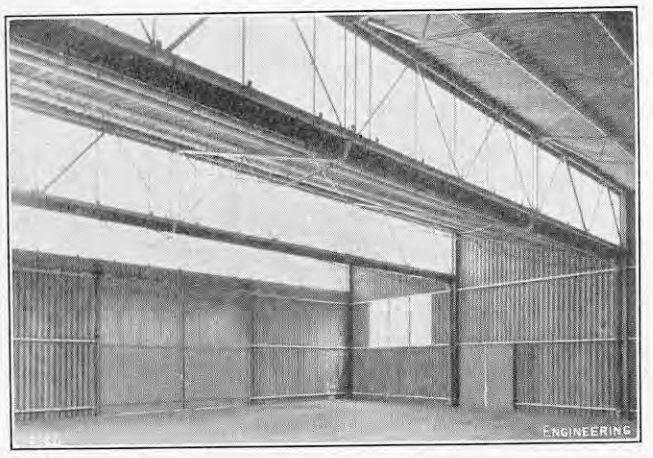


FIG. 3. INTERIOR OF BUILDING WITH SAW-TOOTH ROOF.

"ARCON" STRUCTURES.

PREFABRICATED buildings of the "Arcon" design, which was described in ENGINEERING, vol. 165, page 233 (1948), have been shipped to over 50 countries during the past few years. During recent years, however, the range of Arcon buildings has been greatly increased, and Taylor Woodrow (Building Exports), Limited, 41, Welbeck-street, London, W.1, who handle these products, exported during 1952 various types of prefabricated buildings with a total coverage of over 11 million sq. ft. This range of structures, certain types of which are specifically designed for factory purposes, is now to be made available for the home market.

Fig. 1 shows a storage building in course of erection at Freemantle, Western Australia; this building employs the Arcon roof of welded tubular construction, supplied in the form of two half-trusses requiring only to be bolted together at the apex. A jack roof is also incorporated in the building illustrated to provide adequate ventilation of the space between the outer and inner roof claddings. This type of building is standardised in bays of 16 ft. 8 in., with alternative spans of 33 ft. 4 in. and 50 ft. so that a building of this type may be erected to any multiple of either of these modules. The columns are rolled-steel joists, which are supplied drilled and with all necessary cleats welded in position. Columns are available to give three alternative heights, from floor to eaves level, of 10 ft. 6 in., 14 ft. 6 in. and 20 ft. 6 in. In addition, separate extension pieces may be added to increase the normal roof overhang of about 1 ft. to either 4 ft. 3 in. or 8 ft. 6 in. The walls of such a building can be of standard Arcon panelling, together with standard door and window fitments; or local materials may be used. For covering the roofs and to form a ceiling (which may follow the underside of the roof trusses or be suspended therefrom to give a flat surface) asbestos, aluminium or galvanised sheeting is supplied ready for erection.

The latest addition to the Arcon range is the sawtooth-roof building, the prototype of which is illustrated in Figs. 2 and 3, above. This building, which incorporates the experience gained in other buildings designed for use overseas and can be readily erected by unskilled labour, is designed primarily for industrial and commercial purposes, where ample natural and evenly distributed lighting is essential. The module of this building is 50 ft. by 16 ft. 8 in., and by varying the number and position of different units a building of almost any size and shape in plan can be erected. In the prototype illustrated, the overall dimensions are 50 ft. by 50 ft. In this design, the main trusses are also of welded tubular-steel construction and they directly carry the transverse tubular trusses, the "Aluminex" glazing and also the rain-water gutters. The columns are rolled-steel joists and a choice of two clear heights, of 14 ft. 6 in. and 20 ft. 6 in., is available. For the walls, different types of cladding are available and there is also a variety of sliding and leaf doors, as well as window casements; alternatively, local materials may be used. This building can be cross-braced to withstand specified pressures resulting from winds of up to 100 miles an hour; Fig. 3 shows the cross-bracing in the roof between the ends of the transverse trusses.

In addition to the two buildings described, other types which are to be made available in this country include a demountable building constructed to a module of 10 ft. 8 in. by 10 ft. 0 in., and a panel-construction house, in which the main frame and roof are designed to be erected first, after which the walls, partitions, ceilings, doors, windows and fittings are placed in position.

BIENNIAL CONFERENCE OF THE INSTITUTION OF PRODUCTION ENGINEERS.—Arrangements have been made for the next biennial conference of the Institution of Production Engineers to be held at Harrogate from Thursday, June 25, to Sunday, June 28. The theme of the conference will be "Production for Plenty" and the principal speakers will include Sir Cecil Weir, K.C.M.G., K.B.E., President of the Institution, Sir Hubert Houldsworth, Q.C., D.Sc., chairman of the National Coal Board, and Sir Charles Goodeve, O.B.E., D.Sc., F.R.S., director of the British Iron and Steel Research Association. Discussion groups will consider the generation of a sense of unity in all ranks and sections of industry; the achievement of production for plenty in spite of increasing competition; the use of technical development; and the maintenance of a policy of production. Application forms and further information may be obtained from the secretary of the Institution, 36, Portman-square, London, W.1.

LAUNCHES AND TRIAL TRIPS.

M.S. "FALCONER BIRKS."—Single-screw collier, built by the Grangemouth Dockyard Co., Ltd., Grangemouth, for the North Thames Gas Board, London, W.8 (Managers: Stephenson Clarke, Ltd., London, E.C.3). Main dimensions: 270 ft. overall by 39 ft. 3 in. by 18 ft. 6 in.; deadweight capacity, about 2,700 tons on a draught of 17 ft. Clark-Sulzer eight-cylinder Diesel engine, developing 1,250 b.h.p. at 232 r.p.m., constructed by George Clark (1938), Ltd., Sunderland. Speed on trial in ballast condition, 12·3 knots. Trial trip, April 1.

M.S. "MAID OF SKELMORLIE."—Twin-screw vessel, with accommodation for 650 passengers, built by A. and J. Inglis, Ltd., Glasgow, for the Scottish Region of British Railways, for service on the Clyde. Third of three similar vessels for the Scottish Region. Main dimensions: 165 ft. overall by 28 ft. by 10 ft.; displacement, 420 tons. Two Diesel engines constructed by British Polar Engines, Ltd., Glasgow. Speed, 15 knots. Launch, April 2.

S.S. "AJASA."—Single-screw self-trimming collier, with accommodation for eight passengers, built and engined by Hall, Russell & Co., Ltd., Aberdeen, to the order of the Crown Agents for the Colonies, for the Government of Nigeria. Second vessel of this type built for the Nigerian Government. Main dimensions: 347 ft. 6 in. overall by 46 ft. by 21 ft. 6 in. to upper deck; deadweight capacity, about 4,000 tons on a summer draught of 19 ft. 3 in. Triple-expansion steam engine, developing 1,850 i.h.p., and three cylindrical boilers designed to use quick-burning West African coal. Trial trip, April 2.

M.S. "WAIMEA."—Single-screw cargo vessel, built and engined by Alexander Stephen & Sons, Ltd., Glasgow, for the New Zealand to Australia service of the Union Steam Ship Co. of New Zealand, Ltd., Wellington, New Zealand. Seventh vessel of a series for these owners. Main dimensions: 325 ft. by 50 ft. by 26 ft.; gross tonnage, 3,550; deadweight capacity, 5,100 tons on a draught of about 22 ft. 4 in. Stephen-Sulzer six-cylinder single-acting Diesel engine, developing 2,410 b.h.p. at 128 r.p.m. Service speed, 12 knots. Trials completed, April 4.

M.S. "LONDON LOYALTY."—Single-screw oil tanker, built by the Furness Shipbuilding Co., Ltd., Haverton Hill, County Durham, for London and Overseas Freighters, Ltd., London, W.1. Sixth of a series for these owners. Main dimensions: 556 ft. 5 in. overall by 71 ft. by 39 ft. 3 in.; deadweight capacity, 18,100 tons on a draught of 30 ft. 5¾ in. N.E.M.-Doxford six-cylinder opposed-piston single-acting two-stroke reversible oil engine, developing 6,800 b.h.p. at 119 r.p.m. in service, constructed by the North Eastern Marine Engineering Co. (1938), Ltd., Wallsend-on-Tyne. Speed, 15 knots. Launch, April 16.

BOOKS RECEIVED.

Fatigue of Metals. By Dr. R. Cazaud. Translated by A. J. Fenner. Chapman and Hall, Limited, 37, Essex-street, London, W.C.2. [Price 60*s.* net.]

The Science of Petroleum. Vol. V. Part II. *Synthetic Products of Petroleum.* Edited by Dr. B. T. Brooks and Dr. A. E. Dunstan. Oxford University Press, Geoffrey Cumberledge, Amen House, Warwick-square, London, E.C.4. [Price 100*s.* net.]

Über die Verankerung von Spundwänden. By Dr.-Ing. Egidius Kranz. Second edition. Wilhelm Ernst und Sohn, Hohenzollerndamm 169, Berlin-Wilmersdorf, Germany. [Price 7.50 D.M.]; and Lange, Maxwell and Springer, Limited, 41-45, Neal-street, London, W.C.2. [Price 13*s.* 1½*d.*]

Office Administrative Practices. Office Management Association, Limited, 8, Hill-street, London, W.1. [Price 12*s.* 6*d.*]

Engineering and Western Civilization. By Professor James Kip Finch. McGraw-Hill Book Company, Incorporated, 330, West 42nd-street, New York 36, U.S.A. [Price 5.50 dols.]; and McGraw-Hill Publishing Company, Limited, 95, Farringdon-street, London, E.C.4. [Price 47*s.*]

Pictorial Drawing for Engineers. By A. C. Parkinson. Sir Isaac Pitman and Sons, Limited, Pitman House, Parker-street, Kingsway, London, W.C.2. [Price 16*s.* net.]

College of Aeronautics, Cranfield. Report No. 71. *On Some Aspects of the Noise Propagation from Supersonic Aircraft.* By G. M. Lilley and others. The Librarian, College of Aeronautics, Cranfield, Bletchley, Buckinghamshire. [Price 5*s.*]

Physical Formulae. By Dr. T. S. E. Thomas. Methuen and Company, Limited, 36, Essex-street, London, W.C.2. [Price 8*s.* 6*d.* net.]

London and Home Counties. Regional Advisory Council for Higher Technological Education. Engineering Education in the Region. Offices of the Council, Tavistock House South, Tavistock-square, London, W.C.1. [Price 1*s.*]

Aircraft Propulsion. Theory and Performance. By Dr. A. W. Morley. Longmans, Green and Company, Limited, 6 and 7, Clifford-street, London, W.1. [Price 28*s.* net.]

Società Adriatica di Elettricità. Il Piave e la Sue Utilizzazione. Offices of the Society, Venice, Italy.

Overseas Economic Surveys. India. By Rowland Owen. H.M. Stationery Office, Kingsway, London, W.C.2. [Price 11*s.* net.]

Iron and Steel Directory. Seventh edition. The Louis Cassier Company, Limited, Dorset House, Stamford-street, London, S.E.1. [Price 25*s.* net.]

Dairy Engineering. By Arthur W. Farrall. Second edition. John Wiley and Sons, Incorporated, 440, Fourth-avenue, New York 16, U.S.A. [Price 6 dols.]; and Chapman and Hall, Limited, 37, Essex-street, London, W.C.2. [Price 48*s.* net.]

Foundation Engineering. By Professor Ralph B. Peck, Walter E. Hanson, and Professor Thomas H. Thornburn. John Wiley and Sons, Incorporated, 440, Fourth-avenue, New York 16, U.S.A. [Price 6·75 dols.]; and Chapman and Hall, Limited, 37, Essex-street, London, W.C.2. [Price 54*s.* net.]

Ministry of Transport. Railway Accidents. Report on the Collision which Occurred on 8th November, 1952, at Guildford Station in the Southern Region, British Railways. H.M. Stationery Office, Kingsway, London, W.C.2. [Price 2*s.* net.]

The British Journal Photographic Almanac. 1953. Edited by Arthur J. Dalladay. Henry Greenwood and Company, Limited, 24, Wellington-street, London, W.C.2. [Price 5*s.* net.]

The Standard Manual of the Slide Rule. Its History, Principle and Operation. By Professor J. E. Thompson. Second edition. Macmillan and Company, Limited, St. Martin's-street, London, W.C.2. [Price 15*s.* net.]

BRITISH STANDARD SPECIFICATIONS.

The following publications of engineering interest have been issued by the British Standards Institution. Copies are available from the Sales Department of the Institution, 24, Victoria-street, London, S.W.1, at the price quoted at the end of each paragraph.

Woven-Asbestos Tape for Electrical Insulation Purposes.—Following the publication, in 1951, of B.S. No. 1720, covering woven-asbestos binding tape for electrical purposes, the Institution have now issued a specification (B.S. No. 1944) for plain unimpregnated woven-asbestos tape intended for electrical insulating purposes. Like B.S. No. 1720, the new specification is based on information supplied by the British Electrical and Allied Industries Research Association and, similarly, it does not cover those tapes which have an all-cotton weft or warp. The new publication contains clauses specifying the finish, dimensional requirements, number of threads per inch, and the effect of ageing on the tensile strength, in addition to stipulations concerning the mechanical and electrical properties of the tape. Methods of test are described in appendices. [Price 2*s.* 6*d.*, postage included.]

Fireguards for Heating Appliances.—A new specification, B.S. No. 1945, deals with fireguards for heating appliances, including all types of gas fires, electric fires and oil-burning heaters, whether portable or fixed, used for domestic purposes and the like and having heating elements, exposed flames or radiant materials of such a nature, or so located that there would be a risk of fire or injury from burns resulting from contacts with clothing or textile fabrics if guards were not fitted. The design of the guards is determined by compliance with a test designed to control the sizes of openings in the guard, while the effectiveness of the guard is also determined by a scorching test. [Price 2*s.*, postage included.]

Engineers' Ratchet Braces and Drilling Pillars.—The Institution have now issued a specification covering engineers' ratchet braces and drilling pillars. The various types of brace and the component parts are defined and the clauses given specify requirements for materials, their heat-treatment and hardness, and the finish and assembly of the tools. The publication is intended to apply only to the most commonly used types of brace and pillar; certain types, particularly of drilling pillar, although popular in certain branches of industry, are considered to be special to those branches, and, consequently, have been omitted. The designation is B.S. No. 1937. [Price 4*s.*, postage included.]

TRADE PUBLICATIONS.

Tubes and Tubular Goods.—A copy of a handy publication dealing with tubular practice and containing technical data on mill practice, finish, heat treatment and dimensions and tolerances, relating to tubes and tubular goods in a variety of steels and for numerous industries, has been received from Accles and Pollock Ltd., Oldbury, Birmingham. British-Standard and American specifications for aircraft tubes and tables of data, useful to designers, are included.

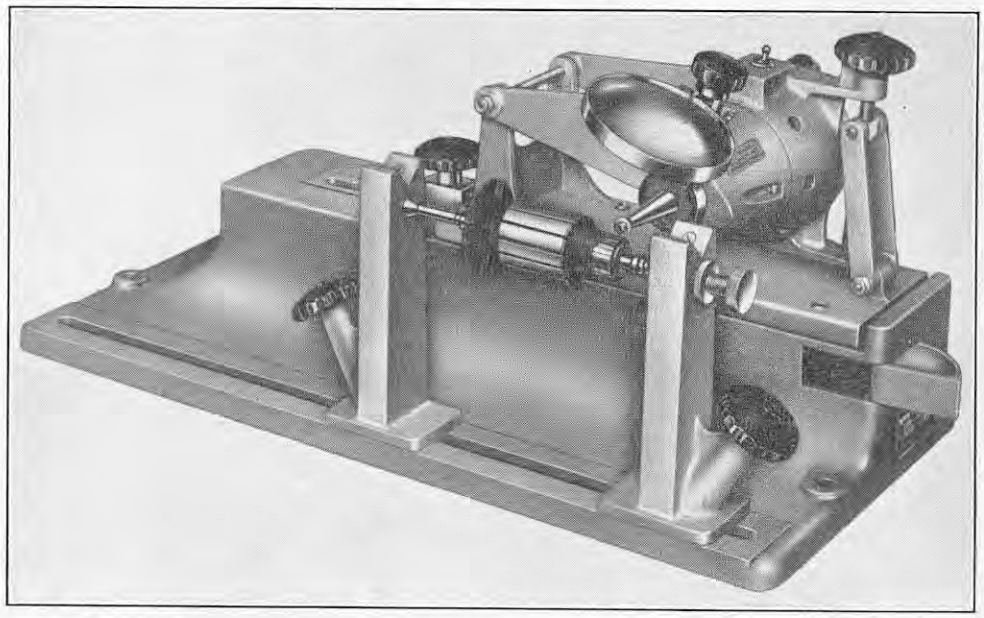
Gear Lubrication.—The Vacuum Oil Co., Ltd., Caxton House (East), Tothill-street, London, S.W.1, have published a comprehensive illustrated booklet dealing with the various aspects of gear lubrication, including the fundamentals of gear operation, methods of lubrication and oil characteristics, together with a glossary of terms.

Dust-Collection Plant.—John Yuille (Metal Works), Ltd., Scottish Industrial Estate, Hillington, Glasgow, S.W.2, have published the third edition of their handbook on the theory of dust collection. It deals with air cleaning, air filtration and dust control, and shows some typical filter arrangements. Reference tables and technical data are included.

Terminal Splicing of Wire Rope.—A pamphlet by A. B. Watts has been received from British Ropes, Ltd., Doncaster, describing and illustrating recommended methods of making a 5-tuck splice, and end splices in 17 by 7 and 34 by 7 multiple-stranded rope, and also of the fitting of a Bordeaux connection. Copies of the booklet are obtainable on application to British Ropes, Ltd.

BENCH-TYPE UNDERCUTTER FOR COMMUTATORS.

MARTINDALE ELECTRIC CO., LTD., LONDON.



BENCH-TYPE UNDERCUTTER FOR COMMUTATORS.

The bench-type undercutter for the insulation of commutators, shown in the accompanying illustration, is made by the Martindale Electric Company, Limited, Westmorland-road, London, N.W.9. It is designed for undercutting the mica between the segments of commutators up to 6 in. diameter, on armatures that do not exceed a diameter of 10 in. The maximum length of armature that can be accommodated is 18 in. plus the length of the shaft extensions. To exceed this length a special outrigger bracket is required.

The main castings of the machine are of aluminium. The base frame is made with two holes for bolting the machine to the bench. Embodied in the base is a raised carriage way with V-grooves in which ball bearings are fitted to minimise the friction between the bed and the carriage which supports an ⅛-h.p. electric motor and cutter. A magnifying glass attached by a bracket to the carriage assists in setting the cutter and also acts as guard against flying chips. The carriage has a manually-controlled travel of 4¼ in., equivalent to the length of cut, and a stop is fitted to the carriageway so that the desired length of travel may be set and over-running of the cutter avoided to prevent damaging the armature. The cutter height is adjustable by a handscrew which also varies the height of the motor. Two sets of V-blocks of different heights are made to carry the armatures. They are mounted on a slide at the front of the base frame and are provided with a locking screw, which passes through a slot in the base and holds them firmly in position. The taller pair of blocks, for small armatures, also has adjustable centres built-in for use with even smaller armatures, to ensure that they are held squarely and firmly in position. The arbor of the motor is interchangeable and a variety of small slitting saws from ¼ in. to ½ in. outside diameter are provided with the cutter. The total weight of the machine is 28 lb.

17-In. Rectangular Cathode-Ray Tube for Television.—An all-glass rectangular television tube, with a 17-in. diagonal grey-glass face, has recently been introduced by Mullard Ltd., Shaftesbury-avenue, London, W.C.2. It incorporates a new form of electron gun designed to give uniform focus over the whole screen and contains an additional anode so that the functions of electron acceleration and pre-focusing are separated. When the potential on this second anode is zero or negative with respect to the cathode, the size of the spot at the centre of the screen and the width of the unfocused beam are such that the greatest uniformity of focus is obtained over the whole picture area.