TRIPLE-SCREW EXTRUSION MACHINE FOR PLASTICS.

The photograph reproduced in Fig. 1 shows a heavy-duty triple-screw extrusion machine for thermoplastics, which is made in the United Kingdom by Messrs. R. H. Windsor, Limited, 16, Finsbury-square, London, E.C.2, under licence from L.M.P., of Turin, Italy. The prototype was shown at the British Plastics Exhibition at Olympia last year. The machine, which is known as the R.C. 200, has a capacity of 200 lb. per hour. The plastic material, in the form of granules or powder, is loaded into the hopper, at the top of the machine, which is provided with an adjustable automatic feeding mechanism so that the correct amount of material is metered to the screws, where it is "compounded" and coloured, if necessary, and is gradually compressed as it is conveyed down a heated barrel. Finally, after passing through a breaker plate to ensure uniform pressure distribution, it is extruded through a heated die. The use of three intermeshing screws, rotating in the same direction, provides highly effective compounding. The three screws are arranged parallel to each other with their axes spaced at 120 deg. It is not possible for the material to flow back, as in a single-screw extruder. The uniform consistency of the material fed to the extrusion die makes it possible to control the final product with great accuracy.

An infinitely variable screw-speed range of 6 to 18 r.p.m. is provided. An 18-h.p. Reyrolle variable-speed alternating-current motor and its starting gear are housed in the base of the machine; the motor is carried on a hinged platform which can be adjusted by a crank-handle to allow for tensioning the V-belts, by which the drive is conveyed to an intermediate gearbox, giving a speed reduction of 25 to 1. The output of the intermediate gearbox is transmitted to the final-drive unit, which comprises a ring gear and three pinions, the shafts of which are coupled to the extrusion screws. The die- and barrel-heater elements absorb 10 to 15 kW. All the shafts of the intermediate gearbox are mounted in ball or roller journal bearings. The driving-belt pulley is secured by a shear pin to the input shaft, on which is mounted a spur pinion driving a spur gear keyed to the pinion shaft. A double-helical pinion, integral with the pinion shaft, drives a double-helical gear which is secured to the output shaft. The latter, which is splined at one end, is connected by a muff coupling to a stub shaft which is similarly connected to the pinion shaft of the final-drive unit. By this arrangement the drive can be easily disconnected by sliding the muffs on to the stub shaft.

A section through the final-drive unit is shown in Fig. 2. Integral with the pinion shaft, which is carried in heavy-duty roller bearings, is a wide-faced spur pinion driving on the outside of a ring gear running on large roller bearings. The ring gear meshes internally with three symmetrically-arranged spur pinions integral with the hollow output

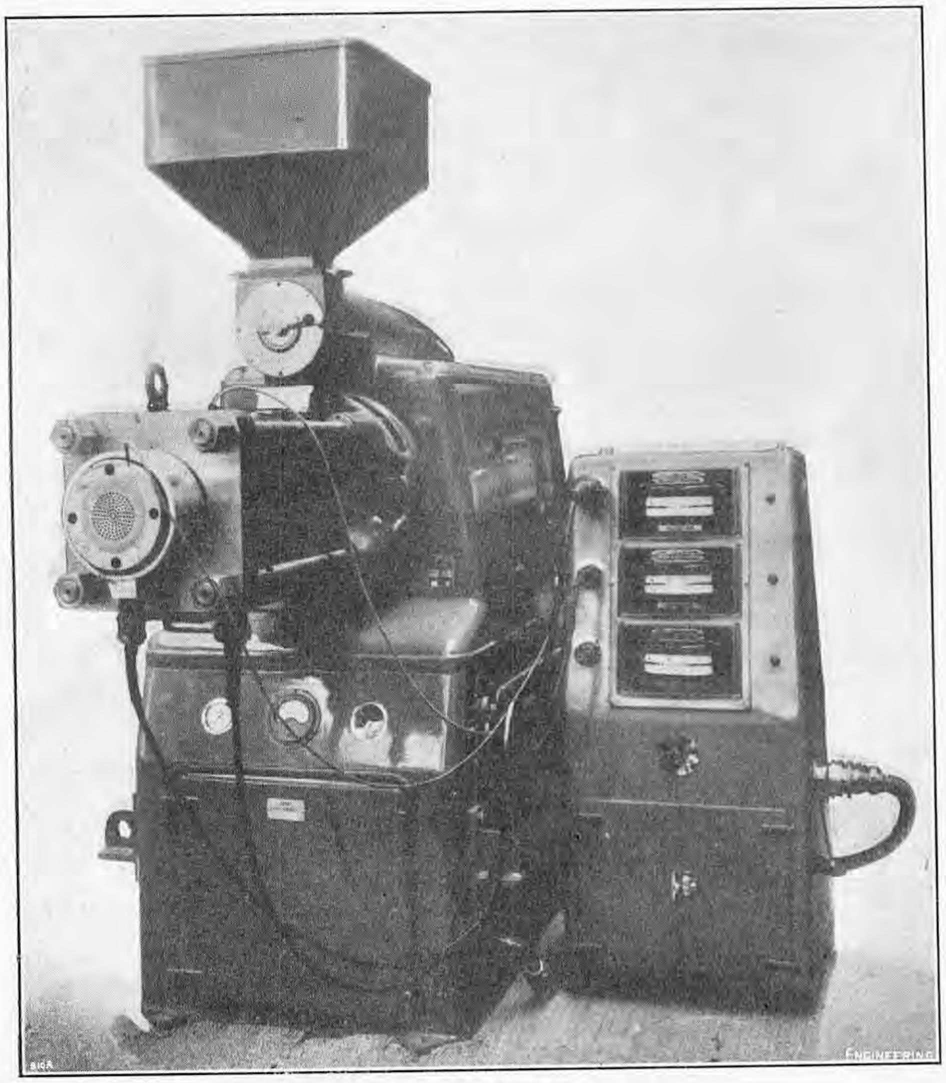
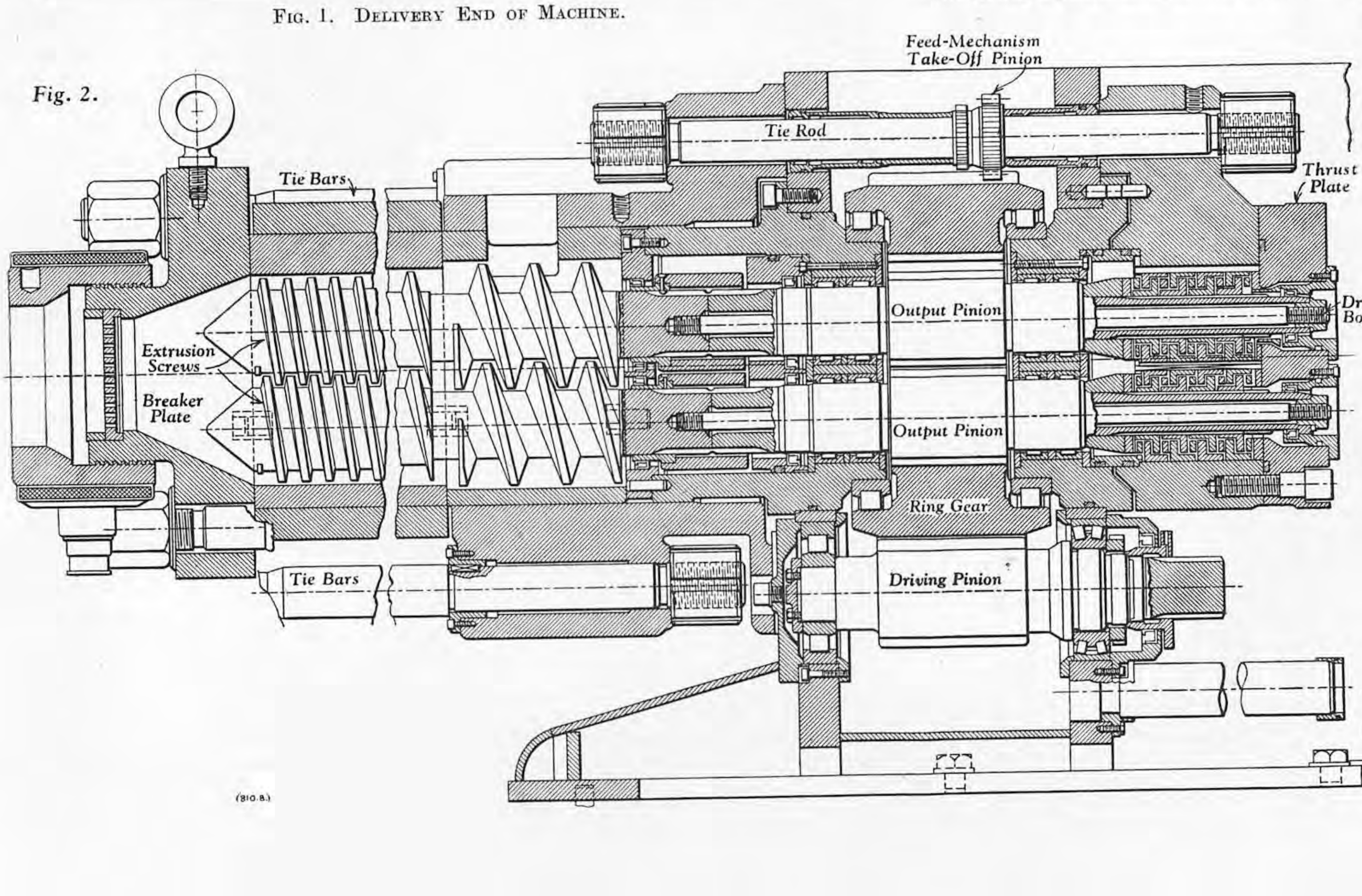


Fig. 1. Delivery End of Machine.

Fig. 2.



TRIPLE-SCREW EXTRUSION MACHINE FOR PLASTICS.

R. H. WINDSOR, LIMITED, LONDON.

Fig. 3.

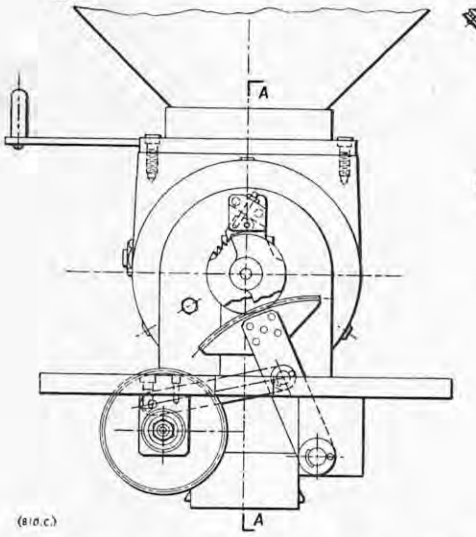


Fig. 4. SECTION A.A.

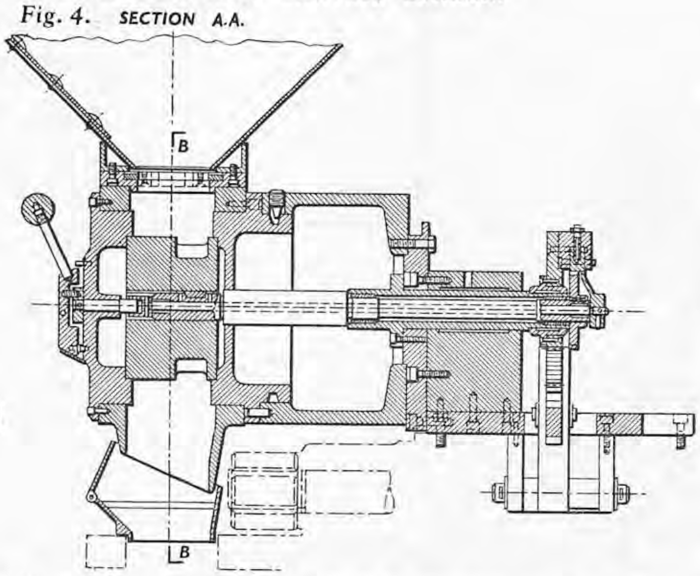
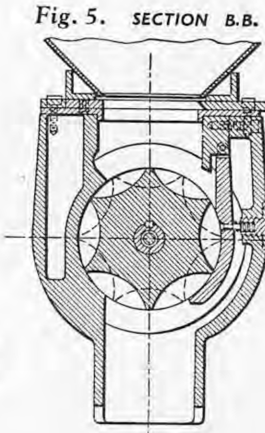


Fig. 5. SECTION B.B.



shafts, which run in needle-roller bearings. The thrust from each extrusion screw is resisted by a multiple-plate thrust block built up from thrust washers. The ends of the output shafts remote from the thrust-block are coupled to the three extrusion screws by splined sleeves, and by draw-bolts which pass through the bores of the output shafts. The draw-bolt attachments provide a ready means for removing the extrusion screws for servicing, by slacking off the draw-bolt nuts and withdrawing the screws from the sleeves; fixtures are provided for this purpose, together with alignment plates for re-assembly. The extrusion screws, of precision-ground alloy steel, are sub-divided into three stages of compression. The respective screw diameters of each stage are 4·93 in. at the hopper end, 4·625 in., and 4·33 in. at the forward end. The pitch is also reduced, as shown in Fig. 21. Oil leakage on to the screws is prevented by oil seals at all glands in the intermediate gearbox and final-drive assemblies.

The extrusion barrel, of heat-treated stainless steel, is made in two sections: the rear barrel liner and the main barrel section. The latter is heated by 14 resistance heaters (not shown in Fig. 1), the temperature of which is regulated by Capacitrol controlling pyrometers manufactured by Messrs. Ether Limited, Tyburn-road, Erdington, Birmingham. The pyrometers are housed in a separate control cabinet, shown on the right of Fig. 2. The adaptor plate and the front barrel sections are secured to the rear barrel housing by four tie bars. By removing the tie-bar nuts, the front barrel section and adaptor plate can be easily dismantled to give access to the screws, the rear barrel liner remaining in place in its housing to support the screws. The adaptor plate is heated by a heater surrounding the adaptor plate nut. Thrust loads on the adaptor plate are transmitted directly to the thrust plate mounting by four tie-rods.

The automatic feed mechanism, illustrated in Figs. 3 to 5, imparts an intermittent rotary motion to a six-pointed star-shaped feed rotor situated below the outlet of the feed hopper. As may be seen from Fig. 4, the rotor delivers the plastic material to a chute serving the extruder screws. The drive to the rotor is transmitted by a take-off pinion meshing with the ring gear that drives the extrusion screws (Fig. 2) to a gear wheel on the feed unit, shown in Fig. 3. This imparts a rocking motion, through a crank and lever linkage, to a quadrant engaged with a gear which carries a pawl and ratchet mechanism. Referring to Fig. 4, it will be seen that the ratchet wheel is keyed to an extension of the rotor shaft. The angle through which the ratchet wheel moves with each cycle of movement of the quadrant can be adjusted by varying the position of a cam which engages with the pawl and releases the latter from the ratchet wheel. The camshaft passes through the centre of the hollow rotor shaft, and is adjusted by a handle at the end remote from the cam, thus providing a range of 22 cam settings from zero to full feed.

Lubricating oil, from a sump in the gearbox, is pumped by a double-helical gear pump, through a suction strainer and a water-cooled oil cooler, to the thrust blocks. The oil pressure ranges from 25 lb. to 40 lb. per square inch, according to the speed of the machine. From the thrust blocks, the oil is bled to all the moving parts in the final-drive unit and the intermediate gearbox, whence it drains back to the sump. An oil-pressure gauge is provided on the left front of the machine base. The other instruments which can be seen in Fig. 2 are an extruder-screw r.p.m. indicator and an ammeter in the driving-motor circuit. The speed of the motor is regulated by a handwheel. It can only be started at the lowest speed. The controls for isolating the heating circuits and adjusting the automatic controlling pyrometers are grouped in a separate cabinet.

LITERATURE.

Servomechanisms and Regulating System Design. Vol. I.

By Harold Chestnut and Robert W. Mayer. John Wiley and Sons, Incorporated, 440, Fourth-avenue, New York 16, U.S.A. [Price 7.75 dols.]; and Chapman and Hall, Limited, 37, Essex-street, London, W.C.2. [Price 62s. net.]

This is the first of two volumes on the theory and design of servomechanisms; that is to say, on automatic controllers distinguished by the fact that they compare the actual value of the controlled quantity with the desired value, and effect control as a function of the difference or error. In electric power stations and industrial instrumentation fields, the servomechanism or error-operated controller has long been familiar under the name "automatic regulator"; a class of application in which the desired value is usually fixed and the function of the regulator is to hold the controlled quantity substantially constant and independent of load variations. More recently, particularly during the second World War, the fields of application have been greatly extended by the development of servomechanisms capable of following rapidly-varying desired values. Examples of this kind are the control of the aim of gun mountings, of the flight of guided missiles, and of machine tools to produce complicated shapes from master templates or models.

This book, Vol. I, is adapted to the needs of engineers and students who have no previous knowledge of closed-loop control systems. The authors are practising engineers with the General Electric Company, Schenectady, and their background is reflected in the care taken to explain the physical implications of mathematical arguments. This should endear the authors to engineers, who are not always, or even frequently, expert mathematicians. Few, if any, systems in nature are truly linear, nevertheless they can often be described with sufficient accuracy by a linear differential equation with constant coefficients. Following two introductory chapters, the classical method of solving such equations is presented and its practical difficulties are pointed out. This leads naturally to an outline of the theory of the present-day method of solution, using the Laplace transform, and is surely one of the clearest introductions to this mathematical process yet written.

The various methods of determining system stability are well presented: firstly, by extracting the roots of the characteristic equation; secondly, by applying Routh's criterion to its constant coefficients; and, finally, by applying Nyquist's criterion to the response of the system to a sinusoidal driving function. The practical applications of Nyquist's criterion by means of plots in the complex plane are illustrated by well-chosen examples. Detailed consideration is given to the relative merits of series and feedback methods of shaping the locus.

A landmark in the development of the theory of servomechanisms was the application of Bode's attenuation theorems to Nyquist's criterion leading to the conception of system analysis from attenuation-frequency diagrams. This method, which lends itself to synthesis as well as analysis, is given the prominence it deserves and the student will find it helpful and instructive that the examples given are mostly those previously analysed by plots in the complex plane. Very clearly printed Nichol's diagrams, relating the magnitude and phase angle of important quantities, are given. The authors treat the problem of relating steady-state sinusoidal to step-function transient response and vice-versa by means of non-dimensionalised charts which give the design characteristics for a series of specified responses. The range of these charts is sufficient for most practical purposes and, since their use involves no detailed calculations, they are invaluable to the designer.

Following a bibliography, which includes most of the really significant literature, the book closes with an exceptionally good list of problems. Many of these are obviously ones which the authors have themselves encountered in their practice as professional engineers. Theory divorced from practice will never make a complete engineer, but if the student can work through these exercises successfully he will be well on the way to becoming a competent designer of servomechanisms. It will have been gathered that the treatment in this volume is confined to systems which can be considered as linear. Consideration of the practical problems raised by non-linearities, such as backlash, Coulomb friction, relay operation, etc., is promised in Vol. II. It is to be hoped that this volume will also discuss operation from pulsed or sampled input data.

For a book evidently destined to become a standard work on the subject, it is unfortunate that there is more than the usual quota of misprints. Most of these, however, will be obvious. Possibly the lack of agreement between the symbols shown in some of the diagrams with those used in the text (δ for ξ in Fig. 3·8-4 and E, K and A for E_{IN}, G and H, respectively, in Fig. 3·8-6) may be due to a last-minute adoption of the nomenclature and symbols recently recommended by the American Institute of Electrical Engineers.

A Bibliographical Survey of Flow Through Orifices and Parallel-Throated Nozzles.

By T. H. REDDING. Chapman and Hall, Limited, 37, Essex-street, London, W.C.2. [Price 32s. 6d. net.]

THE author of this book has performed a useful service in bringing together in one volume such a wealth of information on flow through orifices and nozzles. Not only are there over 600 references to published works on the subject, but these are classified under numerous headings, and, in many cases, are cross-indexed as well. In fact, everything is done to make this a convenient reference book. It is, of course, much more than a mere list of titles. Each entry has a résumé of the subject dealt with, of five to 20 lines, and these alone are often all that an inquirer will need to tell him whether further consultation of that publication will be worth while. Naturally, such a book is not one to be read through continuously, but the author provides a useful introductory section containing terminology and sections dealing with the layout of the book and the classification system employed which repays careful study before using the bibliography itself. A regrettable limitation of the book, however, is that it admittedly only covers the published literature up to 1946 and is therefore six years out of date from the point of view of the most recent information available. There has, in fact, been a great deal of work done in this field, particularly in connection with pulsating flow, in the years since the war, and none of this valuable information is covered.

It must, of course, be almost impossible for one person to cover all the literature available on a particular subject, and, doubtless, the author makes no claims to completeness in this respect. It is curious, however, to notice some omissions. While it is natural that the majority of entries are from British or American sources, with a considerable number from German ones, there are relatively few French and Italian entries and little or nothing from other countries. It also seems strange that, while separate entries are made for successive editions of some books, and even letters to periodicals are dealt with, there is little mention, for example, of work on fire jets. J. R. Freeman's original paper of 1889 is given, but nothing on the more recent work on the subject, such as Dr. J. S. Blair's paper in the *Proceedings* of the Institution of Civil Engineers, in 1940. The book ends with a number of appendices which give the translations of the foreign titles, a list of the periodicals consulted, and a detailed glossary of terms, as well as line drawings showing various types of metering orifices.

Manuel de Ventilation.

Chauffage, Conditionnement d'Air, Tirage mécanique, Dépoussiérage et Séchage. Second edition. Gauthier-Villars, 55, Quai des Grands-Augustins, Paris. (6e). [Price 1,500 francs.]

THIS handbook, prepared under the auspices of La Ventilation Industrielle et Minière (V.I.M.), was first published in 1948; several corrections and modifications have been made in this second edition. Professor Léon Nisolle, of the Ecole Centrale, has edited the work and has himself contributed a number of the chapters; use has also been made of material supplied by the Comité Technique de l'Industrie du Chauffage et de la Ventilation. Following an introduction containing definitions of mechanical and thermal units and a list of conversion factors, there is an account of the chemical constitution and physical properties of dry and moist air. Data relating to the latter are presented both in the form of numerical tables and by means of the Mollier diagram, the use of which is illustrated by a number of examples. The various internal conditions and external climatic factors that contribute to bodily comfort and promote working efficiency are then analysed and, in the light of these, desirable standards of ventilation are laid down. The maintenance of optimum living and working conditions within a room presupposes a knowledge of the amount of heat traversing its bounding surfaces, for the calculation of which tables of thermal conductivities and coefficients of heat transmission are given, covering a wide range of building materials and wall structures. Details of the installation and operation of modern equipment for heating, cooling, air circulating and air conditioning are provided and a section on sound insulation is included.

While the material contained in the first ten chapters is presented in handbook form, accompanied by tables, graphs, nomograms and worked examples, the later chapters are more descriptive in character. The first of these deals with fume exhausting and dust extraction by filtering and electrical precipitation; another outlines the principles of operation of industrial drying plants as exemplified by tunnel, rotary, and high-frequency or dielectric driers. The next chapter discusses briefly processes for humidifying air to satisfy the special needs of the textile, paper and other industries. The concluding chapter is devoted to a description of modern silos for drying grain and oil seeds. Following the text there is a section of plates illustrating the latest heating, ventilating and air-conditioning equipment and typical installations in factories, restaurants, theatres and on board ship, though not in mines. While this manual primarily reflects current French practice, it contains much of general interest to heating and ventilating engineers.

THE INSTITUTE OF METALS.

(*Continued from page* 457.)

WE continue below our report of the all-day general discussion of the seven papers of the symposium on "Equipment for the Thermal Treatment of Non-Ferrous Metals and Alloys," held in London on Wednesday, March 26, during the annual general meeting of the Institute of Metals.

EQUIPMENT FOR THERMAL TREATMENT OF METALS AND ALLOYS.

Mr. C. P. Paton said that Mr. W. A. Fowler had raised some interesting questions with regard to the relative merits of the vertical extrusion and sheet furnace and the horizontal type. The very deep pit which must be dug for the quenching and the fairly high building which must be provided above a vertical furnace meant that there was some disadvantage in this regard. Also, loading was more difficult. The vertical furnace, however, possessed important advantages. First of all, there was the lesser distortion on quenching. If an irregular section were put into the water horizontally it was apt to curve up and become rather badly marked where it was restrained by wires or other means to hold it down in the quenching bath. With the vertical furnace, however, there was less danger of the work coming in contact with other sections in the furnace. It was possible to provide a fair amount of space round heavier sections in the vertical furnace and it was particularly good for heat-treating tubes, on account of the importance of not marring the surface, particularly in view of the exacting demands of the aircraft industry.

Professor Dr. A. von Zeerleder said that, on the question of the solution treatment of alloys as between the continuous and the batch furnace for sections and sheets, whether vertical or horizontal, there was another point which was important from the production aspect, and that was that Duralumin-type alloys needed to be stretched very quickly after quenching, before age-hardening started. With batches this was a disadvantage, because it meant that a large number of sheets or sections had to be dealt with at the same time, and a corresponding number of stretching machines or flattening machines were needed to deal with them before age-hardening set in. On the other hand, with continuous heat-treatment there was the advantage of a continuous flow of the products out of the furnace and through the stretching installation.

Mr. A. Holden, speaking as a furnace builder, said that, normally, they heard only of their bad points and never of good ones. They often heard nothing further about the furnaces that they installed which were a success, and in some cases it had been impossible for them even to see the furnaces. Fortunately, that tendency was becoming less marked at the present time. There was no reason whatever for the assumption contained in the opening paragraph of the first paper, on electric furnaces, that a gas-fired or oil-fired furnace should cost less than a comparable electric furnace; and another point concerning that paragraph was that the authors had referred to "the proved advantages of electric heating" without saying what they were. The question of sulphur was continually being raised. So far as a finish anneal was concerned, on products which must go out of the works untouched, there was possibly some reason for it; but the main difficulty was not sulphur in particular, but variations in the gravity of the gas, and this variation would apply even with a controlled atmosphere from a separate unit. It was not easy to hold the atmosphere within the required limits when the variation in the gravity of the town gas, which Mr. Waight did not appear to mention, was quite large with different types of manufacture. A change from carburetted water gas to town gas produced a change in the relative density of the gas which upset any proportioning device; a point of increasing significance, with the rise in importance of atmosphere control. His company (British Furnaces, Limited, Chesterfield) installed indirect-fired convection heating equipment from a heater external to a furnace and using the principle of recirculating, and it had been found that, although the heat transfer rate was considerably higher and the temperature uniformity was better, it was not quite straightforward, in that there was still hot gas radiation which could produce differences in temperature on thin sections. As far as economics were concerned, however, a convection-heated furnace was as economical on fuel as a direct-type furnace. Convection heating was not particularly new, but it was by no means in the final stages of development.

M. Marcel Lamourdedieu agreed with Mr. Paton that the vertical type of batch furnace was certainly better, or at any rate easier to use, in some cases than the batch horizontal type of furnace, and certainly there was less distortion with the vertical type than with the horizontal type. He added that at Issoire, however, they had a horizontal continuous furnace, and this, in his opinion, was far better than both batch types of furnace. The handling of shapes was easy, because they came directly from the extrusion press on to a roller table and into the furnace, and out of the furnace into the quenching equipment, and they came out very straight, and the big sections did not need any stretching.

Mr. Christopher Smith, who followed, said that the amount of space which continuous-annealing furnaces occupied was enormous, in relation to the amount of work which they performed. Would furnaces having tiers be of more value in saving space, and had any consideration ever been given to that? Moreover, would it be possible, instead of progressing charges longitudinally through a continuous furnace, to progress them laterally, so that the present enormous lengths and widths would not be taken up in heat-treatment shops?

Mr. A. J. Field said that the tonnage of coal used in the non-ferrous metal industry for heating was only of the order of about 1 million out of a total of about 220 millions; nevertheless, any saving possible must be made, particularly in future, and he wondered whether the industry should not evaluate its equipment on the basis of the coal equivalent of this for all the types of furnace involved. The steel industry had come to a fairly standardised form of annealing in bell-type furnaces, which were nearly always heated by gas; radiant tubes were the standard practice, but direct heating also had promise. Each stack of coils was housed in a canister which hermetically sealed it and there was a circulating inert atmosphere inside the furnace which helped to equalise the temperature. He wondered when that would come into non-ferrous practice when the size of the coils and the tonnage might justify it. As one who was in close contact with the annealing of aluminium, he had, of course, to make extensive use of box-type annealing furnaces, and they had many virtues. The efforts of the pioneers in the conveyor-type and other types of furnace would be watched with interest, but in the meantime, it could be said that the box-type furnace, at present for the most part electrically heated, was the standard one. Another standard item of equipment for heat treatment was the salt bath, and its great advantage was uniformity of temperature. Aircraft specifications called for a difference of not more than $\pm$ 5 deg. C., namely, a range of 10 deg. C., but even the biggest modern salt bath could do very much better than that. Another advantage was rapidity of heating.

Finally, he asked that metallurgists should be orthodox in their terminology; that the terminology of the Institute be adopted for the generic title and that it be called "thermal treatment"; that annealing be not included as a branch of heat-treatment; and also that the terms "solution heat-treatment" and "precipitation treatment" be used. Furthermore, for the assistance of members in other parts of the world, and others interested in the non-ferrous metal industry, the designations of material compositions should be always specific. It would also help readers if the Institute's editorial department would put the British tensile units as well as the metric, when metric units were given.

Mr. W. N. Ismay said that gas-fired furnaces had several major advantages which, in many cases, could not be offset by the easier operation and maintenance of electric furnaces. In the first place, efficient gas-fired furnaces used less coal than electrically-heated furnaces, and this was important not only in the national interest but also from the standpoint of manufacturing costs. Secondly, more and more applications nowadays required controlled atmospheres. With electrically-heated furnaces, the cost of providing these atmospheres was a significant item in terms both of heat energy and of monetary cost. As Mr. Waight pointed out, means were now available to control the products of combustion of direct gas-fired furnaces so that a protective atmosphere was obtained without additional cost. He hoped, however, that the gas industry would be able to do more than meet their statutory obligation to provide a fuel of constant calorific value and would provide fuels of more constant composition and lower sulphur content. In some areas, variations in composition upset flow-ratio control devices and thereby resulted in varying the composition of furnace atmospheres. Much work had been done in this country to provide means of bright-annealing brass, but no satisfactory solution had yet been obtained. In many cases people did not try hard enough to get a clean anneal. Most United States manufacturers thought it worth while to have a controlled atmosphere from town gas, natural gas or propane, because it facilitated the solution of subsequent pickling problems.

Mr. J. F. Waight said that they, in the gas industry, were interested that the user should burn gas fuel efficiently and that he should obtain the greatest amount of work out of the minimum quantity of fuel. To that end they carried on extensive investigations into appliance design and usage. He agreed with Mr. Holden that the specific gravity of gas did vary, within fairly small limits. Mr. Ismay had mentioned variation in gas composition. To a large extent, that variation was due to the coals which the gas industry was called upon to carbonise at present. They also suffered from fairly high peak loads, which had to be met by using water-gas plants, and that, of course, did upset the gas composition.

Mr. H. J. Hartley said that there had been references to the variation in the specific gravity of town gas. That, he agreed, was much more important for a fuel-fired furnace than for, say, an electric annealing furnace furnished with separate atmosphere generators. In the case of an atmosphere generator, it was possible to work in the case of most non-ferrous metal alloys with something of the order of 5 to 10 per cent. of combustibles left in the gas, and, under those conditions, the variations in specific gravity never led to oxidation troubles in the furnace, at all events when using nickel alloys. On the other hand, the characteristics of a gas-fired furnace would change quite substantially owing to specific gravity changes.

Mr. P. F. Hancock referred to the presence of sulphur in gas. He said that the gas/air ratio might be nicely adjusted to give just the right nearly-neutral conditions, and then, if a load of work with a considerable amount of lubricant adhering to it were introduced into the furnace the conditions would become considerably more reducing and sulphur staining set in at once. His company (Birlec Limited) had experienced this in a furnace installed about 12 years ago for bright-annealing copper tubes. If the tubes were perfectly clean there was no sulphur contamination, but with the normal amount of lubricant on the tubes things went wrong at once. There was also the difficulty of the variations which were inevitable, as Mr. Waight had pointed out, under present conditions in the composition of the raw town gas. Hence the sulphur purification of such gas, generally speaking, was desirable.

Mr. H. B. Weeks referred to the hot bending of high-strength aluminium alloys. He said that the word "hot" was a little misleading, as the temperatures involved ranged from 130 to 140 deg. C. Recent experiments, which had been confirmed by laboratory work, had proved that materials such as DTD 363 and 364 were much more readily adjusted at slightly elevated temperatures. It was all very well, however, to bend test-pieces in a laboratory, but with pieces of production lengths of 12 to 16 ft. the problem of warming them and keeping them warm to carry out the bending operation was another matter. The advantages to be gained, however, were so great that he put this question in the hope that some information might be forthcoming on the subject.

At this stage of the proceedings, the President adjourned the meeting for luncheon. When the discussion was resumed in the afternoon, Mr. Christopher Smith occupied the chair and the general discussion on equipment for the thermal treatment of metals and alloys was resumed.

The first speaker, Mr. J. O. Hitchcock, said that a study of the papers contributed to the symposium revealed a great deal of progress over the last 20 or 25 years in all fields of heating equipment used for non-ferrous metals and alloys. It was not logical to suppose that no further improvements would be made. Present-day furnaces were ingenious in design and capable of producing articles which were excellent from the metallurgical point of view, but they were not economical in fuel and labour costs. The cost of operating electric batch furnaces, where the charge and time might vary, could easily be doubled by incorrect operation. Belt furnaces, provided they were regularly fed, were less prone to misuse, so that, while it might be expected that a lower annealing cost could be achieved on a batch furnace because there was no belt to heat up and no belt replacement cost, actual figures on one installation where both furnaces were installed on similar work showed that, over a period of some months, lower costs were achieved by the belt furnace. A pull-through strip-annealing furnace showed even lower relative annealing costs. In the case of a pusher-tray furnace, the trays supplied had been in heavy cast heat-resisting alloy. The trays had been re-designed, using a modern creep-resisting alloy, and the weight had been cut to about 30 per cent. There were, no doubt, other structural and moving parts where advantage could be taken of the high load-carrying capacity, at high temperatures, offered by the new heat-resisting alloys developed for gas turbines.

Mr. D. F. Campbell said that one thing which the electric-furnace builders were very anxious to know was how far metal working was going to become a continuous process. Continuous casting was now established, and strip rolling was being carried out at "appalling" speeds; steel was being rolled in this country, at the present time, at 5,300 ft. a minute. Was everything to be done in batches or continuously? That applied to casting, rolling and heat-treatment. One of the things which furnace makers were anxious to know in regard to the next few years was how far they would be asked to produce continuous processes as compared with batch processes. Dr. R. T. Parker, who spoke next, stated that in both the design and the operation of furnaces the metallurgist's point of view should be remembered, as well as that of the engineer who built the furnaces and the engineer who used them. A subsequent speaker, Mr. W. A. Baker, asked whether, for the continuous heat-treatment of light-alloy strip, a salt-bath could be used. In reply to this, Mr. C. P. Paton stated that the metal would be practically molten when it emerged from the salt-bath; it was without any protective coating of oil, and it had obviously to be taken over a number of pulleys and be quenched, without too much distortion, in water and be re-wound. The difficulties which this process would involve would be considerable. It did not take many scrapped lengths of strip, due to distortion or scratching, to offset any economic advantages that the process might otherwise offer.

Mr. H. E. Bennett stated that the rates of heating and of cooling of the charge were important from a metallurgical aspect. Thus, the speed of heating some of the beryllium-copper alloys to the required temperature was very important from the point of view of preventing precipitation from taking place at too low a temperature. The same applied, at the other end of the scale, namely, the speed at which the metal cooled down afterwards. In annealing a standard silver, for instance, if cooling were too slow, precipitation tended to set in and this gave rise to hardening, which was undesirable. Another point was that, very often, metallurgists were not at all sure of the evenness of the temperature in their furnaces, particularly in the lower temperature ranges. A subsequent speaker, Mr. J. C. Howard, stated that bright annealing and bright heat-treatment had come to stay, and metallurgists were familiar with the problem of maintaining a suitable and correct atmosphere, particularly where it was necessary to have a muffle operated at furnace temperature. One of the advantages of induction heating was that the muffle could be kept on the outside of the inductors, so making the muffle (or container) problem simpler than for any apparatus that had to operate at high temperatures. It was possible to have air-tight gaskets and spy holes and covers that could be removed, so that the work under treatment could be seen.

Mr. J. C. Bailey referred to the heating of large aluminium-alloy rivets for hot driving. He said that this had constituted a problem in constructional shops and in shipyards making use of aluminium in rather heavier and thicker pieces than had been customary in such operations in the past. The problem was not proving to be as easy of solution as a first thought on the matter might suggest. It hot riveting, on account of the decades of tradition associated with the hot driving of steel rivets, the riveters wanted to be able to do much the same with light-alloy rivets as they had done with steel rivets, and in fact they had tried to do so. Aluminium-alloy rivets had been thrown on to a coke brazier and when whatever method of temperature indication the foreman favoured had been tried on them, they had been taken out and attempts made to drive them, with disastrous results. A method that had proved to be more satisfactory than others tried had been the resistance heating of the rivets in an adaptation of the normal resistance-heating machine. It was found possible to get the rivets to the right temperature, uniformly heated, in a matter of seconds, but this had not been taken to the stage of actual usage, the main reason being that a rivet-heating furnace did require very often to be portable, and this had set quite a limitation on the design.

Mr. A. B. Ashton referred to a method of heating which he believed had not been mentioned at all, namely, heating by passing a current through the metal to be annealed by ordinary circuit methods, as opposed to induction methods. He stated that, in any furnace operation, a high proportion of structural material was heated, in addition to the metal involved, and the advantage of generating heat within the metal itself was that it was generated where it was wanted and nowhere else. Copper, which probably was the worst possible material to be dealt with in this way, could be heated up to annealing temperatures in seconds by the use of quite heavy currents fed into it by contacts. Fine copper wires could be annealed continuously by running them over contact pulleys, having a potential across them, at speeds of thousands of feet a minute, and this had proved quite satisfactory.

The next speaker, Mr. H. J. Hartley, stated that for the annealing of copper at temperatures of from 150 deg. to 170 deg. C., the obvious method was probably to use an autoclave with high-pressure steam. Mr. Ashton had referred to the annealing of fine copper wire at very high speeds. The only equipment which he had seen on the market for the commercial resistance-annealing of copper wire surmounted the fundamental difficulty of marking the wire at the hot contact by bringing in a very considerable loss of heat or electrical energy. Instead of having the wire at its maximum temperature at the moment when it reached the second contact, it passed through 12 in. or 18 in. of water, which was used to bring the temperature down and keep the second contact controlled. This significantly improved the condition which would otherwise occur at that contact.

Dr. E. Voce wondered whether the problem of the cost of cooling, the space required for cooling and the general inconvenience of cooling might be solved, in some cases, by the introduction of refrigeration methods. He asked if this were possible. A subsequent speaker, Mr. A. J. Field, referred briefly to the question of resistance annealing. He said that one should be able to put into the material to be annealed only as much energy as was required to raise it to its annealing temperature. In practice, however, on a commercial scale, there were many difficulties. For one thing, the size of section that had to be dealt with in the rolling business was often very large; a very common section to be annealed in 99 per cent. pure aluminium, half-hard temper, was 4·8 in. by 0·64 in., namely, about 3 sq. in. in cross-section. This would require a very heavy current. Moreover, this was not the only cross-section that had to be annealed. One might get 10 or 20 tons of that size, and then have a completely different size requiring a completely different current.

Mr. D. F. Campbell said that when rapid heating by induction was referred to, the real meaning, namely, whether seconds or minutes were involved, should be specified. The next speaker, Mr. C. P. Paton, said that one of the strong points of the latest induction heating furnaces was that a gradient could be provided such that all parts of the metal in the billet were at the same temperature when they reached the die. Mr. G. A. Oxby, who spoke next, said that, in connection with continuous annealing furnaces, one point which had not been mentioned hitherto by any speakers was the possibility of measuring continuously some physical property of the product as it was passing out of the furnace or out of the heat-treatment equipment. For example, the continuous measurement of the resistivity or even, in some cases, the possibility of the measurement of the magnetic properties might be a very useful help as a control of the quality of material passing from the furnace. That would cost much less than the sampling of pieces from the coils.

In a brief final speech, Mr. W. A. Baker, the *rapporteur*, voiced the indebtedness of the members to the Institute's Metallurgical Engineering Committee, of which Mr. Christopher Smith was the chairman, for arranging the symposium. In conclusion, Mr. Baker stated that one of the things which had emerged from the discussion had been a very strong plea for much closer liaison between manufacturers and users of furnaces. If there was anything that the British Non-Ferrous Metals Research Association could do to foster development by such closer liaison, it would be only too happy to do so. A vote of thanks to the authors of the papers and to Mr. Baker for his work as *rapporteur* concluded the proceedings and the chairman adjourned the meeting until 10 am. on the following day, Thursday, March 27.

(To be continued.)

INSTITUTION OF ELECTRICAL ENGINEERS.—The date for the delivery of the annual lecture of the Utilization Section of the Institution of Electrical Engineers has been changed from May 8 to Friday, May 23. The lecture, which will be by Mr. W. F. Cartwright, will be entitled "The Use of Electricity in a Modern Iron and Steel Works," and will be delivered at the Institution Building, Savoy-place, Victoria-embankment, London, W.C.2, commencing at 5.30 p.m.

MECHANISMS FOR INTERMITTENT MOTION.

By O. LICHTWITZ, M.I.Mech.E.

(Continued from page 455.)

INTERNAL GENEVA MECHANISMS.

As in the case of conventional gears, Geneva mechanisms can be used for imparting rotation in the same direction as that of the driving gear. Fig. 19, herewith, shows an internal Geneva mechanism with five slots, in the position when the driven gear commences moving, and Fig. 20 shows the same mechanism in a typical position during the period of motion. By means of these figures the properties of internal Geneva mechanisms having n slots, where n is any integer, may be investigated.

As in the previous instances, only those mechanisms will be considered in which the driving rollers enter and leave the slots tangentially, so that the motion starts and ends without shocks. It is possible to use the formulæ derived for external Geneva mechanisms, and to replace n by $-n$, or β by $-\beta$. In this event, however, some results appear negative and, although the negative results can be interpreted, they may easily cause confusion. The internal Geneva mechanisms, therefore, will be considered separately but, the derivation of the formulæ being analogous to that for external mechanisms, the treatment will be more concise.

Since, once again, the substitution of 1 or 2 for n in the previous formulæ leads to values useless from a practical point of view, the smallest whole number for n is 3. Table III, below, contains the values considered above, for the same numbers of stations as in Table II. Whilst, in the case of external Geneva mechanisms, the proportion ν of motion in one cycle increases up to 0·5, as the number of stations increases, in the case of internal mechanisms it is larger than 0·5, and approaches that value from above when the number of stations increases. With increased periods of motion, the kinematic properties of the internal mechanisms can be expected to be better than those of external mechanisms. As the motion of internal Geneva mechanisms occurs over more than half a revolution of the driving gear, it is not possible to provide more than one driving roller, and there are no modifications analogous to those described for external Geneva mechanisms.

Kinematics.—Fig. 20 shows an internal mechanism in a position during the period of motion when the driving gear is at an angle α, and the driven gear at an angle β beyond the central position. The distance of the driving roller from the centre of the driving gear is, by (4a), $AC = r_1 = a \sin \beta_0$, and the distance BC of the driving roller from the centre of the driven gear is

$$\rho = \sqrt{a^2 + r_1^2 + 2\,a\,r_1 \cos\alpha} = a\sqrt{1 + \sin^2\beta_0 + 2\sin\beta_0\cos\alpha}.$$

Fig. 19.

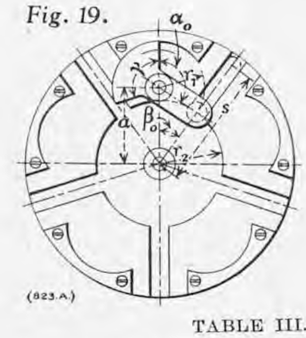


Fig. 20.

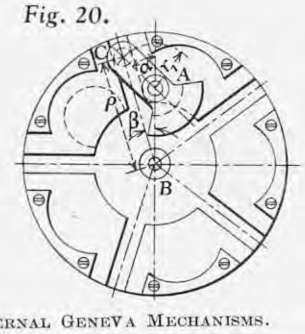


Fig. 21.

(823.A)

TABLE III.—INTERNAL GENEVA MECHANISMS.

n	β_0	α_0	ϵ	$\frac{r_1}{a}$	$\frac{r_2}{a}$	μ	$\frac{S}{a}$	γ	ν	$\left(\frac{d\beta}{d\alpha}\right)_0$	$\left(\frac{d^2\beta}{d\alpha^2}\right)_{-\alpha_0}$	$\left(\frac{d^3\beta}{d\alpha^3}\right)_0$
	deg. min.	deg. min.						deg. min.				
3	60 0	150 0	2·5	0·8660	0·5000	0·5774	1·8660	60 0	0·8333	0·464	1·732	0·01786
4	45 0	135 0	3·0	0·7071	0·7071	1·0000	1·7071	90 0	0·7500	0·414	1·000	0·04163
5	36 0	126 0	3·5	0·5878	0·8090	1·3764	1·5878	108 0	0·7000	0·370	0·7265	0·06053
6	30 0	120 0	4·0	0·5000	0·8660	1·7320	1·5000	120 0	0·6667	0·333	0·5774	0·07475
7	25 43	115 43	4·5	0·4339	0·9009	2·0765	1·4339	128 34	0·6429	0·303	0·4816	0·08332
8	22 30	112 30	5·0	0·3827	0·9239	2·4142	1·3827	135 0	0·6250	0·277	0·4142	0·08936
9	20 0	110 0	5·5	0·3420	0·9397	2·7475	1·3420	140 0	0·6111	0·255	0·3640	0·09313
10	18 0	108 0	6·0	0·3090	0·9511	3·0777	1·3090	144 0	0·6000	0·236	0·3249	0·09519
∞	0 0	90 0	∞	0	1	∞	1	180 0	0·5000	0	0	0

Geometry.—The angle of the driven gear in Fig. 19 is

$$\beta_0 = \frac{\pi}{n}. \quad . \quad . \quad . \quad (1a)$$

The angle of the driving gear is

$$\alpha_0 = \frac{\pi}{2} + \beta_0 = \frac{\pi}{n}\,\frac{n+2}{2}. \quad . \quad . \quad (2a)$$

The ratio of gearing is

$$\epsilon = \frac{\alpha_0}{\beta_0} = \frac{n+2}{2}. \quad . \quad . \quad . \quad (3a)$$

If the distance between centres is a, the radii of the driving and driven gears are

$$r_1 = a \sin \beta_0 \quad . \quad . \quad . \quad (4a)$$

$$r_2 = a \cos \beta_0 \quad . \quad . \quad . \quad (5a)$$

and their ratio is

$$\mu = \frac{r_2}{r_1} = \cot \beta_0. \quad . \quad . \quad . \quad (6a)$$

The length of the slot is determined by the condition that

$$s \geqslant a + r_1 = a\,(1 + \sin \beta_0). \quad . \quad (7a)$$

The arc of the locking drum is

$$\gamma = 2\left(\pi - \frac{\pi}{2} - \frac{\pi}{n}\right) = \frac{\pi}{n}\,(n - 2). \quad . \quad (8a)$$

The duration of motion, related to the duration of one revolution of the driving shaft, is

$$\nu = \frac{2\,\alpha_0}{2\,\pi} = \frac{n+2}{2\,n}. \quad . \quad . \quad (9a)$$

Since

$$\sin\beta = \frac{r_1}{\rho}\sin\alpha = \frac{\sin\beta_0 \sin\alpha}{\sqrt{1 + \sin^2\beta_0 + 2\sin\beta_0\cos\alpha}}$$

$$\beta = \sin^{-1}\frac{\sin\beta_0\sin\alpha}{\sqrt{1 + \sin^2\beta_0 + 2\sin\beta_0\cos\alpha}}. \quad (10a)$$

With the angular velocity of the driving gear equal to unity, the angular velocity of the driven gear is

$$\frac{d\beta}{d\alpha} = \frac{\sin\beta_0\,(\cos\alpha + \sin\beta_0)}{1 + \sin^2\beta_0 + 2\sin\beta_0\cos\alpha}. \quad (11a)$$

In the central position ($\alpha = 0$) the distance ρ reaches its maximum, but it is not so obvious, as in the case of external Geneva mechanisms, that the maximum angular velocity occurs at that position. This can readily be proved, however, by means of the higher differential coefficients, derived below.

The substitution of $\alpha = 0$ in (11a) leads to

$$\left(\frac{d\beta}{d\alpha}\right)_0 = \frac{\sin\beta_0}{1 + \sin\beta_0} = \frac{\sin\beta_0}{2\cos^2\left(\frac{\pi}{4} - \frac{\beta_0}{2}\right)}, \quad (12a)$$

the first value of which can be obtained easily from Fig. 19 without calculus. The angular acceleration of the driven gear is

$$\frac{d^2\beta}{d\alpha^2} = -\frac{\sin\beta_0\cos^2\beta_0\sin\alpha}{(1 + \sin^2\beta_0 + 2\sin\beta_0\cos\alpha)^2}. \quad (13a)$$

The angular acceleration at the start of motion is obtained by substituting $\alpha = -\alpha_0 = -\left(\beta_0 + \frac{\pi}{2}\right)$

in (13a). Thus,

$$\left(\frac{d^2\beta}{d\alpha^2}\right)_{-\alpha_0} = \tan\beta_0 \quad . \quad . \quad (14a)$$

The third differential coefficient of β with regard to α is

$$\frac{d^3\beta}{d\alpha^3} = -\sin\beta_0\cos^2\beta_0 \times \frac{-2\sin\beta_0\cos^2\alpha + (1+\sin^2\beta_0)\cos\alpha + 4\sin\beta_0}{(1+\sin^2\beta_0 + 2\sin\beta_0\cos\alpha)^3}. \quad . \quad . \quad . \quad (15a)$$

The maximum angular acceleration occurs where $\frac{d^3\beta}{d\alpha^3} = 0$, or where

$$-2\sin\beta_0\cos^2\beta_0 + (1+\sin^2\beta_0)\cos\alpha + 4\sin\beta_0 = 0.$$

The solution of this equation is

$$\cos\alpha = \frac{1+\sin^2\beta_0}{4\sin\beta_0} \pm \sqrt{\left(\frac{1+\sin^2\beta_0}{4\sin\beta_0}\right) + 2}.$$

As the value under the square root is larger than 1, only the minus sign is admissible, so that

$$\cos\alpha_{max.} = \left[\frac{1+\sin^2\beta_0}{4\sin\beta_0} - \sqrt{\left(\frac{1+\sin^2\beta_0}{4\sin\beta_0}\right) + 2}\right]; \quad . \quad . \quad . \quad (16a)$$

Thus, $\cos\alpha_{max.}$ is equal but opposite in sign to the analogous value for external Geneva mechanisms. There is, therefore, the relation $\alpha_{max.\ internal} = 180$ deg. $-\alpha_{max.\ external}$.

For any number of stations, the angle (180 deg. $-\alpha_{max.\ external}$) exceeds the angle α_0, and does not represent a position during the period of motion. The largest absolute value of $\frac{d^2\beta}{d\alpha^2}$, although not a true maximum in the mathematical sense, occurs at the start and end of the motion, and is given by (14a). The value of the third differential coefficient, for $\alpha = 0$, is again a measure of the rapidity of the transit from angular acceleration to retardation.

$$\left(\frac{d^3\beta}{d\alpha^3}\right)_0 = -\frac{\sin\beta_0\cos^2\beta_0}{(1+\sin\beta_0)^4} = -\frac{\sin\beta_0\cos^2\beta_0}{16\cos^8\left(\frac{\pi}{4}-\frac{\beta_0}{2}\right)}. \quad . \quad . \quad . \quad . \quad (18a)$$

The values of $\left(\frac{d^3\beta}{d\alpha^3}\right)_0$ are very much smaller than those of external Geneva mechanisms. If the expression (18a) is differentiated with regard to β_0, and the result equated to zero, it will be found on solving the resulting cubic equation in $\cos\beta_0$ that $\left(\frac{d^3\beta}{d\alpha^3}\right)_0$ reaches a maximum at $\beta_0 = 15$ deg. 32·536 min., or when the number of stations is $\frac{180}{15\cdot542} = 11\cdot581$. But even in the case of 12 stations, the nearest whole number to the maximum, $\left(\frac{d^3\beta}{d\alpha^3}\right)_0$ is less than $-0\cdot1$ radian per second.[3] The motion of internal gears near the central position, therefore, can be considered uniform for all practical purposes.

The graphs, Figs. 22 and 23, herewith, show β, $\frac{d\beta}{d\alpha}$ and $\frac{d^2\beta}{d\alpha^2}$ plotted against α, for an internal Geneva mechanism with four stations. The motion is confined to the period from -135 deg. to $+135$ deg. For the remaining 90 deg., the period of standstill, $\frac{d\beta}{d\alpha}$ and $\frac{d^2\beta}{d\alpha^2}$ should be zero, and β constant at the value reached at $\alpha = 135$ deg. Instead, the three curves are indicated by dotted lines, as if (10a), (11a), and (13a) were valid in the period of standstill also. These portions of the graphs will be recognised as the mirror images of the graphs in Figs. 11 and 12 for an external Geneva mechanism with four stations. The complete range of the graphs in Figs. 22 and 23 pertains to a slit-bar mechanism as used for the quick-return motion of shaping machines. Fig. 21, on page 485, shows a slit-bar mechanism which has the same kinematic features as the combined external and internal Geneva-mechanisms with five stations. Figs. 22 and 23 make it clear that the maximum value of $\frac{d^2\beta}{d\alpha^2}$ is associated with an imaginary position of an internal Geneva mechanism. They also show that the motion near to the central position does not differ greatly from uniform motion.

MECHANISMS FOR INTERMITTENT MOTION.

Fig. 22.

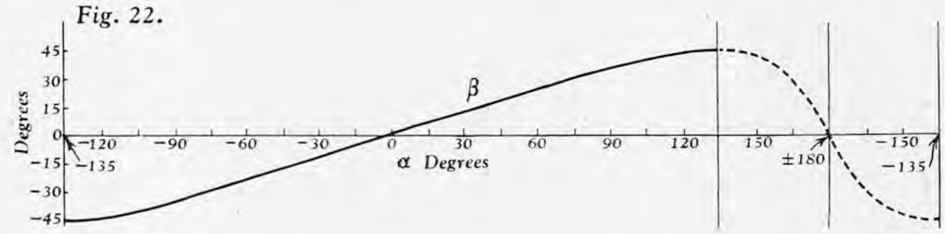
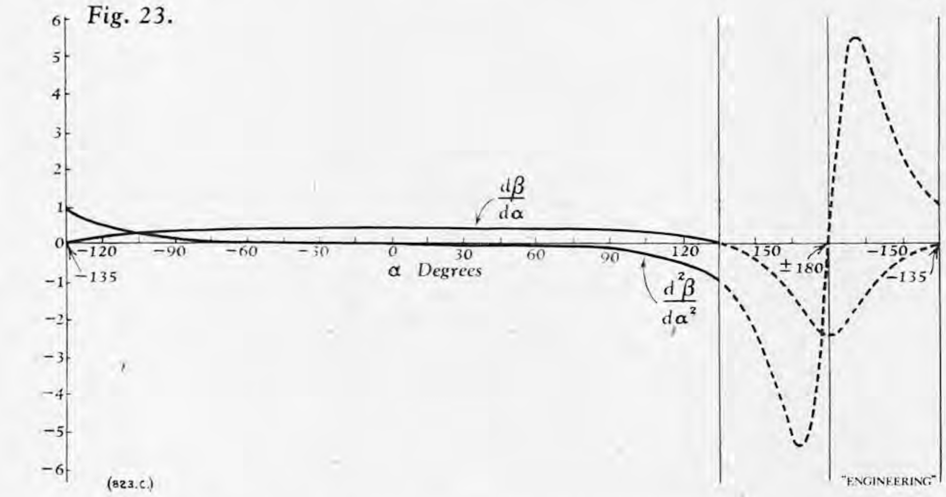


Fig. 23.



From Tables II and III, it will be seen that the characteristic values for an infinite number of stations are identical for external and internal mechanisms, and pertain to the rack-like mechanism shown in Fig. 10. As it was found above that external and internal Geneva mechanisms are complementary kinematically, it will not be surprising that the values of $\left(\frac{d^2\beta}{d\alpha^2}\right)_{-\alpha_0}$, for the same number of stations, are identical. A comparison between Tables II and III reveals that internal Geneva mechanisms, as already mentioned, are more favourable kinematically than external mechanisms. This is also seen from Figs. 22 and 23. The superiority is mainly due to the fact that the period of motion is increased to more than half a cycle, at the expense of the standstill. Because of the reduced duration of standstill, however, internal Geneva mechanisms have a restricted field of application.

Suppose that a mechanism is to be designed to drive a feed roller for which the amount of feed per revolution of the driving shaft is 4 in. The speed N is to be 100 r.p.m., and two-thirds of a cycle are available for the feeding operation, so that an internal Geneva mechanism can be considered. The number of stations may be chosen to be six, for which Table III indicates $\nu = \frac{2}{3}$.

As the feed roller makes one-sixth of a revolution per cycle, its diameter is found from the equation $\frac{d\pi}{6} = 4$ in., or $d = 7\cdot639$ in.

The maximum angular velocity, for $\omega = 1$, is $0\cdot333$ radians per sec. For $N = 100$ r.p.m., it is (by Table I) $10\cdot472 \times 0\cdot333 = 3\cdot49$ radians per sec., and the maximum linear velocity is $\frac{7\cdot639}{2} \times 3\cdot49 = 13\cdot33$ in. per sec. The maximum angular acceleration which occurs at the commencement of motion is $0\cdot5774$ radians per sec.^{2} for $\omega = 1$ (Table III). For $N = 100$ r.p.m., it is (Table I) $109\cdot64 \times 0\cdot5774 = 63\cdot31$ radians per sec.^{2} The maximum linear acceleration is $\frac{7\cdot639}{2} \times 63\cdot31 = 241\cdot81$ in. per sec.^{2}

These results may be compared with those deduced earlier (page 454, *ante*) for a similar but external Geneva mechanism. In spite of the fact that the revolutions per minute of the driving gear are double those of the earlier example, the velocities and accelerations are lower.

Design and Machining.—In designing internal mechanisms it has to be remembered that since the distance between centres has a value lying between those of the radii of the inner and the outer ends of the slots, the driving shaft cannot extend beyond the driven gear, and the driving roller must be supported at one end only. In the mechanism shown in Figs. 19 and 20, the crank which carries the driving roller does not interfere with the driven shaft, so that bearings can be provided on both sides of the driven gear. It will be appreciated, however, that for small numbers of stations, the driving gear may become too large to permit the extension of the driven shaft to the side where the driving gear is moving.

The slots of the driven gear shown in Figs. 19 and 20 are not terminated at the distance s from the centre of the driven gear, but are extended to the outer contour of the gear. Only the slot which the driving roller is about to enter, in Fig. 19, is indicated by dotted lines as terminating at the distance s. The means for locking the driven gear can be designed analogously to those discussed for external Geneva mechanisms, that is, they may be integral with the parts for imparting the motion, as indicated by dotted lines, in Fig. 20, on the locking drum and locking shoe in front of the driving roller. In spite of a rather small radius of the locking drum, the driven gear in this case is very weak at the tips of the slots. To overcome this drawback, the means for driving and locking may be arranged in different planes, as shown by the full lines in Figs. 19 and 20. The radius of the locking drum can be made conveniently large and the locking shoes may be raised integral parts of the driven gear, or parts separately machined and screwed to the driven gear. Although machining of internal gears for uniform motion generally requires special machine tools, internal Geneva mechanisms can be machined in the same way as external mechanisms.

(To be continued.)

Iron and Steel Exposition, Cleveland, Ohio, 1952.—Firms outside the United States are invited to exhibit their products at the 1952 Iron and Steel Exposition, which has been organised by the Association of Iron and Steel Engineers and will be held in conjunction with the Association's annual convention in the Public Auditorium, Cleveland, Ohio, U.S.A. It is stipulated that such exhibits must "pertain to the supply of equipment, services or products for the iron- and steel-producing industry," and that all payments must be made in United States funds. Further particulars may be obtained from Mr. Albert W. Erickson, Junr., at the national headquarters of the Association, 1010, Empire Building, Pittsburgh 22, Pennsylvania, U.S.A. The exposition will be open from Tuesday, September 30, to Friday, October 3, both dates inclusive.

THE INSTITUTION OF NAVAL ARCHITECTS.

(*Continued from page* 469.)

WE continue below our report of the technical sessions of the 1952 Spring Meeting of the Institution of Naval Architects, held in London on April 2, 3 and 4. In last week's issue, we began the report of the discussion on Mr. Basil Sanderson's paper on "Britain's Deep Sea Liner Trade 1945-1951," which is reprinted, abridged, on page 499.

Captain J. P. Thomson expressed surprise at Mr. Sanderson's figure for British liner tonnage, for he had thought it came somewhere between the tramp and tanker tonnages. He also thought that the tanker tonnage was much lower than was shown. In the matter of equipment for handling cargoes, he considered it the duty of the dock authorities to provide the equipment for discharging; ships were not designed to carry transporters, elevators, and so on, to the extent which might be required. In connection with insulation and refrigeration, he asked, could a refrigerated ship be designed with deep tanks as part capacity, to carry oils of high flash-point? He inquired also whether the Isherwood ship would lend itself better to the fitting of the insulation than did the ordinary transverse-framed ship.

Professor E. V. Telfer asked why Mr. Sanderson should be surprised by the increase of 25 per cent. in fuel consumption due to fouling. On looking up some of his own records of fouling in Australian waters, he (Dr. Telfer) had found that the average of his pre-war figures came out at 8 to 10 per cent., which was the figure that Mr. Sanderson gave. On the other hand, as he had shown a year ago, it was now possible to calculate the extra resistance due to "point" or "sharp" roughness with a fair degree of accuracy. The increase in the resistance and the power required was not only a function of the height of the roughness, but it was also a surprisingly important function of the density of the roughness; a very small density of roughness, such as 5 per cent. of the whole surface covered by that roughness, could increase the resistance by something like 20 per cent. of the total resistance possible if the whole surface were covered by that roughness. A superintendent might see a ship in dry dock and say that she has a little shell, but not very much; but apparently that could increase her resistance by as much as 20 to 25 per cent. If the density of roughness went up to 50 per cent., i.e., only half the surface was covered by that particular type of roughness, that was as bad as if the whole surface were covered. Barnacles of the order of 1½ in. long could easily produce 100 per cent. increase in the resistance of the hull.

His other point was whether the modern streamlined ship, and presumably the welded ship, was more sensitive to fouling than the pre-war ship. That was a challenge. He had stated in his 1951 paper that he thought it was so. If the modern ship was 20 per cent. better intrinsically than the pre-war ship, with a consumption represented by 100, the new ship had a consumption represented by 80. If the resistance caused by fouling was the same in both cases, and was 20 per cent. of the 100, then 20 in 80 represented 25 per cent. for the new ship in terms of increased fuel consumption; so that, to some small order of difference, the modern ship must suffer more than the old. Interesting support for a further penalty in the case of the new ship was provided in Mr. J. L. Kent's work on the frictional resistance of long pontoons. The pontoons were towed in the Hamburg tank, about 1927. They had a length of 250 ft. and were tested under various conditions, particularly with smooth surfaces, and then with ordinary riveted construction, with seams running fore and aft. Butts were then introduced on both types. The butts, when applied to the smooth pontoon, increased the resistance by 16 to 17 per cent. The riveted construction alone, without the butts, increased the resistance, as compared with that of the smooth pontoon without butts, by 16 to 17 per cent.; but when the butts were added to the riveted construction there was no further increase of resistance. Evidently, therefore, the existing roughness in the form of rivets and seams could swallow up the additional resistance due to the butts. That led to the conclusion that the pre-war plated ship, which had what might be called a natural structural roughness, could withstand a certain amount of fouling without showing any marked increase of total resistance, whereas the completely new surface, having no such natural roughness to start with, must immediately show the effect of any fouling that took place. It was useless to investigate roughness resistance on a small scale. Conclusions could be drawn from 20-ft. models which were completely the reverse of those drawn from experiments with a pontoon 250 ft. long, and of what was true of the ship.

Dr. J. F. Allan observed that, on the question of fouling, Mr. Sanderson stated that the most efficient modern hulls were bringing their train of troubles in their wake. It seemed to him that that was putting the matter the wrong way round. The percentage quoted by Mr. Sanderson in his paragraph on fouling might appear, on the face of it, rather alarming; but, in point of fact, similar figures were available from other evidence. Nevertheless, the increases of resistance were very serious. The effect of the fouling was entirely, or almost entirely, a matter of increasing the frictional resistance; the modern ship might have been improved as regards wave-making, but that was not influenced materially by fouling. If it was assumed that pre-war ships were fouled to the extent discussed, the modern ships, so far as friction was concerned, were more or less reduced to a par. There was an increase of fuel consumption of 25 per cent., quoted in respect of the modern ship, due to fouling, and of 8 to 10 per cent. for the pre-war ship. Working that out differentially, it could be concluded that the modern ship was initially some 15 per cent. better than the pre-war ship; an interesting conclusion, accepting the initial assumption, which was not unreasonable. That conclusion was being increasingly supported by evidence from other investigations which, he hoped, would be published shortly.

It was suggested by Mr. Sanderson that, in testing modern ships' hulls, something should be done to simulate the fouled condition; but he (Dr. Allan) did not think it is practicable to study the effects of roughness and fouling on the model scale. But, apart from that, the problem should be regarded as a challenge. If the modern ship with the flush welded hull was 15 to 20 per cent. better than the pre-war ship with the all-riveted hull, with new and clean paint, some method had to be found of keeping the modern ship clean. That was a direction in which he thought it very important to pursue research. Another point was that, if the modern ship was so much better than the pre-war ship, it meant that the basic smooth friction was much lower than had been thought, from Froude data. The relevant paragraph in the paper supported the conclusion—which was forced on those engaged in research work—that, for an absolutely smooth ship, it was necessary to get something appreciably lower than the Froude data that had been used for the last 50 or 60 years. The question of fouling was very difficult. Fouling varied from one time of the year to another, and from one port to another; and it was not easy to arrive at a simple rule such as that, if a ship had not been docked for a certain period of time, there would be such and such an increase of resistance.

Sir Ronald T. Garrett (chairman of Lloyd's Register of Shipping) thought that Mr. Sanderson's picture of the state of British shipping was not very encouraging. He seemed to console himself with the thought that the total of British tonnage was back to what it had been in 1939; but in 1939 it was some 10 per cent. less than in 1930, in spite of the fact that world tonnage had been increasing during those years. It was not enough merely to regain the tonnage total of 1939.

Of the world tonnage launched during 1951, almost exactly 20 per cent. was for registration in the United Kingdom. We were barely keeping our place at present. A point which stood out very clearly in Table III was that the total of British dry-cargo tonnage, i.e., the sum of the liner and tramp tonnage, was substantially less than in 1939, and that the overall tonnage had been maintained only by the increase in the tanker tonnage. On the question of passenger traffic, Mr. Sanderson consoled himself, in his analogy of the motor-car trade, with the thought that, up to the middle 1930's, it could reasonably be stated that the motor had created a new traffic, and, by making people more travel-minded, had so increased the volume of travel that even the railways benefited. He did not believe that was a true statement at all. The increase in the total volume of travel in that period was much more likely to have been due to the increase of population and the much higher standard of living in the country than formerly. He did agree, however, with Mr. Sanderson's conclusion that travel created travel and that there was still room for the passenger ship in competition with air, subject to two provisos, namely, that the passenger-ship owners were able to compete in the matter of fares with State-subsidised air services, and that, with the help of the naval architect, they would be able to increase comfort and make travel by ship always more comfortable than travel by air. Naval architects had made a great contribution to that, and could still do so by eliminating, as they were now doing, the annoyance of "groaning" at sea. He was sure that they could make further contributions by improving ventilation, and eliminating the noise and the discomfort in high-speed ships in high winds.

Mr. H. F. Sherborne, on the subject of fouling, mentioned another aspect of the question—the fact that the harbours and estuaries which ships used were undoubtedly becoming fouler and fouler, and ships were tending to remain in them longer and longer. Producers of non-ferrous metals were beginning to have the results of that brought home to them by corrosion arising in certain places where they had supposed that the problem was completely solved. As had been said, fouling varied from one port to another and from one time of the year to another, and he feared that the problem would cause still more trouble in the future Forms of it were now manifesting themselves which, before the war, were so rare as to be almost unnoticed; they arose in ships in the United States, Australia, Africa and, of course, in the ports of the United Kingdom.

Dr. S. F. Dorey, referring to the questions of fouling and increased resistance, observed that the paper rather suggested that the lines of the ships might be at fault; that, the better the shape of a ship and the less the resistance initially, the greater was the increase of resistance due to fouling. He personally felt that it was not so much a question of the lines of the ship, but rather that it had to do entirely with the question of the preparation and protection of the hull from the two aspects of corrosion and fouling. It was on those lines, he thought, that research should be directed. Some years ago, the Iron and Steel Institute started research work in regard to corrosion and fouling, and he understood that it was still being continued; but mention should be made also of the published work on the use of cathodic protection. It would appear that, although only small-scale experiments had been carried out, it should be possible, by cathodic protection, not only to protect the hull from corrosion, but to shed the fouling by means of an applied current. As Mr. Sherborne had said, fouling was likely to increase due to the state of the waters in different parts of the world. The time might come when, by an adjustment of cathodic protection and an applied burst of current when the ship was in harbour, it would be possible thereby to shed all the fouling and start again with a comparatively fresh surface.

Dr. J. Tutin suggested that the first thing to do with regard to the fouling problem was to discover Nature's method of dealing with it, because the creatures which fouled ships did not adhere to whales, or any fish, or even eels. The fundamental attack on the problem, therefore, was to find out exactly why that was so. He would shortly be supervising some experiments to try to find out the reason. If a solution could be found, it might lead to new types of anti-fouling paints which would contain the kind of material, whatever it might be, which protected fishes and whales against fouling.

The President (Viscount Runciman) said that he felt very strongly about fouling. He had never been able to understand why nobody had invented

600/3,000-TON FORGING PRESSES.

WILKINS AND MITCHELL, LIMITED, DARLASTON.

(*For Description, see Opposite Page.*)

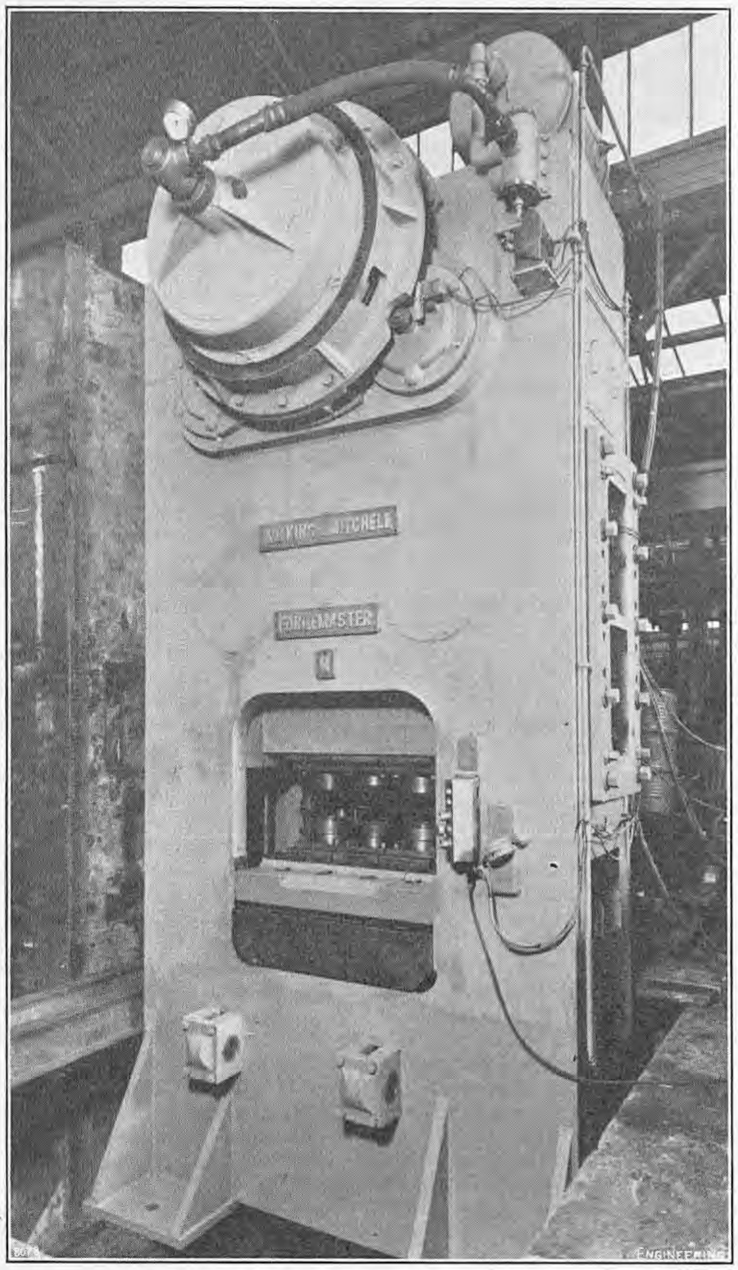


FIG. 1. FRONT VIEW OF 1,200-TON PRESS.

FIG. 2. DEMONSTRATION PRODUCTION OF AUTOMOBILE GEAR BLANKS.

a property in steel which would be as distasteful to winkles in port as the motion of a vessel was distasteful to passengers outside port. Dr. Dorey had perhaps shed a ray of hope on that otherwise rather murky picture. Apart from that, said Lord Runciman, he was prepared to join with anybody in the campaign against the present inefficiency of anti-fouling paints. On the point raised by Sir Ronald Garrett, about sea and air travel, he agreed, on the whole, with what Mr. Sanderson has said; it was true that, the more opportunities for travel that people were given, the more they would travel—traffic did beget traffic. To that extent, there was something to be said for the development of a complementary traffic system between the sea and the air, starting with the rather obvious case of the man who had to go somewhere in a hurry, but who could enjoy some leisure on his way home; he would fly out, and come home by sea. Air and sea travel had both suffered because each regarded the other more as a deadly rival than as somebody who could go a long way with them along a common road.

That led to the general question with which Mr. Sanderson began his paper. The Institution of Naval Architects was established to promote the improvement of ships, and he could think of nothing which militated more against the improvement of ships than the difficulties in building them: he agreed with Mr. Sanderson that taxation was one of the chief difficulties. With regard to the figures for the various classes of ships: liners did suffer from the disadvantages which Mr. Sanderson had mentioned, but one of them was not wholly a disadvantage in times like the present. The liner owner had to keep his fleet in being to maintain his traffic, which meant that he must order ships more or less continuously. Theoretically, if a liner company had 20 ships, the average life of a ship being 20 years, they would automatically order a ship a year; and over a period of rising costs there would be a certain spread, as in the case of the manufacturer who was renewing machinery in his factory all the time. A company that was not so large could not get the same spread. Nevertheless, a year or two hence the liner companies might feel fortunate that they had to build so soon after the war as they did. The tramp owner hung back at that time, saying, quite rightly, that he did not need to build at that particular moment for a particular trade. If he could time it aright, the obvious course of action was to place his orders in times of depression, when he could have his ships built cheaply, in order to benefit by the boom later.

He thought that many tramp owners hoped that, after the war, prices would fall; as they had seen prices rising and rising, they had been more and more discouraged, a few, in desperation, coming in fairly recently at very high prices. If prices became stabilised, or even fell a little, there might well be a considerable amount of tramp building as soon as berths were available. It was arguable that tankers, to some extent, were taking the place of tramps. In an age when oil was being brought into the country instead of coal being taken out of it, that must be the case.

He agreed with Sir Ronald Garrett, and it was implicit in the figures, that the tramp tonnage of the United Kingdom was getting dangerously low. About a quarter of the British dry-cargo fleet was 25 years old, or more; another third, mostly war-built Liberty and other similar ships, would get towards the end of their useful life in about ten years time. At the present rate of replacement of liners and tramps alike, if trends did not alter, the dry-cargo mercantile marine of this country would be down, 10 years' hence, by nearly one-sixth; we should be minus one ship out of every six that we had to-day. Fortunately, life had a way of confuting arithmeticians, and he hoped very much that it would do so in that instance; but it was a warning which should be in everybody's mind, and he thought it is true to say that one of the reasons, and probably the chief reason, was not only the weight of taxation, but the way in which it was assessed at the present time. From those points of view, therefore, he was entirely in agreement with Mr. Sanderson.

Mr. Sanderson, replying to the discussion, expressed some disappointment that he had not been given any hope that something could be done about the structure and lines of ships to reduce the amount of space wasted on insulating, etc. He had hoped that there was something in the suggestion. He assured Sir Ronald Garrett that he did not intend to suggest that he was happy because the state of British liner tonnage in 1950 approximated to that of 1939; he was trying to make the point that, by 1950, the liner companies had replaced their losses. They had the dreadful problem of ships that were getting older and obsolete, and he did not see how they would meet it.

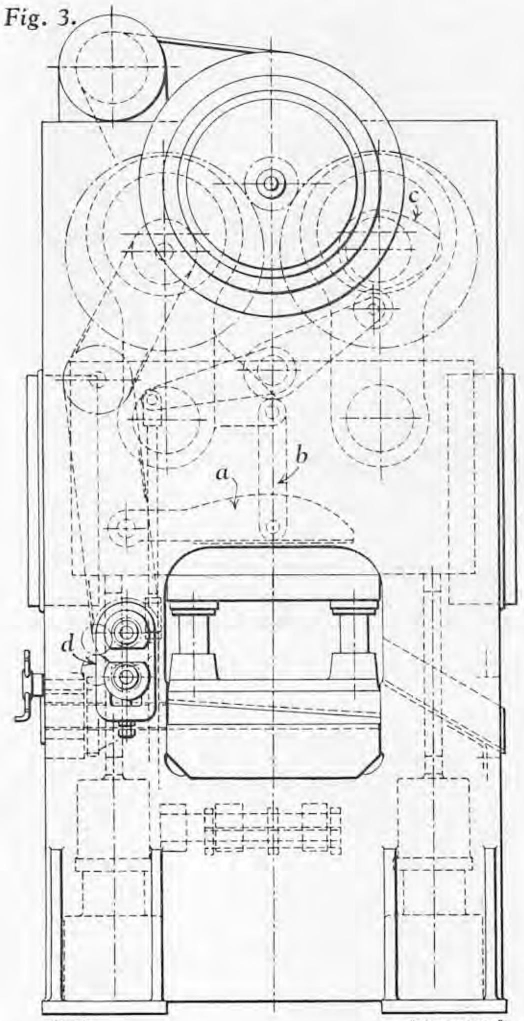
The meeting was then adjourned until the following morning, April 3, when, with Dr. S. F. Dorey, F.R.S., in the chair, Sir Wilfrid Ayre presented his paper on "Merchant Ship Design—A Thought on the Future." This paper will be reprinted, abridged, in next week's issue of ENGINEERING, together with a report of the discussion on it.

(*To be continued.*)

600/3,000-TON FORGING PRESSES.

WILKINS AND MITCHELL, LIMITED, DARLASTON.

Fig. 3.



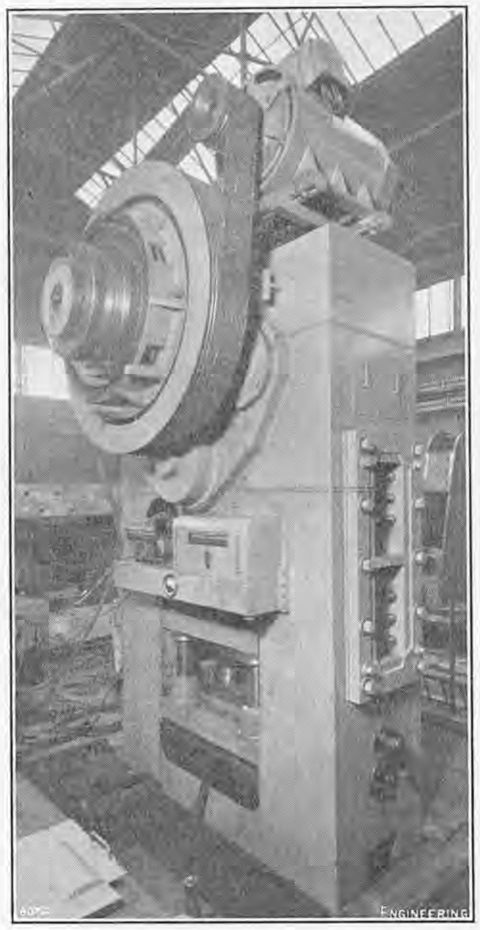


FIG. 4. REAR OF PRESS, SHOWING MAIN DRIVE.

600/3,000-TON FORGING PRESSES.

THE "Forgemaster" forging presses introduced recently by Messrs. Wilkins and Mitchell, Limited, The Green, Darlaston, Staffordshire, cover a range of from 600 tons to 3,000 tons ; they have been designed to allow multiple operations, using up to four sets of dies, and particular care has been taken in the design to allow of high rates of forging. The fabricated frames of the machines have been made specially rigid so that the forgings produced are uniform. The machine shown in the makers' works in Figs. 1 and 2, opposite, and Fig. 4, above, has a capacity of 1,200 tons. Fig. 2 shows how, by making the tool area larger in the lateral direction than from front to rear, the tools can be arranged in a line, thereby facilitating the handling of forgings.

The machine frame, fabricated from rolled steel plate to the firm's "ring-frame" design, has no load-carrying joints. Two vertical plates, one at the front and the other at the back, are spaced apart by deep cross-plates, and an aperture in each provides the tool space. The main driving motor, which is shown in Fig. 4, above, is on an adjustable mounting and is coupled to the grooved rim of the flywheel by V-belts. The flywheel is free to idle on ball bearings, but when the drive is engaged a multi-plate direct-acting friction clutch is actuated by compressed air. A brake, the construction of which is similar to that of the clutch, is used for stopping the machine and is applied automatically by spring pressure when the clutch is withdrawn. Simplicity of design, ease of access, and interchangeability of parts are the chief design features of the clutch and brake, the friction plates of which are identical. The friction surfaces have been made large to give long life, and an induced draught ensures cool operation even during continuous heavy-duty working.

The arrangement of the transmission, which is totally enclosed in the frame, and runs in oil, is shown by dotted lines in Fig. 3. The clutch shaft, mounted on ball and roller bearings, has twin pinions, forged integral with the shaft, which mesh with two pairs of bull wheels ; each pair of wheels is secured to the faces of a forged-steel eccentric, on which a bronze-lined steel eccentric rod is journalled. Each eccentric is keyed to a forged-steel mandrel which is carried in bearings in the press frame. The centre-lines of these mandrels are visible in Fig. 3, one each side of and below the clutch shaft. By thus splitting the load, and applying it to both ends of the main slide, accuracy of tool alignment is ensured. Long production runs are therefore possible before it is necessary to re-sink the dies ; or—to express this advantage reciprocally—close tolerances on the forged parts are more readily maintained. The balanced drive to the bull wheels results in minimum bending stresses in the pinion shaft and bull-wheel mandrels (which are also relieved of all torsional stress) and a minimum bearing pressure on the journals.

The main slide is a deep fabricated structure with long narrow V-ways which are provided with bronze liners of large area. It is aligned by adjustable V-gibs. Contrary to usual practice, the slide is not built into the machine from the front, but through apertures in the sides, one of which is shown in Fig. 4. This arrangement permits the overall width of the machine to be kept to a minimum, consistent with the large width of the working space. As Fig. 3 shows, the working space is well within the points of application of the forging pressure from the eccentric rods. The slide apertures are covered by steel castings which embody the adjustable gibs. Thrust is transmitted to the slide from the eccentric rods through forged-steel mandrels journalled in bronze bushes. The side faces of the slide are sealed to prevent foreign matter rising up into the driving parts of the press, and the bearing faces of the gibs are protected against scale by scrapers.

The mass of the slide and other reciprocating parts is balanced by two compressed-air cylinders, mounted one in each side in the base of the press, as shown by dotted lines in Fig. 3. The cylinders are of the inverted type to prevent ingress of foreign matter, and they are so designed that additional receiver tanks are unnecessary. The reaction of the cylinders also takes up backlash in the gears and working tolerances in other parts, thus eliminating hammering of the bearings and minimum shock when the upper die comes in contact with the workpiece. The bed of the machine, which supports the lower dies, is located by machined faces in the frame ; it can be supplied either plain or adjustable for height, and both types can be fitted with top and bottom dowelled tool-holders, to suit requirements. In the case of the adjustable bed, the tool-holder is an integral part of the wedge equipment, as shown in Fig. 3. The wedge is adjusted by a screw through reduction gears, a positive lock being provided to protect the setting against accidental disturbance.

The top and bottom ejectors are automatic and their mechanisms are protected within the frame. The arrangement is shown by dotted lines in Fig. 3. The top-ejector mechanism consists of a hardened slipper *a*, which bears on knockout pins in the slide face and is actuated by a link *b* coupled to a lug on the left-hand eccentric rod. It is operated during the earlier part of the upstroke, i.e., when the eccentric rod is swung over to the right. The bottom-ejector mechanism consists of hardened slippers which push knockout pins upwards through the bed, the slippers being driven through levers and a link by a cam *c*, which is secured to the right-hand bull-wheel mandrel. The designers have paid close attention to the accessibility of these ejector mechanisms.

The press is controlled electro-pneumatically by means of push-buttons which give continuous working, single-cycle and inching movements. A pedal can also be provided for single-cycle operations. A gap rolling atta hment, the arrangement of which is shown at *d* in Fig. 3, can be provided for the preliminary reducing of stock. The roll centres are adjustable and the design allows both end-rolling and cross-rolling. The rolls are driven from one of the eccentric mandrels and one revolution is obtained during each press cycle. The principal bearings of the machine are lubricated by a continuous-circuit forced-feed system ; they are sealed against the entry of dirt, etc., and oil received from the pump is returned to a sump where it is filtered prior to recirculation. Cam faces and gears are enclosed and run in oil. A large-capacity air filter can be fitted, if required, to ensure that the air supplied to the clutch and slide-balance cylinders is clean, thereby reducing wear and maintenance. Adjustable air jets can be fitted to cool the dies and automatically free them from loose scale after each cycle, and oil-sprays, controlled by a push-button, can be provided for lubricat ng the dies.

SUMMER SCHOOL OF PRODUCTION ENGINEERING.

THE third annual summer school of production engineering, arranged by the Institution of Production Engineers, is to be held at Ashorne Hill, Warwickshire, from August 27 to 31. The theme is to be "The Processes of Production." The school will assemble in the afternoon of Wednesday, August 27, and the President will give an after-dinner address that evening. The following morning a lecture on "The Study and Application of the Processes of Production" will be delivered by Mr. M. Seaman, M.Sc., M.I.Mech.E., A.M.I.E.E., M.I.Prod.E., general manager of the engineering works of the British Oxygen Company, Limited, and this will be followed by informal meetings of discussion groups. In order to give the teachers and those from industry an opportunity to study and discuss specialist subjects, the school will be divided into two sections—on industrial application, and education and training—for the lectures on Friday and Saturday. On Friday, in the first section, Professor J. V. Connolly, B.E., F.R.Ae.S., M.I.Prod.E., head of the Department of Aircraft Economics and Production at the College of Aeronautics, will speak on "The Study of Production Processes" ; and, in the second section, Mr. B. E. Stokes, of Messrs. Joseph Lucas, Limited, will give a lecture on "Planning and Controlling the Processes of Production (Machine Aspect)."

On Saturday, August 30, the lectures will be, respectively, "Practice in Production Processes," by Mr. E. M. Price, M.A., A.M.I.Mech.E., A.M.I.E.E., M.I.Prod.E., manager of the Rugby works of the English Electric Company, Limited ; and "Planning and Controlling the Processes of Production (Human Factors)," by Mr. B. G. L. Jackman, A.F.R.Ae.S., M.I.Prod.E., works director of the British Heat-Resisting Glass Company, Limited. Addresses on "The Producer and the Customer" and "The Producer and the Shareholder" will be given on Friday and Saturday evening, respectively. The proceedings will also include meetings for group reports and discussions, and visits to works in the area. Arrangements are being made for those who wish to attend a performance at the Stratford Memorial Theatre on the evening of Thursday, August 28. A small extra charge will be made. The fee, to cover accommodation, meals, gratuities, a copy of the proceedings and all charges, is 8*l*. 8*s*., but for Midland residents who do not require accommodation or breakfasts the fee will be 3*l*. 5*s*. Application forms are available from the secretary, Institution of Production Engineers, 36, Portman-square, London, W.1.

ELECTRICAL RECORDING ANEMOMETER.

BRITISH RAILWAYS (WESTERN REGION).

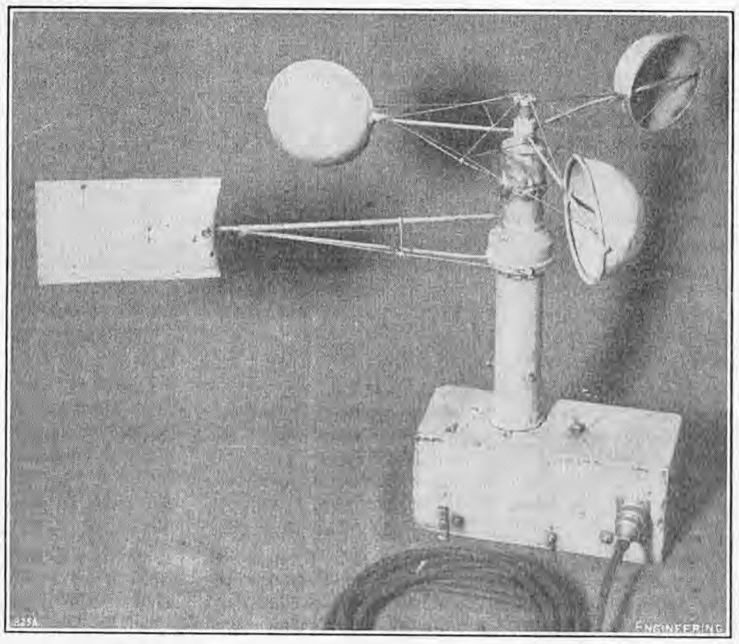


FIG. 1. SPEED AND DIRECTION MEASURING HEAD.

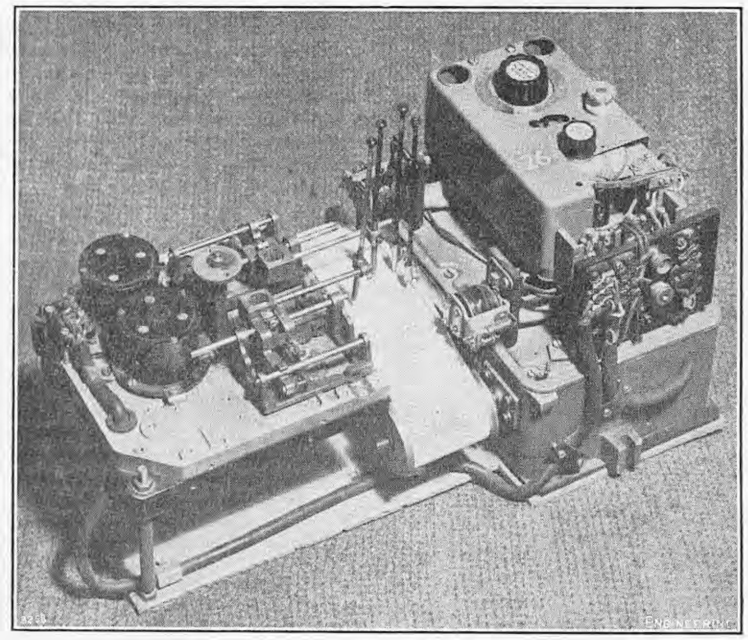


FIG. 2. ELECTRICAL RECORDING APPARATUS.

ELECTRICAL RECORDING ANEMOMETER.

THE two parts of the electrical recording anemometer shown in Figs. 1 and 2, above, i.e., the head of the instrument and the recording apparatus, can be placed at any convenient distance apart, and a record of wind speed and direction can be obtained for a month without attention. The instrument has been made at the Soil Mechanics Laboratory of British Railways (Western Region), and has been installed at Dawlish Warren, near Exeter, to record the velocity and direction of wind in connection with a study of the effects of wind erosion on the sand dunes which protect the railway from the sea at that point. The information obtained from it, in conjunction wth data derived from laboratory wind-tunnel tests, will be used to determine the nature of remedial measures to be taken on the site. The head of the instrument is set up on a tower, 35 ft. high, and is linked by a cable to the recorder, which is in a weatherproof hut.

Wind speed is measured in the usual way by three hemispherical cups mounted at 120 deg. on a vertical shaft. The shaft is geared to a cam which closes a pair of electrical contacts (shown diagrammatically in Fig. 4), thereby actuating a pen over a paper roll. The gearing between the shaft and the cam gives a reduction of 2,500 to 1. The series of "kicks" produced by this speed pen is shown in Fig. 3, against a time base which is marked by a pen controlled by an electrical unit. The instrument is previously calibrated against a portable non-recording anemometer, by means of which a graph is drawn from which a direct reading of the average wind velocity is obtained.

The wind-direction vane is attached to a shaft, concentric with the wind-speed shaft, which is geared to a triple cam. The three lobes of this cam are set at 120 deg. and actuate three sets of contacts, only one set of which is open at any instant, the other two passing a current to a pair of repeater motors in parallel, as shown in Fig. 4; the rotary motions of the motors are converted to reciprocating movements of two pen arms. The two pens are set 90 deg. out of phase, thus enabling the direction of veer of the wind to be obtained. The wind direction is determined by laying a prepared mask over the pen traces shown in Fig. 3; the greatest accuracy is derived from the pen nearest the centre of the travel. The direction can be measured to within 5 deg.

Fig. 3. TYPICAL RECORD OF WIND SPEED AND DIRECTION.

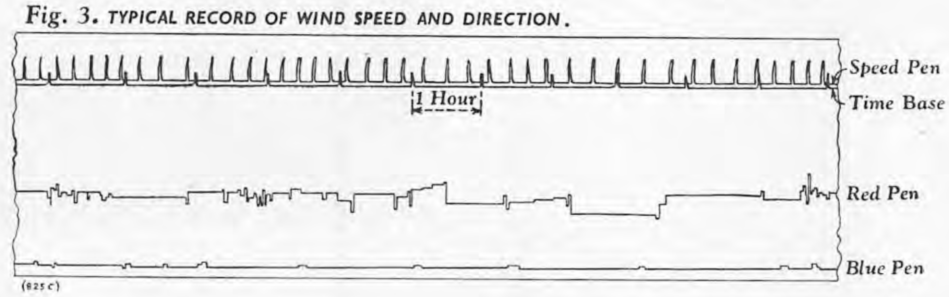
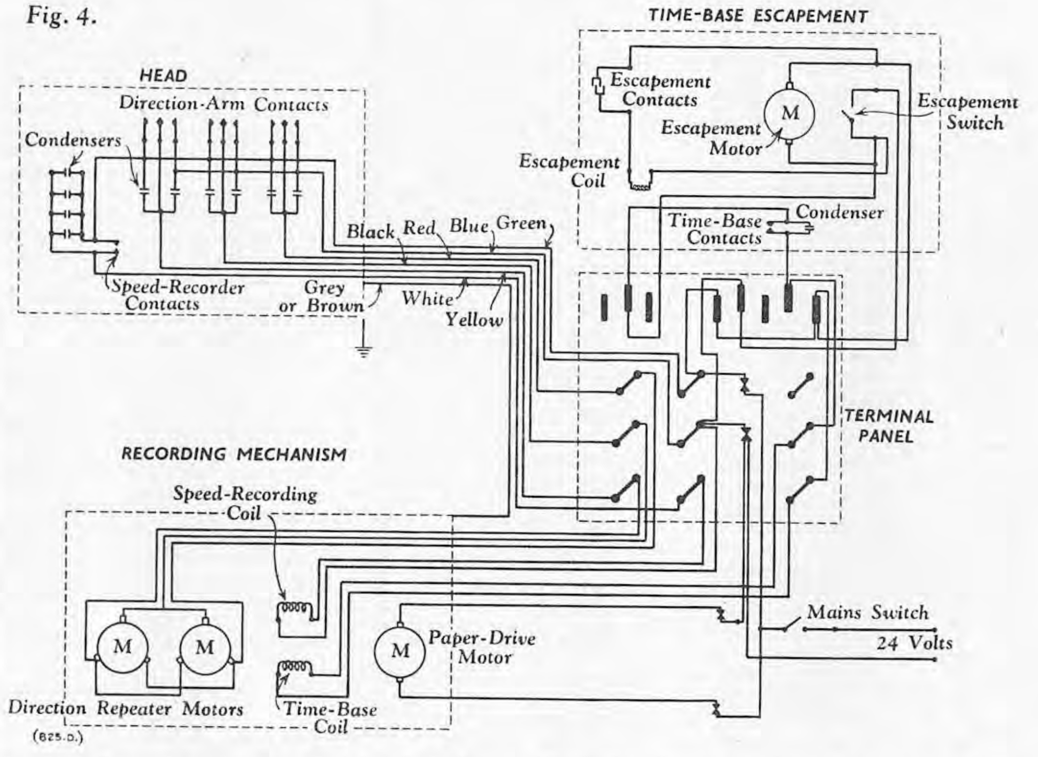


Fig. 4.



SHORT-SERVICE COMMISSIONS, INSTRUCTOR BRANCH, ROYAL NAVY.—Applications are invited from University graduates and qualified teachers under 36 years of age for short-service commissions of three, four, or five years in the Instructor Branch, Royal Navy. Requirements are mainly for officers having qualifications in mathematics, science (physics, chemistry and metallurgy) or engineering. After two years of service, officers are eligible for selection for permanent commissions. Instructor officers serve both ashore and afloat. Further information is obtainable from the Director (P), Naval Education Service, Admiralty, London, S.W.1.

BOLIDEN MINING COMPANY, SWEDEN.—The total ore reserves of the Boliden Mining Co., of Sweden, are estimated to amount to 37,000,000 tons. The company produce iron pyrites, copper, sulphur, gold, silver, arsenic and lead, and, since the 1920's, approximately 6,200,000 tons of minerals have been mined in the original Boliden ore field. Copper, lead, precious metals and arsenic are produced at the company's works on the Gulf of Bothnia. A recently-issued report states that the electrolytic copper works have an annual capacity of 29,000 tons of the metal and the lead works one of 20,000 tons.

MARCONI: COMMEMORATIVE PLAQUE ON FORMER RESIDENCE.—The London County Council are arranging to fix a plaque on the outside of 71, Hereford-road, Paddington, London, to commemorate Guglielmo Marconi's residence there in 1896 and 1897. That was the time when Marconi, after receiving no encouragement in Italy, came to Britain, where he received assistance from the Engineer-in-Chief of the General Post Office, Mr. (later Sir) W. H. Preece, and where, only 13 months after his arrival, financial backing was obtained to establish the Wireless Signal and Telegraph Co., Ltd. later known as Marconi's Wireless Telegraph Company, Ltd.

THE PASSENGER MOTORSHIP "KONGEDYBET."

A/S BURMEISTER & WAIN, COPENHAGEN.

FIG. 1. THE VESSEL AT SEA.

CHANNEL MOTORSHIP "KONGEDYBET," FOR COPENHAGEN-BORNHOLM SERVICE.

WE illustrate herewith and on page 494 the Danish single-screw motorship Kongedybet, recently completed by Messrs. Burmeister and Wain, Copenhagen, for the channel passenger service operated by the A/S Dampskibsselskabet paa Bornholm af 1866 between Copenhagen and Rönne, the capital and principal port of the island of Bornholm, in the Baltic Sea, rather more than 100 miles to the eastward. Except that the distance is rather greater, the service resembles that between Liverpool and the Isle of Man, in that the vessels engaged in it have to be designed either for a night trip, with a large proportion of sleeping-berth cabins, or for a day trip of some seven hours, with 1,500 passengers. The Kongedybet is the twelfth vessel that has been built by Messrs. Burmeister and Wain for these owners, and will maintain the service in conjunction with the previous two, the Hammershus, built in 1936, and the Rotna, built in 1940. She has been built to the classification of the Bureau Veritas and has the following dimensions: length overall, 292 ft., and between perpendiculars, 269 ft.; beam, 43 ft. 6 in.; depth (at side) to main deck, 16 ft. 11 in., and to awning deck, 24 ft. 6 in.; mean draught, loaded, 14 ft. 4½ in. The tonnage is 2,314 gross, and the sea speed is 15½ knots. Aluminium alloy is extensively used in the superstructure.

A feature of note is that the cargo holds are arranged for the handling of general merchandise on pallets and in containers, which are stowed in the holds by the aid of small electric trucks. There are also, for cargo handling, two 3-ton and two 4-ton electric deck cranes, fitted with the neat and simple type of tubular-steel welded jib illustrated in Fig. 2.

PASSENGER ACCOMMODATION.

The passenger accommodation is arranged on the promenade deck, awning deck, main deck and lower deck. There is also a veranda on the boat deck, but the greater part of this deck is devoted to cabins for the captain, the deck officers and the engineer officers. On the promenade deck amidships are the first-class dining saloon (illustrated in Fig. 3, on page 494) and smoking room, the latter room being oval in plan, with the long axis athwartship and the forward side conforming to the curve of the bridge front. It has seating accommodation for 54 passengers, and the dining saloon seats 88. Promenades along both sides of this deck, past the dining saloon, extend to a veranda lounge aft. On the awning deck is the entrance hall, from which a wide staircase leads to the other passenger decks, and which is entered through ports in the ship's sides. The rest of this deck, between the well decks, is occupied by cabins; but there is a general saloon aft, in the poop, and crew's accommodation forward. The main deck amidships is entirely given over to cabins. Abaft the after hatches there are two small saloons reserved for ladies and gentlemen, respectively, and aft of them is the second-class general saloon. There is another second-class saloon at the after end of the lower deck, reached by a stairway from the similar saloon on the main deck; and, forward of the machinery space, on the lower deck, there are cabins to accommodate 93 passengers. In all, there are 118 first-class cabins, with 259 berths, including 26 single-berth cabins.

FIG. 2. ELECTRIC CARGO CRANES.

A safety precaution in the cabins of the Kongedybet, which we do not recall having seen used elsewhere, is the provision, in every cabin door, of an escape panel mounted in a rubber frame so that it can be pushed or kicked out, thus leaving a hole big enough for a person to pass through. Other safety devices include an electric automatic fire alarm, indicating by lights and bells on the bridge and elsewhere if the temperature rises excessively in any of the 284 public and private rooms in the ship. A smoke-detector, connected to the holds, is also fitted on the bridge. The whole of the passenger accommodation is mechanically ventilated, in connection with the heating system. A flow of warm air is arranged over the windows in the wheelhouse, and in the first-class smokeroom, which is immediately below it, to prevent misting of the glass.

MACHINERY AND EQUIPMENT.

The main engine is a Burmeister and Wain direct-reversing single-acting two-stroke cycle Diesel engine of the crosshead type, with airless injection. The engine has seven cylinders, 500 mm. bore and 1,100 mm. stroke, and will develop 2,700 brake horse-power at 155 r.p.m. It can be seen in Figs. 4 and 5, the former showing the control platform at the front of the engine and the latter the auxiliary machinery. This includes three four-cylinder four-stroke Diesel engines, also constructed by Messrs. Burmeister and Wain, each directly coupled to a 160-kW generator, supplying current at 220 volts. These generating sets run at 500 r.p.m. Fig. 6, on page 494, shows the shaft tunnel.

Navigating equipment includes a gyroscopic compass, a radar installation, a wireless direction-finder, and an echo sounder. There is also a radio-telephone transmitter and receiver, with a telephone box in the entrance hall for the use of passengers. The lifeboats number six, of which two are motor-driven.

ECONOMIES IN USE OF NICKEL AND MOLYBDENUM IN ALLOY STEEL

WITH the object of economising in the consumption of nickel and molybdenum in the production of alloy steels, arrangements have been worked out by the Ministry of Supply in conjunction with the alloy-steel makers and the main consumers. These arrangements, which, we are informed, are already in operation to a substantial extent, will become fully effective on June 2, and, in order that they should be applied generally, the Minister of Supply has issued directions to steelmakers. Briefly, these indicate that certain special types of alloy steels, such as tool steels and materials intended to resist heat and corrosion, are not affected. Apart from these, the general effect of the directions is to divide alloy steels containing nickel or molybdenum into three groups. In the first group are materials containing little nickel or molybdenum which may be supplied to any consumer of alloy steel up to the quantity for which he holds an authorisation under the Steel Distribution Scheme. In the second group are steels, somewhat richer in those elements, which may be supplied for particular purposes only. In the third group are those steels, richer still, the supply of which is prohibited except when specifically approved. A consumer who considers it essential to use alloy steel which cannot be supplied without special authorisation may apply for this, in writing, to the Director, Alloy Steel Control, Ministry of Supply, Shell Mex House, Strand, London, W.C.2. Further particulars regarding the scheme may also be obtained from the Director of Alloy Steel Control.

THE PHYSICAL SOCIETY'S EXHIBITION: ERRATUM.—We regret that, on page 425 in our issue of April 4, the wrong photograph was reproduced to illustrate the Muirhead-Pametrada wave analyser which was exhibited by Messrs. Muirhead and Company, Limited. Fig. 4 actually showed the firm's potentiometer type D72A.

NOTES FROM THE INDUSTRIAL CENTRES.

SCOTLAND.

THE LATE MR. JAMES RODGER.—The death of Mr. James Rodger, formerly managing director of Cockburns Ltd., Clydeside Engineering Works, Glasgow, occurred at his home in Glasgow on April 13. Mr. Rodger, who was 75 years of age, was born at Fairlie, Ayrshire. He was of farming stock and spent part of his early life in California. In 1906, soon after his return from the United States, he joined his father-in-law, the late Mr. Robert Cockburn, in the family business of Cockburns Ltd., and was elected a director. He retired from the position of managing director some three years ago but had retained his seat on the board.

IRON AND STEEL PRODUCTION.—Despite acute problems arising from scrap shortages, Scottish steelmaking firms succeeded in increasing production slightly during March as compared with February, the output of ingots and castings being equivalent to an annual rate of 2,161,100 tons, against 2,131,400 tons in February. The corresponding rate for March of last year was 2,466,400 tons. The rate for the first quarter was 1,963,600 tons (2,220,800 tons in 1951). The maintenance of production resulted from a sharp increase in pig-iron production to an annual rate of 906,600 tons in March, compared with 879,500 tons in February, and 771,800 tons in March, 1951. Over the first three months of 1952, the pig-iron output was at a rate of 867,800 tons, against 769,200 tons in the corresponding period of 1951.

EFFECT OF DROP IN COKE SUPPLIES FROM ENGLAND.—Referring to the British Iron and Steel Federation's statement in regard to the coke shortage in England, a spokesman of Colvilles Ltd., Glasgow, said on April 7 that they were dependent, to a certain extent, on coke supplies from England and that any drop in these would have an immediate effect on iron and steel production in Scotland. The firm's three furnaces at the Clyde Iron Works contribute the major proportion of the Scottish pig-iron output.

MECHANISATION IN BUILDING.—Mr. J. C. Watson, chief plant adviser to the Ministry of Works, addressing a meeting of the Scottish Plant Owners' Association in Glasgow on April 9 on the practice of mechanisation of building, said that there was now a wide range of machinery from which the builder could choose, but its reception on the building site must be organised and must be under the supervision of the production engineer. Prefabrication made the fullest use of machinery under favourable conditions, but further development along the lines of prefabrication now depended upon the ingenuity of the architect alone.

NATIONALISATION AND FIFE COAL COMPANY.—The Fife Coal Co. have announced they are to receive 3,000,000*l*. in June as an instalment of the compensation due for their assets taken over by the National Coal Board. Since nationalisation in 1947, some 1,611,000*l*. of issued capital has been repaid.

KYLE FERRY PIER.—The work of reconstructing the old pier at Kyle Ferry, which began a year ago, is now near completion, making it possible for ferries to operate at high and low tides. The new British Railways ferry boat Portree has arrived, and will shortly be put into commission. The Portree has covered accommodation for 50 passengers, and has a mechanically-operated turntable, capable of taking four motor cars.

MID YELL PIER, SHETLAND.—Shetland County Council decided at a special meeting on April 9 to proceed with the construction of Mid Yell pier and to accept the Department of Agriculture's increased grant of 33,984*l*. and a loan of 5,098*l*., being 75 per cent. and 15 per cent., respectively, of the total cost.

CLEVELAND AND THE NORTHERN COUNTIES.

TEES TRADE STATISTICS.—At the monthly meeting of the Tees Conservancy Commission, held on April 7, at Middlesbrough, statistics submitted revealed that imports to Middlesbrough and sub-ports, during February, showed an increase over the corresponding month of a year ago, chiefly on account of heavier iron-ore unloadings. Exports declined, however, and fewer ships entered the river. Imports during the month totalled 239,290 tons, an increase over February, 1951, of 39,762 tons, while exports amounted to 114,655 tons, or 37,337 tons less than the total for the corresponding month last year. The revenue received from river tolls and dues in the second month of this year, however, reached 22,087*l*., and was only 149*l*. less than the aggregate for February, 1951. Alderman B. O. Davies, who presided, thought that the future could be viewed with confidence.

OVERHEAD ELECTRIC CABLES IN LAKELAND.—The Lakes Urban Council at Ambleside has passed a recommendation that the Lakeland Planning Board should permit the installation of overhead lines to bring electricity to the Langdale Valley and Hartsop, near Patterdale, Penrith, Cumberland. Some comment was made by members of the Council that the Planning Board had been unduly influenced by amenity societies and other "busybodies" which were holding up development work in isolated Lakeland villages.

LANCASHIRE AND SOUTH YORKSHIRE.

IMPORTS OF STEEL.—Sheffield steel rolling mills recently have received assistance in the form of American ingots, and the situation in the United States is being watched with special interest. There was relief when it was announced that the decision to stop American shipments had been cancelled. Further arrivals of Japanese steel have reached Hull, including steel sheets. It is understood that further consignments from Japan are due shortly at Hull and also at Middlesbrough.

HIGH PRE-EASTER COAL OUTPUTS.—In what is traditionally styled "bull week," the last full week before a statutory holiday—in this case, the week ended April 5—Yorkshire collieries raised more than a million tons of coal. It was the fourth time the million-ton mark had been passed this year, and the sixteenth since nationalisation. The actual tonnage was 1,041,000.

LARGE CUTLERY ORDERS BLOCKED.—Sheffield cutlery manufacturers, who normally carry on a considerable trade with Australia, are in a dilemma, as they have some 700,000*l*. worth of cutlery in warehouses, ordered before the 80 per cent. import cuts imposed by Australia came into operation. Some of the cutlery is stamped with the names of Australian importers and most of the designs and patterns are unsuitable for other markets. It is stated in Sheffield cutlery circles that some Australian importers are supporting protests submitted by Sheffield firms for the consideration of the Australian Government.

PREVENTION OF SMOKE POLLUTION.—To prevent increased smoke pollution of the air in Sheffield, all building development applications sent in for the consent of the town planning authority are being closely scrutinised by the Sheffield City Council. Last year, deposits of soot in Attercliffe, where many of the chief steel furnaces are situated, totalled 420 tons a year per square mile, compared with 570 tons during the late-war period. For many years the Public Health Department has co-operated with Sheffield University in employing a team having as their object the promotion of fuel-utilisation efficiency.

UNEMPLOYMENT AMONG WOMEN.—A rise in unemployment in Sheffield to 1,538 in March, from 1,354 in February, has been due mainly to an increase in the number of women out of work. A similar state of affairs prevails at Rotherham and Chesterfield, and it is officially reported that unemployment has now spread to younger women. Expressed as a percentage of insured employees, however, unemployment in Sheffield is only 0·6, against 2·1 for the country as a whole, and a much higher percentage in the textile areas.

THE MIDLANDS.

THE STRATFORD-BLISWORTH BRANCH RAILWAY.—The London Midland Region branch line from Stratford-on-Avon to Blisworth, formerly the East and West Junction Railway, was closed to passenger traffic on April 5. The line has an interesting history. Experiments were made on it with the electric lighting of passenger stock at an early date, but the most novel of the railway's activities occurred in the 1930's. At that time it was the scene of an experiment with a dual-purpose motor coach, known as the "Ro-railer," which had both flanged wheels for track running, and rubber-tyred wheels which could be lowered to enable it to run on the road. The station on this branch which served Stratford-on-Avon is about half a mile from the town centre, and the vehicle made this part of the journey on its road wheels. The "Ro-railer" was withdrawn after a short period of service, and the line reverted to the normal steam locomotives and passenger rolling stock. The branch is to be kept open for goods, and will, in fact, carry an increased amount of this traffic now that the passenger trains have been withdrawn. It will be used particularly for iron-ore trains travelling to South Wales, and will enable the junction at Banbury to be by-passed.

THE BIRMINGHAM GUN TRADE.—At the annual meeting of the Guardians of the Birmingham Gun Barrel Proof House, held in Birmingham on April 2, the chairman, Mr. E. G. Bewley, said that, in spite of the difficulties the trade had experienced, the number of proofs made last year was the highest since 1924. The number, 200,809, exceeded the 1950 figure by 29 per cent. The barrels proved were all for sporting guns. Mr. Bewley said that competition from Europe was particularly severe, and was difficult to meet, because of the low wages paid to some of the Continental employees. He added that the quality of the Birmingham products was much above that of its foreign competitors.

THE SHROPSHIRE LANDSLIP.—The slow landslip which has been causing damage at the Severnside village of Jackfield, Broseley, Shropshire, for the past six months, has now affected so much property that about 200 people are in need of re-housing. The road leading to the village has been declared unsafe for vehicles, and a temporary gas main has had to be laid on the surface alongside the road to maintain gas supplies. About 200 yards of the Western Region Severn Valley branch railway line are also affected, and at present a maintenance gang is employed on full time to keep the track in repair. Re-aligning and packing of ballast have to be carried out at intervals of a few hours, and a speed limit of 5 m.p.h. has been imposed on the 16 trains a day which use the branch. The cause of the landslip has not yet been ascertained, but the local authority, the Wenlock borough council, are conferring with the various public authorities concerned to see what steps can be taken to prevent further movement of the land.

BIRMINGHAM-LONDON HELICOPTER FREIGHT SERVICE.—The first helicopter on the new Birmingham-London freight service operated by British European Airways, left Elmdon airport, Birmingham, on April 7. The new service replaces that formerly run for passengers, which ceased on April 5, after operating for nine months.

LABOUR IN MINING AND TRANSPORT.—Until the end of 1951, the mining and transport industries in the Midlands, like those in other parts of the country, were suffering from a serious labour shortage. There are still numerous vacancies in these trades, but in the first three months of this year there have been definite signs of a return of personnel to what are often known as the "less attractive" industries, and mining and transport have benefited accordingly. Man-power in the National Coal Board's West Midlands Division, for example, has increased by 1,300. The effect on road and rail transport is seen in the fact that several services previously suspended because of labour shortage have now been restored. Some further improvement in these industries is expected as a result of the recession in the textile trades.

SOUTH-WEST ENGLAND AND SOUTH WALES.

WALES-IRELAND AIR SERVICE.—The Welsh Advisory Council for Civil Aviation has been informed that the first regular air link between Wales and Eire is to be officially opened on Tuesday, June 10. It will be operated by Aer Lingus, between Dublin and Rhoose Aerodrome in the Vale of Glamorgan, seven miles from Cardiff. Should the service prove successful, the Minister of Civil Aviation has announced that Rhoose would be developed as the future passenger aerodrome for Cardiff and South Wales.

PURCHASE OF WELLFIELD WORKS.—The Wellfield Works, Llanelly, owned by Richard Thomas and Baldwins, Ltd., where galvanised sheets were once made and which has been idle for many years, have been purchased by J. and P. Zammit, Ltd., works' contractors, Llanelly. The site is about ten acres in extent and the new owners intend, for the present, to use the works to store materials needed in the modernisation in progress at the Llanelly Steel (1907) Co., Ltd. It is reported that the works will later be used for "a more important industrial purpose" unspecified.

MACHYNIS WORKS, LLANELLY.—Mr. E. H. Lever, the chairman and managing director, last week performed the opening ceremony of the Machynis Foundry and Engineering Works of Richard Thomas and Baldwins, Ltd., at Llanelly. The new works has cost 600,000*l*. Situated within half a mile of the great Trostre works and adjacent to the South Wales Steelworks, the new plant has been designed to cope with every kind of breakdown or maintenance task for all the works of Richard Thomas and Baldwins, Ltd., and the Steel Company of Wales, Ltd. The works have been laid out to provide modern conditions of space and lighting. There are four blocks of buildings, all 350 ft. long, and provision has been made for extensions as required. The whole plant covers an area of 11½ acres.

UNEMPLOYMENT STATISTICS.—The number of unemployed in Wales, during March, fell by 1,161, according to figures issued by the Ministry of Labour. The number of persons registered as temporarily stopped fell from 2,291 in February to 1,988, and the approximate percentage rates of unemployment in Wales were: men, 2·5; women, 4·4; and total, 3 per cent.

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.

ILLUMINATING ENGINEERING SOCIETY.—*Sheffield Centre:* Monday, April 21, 6.30 p.m., The University, Western Bank, Sheffield. Address by the President of the Society. *Bradford Group:* Thursday, April 24, 7.30 p.m., Offices of Yorkshire Electricity Board, 45-53, Sunbridge-road, Bradford. "Hospital Lighting," by Mr. J. K. Frisby. *Leeds Centre:* Monday, April 28, 7 p.m., Lighting Service Bureau, 24, Aire-street, Leeds, 1. Annual Meeting.

INSTITUTION OF ELECTRICAL ENGINEERS.—*District Meeting:* Monday, April 21, 7 p.m., George Hotel, King-street, Reading. "Electricity in Large Buildings, with Particular Reference to Post Offices and Telephone Exchanges," by Mr. A. E. Penney. *Measurements Section:* Tuesday, April 22, 5.30 p.m., Savoy-place, Victoria-embankment, W.C.2. (i) "An Analogue Computer for Use in the Design of Servo Systems," by Mr. E. E. Ward. (ii) "The Design and Testing of an Electronic Servo-Simulator for a Hydraulic Remote Position-Controller," by Mr. F. J. U. Ritson and Mr. P. H. Hammond. *Scottish Centre:* Tuesday, April 22, 7 p.m., Royal Technical College, Glasgow. Faraday Lecture on "Sound Recording: Home, Professional, Industrial and Scientific Applications," by Dr. G. F. Dutton. *Supply Section:* Wednesday, April 23, 5.30 p.m., Savoy-place, Victoria-embankment, W.C.2. "The Design of High-Voltage High-Power Mercury-Arc Convertors," by Dr. Ing. H. von Bertele and Mr. R. Tucker. *Southern Centre:* Wednesday, April 23, 6.30 p.m., Royal Beach Hotel, Portsmouth. Discussion on "The Place of Electricity in a National Fuel Policy," opened by Mr. D. P. Sayers. *Institution:* Thursday, April 24, 5.30 p.m., Savoy-place, Victoria-embankment, W.C.2. Forty-Third Kelvin Lecture on "Iron Atoms in the Service of the Electrical Engineer," by Sir Charles Goodeve, F.R.S. *Education Discussion Circle:* Friday, April 25, 6 p.m., Savoy-place, Victoria-embankment, W.C.2. Discussion on "The Teaching of Transients and the Use of Operational Methods," opened by Instructor-Commander D. K. McCleery and Dr. H. Tropper.

INSTITUTION OF PRODUCTION ENGINEERS.—*Derby Section:* Monday, April 21, 7 p.m., School of Art, Green-lane, Derby. "Production in Foundries," by Mr. J. Hill. *Manchester Section:* Monday, April 21, 7.15 p.m., College of Technology, Sackville-street, Manchester. "Research in Relation to Production Engineering," by Dr. D. F. Galloway. *Wolverhampton Graduate Section:* Tuesday, April 22, 7.30 p.m., County Technical College, Kendrick-street, Wednesbury. "Fundamental Machining Problems Associated with the Production of Gas-Turbine Components," by Mr. P. Spear. *Coventry Section:* Wednesday, April 23, 7 p.m., Geisha Café, Hertford-street, Coventry. Discussion on "Materials Handling" (with films). *Manchester Graduate Section:* Wednesday, April 23, 7.15 p.m., College of Technology, Sackville-street, Manchester. "Photography in Engineering," by Mr. A. Horder. *Western Section:* Wednesday, April 23, 7.15 p.m., Grand Hotel, Bristol. "The Production of the X.K.120 Jaguar," by Mr. J. Silver. *South Essex Section:* Wednesday, April 23, 7.30 p.m., Ilford Bowling Club, near Ilford Station, Ilford. "Incentives," by Mr. C. Cooper. *Leicester Section:* Thursday, April 24, 7 p.m., Bell Hotel, Leicester. "The Production of the Weighing Machine," by Mr. L. Sanders and Mr. E. Cox. *Stoke-on-Trent Section:* Thursday, April 24, 7.30 p.m., North Stafford Hotel, Station-road, Stoke-on-Trent. "The Control of Quality in Large and Medium Quantity Production," by Mr. J. Loxham. *Cornwall Section:* Friday, April 25, 7 p.m., Cornwall Technical College, Trevenson Park, Pool. "Hard Facing," by Mr. W. D. Biggs (with film).

SHEFFIELD SOCIETY OF ENGINEERS AND METALLURGISTS.—Monday, April 21, 7.30 p.m., The University, St. George's-square, Sheffield. Film Evening.

INSTITUTE OF FUEL.—Tuesday, April 22, 5.30 p.m., Institution of Mechanical Engineers, Storey's-gate, St. James's Park, S.W.1. "Recent Developments in Instruments," by Mr. E. C. Klepp. Wednesday, April 23, Institution of Mechanical Engineers, Storey's-gate, S.W.1. 4.30 p.m., Annual Meeting (for Corporate Members only). 5.30 p.m., Presidential Address on "Fuel Technology and Civilisation," by Dr. G. E. Foxwell. *Yorkshire Section:* Friday, April 25, 5.45 p.m., Royal Victoria Station Hotel, Sheffield. Annual Meeting.

ASSOCIATION OF SUPERVISING ELECTRICAL ENGINEERS.—Tuesday, April 22, 6.30 p.m., Lighting Service Bureau, 2, Savoy-hill, Strand, W.C.2. "Electricity and Productivity," by Mr. C. T. Melling.

INSTITUTION OF WORKS MANAGERS.—*Birmingham Branch:* Tuesday, April 22, 7 p.m., Grand Hotel, Birmingham. "Atoms," by Professor P. B. Moon, F.R.S. Friday, April 25, 7.30 p.m., Imperial Hotel, Birmingham. Joint Meeting with the INCORPORATED PLANT ENGINEERS (*Birmingham Branch*). "Incentives," by Mr. T. Adams. *Leicester Branch:* Tuesday, April 22, 7 p.m., Bell Hotel, Leicester. Annual Meeting. *West Yorkshire Branch:* Tuesday, April 29, 7.30 p.m., Collinson's cafe, Huddersfield. Annual Meeting.

INSTITUTE OF INDUSTRIAL ADMINISTRATION.—*London Centre:* Tuesday, April 22, 7 p.m., Management House, 8, Hill-street, W.1. "Management in Practice. No. 8. Profit Sharing and Co-Partnership in Practice," by Mr. George Mathieson.

INSTITUTE OF BRITISH FOUNDRYMEN.—*Coventry Students' Section:* Tuesday, April 22, 7.15 p.m., Technical College, Coventry. Film on "How Steel Is Made." *Birmingham Branch:* Wednesday, April 23, 7.15 p.m., James Watt Memorial Institute, Birmingham. Annual Meeting and "Symposium of Defects." *West Riding of Yorkshire Branch:* Saturday, April 26, 6.30 p.m., Technical College, Bradford. Annual Meeting. *London Branch:* Wednesday, April 30, 7 p.m., Waldorf Hotel, Aldwych, W.C.2. Annual Meeting. "Surface Finish and Design Sands," by Mr. F. Roy Pell.

ROYAL SOCIETY OF ARTS.—Wednesday, April 23, 2.30 p.m., John Adam-street, Adelphi, W.C.2. Percy Smith Memorial Lecture on "John Baskerville: Printer and Designer," by Sir Francis Meynell. Wednesday, April 30, 2.30 p.m., "Amenities in Factory Design," by Mr. Walter R. Bennett.

ROYAL METEOROLOGICAL SOCIETY.—Wednesday, April 23, 5 p.m., 49, Cromwell-road, South Kensington, S.W.7. Annual Meeting. Presidential Address, on "Atmospheric Ozone and the Upper-Air Conditions," by Sir Charles Normand.

ROYAL STATISTICAL SOCIETY.—Wednesday, April 23, 5.15 p.m., London School of Hygiene and Tropical Medicine, Keppel-street, W.C.1. "Accident Proneness: A Criticism of the Concept Based Upon an Analysis of Shunters' Accidents," by Dr. A. M. Adelstein. *Sheffield Industrial Applications Group:* Thursday, April 24, 6.30 p.m., Grand Hotel, Sheffield. "The Accuracy of the Sampling of Coal," by Mr. J. Hebden and Mr. G. H. Jowett (Preceded by the Annual Meeting of the Group). *South Wales Industrial Applications Group:* Friday, April 25, 7 p.m., University College, Cathays Park, Cardiff. "A Discussion on Sequential Analysis," by Mr. J. Parry Lewis.

WOMEN'S ENGINEERING SOCIETY.—*Manchester Branch:* Wednesday, April 23, 6.30 p.m., Engineers' Club, Albert-square, Manchester. "Transport of Heavy Electrical Plant," by Mr. A. Mycoe.

INSTITUTION OF STRUCTURAL ENGINEERS.—*Yorkshire Branch:* Wednesday, April 23, 6.30 p.m., Great Northern Hotel, Leeds. Annual Meeting. *Institution:* Thursday, April 24, 6 p.m., 11, Upper Belgrave-street, S.W.1. "An Investigation of the Behaviour of a Riveted Plate Girder Under Load," by Dr. S. Mackey and Dr. D. M. Brotton.

ROYAL SOCIETY.—Thursday, April 24, 4.30 p.m., Burlington House, Piccadilly, W.1. Lecture on "The Forest Products Research Laboratory," by Mr. F. Y. Henderson. (Postponed from February 7.)

INSTITUTE OF PETROLEUM.—Thursday, April 24, 6 p.m., Institution of Mechanical Engineers, Storey's-gate, St. James's Park, S.W.1. Presidential Address on "Kuwait," by Mr. C. A. P. Southwell.

INCORPORATED PLANT ENGINEERS.—*South Yorkshire Branch:* Thursday, April 24, 7.30 p.m., Grand Hotel, Sheffield. Film on "The Manufacture of Wire Ropes."

INSTITUTION OF MECHANICAL ENGINEERS.—Friday, April 25, 5.30 p.m., Storey's-gate, St. James's Park, S.W.1. Meeting in conjunction with the *Internal-Combustion Engine Group* and the *Steam Group*. "Explosions in Enclosed Crankcases of Steam and Internal-Combustion Engines, Their Cause, Effect and Possible Remedy," by Mr. John Lamb.

JUNIOR INSTITUTION OF ENGINEERS.—Friday, April 25, 6.30 p.m., 39, Victoria-street, S.W.1. "Condensed Steam Collection: A New System," by Mr. A. J. Simpson. *Sheffield Section:* Monday, April 28, 7.30 p.m., Co-operative Educational Centre, 201, Napier-street, Sheffield, 11. Various short lectures.

INSTITUTION OF HEATING AND VENTILATING ENGINEERS.—*Manchester Branch:* Friday, April 25, 6.30 p.m., Engineers' Club, Albert-square, Manchester. "Ventilation and Heating of Laboratories," by Mr. H. Coase. *Scottish Branch:* Tuesday, April 29, 6.30 p.m., Engineering Centre, 351, Sauchiehall-street, Glasgow, C.2. "A Review of Current Research in Heating and Ventilating," by Mr. N. S. Billington.

INSTITUTE OF PACKAGING.—*Midland Area:* Monday, April 28, 6.30 p.m., Imperial Hotel, Birmingham. Joint Meeting with INSTITUTE OF EXPORT. Open Discussion.

INSTITUTE OF ROAD TRANSPORT ENGINEERS.—*Scottish Centre:* Monday, April 28, 8 p.m., North British Hotel, Edinburgh. Annual Meeting.

PERSONAL.

SIR WILLIAM WALLACE, C.B.E., M.I.Mech.E., M.I.N.A., F.R.S.E., chairman and managing director of Brown Bros. & Co. Ltd., Edinburgh, has been elected President of the Institution of Engineers and Shipbuilders in Scotland as from October 1.

SIR ARCHIBALD FORBES has been re-elected President of the Federation of British Industries, 21, Tothill-street, London S.W.1, for a second year of office.

CAPTAIN (E) M. LUBY, R.N. (ret.), B.Sc., M.I Mech.E., F.R.Ae.S., who at present holds the position of director of engine research and development (air) at the Ministry of Supply, is resigning that position in July to take up that of director and general manager, Rotax Ltd., Willesden Junction, London, N.W.10. In addition, he will be appointed a member of the board of Joseph Lucas (Gas Turbine Equipment) Ltd., with responsibility for the co-ordination of the aircraft development work of the parent company, Joseph Lucas (Industries) Ltd.

MR. A. BELL retired from the position of assistant manager and works controller of the Automatic Telephone & Electric Co. Ltd., Strowger Works, Liverpool, 7, on March 31.

MR. F. H. JOHNSON, for some years past a local director of Thomas Smith & Sons (Rodley) Ltd., has been appointed a full director of the company. The firm is a member of the Thos. W. Ward Group of Companies.

MR. ALEC ISSIGONIS, for some years with Morris Motors Ltd., Oxford, is to join Alvis Ltd., Holyhead-road, Coventry, on May 1.

MR. P. G. ELWELL has been appointed to the board of Edward Elwell Ltd., a subsidiary company of Edge Tool Industries Ltd.

MR. H. T. MEADOWS, D.S.C., R.D., M.I.Mar.E., A.I.Pet., has been appointed representative for the United Kingdom and Ireland of Guthrie, Murdoch & Co. Ltd., ship repairers, Antwerp. He has opened an office at 215, Dashwood House, 69, Old Broad-street, London, E.C.2. (Telephone: LONdon Wall 5941/5961.)

MR. D. K. BUIK has been elected a director of Canadian Pacific Steamships, Ltd. He was formerly special representative, in London, of the President of the Canadian Pacific Railway. Mr. Buik's headquarters will continue to be in London.

MR. R. M. GRANT, B.Sc., M.I.E.E., who joined the staff of the British Thomson-Houston Co. Ltd., in 1929, has been appointed assistant manager of the firm's plant sales department, Rugby.

The British Broadcasting Corporation announce the appointment of MR. H. W. BAKER, A.M.I.E.E., as superintendent engineer, television studios; MR. T. H. BRIDGEWATER, M.I.E.E., as superintendent engineer, television outside broadcasts; MR. H. WALKER, O.B.E., A.M.I.E.E., as head of technical operations, television service; MR. M. H. HALL as engineer-in-charge, television studios; MR. W. D. RICHARDSON as engineer-in-charge, television outside broadcasts; MR. F. AXON, D.C.M., as senior superintendent engineer, external services and MR. F. WILLIAMS, B.Sc., M.I.E.E., as senior superintendent engineer, home broadcasting. MR. H. G. WHITING, A.M.I.E.E., has relinquished his post as engineer-in-charge, Sutton Coldfield television transmitting station to become assistant engineer-in-charge (television), Birmingham. MR. R. C. HARMAN, A.M.I.E.E., has succeeded Mr. Whiting as engineer-in-charge at the Sutton Coldfield television station.

MR. GORDON EYRE has been made general sales manager of Monks and Crane Ltd., moving from London, where he has represented the firm since 1947, to the head office in Stanhope-street, Birmingham, 12. MR. P. A. H. LUTTRELL has succeeded Mr. Eyre as manager of the London area, and MR. W. DUCKETT, hitherto North Midland representative, has moved to Manchester as northern area manager.

MR. R. A. SYMES-SCHUTZMANN has been appointed Press officer of K.L.M. Royal Dutch Airlines, 196, Sloane-street, London, S.W.1, for the United Kingdom and Ireland region.

Macrome Ltd. announce that MR. WILLIAM FROST has relinquished his territory in North Lancashire and taken over the South Lancashire territory, previously held by MR. S. PROCTER who is now no longer with the company. A new representative, MR. J. BRADLEY, has been appointed to take over Mr. Frost's former area.

SIR JAMES LAING & SONS, LTD., Sunderland, are laying out a 620-ft. shipbuilding berth at their shipyard. It will be able to accommodate ships of 26,000 tons deadweight capacity.

The firm of HENRY ROBINSON (IRONFOUNDERS) LTD. Stourbridge, Worcestershire, has been acquired by MR. B. S. FLETCHER, his son MR. D. FLETCHER, and MR. G. C. ROBERTS. MR. B. S. FLETCHER was formerly associated with Fletcher, Houston & Co. Ltd., Dudley Port, Tipton, Staffordshire.

BAKELITE LTD., 18, Grosvenor-gardens, London, S.W.1, inform us that their new telephone number is SLOane 0898.

THE PASSENGER MOTORSHIP "KONGEDYBET."

A/S BURMEISTER & WAIN, COPENHAGEN.

(*For Description, see Page* 491.)

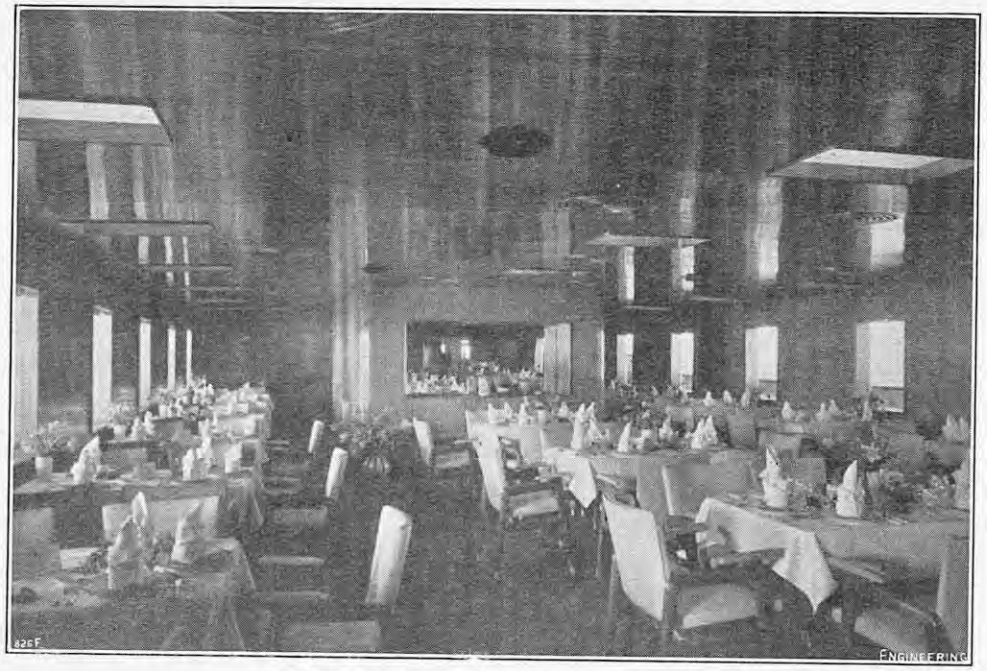


Fig. 3. First-Class Dining Saloon.

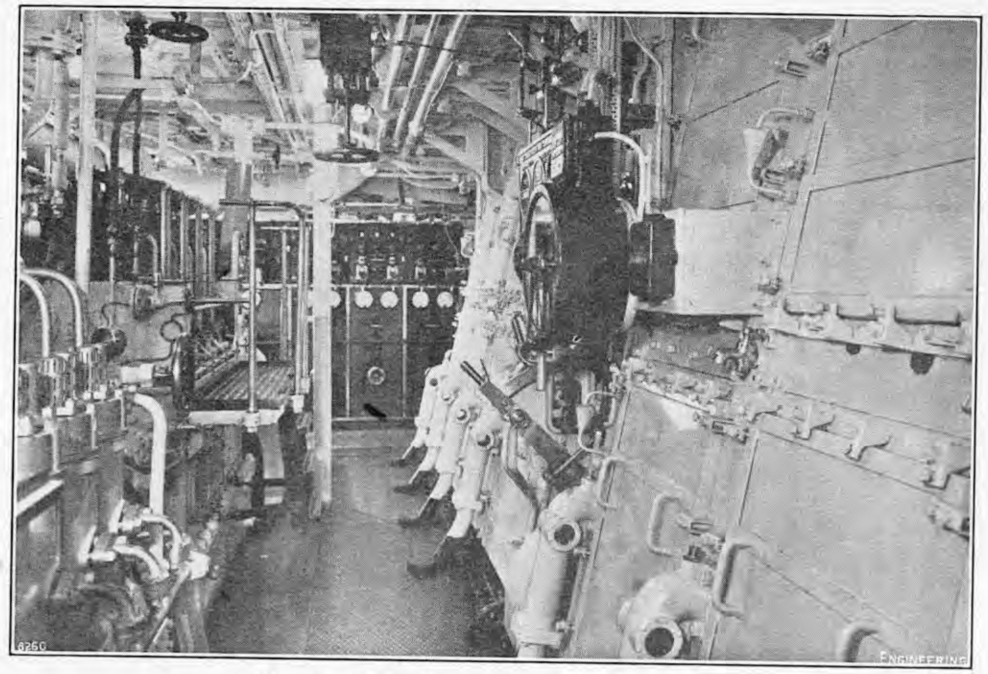


Fig. 4. Main Engine Control Platform.

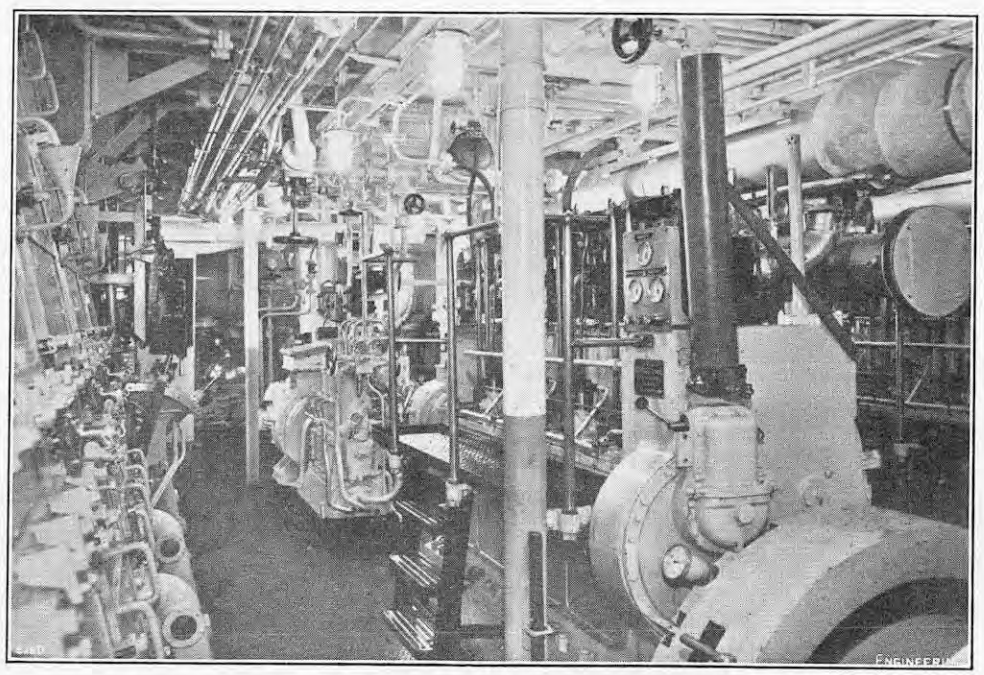


Fig. 5. Auxiliary Machinery.

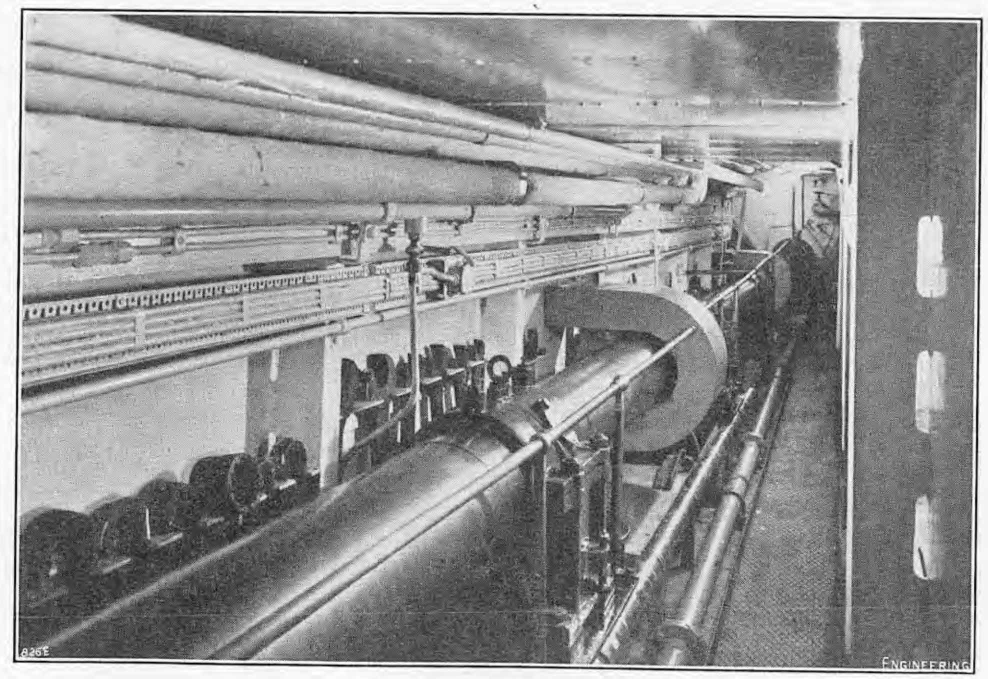


Fig. 6. Shaft Tunnel.

ENGINEERING

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ENGINEERING

FRIDAY, APRIL 18, 1952.

VOL. 173. No. 4499.

TRAINING IN INDUSTRIAL CITIZENSHIP.

THE recent visit of Sir Walter Monckton, Q.C., M.P., the Minister of Labour, to the Thorncliffe works, near Sheffield, of Messrs. Newton, Chambers and Company, Limited, did rather more than merely to set the seal of Government approval upon the endeavours of a single firm—albeit a large and important firm—to provide for their employees amenities of a standard somewhat above the average; for it served also to focus attention upon a far-sighted policy of training and welfare which goes some way beyond the ordinary provision of training and other facilities as practised by many undertakings in the British engineering industry. The primary reason for the Minister's presence at Thorncliffe on April 4 was to declare open the new baths building which has been built and equipped for the benefit of their foundry personnel. In the new building, the foundrymen enter a clean-clothes locker room and place their ordinary clothes in lockers; they then cross the centrally-placed bath room to another locker room where they put on their working raiment, and proceed into the foundry. At the end of the shift, they reverse the process, with the addition of a shower bath (hot or cold, as they may desire) between shedding their working garments and resuming what the Army would call their "walking out" clothing. This is an amenity which, we feel sure, will be greatly appreciated; but, by itself, though far from being universal, it can be paralleled by instances elsewhere. What is much more significant is the whole conception of training and welfare as practised at the Thorncliffe works, of which the new foundry baths, and the adjacent apprentice training school, which the Minister also visited, are typical developments.

The business of Messrs. Newton, Chambers and Company dates back to 1793. Until the nationalisation of the coal-mining industry, it included coal mines of sufficient size to justify the establishment of separate training facilities for the pit apprentices alone, and this was done, with notable success. That part of the firm's business is no longer in their hands, but what remains—heavy engineering, the production of power shovels, an important section dealing with toilet preparations, and a light castings department producing domestic stoves, etc.—still forms one of the principal groups in the Sheffield area, employing about 4,000 persons, and operating one of the most comprehensive schemes in the country for training young people of both sexes; for training in office work, for girls, is regarded as being quite as essential as training in handicrafts for trade apprentices. The scheme for trade apprentices was started in 1942 by Sir Harold West, the present managing director, and the training school for girls, to prepare them for the many office employments offered by a large engineering undertaking, dates from the following year. Since then, nearly 1,000 boys have passed through the firm's schools, and almost 400 girls, and 171 National Certificates have been gained.

Before considering further the main scheme as it was initiated and has been developed by Sir Harold West, we may mention that the new apprentice training school (which takes the place of an older building, converted to that purpose from being a workshop and store) consists of a range of buildings comprising an entrance hall giving access to machine and fitting shops, a large and well-equipped gymnasium, class rooms, laboratory, foundry training department (including a cupola which was built by apprentices in the constructional-engineering department), a welding bay, core-making and drying plant, etc. The training centre possesses, in fact, all the necessary resources to prepare apprentices for any of the skilled trades employed in the engineering departments of the Newton Chambers group of companies. The boys are taken in at school-leaving age and are first given a month's pre-entry course, to ascertain any natural aptitudes that they may evince at that early stage and to teach them something of the firm's interests and products, and introduce them at the outset to the industrial surroundings in which they are to work. This initial course over, the boy enters the shops in the trade selected, but returns to the training school for one month in six to receive technical instruction. Those who attain the necessary standard can be released on one day a week to attend the technical colleges in the district, as is customary now in all the main industrial areas, so that they may qualify for Ordinary and Higher National Certificates, etc.

So far as the above brief outline goes, it might appear that the training scheme in operation at Thorncliffe does not differ greatly in essentials from a number of others to which we have made editorial reference from time to time; but in certain basic principles, and in numerous details, it does differ materially from most such schemes. It might be described, indeed, as being not so much a training in particular handicrafts as a training in what may be termed industrial citizenship, naturally "weighted" by consideration of the needs of the Newton Chambers group for a steady intake of men skilled in particular trades, but inspired by the general aim to promote understanding of the structure of industry and a broader mental outlook than is normally acquired by the apprentice who merely "goes through the shops" and supplements that experience by a certain amount of technical education. This difference is inherent in the scheme from the outset; for example, during the pre-entry course of one month, the boys are addressed in turn by the executive heads of the different departments in the works, who explain not only the productive activities of their respective departments, but the nature of their own personal functions and responsibilities. Thus, when the boy goes into the department to which he is eventually assigned, the head of that shop or section of the works is to him not merely a remote "boss," but an individual who is known to him by name, and of whose duties he has already been given some real, if initially slight, understanding. The personal touch is there from the beginning, and it is a personal touch that works both ways, between the manager and the boy, and between the boy and the manager.

The way in which the scheme originated was described by Sir Harold West two years ago in an address which he then delivered in London before the Royal Society of Arts. The title which he gave it was "The Thorncliffe Experiment in Employee Relationships," but he admitted at the time that he had been tempted to adopt the alternative and alliterative title of "Fighting Friction, Frustration and Fear in Foundry, Factory and Forge," which expressed more obviously the objects that he had in view. The firm already operated sports clubs, benevolent schemes and most of the other activities that come under the general heading of "welfare," but it was felt that something more was needed; that, in Sir Harold's own words, they should provide a training "of the whole person, aiming to bring out character, self-respect, a sense of service, pride in the job and in achievement."

To that end, the method of training was revised so as to present the instruction, not as a cramming course, but as a succession of studies of particular subjects—coal, iron, stone and other raw materials, the sources and application of power, the historical development of industries and trades the debt that industry owes to the engineering and scientific pioneers such as Watt, Newton and Parsons. Where the presentation could be linked in any way with the development and current operations of the firm, the opportunity was taken to do so; but throughout there was the endeavour to inculcate a realisation that a works, and even a trade, is not an isolated entity, possibly even in conflict with other factories and other trades, but a unit that can only justify its existence and ensure its successful continuance by contributing its share to the general well-being of industry and mankind. This, obviously, involves something more than the mere mass-production of "contentment" in the sense of an unthinking and bovine acceptance by the employee of the environment and wages that his firm have to offer. It requires constructive thought and co-operative action from all concerned, and a recognition that the true interests of employer and employee are fundamentally allied.

To have achieved this aim with the success that has been accomplished is something of a triumph, for there is a strong tendency in many men, and in more boys, to fight shy of anything which appears to them to savour of "uplift"; but Sir Harold has succeeded in winning the active co-operation, not only of his colleagues, but of the adult operatives and of the trade-union representatives. The full benefits may not be seen until the earliest batches of trainees are a few years older, but already the results are notably encouraging and certainly justify the care and forethought that have been devoted to every detail of the curriculum and its presentation. An example was afforded not so long ago when there was a strike of engineering apprentices on Clydeside and in Lancashire. The strikers (following the technique of their fathers in such matters) sent delegates to the Sheffield area in the hope of inducing sympathetic action; but the Newton Chambers apprentices declined to come out, holding that there was no reason why they should. A straw in the wind, perhaps; but an encouraging sign that "solidarity" can mean master plus man, and not only man versus master.

POWER AND MAN-POWER.

THE productivity of a country depends on a number of factors. One of the more important is the extent of its natural resources, but a second factor, the mentality of its people, will determine what advantage is taken of such endowments. The superior productivity of the United States as compared with that of Great Britain is partly to be explained by its mineral wealth, but even more by the way in which that wealth is exploited. Fair comparison between, say, the colliery industries of the two countries cannot be expressed in numerical terms, though the overall fact that the United States, with three times the population, has six times the national income owes something to the relative extent and nature of the coal seams of the two countries. There is one factor, however, affecting productivity capable of exact expression, namely, the amount of mechanical power available per industrial employee. Comparisons have frequently been made between the United States and the United Kingdom in this matter and it has been stated that the figure for the former country is three times that of the latter.

As the mineral wealth of this country is restricted to coal and as the maintenance of even its present standards depends on its productivity, the power available per industrial employee, which is a definite factor in output, is of the first importance. It would be satisfactory to know that it is increasing. Unfortunately, some figures given in a recent book* are not promising. The data do not cover a later year than 1946, and possibly there has been some improvement since then, but so far from showing that the power per head increased between 1938 and 1946, they actually record a fall. A similar decline, it should be noted, occurred in Belgium, Switzerland, France and the Netherlands.

All these countries were still suffering, in 1946, from the effects of the war, and it may well be that the declines exhibited between that year and 1938 represent dips in curves of progress and are not an indication of general trends. On this basis, however, it is not easy to understand why Switzerland should show a fall from a figure of 2,511 in 1938 to 2,313 in 1946. These figures represent the energy consumption *per capita* in millions of calories. Energy derived from "coal, electricity, wood, petroleum and natural gas" is included and it may be assumed that "electricity" in this list covers water-power. The figures given for Great Britain are 5,400 in 1938 and 5,304 in 1946. Moreover, these totals represent consumption per head of population, not consumption per industrial employee; therefore, as the domestic demands on electric supply are rising, it is possible that the fall in consumption by industry was even greater than indicated. In view of these considerations and of the year to which the latest figures relate, it may be that these records are little or no indication of the position in 1952. They are, however, of value in emphasising one of the factors on which the industrial supremacy of the United States is based. The million calorie figure for the country in 1938 was 8,820, compared with 5,400 for Great Britain in the same year. In 1946, the respective figures were 12,507 and 5,304.

The book from which these figures are quoted is not primarily concerned with the question of horse-power per employee. Its purpose is to inquire into the activities of the population of the United States as a whole, to determine the proportions directly engaged on production and administration, the proportion of women in industry, the number of elderly people in employment and cognate matters. It is pointed out by the authors that figures for these various classes of the population are available in census and other returns, but that statistical tables do not, and do not attempt, to deal with the reasons which determine why, for instance, some working people promptly retire on reaching the age limit while others continue working. Clearly, individual decisions on matter of this kind depend on personal circumstances, but considering the population as a mass, there will be general factors which determine the size of the various groups. The book analyses these factors in detail.

The matter presented is concerned with American conditions and is addressed to American readers, but the treatment adopted could be applied to other countries and in some cases, for purpose of comparison, information about European conditions is given. The question of horse-power per employee, already referred to, is actually an aspect of technological development. Extra power in industry implies the existence of appliances and machines in which the power is used. The effect of invention may cause temporary unemployment, but its overall effect in increasing consumption and consequently the demand for labour are fully discussed. The productivity of the United States is, apart from questions of attitudes of mind, a measure of the extent of mechanisation. This is well shown in an interesting table giving the relative productivities of the United States and the United Kingdom in various industries and activities. It is not surprising that, taking 100 as representing the productivity of the latter, in the mining of fuel, the figure for the former should be 415; "fuel" presumably includes oil and natural gas, and the great difference in the levels of productivity in the two countries may largely be explained by natural deposits. In manufacturing, however, the United States figure of 215, compared with 100 for the United Kingdom, may be taken as almost a direct measure of mechanisation and the full advantage taken of it. The point is accentuated by the proportions given for some activities which are less directly affected by machines and appliances; for building and construction the United States figure is 115, compared with 100 for the United Kingdom, and for fisheries the latter has a considerable lead, with 100 as against 79 for the United States.

There has been much discussion lately about the retention of older people in industry, with the idea of increasing production by what, in effect, would be an increase in man-power resources. A further table in this book indicates that in this matter there was little difference between this country and the United States. Of men between 20 and 64 years of age, 96·7 per cent. in the former and 98·7 per cent. in the latter were gainfully employed. For older workers, of 65 years and over, the figures for the United States and the United Kingdom are again close, at 47·9 per cent. and 41·7 per cent.

When workers between the ages of 15 and 19 are considered, the difference between the proportions in employment in the United States and the United Kingdom is very great. In the former, 36·5 per cent. are so engaged and in the latter 88·3 per cent. The figure for the United States is lower than that of any other of the 29 countries, and that for the United Kingdom higher than that of any other except Egypt. Arithmetically, it is clear that man-power resources are not increased by postponement of the average age of entry to productive activity, but a necessary deduction from the figures would appear to be that the average individual starting working life at a later age is a more efficient worker than the one who begins to earn his living earlier. This, indeed, was one of the arguments for raising the school-leaving age. In the present condition of this country, however, it would not be wise to reduce the proportion of young workers to the United States level. The only effective procedure is to make the most of man-power resources.

* *Manpower Resources and Utilization. Principles of Working Force Analysis.* By A. J. Jaffe and Charles D. Stewart. John Wiley and Sons, Inc., 440, Fourth-avenue, New York 16, U.S.A. [Price 6.50 dols.] Chapman and Hall, 37, Essex-street, London, W.C.2. [Price 52*s*. net.]

NOTES.

The Manchester Joint Research Council.

A Survey of the practice and needs of industry in the use of scientific ideas and developments was the main occupation of the Manchester Joint Research Council during 1951, according to their annual report for the year. The object was to assemble a reliable picture of the use of science by a cross-section of industry in the North-West, and to attempt to find how scientific ideas and information could be more effectively and quickly absorbed into industrial practice. The survey is being carried out with the support of the Department of Scientific and Industrial Research. Beginning in November, 1950, three full-time investigators have been engaged on the first stages of the work. A group of firms, selected as representative of the range of relevant industries and of the size of industrial units in the area, were invited to co-operate, and 76 per cent. of them agreed. The investigators then obtained their information, under previously-agreed headings, by discussion with the chief executives of firms and their specialist experts, rather than by the questionnaires which have been used in somewhat similar previous investigations. So far, 190 firms, covering over 300 establishments, have been visited in this way. As establishments fewer than 50 persons were excluded from the main investigation, and the investigation deals only with production (excluding agriculture, mining, clothing and building), and not with services, this number represents some 10 per cent. of the relevant establishments in the area. The majority of these are concerned with chemicals, mechanical engineering, electrical engineering, textile manufacturing, and textile finishing, but the sample has been chosen to include a group of other smaller industries. The information collected includes the following: scientific qualifications of directors and staff; recruitment, training and encouragement of scientific and technical staff; organisation for research and development; use of research associations; contact with universities and technical colleges; use of, and familiarity with, sources of scientific information, including library and information services and consultants; attitude to sponsored research and the National Research Development Corporation; and the limitation of development by factors involving finance, supply of materials and pressure for current production. The final report on these significant matters will be read with interest and its value will not be confined to the North West. What Manchester does to-day, it is often said, the rest of the country does to-morrow.

De-Nationalisation of Steel and Road Haulage.

The Prime Minister, Mr. Winston Churchill, stated in the House of Commons on Wednesday, April 9, that the Government intended to de-nationalise road transport at the earliest possible moment, and that the Minister of Transport had given a direction to the Iron and Steel Corporation not to alter the financial structure or management of the publicly-owned iron and steel companies or to sell or dispose of the undertakings or securities without his consent. Mr. Churchill recalled that it had been announced, in the King's Speech on November 6, that a Bill would be introduced to annul the Iron and Steel Act with a view to the re-organisation of the industry under free enterprise and with an adequate measure of public supervision. The Minister of Supply had amplified this on November 12, and had said that the creation of an Iron and Steel Board, embracing the whole industry, would be an essential feature of the Government's proposals. Details of the Government's intentions regarding the road-haulage industry, he said, would be announced shortly after the Easter Recess. Mr. Churchill was replying to a question by Mr. J. Grimond, who asked what progress the Prime Minister had made in his investigations into the nationalised industries. Following a supplementary question by Mr. Grimond, he said that, in regard to transport, the great thing was to meet the needs of the consuming public, while at the same time safeguarding the conditions of the railwaymen. When Mr. James Griffiths drew attention to the last sentence of Mr. Churchill's original reply—"Good results have been achieved in the coalfields"—Mr. Churchill said "I have always thought that the men who do this hard manual work, with danger, and far from the light of the sun, should have special consideration, and I used these very words long before many of the hon. Gentlemen opposite were born when introducing the miners' eight-hour day Bill." At this point several members rose to take part in the debate but the Speaker intervened to say that it was becoming too large a question for discussion at that time.

International Mechanical Engineering Congress.

The 4th International Mechanical Engineering Congress, organised by the Federation of Swedish Mechanical Engineering Industries, is to be held at Stockholm from June 4 to 10. The topic for discussion will be "the study, from the designer's point of view, of the improvement of raw materials used in manufacture," and there will be sessions devoted to ordinary steels, alloy steels, light alloys, powder metallurgy, non-metallic materials (e.g., plastics, nylon, etc.) and non-ferrous metals and alloys. There will be about 60 papers, which will not, however, be read but will be introduced by a survey of the subject of each session so as to allow time for discussion. Advance copies of the papers are therefore being sent to participants, and the official languages of the Congress are French and English. The only British contributor of a paper is Dr. A. B. Everest, of the Mond Nickel Company, Limited, who will speak on "Engineering Properties and Applications of Spheroidal Graphite Cast Iron." Dr. Everest will also be chairman of the session on cast iron. During the congress there will be visits to a large number of factories, and after there will be a seven-day study tour of Swedish industry. The closing date for the receipt of registration forms is April 25. Further information may be obtained in this country from the British Engineers' Association, 32, Victoria-street, London, S.W.1. Communications to Sweden should be addressed to the Congress Committee, Sveriges Mekanförbund, Stockholm, 16.

Conference on Industrial Physics.

Physics in the transport, shipbuilding and engineering industries is to be the theme of the 4th. Industrial Physics Conference, organised by the Institute of Physics, which is to be held in the Royal Technical College, Glasgow, from June 24 to 28. The programme includes an exhibition of instruments, apparatus and books which will be opened on June 23 and continue throughout the conference, and a number of visits to research laboratories and industrial works are being arranged. More than 70 firms and Government Departments have accepted invitations to take part in the exhibition. Membership of the conference is open to all interested without charge, and is not confined to members of the Institute of Physics. The lectures, followed by discussions, will include "Physics in the Service of Metallurgy," by Sir Andrew McCance, F.R.S. (chairman of the executive committee of the conference); "Meteorology in Industry," by Sir Robert Watson-Watt, C.B., F.R.S.; "The Education and Training of Industrial Physicists in Scotland," a discussion on which will be opened by Dr. J. Taylor, M.B.E., Professor P. I. Dee, C.B.E., F.R.S.; and Professor J. S. Rankin, Ph.D.; "Some Applications of Physics in Naval Architecture," by Professor A. M. Robb, D.Sc.; "Some Applications of Physics in Transport," by Mr. M. G. Bennett, M.Sc., and Mr. T. A. Eames, M.Sc.; "Automatic Control of Industrial Processes," by Mr. A. J. Young; and "Noise and its Suppression," by Mr. N. Fleming, M.A. The conference will be opened by the Rt. Hon. Lord Bilsland, M.C., D.L., Ll.D., J.P., President of the Scottish Council, and on the evening of Wednesday, June 25, there will be a public address on "Physics and Sound Reproduction," given by Mr. D. T. N. Williamson in St. Andrew's Halls (Berkeley Hall), and accompanied by demonstrations. Full particulars, application forms for conference membership and tickets of admission to the exhibition can be obtained from the secretary, Institute of Physics, 47, Belgrave-square, London, S.W.1.

Steel Authorisations.

As a result of a letter commenting on the difficulties of steel authorisations, published on page 468 of last week's issue of Engineering, a Ministry of Supply spokesman has made the following statement. "There is nothing in the Iron and Steel Distribution Order to stop authorisation being given for periods any length ahead, but we cannot do this as we do not know in advance the amount of steel which will be available for distribution in any one future period. During the debate on the Order in the House of Commons on March 4, the Minister of Supply (Mr. Duncan Sandys) said that he would not venture to forecast what allocations would and could be made until he knew much more about the prospects of home production. It would be unwise to give forward authorisations enabling manufacturers to acquire large amounts of steel before they needed them. The purpose of the scheme is to bring supply and effective demand into balance. To achieve this it is necessary to allocate for reasonably short periods. We do, however, issue provisional authorisations for future periods based on a percentage of current allocations. In some cases, when long production cycles are involved, firms have been given provisional allocations for periods up to the end of the year, ; in a few cases even later. We do not agree that it is a major fault that authorisations lapse if delivery is delayed, because if there were no time limits on delivery there would be the danger of a growing back-log. One of the reasons 'Frustrated' has had to send his orders up to 18 months ahead of the time delivery is required is that steel-makers' order books have been clogged with duplicated orders. The Order is designed to stop this. If we allowed forward orders to be placed without a steel authorisation, there would be no means of stopping duplicate orders, and the makers' order books would be clogged up again. If the consumer is unable to obtain delivery within three months of the end of the period for which the steel was authorised he should make fresh application to the issuing authority. If the author of the letter is still not satisfied he should contact the authorising department concerned with his allocation of steel."

LETTER TO THE EDITOR.

HIGHER TECHNOLOGICAL EDUCATION.

To the Editor of Engineering.

Sir,—Dr. Garrard, whose further letter you published on page 403, *ante*, agrees with me in condemning the proposed Technological University, but goes on to say that the Imperial College of Science is not big enough. The question of the number of graduate engineers that should come out of the universities of Great Britain every year was investigated by the Barlow Committee some years ago and, as far as I can recollect, though I am unable to check my references, a year or two ago it was stated that the annual requirements of the engineering profession were now being met by the number of graduates annually. To forecast the need for engineering graduates is difficult, but certainly it is unlikely that anybody without the sources of information of the Barlow Committee could make a better estimate than they did. Dr. Garrard must not forget the engineering faculties of the other universities of Great Britain. It would be invidious to single out any of them for special mention, but undoubtedly the graduates of most of them must be added to the 1,565 from the Imperial College, mentioned by him.

The point I have tried to make throughout this correspondence is that, if more engineers of high professional standing are required, the way to get them is by increasing the existing faculties of engineering. The point which Dr. Garrard and I have in common is that the idea of the so-called "Higher

Technological University" is a bad thing; I hope, therefore, he will agree that we ought to join in killing it.

Yours faithfully,
F. NEWHOUSE.

8, Montpelier-row,
Twickenham, Middlesex.
April 7, 1952.

OBITUARY.

MR. SHIRLEY B. RALSTON.

CLYDESIDE has lost one of its best-known naval architects by the death, on April 4, of Mr. Shirley B. Ralston, for 31 years a director of Messrs. Alexander Stephen and Sons, Limited, of Linthouse, with which firm he had spent more than 50 years. He was 77 years of age.

Shirley Brooks Ralston was born in 1874, and received his training as a naval architect in the drawing office of Messrs. G. L. Watson and Company, whose principal business was the designing of yachts, both sail and steam. He served an apprenticeship with them of rather more than five years, concurrently attending classes in naval architecture, first at Glasgow Technical College and later at, Glasgow University. In December, 1896, he entered the ship drawing office of Messrs. Stephen, where, in no more than six years, he progressed from the position of an improver to that of chief estimator, putting his knowledge of yacht design to good purpose, during that period, by taking a major part in the design of the steam yacht Calanthe, which was built at Linthouse in 1898 for the then head of the firm, Mr. Alexander Stephen. In 1902, he left the Clyde to become shipyard manager with Messrs. Summers and Payne, Limited, at Southampton, but returned to Linthouse in 1904 to resume his former post of chief estimator. Two years later he was appointed chief ship draughtsman and in 1921 was made a director, holding that position until his death.

Mr. Ralston was a member of the Institution of Naval Architects, which he joined in 1911, in which year he delivered a paper at the Spring Meeting, containing a "Description of a Stability and Trim Indicator." He served on the Council of the Institution from 1944 to 1947. He was also a member, for 43 years, of the Institution of Engineers and Shipbuilders in Scotland, and in that Institution likewise he served for several years on the Council. By nature somewhat reserved, he spoke only seldom at the meetings of either institution, but, when he did, his remarks were always to the point; and the long list of vessels, naval and mercantile, with which he was associated—they numbered at least 220—sufficiently testified to his ability as a designer.

MR. J. E. HODGSON.

IT is comparatively seldom that ENGINEERING devotes an obituary notice to anyone who was not a technical man by training, but Mr. John Edmund Hodgson, who died on April 10 at his home in Bidborough, Kent, had established a definite claim upon the attention of engineers and scientists by his work as the historian of the beginnings of aviation. Mr. Hodgson, who was 77 years of age, was a son of Mr. Henry Hill Hodgson, a former Master of the Worshipful Company of Stationers, in the City of London; and, after leaving Tonbridge School, spent some time with the firm of Bickers, booksellers, of Leicester-square. He then joined the business in which his family had been engaged since 1807 in Chancery-lane, London—that of book auctioneers, in which he soon acquired a reputation for his knowledge of technical publications. Before long, he began to specialise in everything connected with the early history of aeronautics, becoming the possessor of the remarkable collection of prints, etc., amassed by John Cuthbert of Lambeth, and dating from the first quarter of the Nineteenth Century; a collection which Sir Frederick Handley Page eventually bought and presented to the Royal Aeronautical Society.

With this collection as a basis, Hodgson produced a book in 1924—his *History of Aeronautics in Great Britain*—which was speedily recognised as a classic in its specialised field, and, in due course, led to the conferment upon him of the honorary Fellowship of the Royal Aeronautical Society. While the book was in preparation, he was appointed (in 1923) honorary librarian to the Society, holding that office for a number of years. He was also a member, for several years, of the Council of the Newcomen Society, for whom he edited the *Note-Book (ca. 1799-1826) of Sir George Cayley*, one of the British pioneers of flight, on whose researches he had previously read a paper before the Society. It was due to him that this note-book was discovered in a mass of miscellaneous papers preserved by the Cayley family at Brompton Hall, Yorkshire.

In 1928, he took a prominent part in securing wider recognition (and, by the erection of an inscribed tablet in Oxford, a permanent memorial) of James Sadler, the pioneer English aeronaut, who made his first balloon ascent from Oxford on October 4, 1784—a matter of ten weeks before the death of Dr. Samuel Johnson; and it may be remarked that Hodgson was an ardent and erudite Johnsonian, and a trustee of Dr. Johnson's house in Gough-square, London. It is safe to say that no future historian of flight, either by heavier-than-air or lighter-than-air contrivances, can afford to ignore Hodgson's *con amore* researches, or is likely to add materially to the information that he has recorded on the development of flight from the earliest times down to the end of the Nineteenth Century.

MR. MARCEL DESOUTTER.

BY an unfortunate coincidence, we have to include in this issue, with the obituary notice of Mr. J. E. Hodgson, historian of aviation, a memoir of one of the pioneers in this country of mechanical flight, namely, Mr. Marcel Desoutter, who died on Easter Sunday, April 13—exactly 39 years since he lost his left leg in an aeroplane accident and thereby altered the whole course of his career. He was 58 years of age.

André Marcel Desoutter was one of three brothers who, in the years immediately preceding the 1914-18 war, devoted themselves to the then novel excitement of flying. He began, as so many did, by making model aircraft and in 1911, being then only 17, apprenticed himself to Louis Blériot. He was Beaumont's mechanic in the *Daily Mail* competition flight round Britain in that year, and quickly secured his own certificate as a pilot; it was issued to him by the Royal Aero Club on February 27, 1912, and was No. 186. (It may be remarked that No. 1 certificate is held by Lord Brabazon of Tara.) Having become qualified as a pilot, Desoutter soon graduated to the position of instructor in the Blériot School at Hendon, and subsequently became chief instructor in W. H. McEwen's school of flying, and then test pilot to the Grahame White Aviation Company. He established various speed and height records at Hendon (though they did not stand long before being successfully assailed) and also carried out experiments in night flying—a daring innovation at that time.

In April, 1913, while testing a Blériot monoplane, Desoutter crashed heavily and had to have his left leg amputated. He resumed flying in the following year, but, meanwhile, found the weight and general clumsiness of his artificial leg to be a serious handicap. He therefore designed and made an artificial leg of aluminium alloy, covered with leather, which he patented as a preliminary, before setting up, in conjunction with his brothers, a factory for the production of artificial limbs. It was characteristic of his active and ingenious mind that he used slow-motion cinematograph films to study the action of walking, so that the movement of the joints in the artificial legs that he made might be as natural as possible; a decidedly advanced method of investigation in 1916. It was certainly effective, however, as Desoutter was able to run on the new leg of his own design. He continued the manufacture of artificial limbs for ten years or so, but then formed the Desoutter Aircraft Company to produce a three-seat cabin monoplane which was exhibited in the International Aero Exhibition at Olympia in 1929, and was described and illustrated in ENGINEERING at that time. More than 200 of the type were made, but financial difficulties affected production, during the depression between the wars, and the company was wound up in 1932. He also founded, with his brother, the firm of Desoutter Brothers, Limited, makers of power-operated hand tools, though he relinquished his personal share in its direction some 12 or 15 years ago. Desoutter then turned his attention to the development of airports, becoming managing director of Airports, Limited, owning those at Gatwick and Gravesend, where he operated training schools for the Royal Navy and the Royal Air Force Volunteer Reserve and also made aircraft components, activities which occupied him until his death. He was an Associate Fellow of the Royal Aeronautical Society, a member of the Advisory Council of the College of Aeronautical Engineering and of the Civil Aviation Section of the London Chamber of Commerce, and a Fellow of the British Institute of Surgical Technicians.

MR. E. S. SHRAPNELL-SMITH, C.B.E.

WE regret to record the sudden death of Mr. E. S. Shrapnell-Smith, C.B.E., the well-known authority on motor road transport, which occurred on Tuesday, April 8, at a dinner given in Canterbury by the East Kent Road Car Company, of which he was the senior director. Edward Shrapnell Shrapnell-Smith was born in Liverpool on February 10, 1875, and was educated at the Royal Institution School, Liverpool, and at Liverpool University College. He served an apprenticeship in the chemical industry at Widnes and served for some time as a research chemist, in which occupation he achieved the distinction, in 1899, of being the first to produce crystalline sodium hypochlorite.

It was about this time, however, that he turned his attention to motor transport on roads and maintained his interest in this activity throughout his life. He organised the Lancashire heavy motor vehicle trials in 1898, 1899 and 1901, was general manager and secretary of the Road Carrying Company, Limited, from 1901 to 1903, and was editor of *The Commercial Motor* from 1905 to 1917. For many years he was connected with the Commercial Motor Users' Association, as honorary treasurer from 1903 to 1913, as chairman in 1918, and as President from 1920 to 1929. Mechanical transport, it will be remembered, figured largely in the first world war, and Shrapnell-Smith's extensive experience was utilised in the Army Service Corps and as Commandant, Motor Transport Column, City of London National Guard. He was made a C.B.E. in 1918 for his war services. Both during and after the war, he served on numerous committees on motor fuels, testing brakes for motor vehicles, and other matters relating to motor transport. He was for many years a member of the Appeal Tribunal set up under the Road and Rail Traffic Act of 1933 in connection with the licensing of goods vehicles. He acted as the British Government's official representative at the International Road Congresses held in Milan in 1926, in Washington in 1930, and in Munich in 1934, contributing to the proceedings in each case. He also contributed numerous papers to technical societies and the Press, and in 1945 delivered the first Henry Spurrier Memorial Lecture to the Institute of Transport. This Lecture, which was entitled "Five Decades of Road Transport," was reprinted in the 161st volume of ENGINEERING (1946). Shrapnell-Smith was chairman of the Spurrier Memorial Committee, which collected a large sum for road-transport education. He was a founder life member of the Royal Automobile Club and a life member of the Automobile Association.

PROPOSED EXTENSION OF HIGHLAND GRID.—The North of Scotland Hydro-Electric Board have published details of a proposed addition to the 132-kV Highland grid which will be erected over the 2,507 ft. high Corrieyairick Pass in Inverness-shire, through which runs the road built in the Eighteenth Century by General Wade. The new transmission line will stretch 25 miles from Fort Augustus to Glentruim, near Newtonmore, where it will join an existing 132-kV line from the Tummel Valley to Keith, Banffshire. At Fort Augustus the new line will connect with lines which will carry the electricity produced by the Affric, Garry and Moriston hydro-electric stations. No damage will be done to Wade's bridges during the construction of the line, and those which are unfortunately already unfit for use will be by-passed.

BRITAIN'S DEEP-SEA LINER TRADE, 1945–1951.*

By BASIL SANDERSON, M.C.

AT the Spring Meeting of this Institution in 1944, Mr. Walter Warwick presented a paper entitled "Post-War Merchant Ships from the Owner's Point of View." I propose to carry the story up to date, largely from the view-point of the deep-sea liner owner. To start with a few facts: below are set out, through the courtesy of the Chamber of Shipping, two Tables of which the headings fully describe the contents. A great difficulty, to which Mr. Warwick made reference, was the impossibility of indicating even approximately the likely conditions or volume of international trade, of which sea-borne trade forms so important a part, and particularly for this country.

TABLE I.—*World Tonnage by Nationality,* 1939, 1949 *and* 1950.* (*Thousands of Tons Gross.*)

—	September 3, 1939.	December 31, 1949.	December 31, 1950.
United Kingdom ..	16,892	16,321	16,557
Canada	358	1,584	1,494
Other British countries	1,358	1,477	1,575
British Commonwealth..	18,608	19,382	19,626
Argentine	246	744	826
Belgium	386	435	459
Brazil	446	675	636
China	†	787	616
Denmark	1,093	1,127	1,170
Finland	553	463	497
France	2,748	2,686	2,880
Germany	4,185	93	509
Greece	1,763	1,334	1,306
Holland	2,792	2,789	2,908
Honduras	†	476	581
Italy	3,322	2,373	2,615
Japan	5,427	1,200	1,200
Norway	4,686	4,809	5,223
Panama	722	3,037	3,350
Portugal	213	440	406
Russia	1,154	1,059	1,141
Spain	932	971	971
Sweden	1,442	1,893	1,919
United States	8,722	26,045	26,114‡
Other countries ..	1,986	2,091	2,452
Total	61,426	74,909	77,405

*Steam and motor vessels of 500 gross tons and over, excluding lake and river tonnage and miscellaneous craft, e.g., tugs, trawlers, etc. The figures are estimates based on the latest information that is available and are not official figures. In particular data for Russian, German and Japanese tonnage are known to be incomplete. The United States figures exclude merchant-type tonnage owned by the United States Army and Navy, but include vessels in the Reserve Fleet estimated at about 14 million gross tons at the end of 1950.
† Included in "Other Countries."
‡ Vessels of 1,000 gross tons and over.

TABLE II.—*Steam and Motor Tonnage Owned in the United Kingdom Compared with World Tonnage.** (*Thousands of Tons Gross.*)

Mid-year.	U.K.	U.S.A.	World.	U.K. as Per Cent of World.
1905 ..	14,497	1,339	28,743	50·4
1915 ..	19,236	2,580	43,498	44·2
1925 ..	19,305	11,932	60,103	32·1
1930 ..	20,322	10,646	65,566	31·0
1935 ..	17,298	9,665	61,247	28·2
1939 ..	17,891	8,910	66,057	27·1
1945† ..	14,000	40,800	77,700	18·0
1948 ..	17,100	27,000†	78,027	21·9
1949 ..	17,600	26,300†	80,315	21·9
1950 ..	17,800	26,400†	82,294	21·6

* Vessels of 100 gross tons and over; excluding U.S. tonnage on the Great Lakes.
† Approximate figures only.

Table II shows the enormous increase in world tonnage between 1905 and 1950, i.e., from 29 million tons gross approximately to a grand total of 82 million tons afloat to-day. It is a truism to say that the fleets of the world would not have grown to such an extent without a material increase in the sea-borne trade of the world. Unfortunately, however, the respective growths of trade and tonnage did not march hand in hand, and the increase in world shipping of 50 per cent. between 1915 and 1930 was followed by the worst depression in the history of British shipping. By 1939, this country had suffered an actual decline in total tonnage, while others, partly assisted by State subsidies and other measures of support, were responsible for a vast increase. During much of the time most British shipping companies failed to earn their statutory depreciation and the tramp section of the industry had to secure State aid, in order to preserve its existence until trade should revive.

Two world wars have also had their influence upon tonnage statistics, so that to-day, through the prodigious efforts of the United States during the early 1940's, the total has leapt from a pre-war 66 million gross to 82 million in 1950. A considerable proportion, however, of the United States total of over 26 million (estimated at 14 million gross tons in 1950) was laid up as a fleet reserve after 1945, though many vessels have lately been re-commissioned to meet the extraordinary needs imposed upon shipping by the export of American coal to Europe—caused by the shortage in the United Kingdom—by the re-armament drive and by the conflict in Korea. An actual shortage of world shipping developed as a result, which forced up tramp rates to a degree unthinkable 18 months ago; but, should hostilities cease, the position may be modified. One would expect, on the other hand, that, in such circumstances, the United States would again lay up many of the units which they have lately re-commissioned and this should aid as a healthy corrective.

At the close of hostilities in 1945, the gross total of foreign-going merchant shipping on the United Kingdom register (i.e., excluding coasting and home trade) was approximately 12 million tons gross, which was roughly subdivided into liners, 6·7 millions (55·9 per cent.); tramps, 2·9 millions (24·1 per cent.); and tankers, 2·4 millions (20 per cent.). This, however, hardly gives a true picture and for that purpose we must analyse so far as we are able the efficiency factor of the ships themselves. The make-up of the fleet in 1939, 1945, and 1951 was as shown in Table III.

TABLE III.—*United Kingdom Foreign-Going Merchant Fleet.* (*Million Gross Tons.*)

—	Liners.	Tramps.	Tankers.	Total.
1939	8·8	3·4	2·7	14·9
Less war losses ..	4·1	2·5	1·3	7·9
Pre-war built vessels still afloat in 1945	4·7	0·9	1·4	7·0
Add war additions less losses ..	2·0	2·0	1·0	5·0
Post-war total, 1945	6·7	2·9	2·4	12·0
June, 1951, totals (estimated) ..	8·5 (57·4 per cent.)	2·9 (19·6 per cent.)	3·4 (23 per cent.)	14·8 (100 per cent.)

I am confining myself principally to the problem of the deep-sea liner owner and so shall disregard all but general inferences arising from the figures relating to the other categories of tonnage. Suffice it to say that the great tanker companies and certain smaller interests have laid down a scale of tonnage replacement and additions which is often embarrassing to the dry-cargo and passenger liner interests in their periodic attempts to place building contracts at what they consider to be economic prices.

Many tramp owners after the war seemed to take the view that the cost of building was too high to give any chance of adequate return upon the investment. In result, therefore, the tramp tonnage afloat in June, 1950, with its total of 3,136,000 gross tonnage (since reduced by sales and scrapping to 3 million) shows: built up to and including 1939, 898,000 tons; built 1940-45, 2,002,000 tons; built 1946-50 (June), 236,000 tons. It is true that many contracts have been placed since the steep rise in tramp freights during the last 12 months, but on balance it would seem that the tramp fleets must comprise an unduly high percentage of the Liberty type and other war-built vessels, which would not appear to be the ideal economic vessel for sustained competition in the world's markets. It would be little short of a disaster if the British tramp industry were not fully to rehabilitate itself to its pre-war efficiency, as the tramp ship, both in peace and war, is vital to the national economy.

During the war, the liner fleets lost nearly 50 per cent. of their pre-war tonnage. They entered the war with an approximate total of 8·8 million tons gross, and they emerged with fleets estimated to total 6·7 million tons gross. The explanation for the apparent contradiction is that during the war years net additions—new building less losses—approximating 2·0 million gross tons were made to the liner fleets. Figures can be deceptive, however; the position was even worse in 1945 than that indicated above. The pre-war tonnage remaining afloat was all six years older, and with many added grey hairs due to war strain and deferred upkeep, and a high proportion of the war-built ships were not suitable for the trades in which they had to be run.

Liner trades are individual in character and are highly specialised. It is rare indeed that a liner built for one service or trade will fit into another. Whereas tramp owners were able to and still continue to operate Liberty vessels and other types built during the war years—though probably regarding them as the weaker members of their fleets—the liner owner could only view the majority of such acquired vessels as unsatisfactory stop-gaps demanding, with comparatively few exceptions, early replacement. There were, therefore, two problems to tackle: the immediate problem of making good war losses, towards which the vessels acquired during the war made but little effective contribution; and the longer term and far more difficult problem of replacing vessels obsolescent, and in some cases already obsolete.

The first problem was bad enough. The owners had received insurance moneys for vessels lost by enemy action, and in addition had, against the cost of such replacements, a claim against moneys retained in Government hands, representing a calculated excess over insured values. As, however, under the arrangement with the Government, values were fixed in relation to those ruling at the time of casualty, and as private replacement of tonnage was not practicable during the war years, the total sums received by owners for losses through enemy action bore little resemblance to the price of new vessels when orders were actually placed from 1945 onwards. By that date, the cost of building a ship had already advanced by 120 per cent., as compared with 1937, and prices have continued to rise in a steady curve, until in 1950 the Chamber of Shipping estimated that, for new construction, the cost approximated three times the average of the three years 1937-39. Since then, further increases have been intimated and the curve shows no sign of flattening. In the result, therefore, liner owners found that they could only replace their actual war losses by dipping heavily into their reserves, before ever beginning to tackle the problem of obsolescence. That liner owners tackled this first hurdle with determination is shown by the figures. By June, 1950, they had added to their fleets over $2\frac{1}{2}$ million gross tons of new construction and these fleets approximated in size to the pre-war total, the present tonnage being 8·5 million gross as opposed to 8·8 million tons in 1939.

The second problem, obsolescence, is now the crucial one, and the prospect is gloomy. Whereas in 1939, after the worst slump which the industry had known, the percentage of liners over 20 years old was 24 per cent., in 1950 the relative percentage was 27 per cent. To make matters worse, of nearly $2\frac{1}{2}$ million gross tons of shipping delivered during the war years and retained in the liner fleets, a high percentage are the stop-gap units to which reference has already been made.

Under the British system of taxation, a shipping company receives the same consideration, or lack of it, as a shore factory, inasmuch as it is permitted to claim as a deduction from its assessable profits the actual cost of plant and equipment spread over their estimated life. This is called "wear and tear," and, broadly speaking, over the years has approximated in the case of shipping companies, to 5 per cent. of the prime cost of vessels, until, as each unit reaches the age of 20 years, it is fully written off for taxation purposes, and the wear and tear allowance upon that unit ceases.

In times of stable currency, this system has worked not unjustly. When, however, the purchasing power of currency declines rapidly, as has happened during the last decade, when costs of replacement have risen to three times and more for the new unit, then the system of taxation described is inequitable, and it can become lethal in its results. Taking a refrigerated cargo vessel built in 1932 for 350,000*l*., then, in theory, by 1952 the owner should have put by from depreciation on the vessel an equivalent sum out of untaxed profits. The new vessel to-day, on the other hand, will cost him $1\frac{1}{4}$*l*. million, and it is most unlikely that he can put his hand on even the 350,000*l*., because this has been spent, and more than spent, in making good the gap between the insurance moneys received for his war losses and their actual cost of replacement. A vessel built in 1945 for a million pounds would cost one and a half million to-day and the score is mounting steadily. To bridge this large gap the liner companies have to fall back upon taxed profits, but it is unlikely that these will meet the position. There are definite limits to the level of charges which can be made, for liner services at any time, as otherwise the volume of trade is discouraged and will gradually fall away. But our system of taxation blindly disregards the necessity for replacement, and imposes a cut of over 50 per cent. in that portion of so-called profit which is required to replace wasting capital assets.

Another unfortunate aspect arises from the misleading appearance given to balance sheets and profit and loss accounts, by a system of accountancy which does not differentiate adequately between surplus as opposed to true profit. The accounts of many shipping companies lead the public to suppose that these are making greatly increased profits and this in turn gives rise to ill-informed criticism, based upon a complete lack of understanding as to the true state of affairs. It is a moot point, indeed, whether the system of accountancy does not foster a practice of paying dividends out of capital.

To argue that, if an exception is made for the shipping industry, it must become of general application is in itself no argument. If foolish injustice is being done, it is time for wholesale correction. The position of the

* Paper presented at the Spring Meeting of the Institution of Naval Architects, held in London, April 2 to 4, 1952. Abridged.

shipping industry is unusual, if not unique. What other industry has such a large proportion of its capital represented by plant depreciating so quickly as within 20 to 25 years? What other industry, when it has built a factory (in this case, a ship), has always to scrap 100 per cent. at one time because the unit is becoming uneconomic? One thing is certain, however, and that is, failing the introduction of some logical system of taxation which faces up to realities, the British merchant navy will dwindle steadily in size until, within measurable time, it is unable to fulfil its duty towards the country as an earner of invisible exports, and as a vital strategical asset in time of war. This factor should be fully realised by both Government and people, as otherwise they will equally be living in a fool's paradise.

Mr. Warwick, in his 1944 address, referred to the influence which air travel, subsidised or otherwise, might have upon the future of passenger lines, and the seriousness of the position from the strategic aspect were this country to be denuded of fast passenger ships. This there is no gainsaying. At one time, considerable agitation was displayed by railway companies at the detrimental effect that the motor-car would have upon the volume of traffic carried by rail. In effect, in spite of the multiplication of motor-cars, statistics taken out before this last war showed that the passengers carried by the main-line railway companies had actually increased since the coming of the motor-car. Admittedly, the more recent trend seems to be away from rail to road, but it is a fair assumption that many of the rail-borne passenger fares have latterly been raised to the point where they are becoming noncompetitive. Similarly, the lesson of the last few years would seem in general to show that air has not only brought into being a new traffic, but is in its turn making the world still more travel-minded to the benefit of the total traffic moving. Disregarding, therefore, certain particular routes when special conditions may apply, it would seem to be a fair assumption that history will prove that ample scope exists for the passenger liner as a means of alternative travel to air.

It seems difficult to accept as sound and reasonable that, ever since the days of the Phoenicians, no real advance has been achieved—with one notable exception —in the design of vessels destined to handle cargo. Cargo still continues to be brought alongside a hatch, is then lifted 30 or more feet into the air, is swung out a like distance, and all for the benefit of being subsequently lowered into position to a depth which, at the beginning of loading operations at any rate, approximates to the lift. It is true that certain types of bulk cargoes are handled by more rational methods, for which due credit should be given to those who conceived them. The exception is that brought about for military purposes by the introduction during the late war of the L.C.T. and L.S.T., which has been seized upon by at least one post-war operator, and modified for use in a short-haul trade for door-to-door delivery.

While appreciating some of the structural difficulties involved in designing a hull of a strength and type adequate to permit of a measure at least of horizontal as opposed to vertical loading, I would like to ask whether there is not some alteration in conception, which would be possible and which would lead to some economy, as opposed to the present system. Coupled to such a revolution in design might come the elimination of such anachronisms as masts and the projecting vertical funnel. These measures, if they can be reconciled with efficiency of hull, would make possible a discharging and loading berth of the future, where the general cargo carrier could enter a hangar berth and carry out these operations entirely protected from the weather, which causes such delay and expense in the working of general and perishable cargoes.

When calculating the deductions which a vessel must suffer in carrying capacity, if she is to be insulated and refrigerated, shipowners have to allow for anything from 15 to 20 per cent. loss for insulation, trunks, batteries, fans, grids, sheathing, etc., etc., according to the type of refrigeration to be installed, and the dimensions of the compartment or hold to be fitted. This is quite apart from the space occupied by the refrigerating machinery. My personal suspicion is that too much attention has been paid in the past to improving the power and system of the refrigerating plant, and too little to the quality and efficiency of the insulating medium. Since the end of the recent war, a number of shipping companies have set up a Refrigerated Research Council, upon which eminent scientific thought is represented, as well as the practical side, and it may be said that this body is already paying dividends as a result of the researches which it is undertaking on behalf of its members. Latterly, it has been asked to investigate this question of the medium used for insulation.

Quite apart from the perfection or imperfection of the material used, however, there is a serious problem confronting those who are engaged in the actual work of insulating any particular space. Not only has the skin of the ship to be covered by a thickness of insulation adequate to prevent, so far as practicable, exterior heat from affecting inside temperatures, but there is a mass of frames, stringers, etc., all directly connected with the outside atmosphere and acting as efficient conductors of heat. They project inwards a number of inches and consequently force the insulating contractor either to increase very materially the depth of insulation on the ship's side, so as to give complete and efficient coverage to these projections, or to leave them lightly covered and face considerable leakage of heat into the compartment from the outside. The first alternative is uneconomic owing to the cubic loss of space involved; so the problem is settled by a compromise which involves more than adequate protection to the skin of the ship while permitting considerable heat leakage into the compartments. This, in turn, necessitates more powerful refrigerating plant. The question therefore resolves itself into asking whether there is no possibility, by alteration or modification of hull design, of eliminating or at least reducing this nuisance and of obtaining compensating structural strength by other means than those employed to-day.

Finally, one question on hull design. As a ship operator, it is becoming increasingly forced upon my notice that the latest and most efficient hulls are bringing their train of troubles in their wake. When they are new and clean, their results in the field of speed and consumption are often startling; but leave a vessel out of dry-dock for more than a comparatively short period and, particularly if she has been trading in warm waters, the falling off is equally remarkable. Unfortunately, graving docks in this country are to-day over-taxed and my company recently had to send a modern vessel due for docking to Australia without this being possible. Under almost exactly comparable conditions of trim, draught, weather, and speed, she suffered an increase in consumption over the previous voyage of 25 per cent., or 17 tons of oil fuel per day. This, translated into money over a 35-days voyage, teaches a severe lesson. It is clear that the older and less efficient hulls do not suffer to anything like so great an extent through fouling, and 8 to 10 per cent. at the outside is all that would be allowed for under similar conditions. It is possible, therefore, that we are misled in striving too far for perfection in line and that it would pay shipowners in tank tests to insist upon comparative data being obtained between alternative designs of hull under conditions which allow for a moderate degree of fouling, as opposed to the ideal conditions which are now invariably simulated.

"HINTS TO BUSINESS MEN" HANDBOOKS.—Revised editions of the "Hints to Business Men" Handbooks for the Netherlands, Denmark, Mexico, the Rhodesias and Nyasaland have now been published. United Kingdom exporters can obtain copies on application to the Board of Trade, Commercial Relations and Export Department (Industries Branch), Dissemination Section, Horse Guards-avenue, Whitehall, London, S.W.1.

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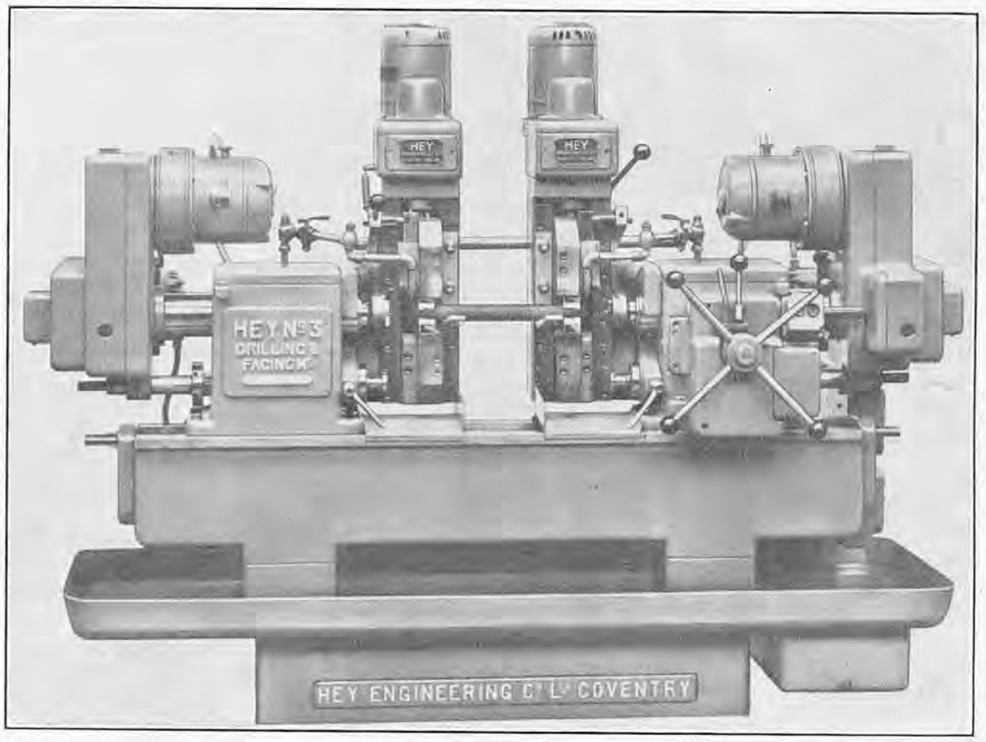


DOUBLE-ENDED CENTRING MACHINE.

THE Hey No. 3 double-ended centring machine shown above has been designed by the Hey Engineering Company, Limited, Coventry, to centre-drill and face both ends of a workpiece simultaneously; the ends are machined accurately to length and the end faces are true. By its use, preparatory milling to length or subsequent facing between centres in a lathe is eliminated, and handling and machining times are considerably reduced. A typical output is 60 automobile crankshafts an hour, the ends centre-drilled $\frac{5}{8}$ in. in diameter and $\frac{1}{4}$ in. faced off each end. The machine has a wide field of application, to, for example, camshafts, rifle barrels, torsion rods, track rods, etc., and the speed with which the machine can be set up makes it economical for short runs. A part of the outside diameter can also be machined at the same time if required.

The workpiece is held in manually- or electrically-operated vices, as shown. The machine will centre-drill up to $1\frac{1}{4}$ in. in diameter, and will simultaneously face, chamfer, recess, or machine the outside of the ends of workpieces up to 3 in. in diameter. Work lengths up to 2 ft., 4 ft., and 6 ft. are accommodated in three machines with beds of standard lengths, though longer beds can be supplied. The vices, which automatically locate the workpiece with its axis on the centre-line of the machine, can grip work up to 6 in. in diameter. An ample height of centres—$10\frac{1}{2}$ in.—permits the use of larger vices or special fixtures. Standard centre drills, combined with inserted-blade facing cutters, are suitable for most work, but other drill and cutter arrangements can be used to suit the machining required.

Two independent motor-driven spindle heads are supported on the bed and can be adjusted to suit the length of workpiece. The spindles run in ball and roller bearings in large sliding sleeves, and are driven either through totally-enclosed V-belts (giving a high-speed range of 375 to 3,000 r.p.m.) or through an oil-bath gear drive (giving a low-speed range of 60 to 1,500 r.p.m.). Speeds are selected by the pulleys or by pick-off gears, and different speeds can be used at the two ends if required. Each motor is from 1 to 5 h.p., depending on the size of machine and class of work.

The feed motion for the spindles may be hand or power operated, and a fully automatic cycle can be arranged for continuous production. Cams giving a working stroke of 4 in. act directly on the spindle sleeves so as to produce accurate work lengths without using dead stops. Each spindle has an independent micrometer adjustment over a range of 2 in. for setting. The range of feeds, from 0·001 in. to 0·020 in. per revolution, is obtained by slip gears. Coolant is supplied by a motor-driven pump in the base of the machine.

BURNING OF BOILER FUELS IN THE TANKER "AURICULA".

THE successful completion of five and a half years' continual service of the motor-tanker Auricula, during which nothing but boiler fuels were burnt in the main engine, must remove any doubts, if such doubts still existed, regarding the practicability of using these fuels for long periods in large Diesel engines. The Auricula, it will be recalled, was built by Messrs. R. and W. Hawthorn, Leslie and Company, Limited, Hebburn-on-Tyne, in 1946, for the Anglo-Saxon Petroleum Company, Limited, the shipping organisation of the Royal Dutch Shell Group. She has a length of 482 ft. 6 in., a breadth of 59 ft. 2½ in., and a depth of 34 ft. 10 in., and is fitted with a solid-injection eight-cylinder Hawthorn-Werkspoor single-acting Diesel engine having a bore and stroke of 650 mm. and 1,400 mm., respectively, and a rated output of 3,600 brake horse-power. She was commissioned in August, 1946, and since that date has operated throughout on various commercial grades of boiler fuel shipped at 56 different ports in both the eastern and western hemispheres.

During the first three years of operation, fuels having a viscosity ranging from 1,200 to 1,500 seconds Redwood 1 at 100 deg. F. were used, but for the past 2½ years the engine has operated on fuels with viscosities ranging between 1,500 and 3,500 seconds Redwood. Two sets of fuel valve nozzles have been employed, one with eight 0·85-mm. diameter holes for fuels up to 1,500 seconds Redwood and the other with eight 0·75-mm. diameter holes for fuels with viscosities above 1,500 seconds Redwood. All fuel consumed by the engine has been purified and clarified in centrifugal

Liner No.	Total Hours at Full Power.	Mean Wear, mm.	Maximum Wear per 1,000 Hours, mm.	Remarks.
1	33,214	Top 3·39 Middle 1·75 Bottom 1·37	0·10	Original liner.
2	33,214	Top 3·02 Middle 1·96 Bottom 1·95	0·09	Original liner.
3	33,214	Top 3·29 Middle 1·92 Bottom 1·92	0·09	Original liner.
4	14,522	Top 2·10 Middle 1·19 Bottom 2·25	0·14	Fitted September, 1949, for experimental purposes.
5	14,522	Top 0·39 Middle 0·41 Bottom 0·41	0·026	Chromium-plated liner fitted September, 1949. To be re-gauged.
6	33,214	Top — Middle — Bottom —		Original liner. Not yet gauged.
7	33,214	Top 3·59 Middle 1·78 Bottom 1·63	0·10	Original liner.
8	33,214	Top 3·49 Middle 1·93 Bottom 1·75	0·10	Original liner.

separators, as recommended by Mr. John Lamb, manager of the Marine Research and Development Department of the Anglo-Saxon Petroleum Company, in the paper he presented on this subject before the Institute of Marine Engineers in December, 1947.

Since being commissioned, the Auricula has covered 385,584 miles between pilot vessels, during which the engine operated for 33,214 hours at full power, the average indicated horse-power being 4,120 and the fuel consumed 18,212 tons. Recently the vessel was dry-docked at Birkenhead in order to repair hull damage, and the opportunity was taken to carry out a survey of the main engine. By courtesy of the owners, we were able to be present while the engine was dismantled and it was noted that, contrary to expectations, the condition of the working parts was little worse than that found in engines operated on normal Diesel fuels. There was, of course, a greater formation of carbon, but, in general, the parts were surprisingly clean. Possibly the most outstanding feature was the condition of the piston rings; in all cases, these were quite free and could easily be turned in their grooves by hand. Five of the cylinders had been lubricated by a detergent-type oil and the remaining three by a straight mineral oil, and it was noted that, when the former oil had been used, the rings showed every sign of having received better lubrication, there being a good film of oil round the rings and in the piston grooves. Furthermore, the piston deposits were of a much softer nature than usual, it being possible to wipe away those in the vicinity of the grooves by means of a dry rag. It is understood that, in view of the satisfactory results achieved, the owners intend using such oils for cylinder lubrication on all their motorships.

During the normal operation of the vessel, the opportunity has been taken to carry out certain experiments to determine the best materials and finishes for such components as the piston rings and cylinder liners. So far, piston rings made by six different manufacturers have been tried out, the materials varying in Brinell hardness from 160 to 230. Materials not usually adopted, including ductile cast iron and stainless steel, have been tested, and although it is too early to arrive at definite conclusions, the former material shows definite signs of promise. In September, 1949, two of the original liners, namely, Nos. 4 and 5, were replaced by one new standard liner and a chromium-plated liner respectively, to obtain a true measure of the advantages of plating the bore. The wear rates of these two liners, together with those for the remaining liners, are given in the table, herewith, and it will be seen that the results obtained with the chromium-plated liner are quite remarkable. The readings were obtained since the vessel arrived in the Mersey at the beginning of this month.

In assessing the cylinder-liner wear results, however, it must be borne in mind that, until knowledge of the adjustments necessary to burn boiler fuels to the best advantage had been gained, the engine operated under conditions far from conducive to minimum wear. Furthermore, during the first year of service, much research was done and the engine, as a consequence, operated for long periods under exacting conditions. It was run, for example, at greatly reduced powers to determine the modifications required to ensure reliable operation in such conditions.

There have been, of course, considerable savings in the fuel bill, and it has been estimated that, since entering service, the total saving for the Auricula is in the neighbourhood of 61,000*l*. Mr. Lamb has emphasised, however, that the increased fuel flexibility is of equal importance, as motorships fitted with the necessary equipment for burning boiler fuels can pick up bunkers almost anywhere in the world, the only stipulations being a viscosity of 3,500 seconds Redwood or less, and a sulphur content of not more than 5 per cent. The Auricula is not, of course, the only vessel in the Anglo-Saxon fleet to be fitted with this equipment; she was, however, the first and has, therefore, been used for the ensuing experimental work. Nevertheless, she has not been nursed; in fact, though other vessels of the fleet dry-dock every nine months, in the case of the Auricula this period has been extended to a year. Moreover, the usual practice in similar vessels of the fleet is to operate the Hawthorn-Werkspoor engines at 3,900 indicated horse-power, whereas, on the Auricula, the average indicated horse-power has been 4,120.

CONVENTION ON ELECTRICAL CONTACTS.

A CONVENTION on electrical contacts, organised by the East Midland Centre of the Institution of Electrical Engineers, was held at Loughborough College, Loughborough, from Monday, April 7, to Wednesday, April 9. A number of papers were presented on the theory and practice of the subject, which is becoming of increasing importance in both the heavy and weak current branches of the industry.

In a brief review of contact selection and design, Dr. L. B. Hunt discussed the chemical and physical properties of the materials employed and the electrical and mechanical conditions of operation. As, however, the performance of a contact material still depended upon the correct design both of the contact itself and the operating mechanisms, the author laid down some general considerations on the size and proportions of contacts and on the methods of manufacture to achieve economical assembly. The behaviour of metallic contacts at low voltages in adverse environments was discussed by Dr. A. Fairweather, who said that the surfaces of electrical contacts were usually contaminated by foreign layers. Such layers might consist of dust or grease; or of films produced by adsorption, tarnish or corrosion. The applied voltage was regarded as "low" when it was too small to initiate conduction by any process analogous to "breakdown." The problem in such circumstances was to obtain a metal-to-metal contact mechanically. An attempt was made to describe the behaviour of a closed contact subjected to corrosion, and the closure processes for a corroded contact, both with and without "wipe." The principles outlined in this paper provided the necessary theoretical basis for design and testing techniques. The results represented an interim stage in part of a wider investigation in this field, which was in progress at the Post Office Research Station.

In dealing with long-life contacts for unidirectional currents up to 20 amperes, Dr. A. L. Allen discussed the possibility of producing reverse and zero material migration with platinum contacts at voltages from 1·5 to 2 volts and with currents from 10 to 20 amperes. He also gave an account of the practical success obtainable with contacts of dissimilar metals and recorded the observations that had been made on the resistance of tungsten contacts in inert gas atmospheres. A review was also given of the methods of producing exceptionally long contact life. In a paper on the effect of inductance on fine transfer between contacts, Miss J. Warham suggested that such fine transfer might note as originally supposed, be arc-free, but be due to dissipation in a short arc of the inductive energy stored in the circuit at break. This suggestion was investigated, mainly with platinum contacts in a 6-volt circuit. The currents broken were about one ampere and the circuit inductance was between 0·05 and 10 millihenries. The results showed that there was a residual transfer independent of the inductance, but that the transfer was dependent on the inductance when the latter was greater than 0·3 millihenries. This second transfer was thought to be due to a short arc.

The importance of the molten metal bridge in the process of fine transfer was discussed in a paper by Mr. R. Hill Jones, who reviewed the various theories which had been advanced to account for this phenomenon on the basis of investigations into the properties of microscopic molten bridges. Experiments on the properties of molten metal bridges formed in a single contact operation were described, and the bearing of the results on the mechanism of transfer was considered. Contact erosion due to electrical discharges was the subject of a paper by Professor F. Llewellyn Jones, in which the various processes by which electrical discharge phenomena could produce erosion of contact electrodes were discussed. These included: metal transfer at "break" by arcs at voltages higher than the ionisation potential of the gas; low-voltage arcs at "break"; discharge processes at "make"; and electrode evaporation. The hitherto unsuspected importance of discharge phenomena between electrodes just about to meet was emphasised, and the physical processes of avalanche initiation and growth under these conditions were treated in detail.

Some of the effects of surface films of oxides and sulphates, as well as of grease, oils and particles of dust, on contact behaviour were reviewed by Dr. J. C. Chaston. The effects of heating by the arc at break were also described and special attention was paid to the properties of sulphide films on silver and to the factors influencing their rate of growth in sulphur-contaminated atmosphere and their dissociation by arcs and by heating generally. In a paper on the design of light-duty sliding contacts, Mr. D. O. Walter emphasised the gulf which existed between the theoretical work on this subject and practical considerations. The practical problems commonly encountered included those connected with the slip rings employed in signal channels in navigational and allied equipment and in test apparatus involving strain or temperature measurement on rotating elements. The use of precious-metal contacts in telephone selector switching was also described. The large number of contacts in telephone exchange systems demanded, Mr. C. W. A. Mitchell and Mr. T. F. A. Urben said, low cost, small size and low noise when passing speech, as well as reliability and freedom from extraneous interference, such as dust. A number of suggestions as to how present practice could be improved in these respects were made, and the behaviour of various materials under different mechanical conditions in telephone exchanges was described.

For dealing with arc suppression at contacts interrupting medium currents, Dr. R. W. Sillars said that the suppression of overvoltage in current up to 20 amperes had little effect on the duration of the arc. The forcible interruption of the arc thus made necessary was apt to produce overvoltage, which must be controlled. The limitations of the method of suppression by capacitance were discussed and it was pointed out that in some cases a separate overvoltage suppressor was more economical. Complete sparkless interruption was possible, if current capacitance and rapidity of contact separation were suitably related. It was pointed out by Mr. T. H. Cook and Mr. M. Vaughan that the mean effective arc of contact between a carbon brush and commutator often differed appreciably from the arc apparently covered. This adversely affected commutation conditions and the stability of performance. Some methods of improving brush contact efficiency were described, including the circumferential staggering of brushes and the employment of the split and tandem types.

In a paper on the volt-ampere characteristics of sliding contacts, Dr. P. F. Soper discussed the possible properties that determined the shape of the volt-ampere characteristic of sliding contacts. His analysis was based on the assumption that field emission was the mechanism of current transfer. A family of curves along each of which the field strength was constant was investigated. Formulæ were derived for the effective contact-spacing and the true emission area. Those formulæ were also applicable to the alternating-current characteristic and provided reasons for the different shapes obtained with different materials and operating conditions. Several other papers were also presented.

THE IRON AND STEEL INSTITUTE.

The eighty-third annual general meeting of the Iron and Steel Institute will be held on Wednesday and Thursday, April 30 and May 1. The morning session, on the first day, will take place at the Royal Institution, Albemarle-street, London, W.1, and the remainder of the meeting at the offices of the Institute, 4, Grosvenor-gardens, London, S.W.1.

The meeting will commence on the first day at 9.45 a.m., when the report of Council and the statement of accounts for 1951 will be submitted, after which the Bessemer Medal for 1952 will be presented to M. H. H. Burton, C.B.E., the Sir Robert Hadfield Medal for 1952 to Dr. L. Reeve and the Williams Prize for 1951 to Mr. J. A. Bond and Mr. T. Sanderson. Then will follow the induction of the new President, Captain H. Leighton Davies, C.B.E., who will deliver his presidential address. After a short interval, Professor E. N. da C. Andrade, D.Sc., F.R.S., will deliver the sixth Hatfield Memorial Lecture, on "The Flow of Metals."

At the afternoon session on April 30, commencing at 2.30, four papers will be presented and discussed, namely, "Cold Rolling with Strip Tensions. Part I. A New Approximate Method of Calculation and a Comparison with Other Methods," by Dr. H. Ford, Mr. F. Ellis and Mr. D. R. Bland; "Effect of Tension on Torque and Roll Force in Cold Strip Rolling," by Mr. W. C. F. Hessenberg and Mr. R. B. Sims; "Pressure Distribution Between Stock and Rolls in Hot and Cold Flat Rolling," by Dr. C. L. Smith, Dr. F. H. Scott and Mr. W. Sylwestrowicz; and "Softening of Metals During Cold Work," by Mr. N. H. Polakowski.

On the evening of Wednesday, April 30, at 7 for 7.30, a members' dinner will be held at Grosvenor House, Park-lane, London, W.1.

The morning technical session on the second day of the meeting, Thursday, May 1, will be held from 10 until 1 p.m., during which time four papers will be presented and discussed. The first two are "An Experimental Furnace for the Investigation of Open-Hearth Furnace Combustion Problems. Part V. Experiments With a Venturi Port and Modifications Thereof," by Mr. J. F. Allen, and "Part VI. Summary of Results and Their Applications in Practice," by Mr. J. R. Hall and Dr. A. H. Leckie. The third paper is "Measurement of Air Infiltration in Open-Hearth Furnaces," by Mr. R. Haynes, and the fourth, "Aerodynamic Factors Associated With the Wear of Open-Hearth Furnace Roofs," by Mr. J. A. Leys and Mr. E. T. Leigh.

The final session of the meeting will be held from 2.15 until 4 p.m., on May 1, when four papers will be presented and discussed, namely, "The Determination of Hydrogen in Liquid Steel," by Mr. R. M. Cook and Mr. J. D. Hobson; "Diffusion of Hydrogen in Iron and Iron Alloys at Elevated Temperatures," by Dr. P. L. Chang and Mr. W. D. G. Bennett; "Distribution of Hydrogen in Large Ingots and Forgings," by Mr. J. D. Hobson and Dr. C. Sykes, F.R.S., and "The Effect of Hydrogen on the Properties of Low-Alloy Steels," by Mr. J. D. Hobson and Dr. C. Sykes, F.R.S.

THE METALLURGICAL INDUSTRY IN THE UNITED STATES.—A course of four lectures on "The Metallurgical Industry in the United States" will be given by Professor Clark B. Carpenter, B.S., M.S., Professor of Metallurgical Engineering, Colorado School of Mines, at the Imperial College of Science and Technology, Royal School of Mines, South Kensington, London, S.W.7. The first lecture will take place on Tuesday, April 22, when Professor Carpenter will discuss the general economic conditions that have led to the enormous demand for metals in the United States, and will also consider the iron industry. The remaining lectures will be delivered on Friday, April 25, Tuesday, April 29, and Thursday, May 1, when the subjects will be "The Steel Industry," "The Lead and Zinc Industries," and "The Copper and Aluminium Industries," respectively. Each lecture will commence at 5 p.m. and admission will be free.

H.M. TELEGRAPH SHIP "MONARCH."—H.M. Telegraph Ship Monarch left Greenwich on Tuesday, April 8, for the United States, where, under contract to Bell Laboratories, Limited, she will lay four cables, each 60 miles long, between Florida and the Bahamas. The Monarch is the largest cable-laying ship in the world and is the fourth of her name to be constructed for this work. Two of her predecessors were sunk by enemy action, one during the 1914-18 war and one during the 1939-45 war. She was first commissioned in 1946 and is capable of carrying 2,600 nautical miles of cable in four tanks with a total volume of 125,000 cub. ft. She is oil-fired and is equipped with electrically-operated gear and with a wide range of measuring and communication instruments. Since 1946, the Monarch has laid two Dutch-Danish telephone cables with two repeaters in each and the major part of the England-Denmark coaxial telegraph cable and of the most recent cable to Holland, as well as carrying out repair work in various parts of the world.

LABOUR NOTES.

EASTER, as for some years past, was the time chosen by a number of trade unions for holding their annual conferences. Among those meeting last week-end was the Union of Shop, Distributive and Allied Workers, which, with a membership of more than 350,000, is one of the six largest trade-union organisations in Great Britain, and, as it was the first of the six to hold an annual conference this year, its decisions may well set the pattern to which those of the remainder will conform. About one thousand delegates attended the three-day discussion at Margate on Sunday, Monday and Tuesday last. The rearmament programme was condemned as being excessive and demands were put forward that further increases in wages should be secured.

In his presidential address to the union, Mr. W. E. Padley, M.P., condemned the rearmament programme as being far beyond the economic strength of the country, unless there was a "switchover to a near-war economy," which no one wanted to advocate. That was shown by the scale on which aid from the United States was being sought and granted, as well as by the political conditions which were now attached by the United States Congress to economic assistance. To undermine British independence by shouldering an arms burden greater than the nation's resources permitted was a grave disservice to the influence which Britain ought to wield in world affairs. Mr. Padley considered that wage demands must be pressed to a successful conclusion, in view of the rising cost of living and the "open attack" in the Budget on the lower-paid employees. He stated that the Budget provided no tax reliefs to the bulk of those employed in the distributive trades, as men with families earning six pounds a week or less were already exempt from income tax.

Unanimous approval was given by the conference on Monday to a resolution requiring the union's executive council to commence negotiations as soon as practicable for further "substantial" increases for all members, and, by the constant submission of fresh demands to the employers, to ensure that the higher wages secured should not be absorbed by increases in the cost of living. Other resolutions approved by the conference included demands that the Government should abolish purchase tax on essentials, especially textiles, restore and increase food subsidies, reintroduce war-time price controls, and impose severe taxation on profits. These decisions arose from a debate during which a large number of propositions put forward by branches for wage improvements were considered in bulk, together with an emergency proposition from the executive council criticising the Government's economic policy and complaining about the increases in the cost of living. Negotiations on a number of wage claims by the union are now in their concluding stages and last Monday's wage resolution suggests that new demands will be put forward immediately the existing claims are decided. Employees in the retail trades covered by the union number about 1,800,000.

During the debate, Mr. J. A. Birch, the union's general secretary and a member of the Trades Union Congress General Council, contended that there could be no restraint in demands for higher wages as long as wages were lagging behind prices. The Government had abandoned its responsibilities and had given "the spinning top of prices and wages a flick of the whip." He considered that the trade-union movement was entitled to ask any Government to maintain full employment. A Government must take any measures necessary to ensure the maximum stability of price levels, and control, as far as overseas factors permitted, the prices of essential consumer goods. Unions also asked that serious inequalities in living standards should be prevented by adequate social services based on the taxation of those able to pay. He asked that the country's economic and industrial resources should be subjected to careful planning in an effort to achieve a balanced economy. Income tax had been reduced, by 229 million pounds in a full year, in an effort to justify the cutting of food subsidies, but the swings and roundabouts must be owned by the same firm for such a policy to be effective. There was little opposition to the resolutions, but one delegate suggested that the country's workpeople were not doing too badly when 778 million pounds were spent on tobacco, 650 million pounds on gambling and 448 million pounds on beer.

Industrial action, Mr. Birch characterised as a polite euphemism for a strike, and roundly condemned such ideas as a disservice to the union's members. It did not help the efforts for increased wages and improved working conditions to indulge in sporadic action on political slogans and he suggested that the delegates should consider what such action would mean to their own occupations as co-operative employees, pharmacists and assistants in multiple stores. In spite of strenuous objections, the delegates approved the executive council's policy for the introduction of incentive bonus schemes, provided that certain safeguards were observed. On Tuesday, an emergency resolution, sponsored by the executive council, calling for a re-examination and reduction of the rearmament programme "in the light of present-day national and international political and economic circumstances," resulted in a lengthy debate. In spite of vigorous opposition by Mr. Alfred Robens, M.P., formerly Minister of Labour, this resolution was approved, with only 12 votes being recorded against it.

Among the smaller unions holding conferences at Easter was the Association of Engineering and Shipbuilding Draughtsmen, the annual meeting of which was held at Edinburgh. In his presidential address to the delegates, Mr. G. Fowler deplored the fact that the control of industry by employees was practically non-existent. He disagreed, therefore, from those trade-union leaders who argued that the strike weapon was out-dated in modern Britain, and affirmed that the power of trade unionism rested ultimately on the right of working men to withhold their labour. He accused a leading electrical-manufacturing company of the non-observance of national agreements. The firm had not only flouted provisions relating to hours of work in the five-day week agreement, but had also violated the procedure agreement. It was a challenge which the Association would accept.

At a private session of the A.E.S.D. on Easter Saturday, resolutions were adopted accepting the wage policy of the executive committee. It was stated subsequently, on behalf of the Association, that the delegates had pledged themselves to support an application for higher wages, but the details of the application were not to be made public at that stage. On the previous day, during the discussion on the executive committee's report on its negotiations with the British Electricity Authority for a wage increase, there was a protest by one of the delegates against the Electrical Power Engineers' Association being the only union allowed to negotiate on behalf of draughtsmen in the employ of the Authority. He claimed that draughtsmen should be recognised as free agents and allowed to decide for themselves what organisation should represent them, but a motion to refer the report back to the executive committee was rejected.

Claims that clerks were joining the trade-union movement at the rate of over five hundred a week were made at the annual conference of the Clerical and Administrative Workers' Union, which opened at Scarborough on April 11. Miss Helene Walker, the President, informed the 270 delegates in her address that the membership of the union now totalled more than 45,000 and that, although 6,780 persons joined the C.A.W.U. last year, the number of new members so far this year had reached almost the same level. She condemned those who took part in disputes that "smelt even slightly of personal ambitions, animosities, or that wore the appearance of petty conspiracy." The trade-union movement was not created as a ladder for careerists. It endured because of the unselfish devotion of millions of little people and, in any dispute, they would be the final arbiters.

Engineering members of the union were "grossly dissatisfied" with their salaries and conditions of work according to the report of the general secretary of the C.A.W.U., Mr. Fred C. Woods. He stated that the union's executive had given instructions for the preparation of a new wage and working-conditions charter for clerical employees in the engineering and shipbuilding industries, of whom there were nearly 200,000, and, in order that a "concerted attack" might be made to gain the required concessions, the co-operation of other unions catering for office staffs was to be sought. On the second day of the conference, the executive agreed to implement as soon as possible the principle that a substantial increase in the wages of all clerical employees should be granted. The delegates deplored the fall in the living standards of clerks compared with those of manual employees, and considered that they paid too dearly for the privilege of being referred to as "Mr." and "Miss."

Statistics issued by the Amalgamated Engineering Union show that, according to returns submitted to the head office by branch secretaries, its total membership at the end of March, 1952, was 863,651, an increase of 11,902 on the figures for the preceding month. The union has 2,441 branches. There were 21,868 members in receipt of superannuation benefit and 7,089 in receipt of sick pay. Unemployed members numbered 1,551, of whom 659 were in receipt of benefit from the union. As a result of the recent ballot, Mr. Ben Gardner was re-elected general secretary for a further period of three years, commencing on September 20.

OIL-FIRED TANK LOCOMOTIVE FOR IRAQ PETROLEUM COMPANY.

HUDSWELL, CLARKE AND COMPANY, LIMITED, LEEDS.

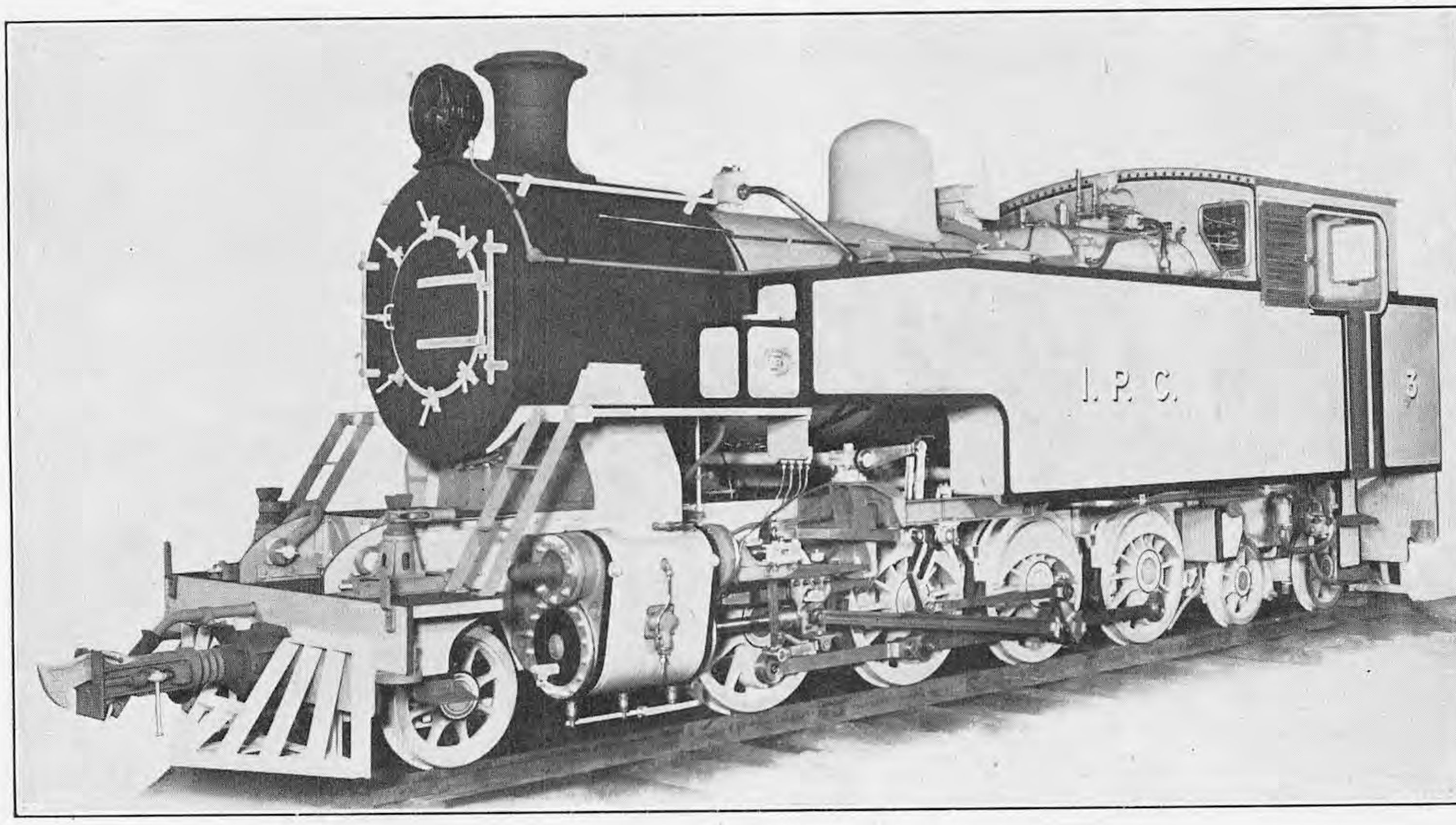


Fig. 1. One of the Three Locomotives Supplied.

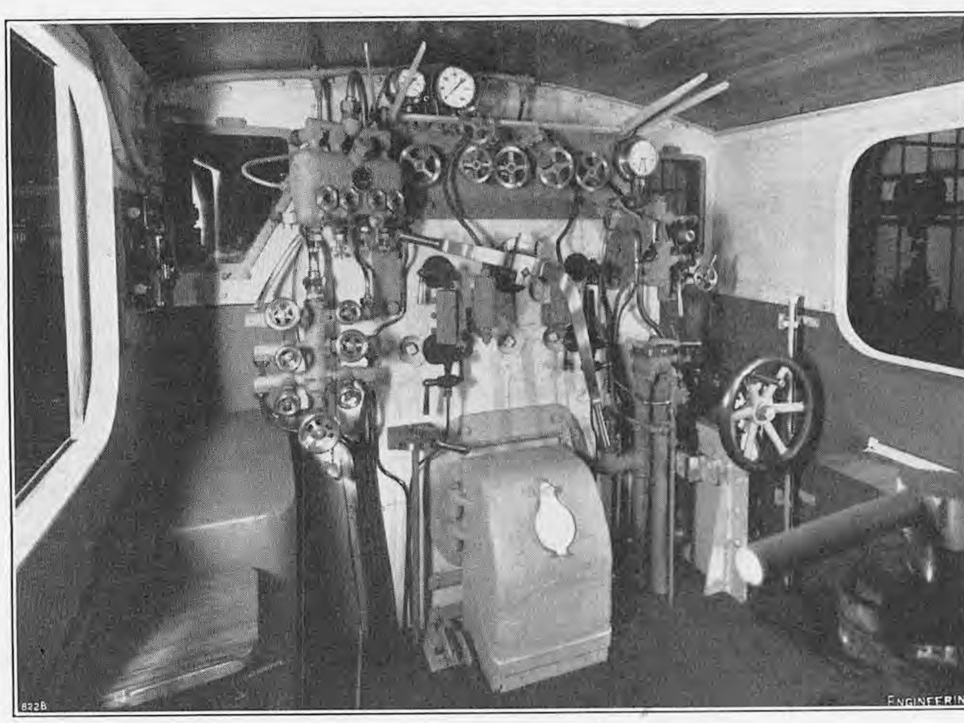


Fig. 2. Footplate Fittings.

OIL-FIRED TANK LOCOMOTIVES FOR THE IRAQ PETROLEUM COMPANY.

Three metre-gauge 2-8-4 tank locomotives recently built for the Iraq Petroleum Company by Messrs. Hudswell, Clarke and Company, Limited, Leeds, 10, are oil-fired engines with a maximum axle-load of only $9\frac{1}{2}$ tons and a tractive effort (at 85 per cent. of boiler pressure) of 18,800 lb. The inner firebox is of steel, and the piston valves, actuated by Walschaerts valve gear, are 8 in. in diameter and are of the long-travel type. The engines will run on the lines of the Petroleum Company but will be maintained by the Iraqi State Railways. As many parts as possible have, therefore, been made the same as, or at least interchangeable with, the corresponding parts of existing locomotives of the State Railways. The locomotives have been built to the requirements and inspection of the Crown Agents for the Colonies.

The boiler works at a pressure of 180 lb. per square inch and has a total heating surface of 1,126 sq. ft., comprising 1,040 sq. ft. for the tubes and 86 sq. ft. for the firebox (there is no superheater). The grate area is 19 sq. ft. Flannery-type flexible water-space stays are used in breaking zones of the Belpaire firebox and for the first two rows of roof stays. Water is delivered to the boiler by two Davies and Metcalfe Nathan hot-water injectors, through a Davies and Metcalfe 2-in. duplex top-feed clack-box which is near the front end of the boiler, as shown in Fig. 1. An "Everlasting" blow-off cock is fitted at the front of the firebox and the boiler is lagged with Blue Limpet asbestos mattresses, which were supplied by Messrs. J. W. Roberts, Limited, Armley, Leeds, 12.

The plate frames are 1 in. thick and the horn guides and axleboxes are fitted with manganese-steel liners. The spring gear is of the overhead type, compensated throughout the coupled wheels, and the coupled-wheel axleboxes are of steel with gunmetal "brasses." The cylinders have cast-iron barrel liners with a bore of $15\frac{1}{2}$ in., and the piston stroke is 22 in. Lubrication of the cylinders is by means of a Wakefield A.C.-type sight-feed lubricator, which is shown in Fig. 2; this illustration also reveals the orderly arrangement of the footplate fittings. The axleboxes (which are provided with Armstrong oilers) and the coupling and connecting rods are oil-lubricated. The coupled wheels are 3 ft. 7 in. in diameter and the truck and bogie wheels are 2 ft. 4 in.

A steam brake and a hand brake act on the coupled wheels, but vacuum-brake equipment is provided for connecting to the train. The Stone's electric-lighting equipment which is fitted to the locomotives includes Tonum-E head-lights at both ends, a turbo-generator, the usual cab fittings, and a bunker light to facilitate re-fuelling. The oil-fuel apparatus is of the Mexican trough type, which is standard on the Iraqi State Railways. Other fittings include two Ross pop safety-valves, and A.B.C. automatic couplers (type PH). Steel castings for the locomotives were supplied by K. and L. Steelfounders and Engineers, Limited, Letchworth, Hertfordshire.

The total weight in working order is 58·36 tons, the adhesion weight is 36·35 tons, and the adhesion factor is 4·3. Water capacity is 1,200 gallons and oil capacity 500 gallons. The locomotives were shipped fully erected to Busra, which is in Syria, near the Jordan frontier.

Model Form of General Conditions of Contract.—A shorter Model Form of General Conditions of Contract (known as Form A1.SF—Home Contracts, with Erection, Short Form) has been prepared by the Joint Committee on Model Forms of General Conditions of Contract of the Institution of Mechanical Engineers and the Institution of Electrical Engineers. Copies can be obtained from the secretary of either Institution at a price of 4s. post free. The new form is a shorter and modified version of "Model Form of General Conditions of Contract A—Home Contracts, with Erection," and is designed for contracts for which a minimum of site engineering work is necessary and for which the purchaser does not employ an independent engineer. It is therefore hoped that for many smaller contracts it will take the place of the separate conditions now used by individual contractors and purchasers.

THE ABRASION OF PAINT.

Fig. 1.

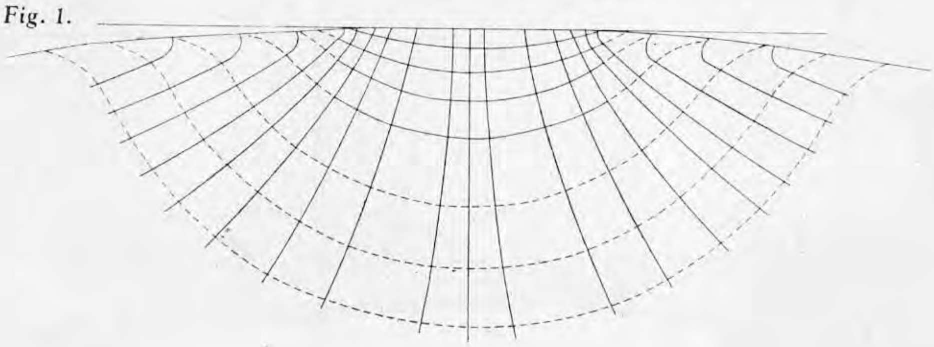
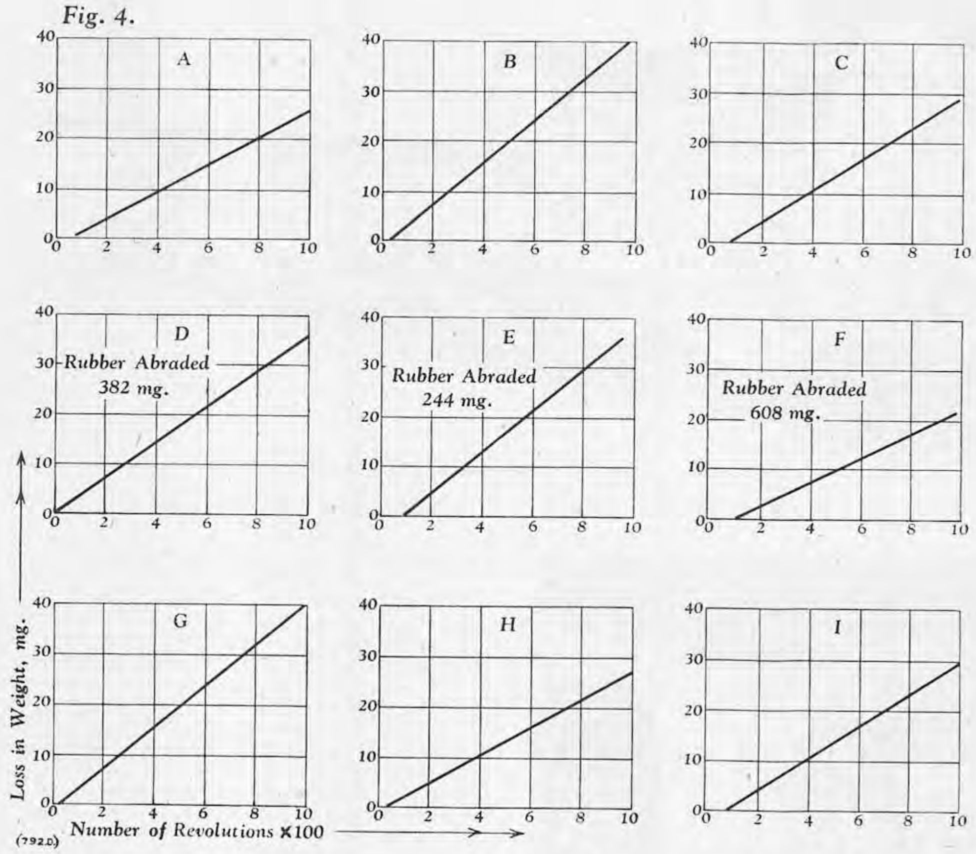


Fig. 4.



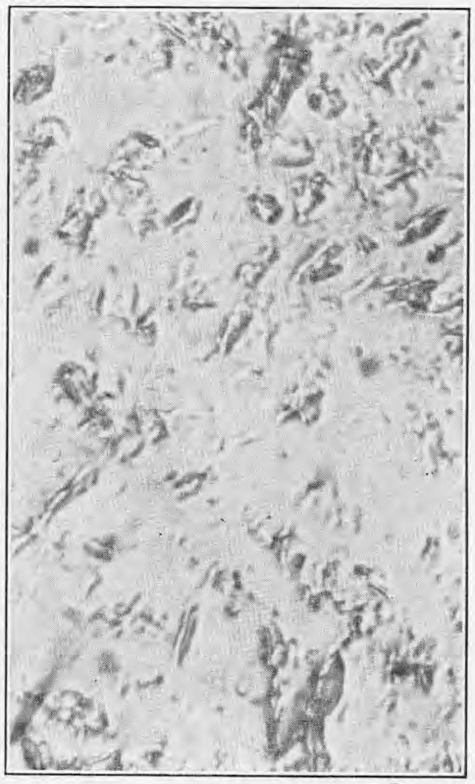


FIG. 2. EFFECT OF FALLING CARBORUNDUM ON VARNISH "A". × 300.

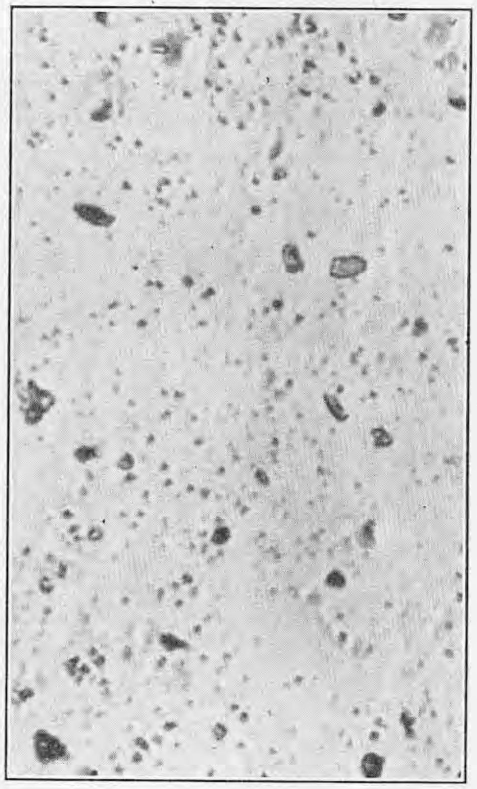


FIG. 3. EFFECT OF FALLING CARBORUNDUM ON VARNISH "C". × 300.

SOME INVESTIGATIONS OF THE ABRASION OF PAINT.*

By DR. N. A. BRUNT.

THE subject of our investigation is the abrasion of paint by mechanical causes and we define abrasion, therefore, not only as the removal of material by friction, but also as a result of impact. In many cases in practice, abrasion is effected by impact of dust and grains of sand, but generally both friction and impact will be the cause of abrasion.

However, for a better understanding let us distinguish between these two extreme cases, abrasion by impact and abrasion by friction. As we shall see, these two cases differ fundamentally.

No material can break without the existence of stresses that exceed an ultimate value and, therefore, our problem should be discussed in terms of fundamental mechanical constants. The quantities governing the mechanical behaviour are only few, namely, the modulus of elasticity and the ultimate tensile strength, but, unfortunately, they are complicated functions of time and temperature.

First, consider the abrasion by impact. For a better understanding it is necessary to idealise the process and we will imagine an infinitely thick homogeneous layer with a definite modulus of elasticity and a definite tensile strength. A rain of spheres identical in mass and shape is falling on the surface. As a first approximation, we suppose modulus and ultimate stress to be time-independent. What will be the maximum stress in the material as an effect of the impact force of a sphere? This is the well-known problem of the penetration of a sphere into a homogeneous material. The stress in the material, effected by the sphere, varies from point to point along the circumference of the penetrating body. The lines of principal stress are represented in Fig. 1, herewith. This drawing is an approximation made by Fuchs; for an exact calculation, very complicated integrations are necessary. The stress is at its maximum at the centre of the contact area. The full lines represent pressure and the dotted lines tension. Near the compressed area, both the principal stresses are pressures; a little farther away, one set of lines shows tension near the surface and pressure in the central portions. Still farther away, the same set of lines shows tension throughout.

The value of the maximum stress is given by the equation

$$P_m = \frac{3\,P}{2\,\pi\,a\,R}, \qquad (1)$$

where P is the force exerted upon the penetrating sphere, a is the depth of the impression and R is the radius of the sphere. We see from this equation that the maximum value of the stress P is inversely proportional to the radius of the sphere. That means that little spheres lead to high stresses and are more dangerous than bigger ones. An irregularly-shaped body can be taken as a complex of spheres with different radii. When the radius of curvature is very small, the local stress will exceed the maximum value of the stress at rupture and a crack will arise. It is obvious therefore that the impact force of dust and sand on a paint surface will lead to the formation of micro-cracks. These micro-cracks are the starting points for further growing tears and damage.

It is possible to calculate approximately the relation between the energy of the colliding particle and the maximum value of the stress in the material. This calculation results in

$$P_m = 2\,W^{\frac{1}{4}} \left[\frac{E}{\pi\,R}\right]^{\frac{3}{4}} (1 - \sigma^2)^{-\frac{1}{2}}. \qquad (2)$$

where W is the energy of the sphere, E is the modulus and σ the Poisson constant. It is obvious that a high value of the modulus of elasticity always gives rise to a high value of the maximum stress; therefore, the problem of abrasion by impact is essentially dependent on the value of the modulus of elasticity and the ultimate strength of the material. In a material with a low modulus, the maximum stress will also be small and there is little chance that the ultimate value of the stress will be exceeded. In this case, there will be a complete recovery after the impact; there is, so to speak, no abrasion. An example of such a material

* Paper presented at the Conference on Abrasion and Wear, held at Delft, Holland, on November 14 and 15, 1951.

THE ABRASION OF PAINT.

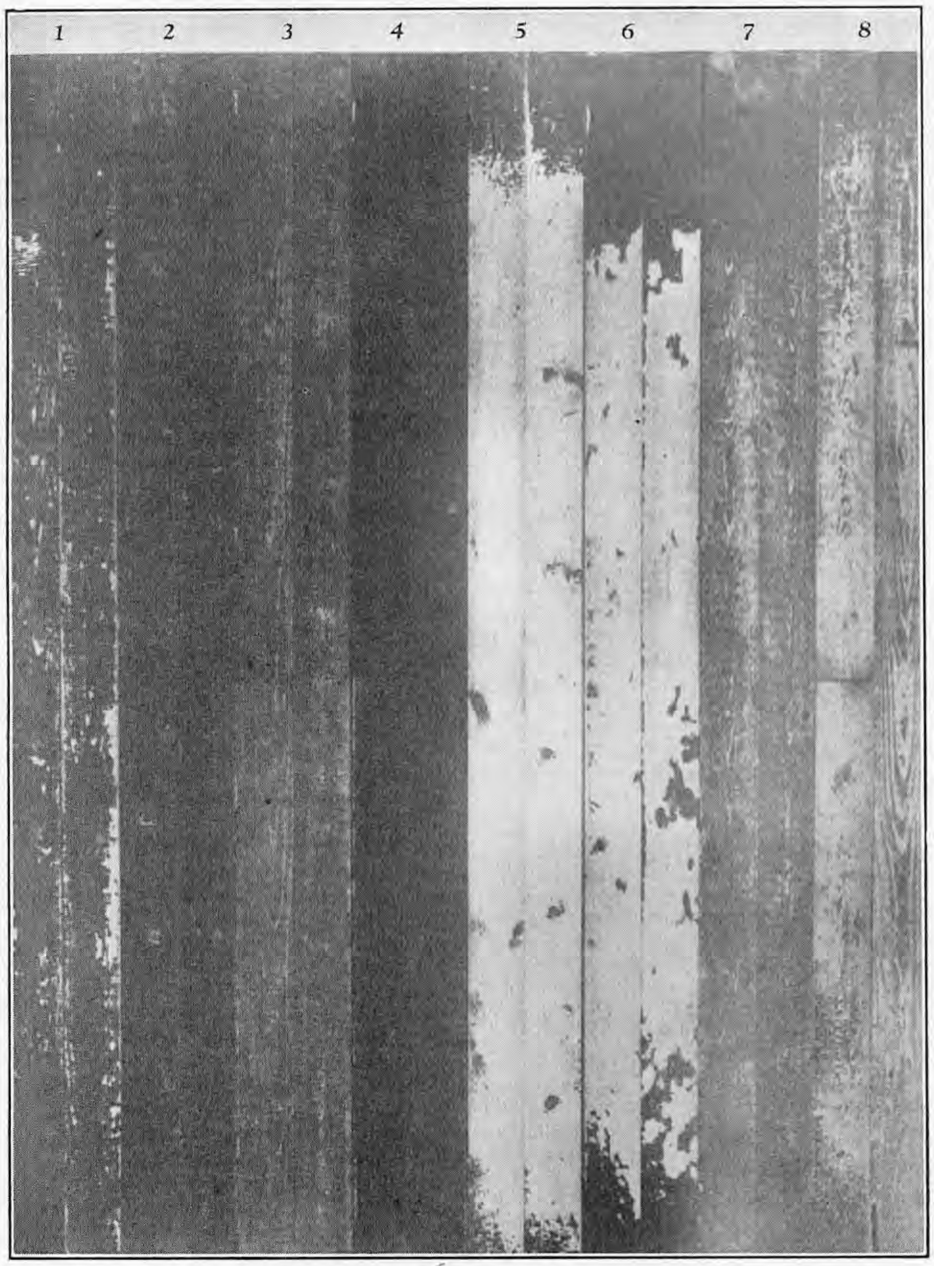


FIG. 5. WEAR OF PAINTS ON PLANKS IN STATION SUBWAY.

is rubber. The abrasion resistance of rubber compared with materials like paint, plastics, wood, etc., is excellent. Glass, for instance, is an example of a material with a very high modulus of elasticity; in this case, however, the ultimate tensile strength is also high.

We tried to make an experimental verification of these suppositions, and composed a series of nitrocellulose lacquers with a decreasing modulus of elasticity and an increasing value of ultimate tensile strength. Of course, only a qualitative correlation between the abrasion resistance and the fundamental mechanical quantities may be expected, for two reasons. The first is that the modulus and ultimate strength are both time-dependent. The duration of the impact is generally unknown, but in any case it is very short, i.e., of the order of a small fraction of a second. Therefore, the experiments for determining the modulus and the ultimate tensile strength must be finished in the same time.

The second reason is another serious difficulty, namely, the inhomogeneity of the paint layers. In the centre of the nitrocellulose layers there is a retention of the low-molecular solvent, which causes a high effect of plastification. Even after a very long drying time at 50 deg. C., the layer is not homogeneous. Therefore, only a qualitative correlation between the abrasion resistance and the results of our experiments may be expected.

We composed nine lacquers from three types of nitrocellulose, with increasing viscosity values, being low-molecular, medium-molecular, and high-molecular, though the exact molecular weights were unknown. We expected the molecular weight to influence the ultimate tensile strength and the addition of a plastifier to have mainly an effect on the value of the modulus. We made three groups, with 0 per cent., 30 per cent. and 60 per cent. of the plastifier, respectively. In this way, the nine lacquers of Table I were obtained.

TABLE I.—*Numbers of the Lacquers.*

—	Plastifier Content.		
	0 per cent.	30 per cent.	60 per cent.
Low-molecular ..	A	B	C
Medium-molecular ..	D	E	F
High-molecular ..	G	H	I

The modulus of elasticity, the ultimate tensile strength and the abrasion resistance of these varnishes were determined, the last by means of an experiment with falling carborundum.

The modulus of elasticity was measured by a simple extension experiment. An unsupported detached varnish film was loaded and the elongation measured. For the varnishes containing 0 per cent. or 30 per cent. plastifier, no plastic flow occurred; the recovery after unloading was perfect. On the other hand, the varnishes with 60 per cent. plastifier showed viscous properties, which indicated that the value of the modulus is time-dependent. Between the application of the load and the reading of the extension about 10 seconds elapsed, which time is considerably longer than the time of the impact for falling sand or carborundum. Nevertheless, the modulus was decreased so much that, for a qualitative comparison, the results obtained in this way were sufficient.

The determination of the ultimate tensile strength was made by H. van Lingen, one of the collaborators of the Fibre Research Institute. The apparatus was an electronically-controlled dynamometer. The rate of extension was 250 mm. per minute and all strips broke within 5 seconds.

The determination of the abrasion by impact was carried out by means of falling carborundum (grain size 0·17 mm.). The surface of the test specimens was included at an angle of 45 deg. to the direction of the falling carborundum and the damage done to the surface was measured by the amount of light scattering. An electric spark prevented the adherence of the particles to the surface by ionising the air. There were two identical samples of each test specimen, and each sample was measured six times. The determinations were carried out by Ir. Heyboer of the Plastics Research Institute. In this experiment, a high abrasion resistance corresponds with a low value of light scattering. In Table II, herewith, the values of the modulus of elasticity, the ultimate tensile strength and the abrasion resistance have been compared.

TABLE II.—*Comparison Between the Values of the Modulus of Elasticity, the Ultimate Tensile Strength and the Abrasion Resistance as the Differences in Light Scattering Before and After the Damage Done by the Falling Abrasive.*

Number of the Lacquer.	Modulus in Dynes per sq. cm. $\times 10^{10}$.	Ultimate Tensile Strength, kg. per sq. cm.	Abrasion Resistance in Relation to Light Scattering.
A	4·10	760	14·2
B	2·27	680	15·3
C	0·324	88	7·5
D	4·72	1,140	15·8
E	1·04	660	15·3
F	0·053	128	5·8
G	3·11	1,080	15·2
H	2·47	720	19·2
I	0·276	240	7·1

It is obvious that the value of the abrasion resistance corresponds with the value of the modulus of elasticity. A low modulus gives a material with a high abrasion resistance, the light scattering being low in that case. For the varnishes C, F and I, with a plastifier content of 60 per cent., the values of the modulus are considerably lower than those of the other lacquers, and we see that, in spite of the lower value of the ultimate tensile strength, the abrasion resistance is much higher. For the other varnishes, with smaller differences in the moduli, the differences in abrasion resistance are less outstanding. The abrasion resistance of the lacquers D and E is nearly the same, but there is a difference of over 4 between the moduli. It must be borne in mind that, in case D, the ultimate tensile strength is 1,140 kg. per square centimetre, whereas for number E it is only 660 kg. per square centimetre. This phenomenon is also shown by the lacquers G and H. Unfortunately, it must be stated that an increase in plastifier content diminishes the modulus of elasticity as well as the ultimate tensile strength. The increasing degree of polymerisation has little or no influence. Nevertheless, we see that our general expectations are justified and a low modulus is favourable for a high abrasion resistance.

Figs. 2 and 3, opposite, show micro-photographs of the damage caused by the falling carborundum, for the varnishes A and C. In the first case, there are real cracks in the surface. As an effect of the collisions the paint layer is crazed; but in the second case there is no trace of cracks, only little impressions—undoubtedly an effect of the viscous flow, i.e., the non-recoverable deformation of these highly plastified lacquers.

Abrasion by friction is totally different from the type of damage caused by impact. In the case of friction, a hard and sharp object is pressed into the material and afterwards moved tangentially, i.e., is displaced parallel to the surface of the material. By these tangential movements, the ultimate value of the tensile strength is always exceeded.

Suppose the penetrating material to be infinitely hard, then the depth of the impression is a function of the hardness of the material: the harder the material, the smaller the impression. But if the impression is small, the trace, as an effect of the tangential movement, will be shallow and the mass of the material which is torn away is also small. If the object which is pressed against the material is not infinitely hard, then there will be a competition in abrasion between the paint and the rubbing material. This question is very complicated and there are several possibilities concerning the relations between the modulus of the paint and that of the rubbing material, the ultimate strengths of both materials, etc. The same lacquers have been investigated with the Taber abrader, and the graphs in Fig. 4, opposite, show the results. In the Taber abrader used in these tests a ring made from a mixture of natural rubber and carborundum, mounted on a metal wheel, was rotated in contact with the lacquer surface under test, a constant pressure being maintained between them. The graphs show, as ordinates, the weight of lacquer worn away for a given number of revolutions, shown as abscissæ. In the case of the lacquers D, E, F, the total loss of weight from the abrasive rubber ring is also noted.

The differences between the low-plastified and the highly-plastified lacquers have completely disappeared, when only the loss in weight of the test specimens is considered. A real difference in character, however, comes to light when we observe the weight of abrasive which is rubbed away from the abrasion wheels. This weight, for the highly-plastified varnishes, is three times higher than for the unplastified lacquers. Therefore, the experimental results of a friction apparatus are totally misleading when the type of abrasion in practice does not agree with that produced by the apparatus; that is, it is not caused by friction. Abrasion in practice is often the effect of normal, or nearly normal, movements and in all these cases the soft and tough materials are the most abrasion-resistant.

This supposition agrees perfectly with the results of an experiment done by us with a certain number of paints which have been used as floor finishes. In this way, eight paints were investigated. Four of them were oil paints, composed of soft and weak vehicles; the other four were hard, physically drying paints, composed of nitrocellulose, chlorinated rubber and pliolite. These paints were applied to planks which were laid down in the subway of the central station of Amsterdam. Here the traffic is very heavy; each day, 40,000 persons passed through the subway. After seven days, the paints appeared as shown in Fig. 5, page 505.

The compositions of the paints were as follows:—

	Weight Ratio.
1. Standoil—modified phenolic resin	2 : 1
2. Air-drying alkyd resin	
3. Tung oil—phenolic resin... ...	2 : 1
4. Dehydrated castor oil—modified phenolic resin	2 : 1
5. Cellulose nitrate—non-drying alkyd resin	2 : 1
6. Cellulose nitrate—maleic resin—dibutylphtalate	10 : 5 : 6
7. Chlorinated rubber — chlorodiphenyl	4 : 3
8. Pliolite—chlorinated paraffin — linseed oil	20 : 2 : 1

From the results of the experiment it is apparent that the soft and weak oil paints have a very high abrasion resistance and that the hard, physically drying materials are non-resistant. From this last group, No. 7 is the best, and this is the paint with the greatest percentage of plastifier.

PRODUCTION OF SULPHUR FROM PETROLEUM.—Raw sulphur is now being made from petroleum on a commercial scale in this country at the Stanlow refinery of the Shell Petroleum Co., Ltd., Cheshire. The cracking of crude-oil fractions always results in the production of some by-product hydrogen sulphide. Accordingly, when a catalyst cracking unit was planned as part of the Stanlow refinery extensions for the processing of Middle-East crude oil, it was decided also to install facilities for converting this by-product hydrogen sulphide into elemental sulphur. A sulphuric-acid manufacturing plant is to be installed by the end of the year, but raw sulphur will also be made available for outside firms.

PROPOSED OIL REFINERY FOR WESTERN AUSTRALIA.—Further details have been made available regarding the plan of the Anglo-Iranian Oil Company, Limited, to build a new refinery at Kwinana, near Freemantle, Australia. The scheme envisages the construction of a plant having a capacity of 3,000,000 tons per annum, sufficient to meet the requirements of the company's Australasian associates, Commonwealth Oil Refineries, Limited, and the British Petroleum Company of New Zealand; it will also provide for the Anglo-Iranian Australian bunkering trade through B.P. (Australia), Ltd. The site chosen is approximately twelve miles south of Freemantle and is favourably placed geographically for tankers coming from the Middle East, which will be the source of supply for crude oil. The plant will consist of atmospheric and vacuum distillation units, a catalytic cracker and the normal treatment plants. The site is well above sea level, has good load-bearing properties and is beside sheltered deep water so that the larger modern tankers will be able to discharge crude oil directly to the refinery area. A certain amount of dredging, however, will have to be carried out, and this work, it is understood, will be accomplished by the Government of Western Australia.

THE NATIONAL FOUNDRY COLLEGE.

IN 1935, under the inspiration of the British Cast Iron Research Association and its director, Dr. J. G. Pearce, and with the full concurrence of the then Board of Education, the founding industry opened the British Foundry School in Birmingham. The School offered an advanced course in foundry technology, metallurgy and management, extending over a full academic year, and students who successfully completed the course were awarded the British Foundry School Diploma. At that time this Diploma was recognised as the highest award of its kind. The School operated for four years, during which time 35 Diplomas were awarded, but, in September, 1939, the Governors decided to suspend activities in view of the war emergency. When hostilities ceased it soon became evident that it was the wish of the industry that the School should be reconstituted in some convenient form, and, in due course, it was agreed by all the parties concerned that it should be re-opened and renamed the National Foundry College. The first session commenced in January, 1948, in the new home of the College at the Wolverhampton and Staffordshire Technical College.

The National Foundry College has now been in existence for four years and a report covering its first four sessions, namely, from 1948 to 1951, has recently been published. Briefly, the curriculum, since January, 1949, is spread over two courses. Part One course covers a period of six months of full-time study from September to March, and is followed by an interval for renewed industrial experience before the Part Two course, which opens in September and continues until July of the following year. Exceptionally qualified candidates, however, may be admitted direct to the Part Two course. Approximately half of the time in the Part One course is devoted to an introductory treatment of the principal subjects, which are foundry technology, management, metallurgy and foundry projects. In the latter subject are included moulding and casting studies and foundry planning and layout. The remainder of the time in Part One course is allotted to the study of essential ancillary subjects. These, it is pointed out in the report, may vary from year to year, and even from student to student. The whole of the time in the Part Two course is devoted to a detailed study of the main subjects: foundry technology, foundry metallurgy, foundry management and foundry projects. The work of the College staff is supplemented by a series of over 90 lectures given to the students in their final year by foundry specialists, each lecture being followed by a full discussion, while visits to foundries and allied works form an important part of the curriculum.

The College Diploma is recognised as being the premier award in foundry science and management, and, during the four sessions covered by the report, it was awarded to 56 students. Of this number, 22 were sponsored by their employers, 10 were awarded National Foundry College scholarships and 11 obtained aid from other institutions. The remaining 13 students came from overseas: one from Egypt, one from Ceylon, six from India, two from Switzerland, one from China, one from Norway and one from South Africa. A College hostel, Tor Lodge, which is available for the students, is some three miles distant from the College. It was originally acquired by the Wolverhampton local authority and subsequently purchased by the ministry of Education. It is now held in trust by the Board of Governors.

REDUCTIONS IN PRICES OF COPPER.—The Minister of Supply has issued an Order reducing the maximum controlled price of secondary unwrought copper, other than electrolytic and fire-refined ingot bars and wire bars, and cathodes, from 200*l* to 185*l* per ton. In addition, the Order includes a provision for special prices to be authorised for unusual requirements of unwrought copper. The Order—The Non-Ferrous Metals Prices (No. 9 Order) (Amendment No. 2) Order (Statutory Instrument, 1952, No. 685)—came into effect on April 1. It is on sale at H.M. Stationery Office, price 2*d*.

OVERSEAS SCIENCE STUDENTS' ASSOCIATION.—At a meeting held in London on Wednesday, March 19, at the premises of the Society for Visiting Scientists, Ltd., the Overseas Science Students' Association was formed, with the object of bringing graduate science students from overseas into contact with the scientific life of Great Britain and with other students by holding meetings and arranging visits to places of scientific interest. The Association is affiliated to the Society for Visiting Scientists. About 100 students have already joined. Applications for membership should be addressed to the secretary, Mr. P. Sen, care of the Society for Visiting Scientists, Ltd., 5, Old Burlington-street, London, W.1.

ACCELEROMETERS FOR DETERMINING AIRCRAFT FLIGHT LOADS.

By J. TAYLOR.

(*Concluded from page 475.*)

THE first part of this article, published in last week's issue, discussed the characteristics required for measuring slowly-varying accelerations. The second part of the article, which follows, describes a counting accelerometer with such characteristics. The primary purpose of recording accelerations in aircraft is to determine the structural loads induced by the applied aerodynamic forces. Although a little detailed study of the variation of acceleration over short periods of time is essential, there is far more interest in the statistical examination of the accelerations imposed on the aircraft. From static-strength considerations it is necessary to know the chance of exceeding particular high accelerations. From fatigue-strength considerations a study of the large number of low accelerations is required. The main source of fatigue damage is the fluctuation of the loads, rather than their absolute value, and so it is necessary to make an estimate of the ranges of acceleration, that is, the values of consecutive maxima and minima accelerations. The detailed study over short periods of time should be sufficient to obtain a correlation between loads and accelerations and also to determine the general pattern of acceleration with time.

An examination of continuous records of accelerations imposed on aircraft by gusts has shown that there is fair correlation between the number of peaks of acceleration encountered and the ranges of acceleration. Thus, apart from the limited amount of flying which is necessary to obtain this correlation, it is only necessary to count the peaks. There is no technical difficulty in recording the accelerations continuously and subsequently counting the peaks. The labour involved in such a process, however, would be quite impracticable for extensive use. It is essential, therefore, that the counting should be done by the instrument.

A counting accelerometer* has been designed with the object of counting the accelerations imposed on civil air liners in service. It is thought that by far the greatest number of these accelerations imposed in flight are due to gusts. In addition, there are considerable numbers of accelerations imposed by the ground. As the loads associated with gust accelerations are completely different from those associated with ground loads, steps must be taken to count them separately. If the counts were grouped together indiscriminately, subsequent sorting would be impossible.

In deciding what form the counting should take, it has to be remembered that there would be no detailed record of the order in which the counts were made, nor would the shape of the acceleration-time curve be recorded. In particular, care has to be taken not to be misled by minute fluctuations of acceleration, which cause negligible structural damage; should they be superimposed on any given level of acceleration it is essential that the counting accelerometer should not record them. It is also essential that any minute changes of the acceleration record, due to the airframe-vibration acceleration not being completely rejected, should also not influence the counts. A decision has to be taken as to what should be regarded as minute from this standpoint. Any particular threshold is then given, for the purpose of counting, a small, though finite, width so that no count is made unless the band has been completely crossed. In the instrument to be described the width of this band is $0 \cdot 1g$ and the full range of the instrument is $4g$.

The counting accelerometer, which has been designed to have the characteristics given in the first part of the article, and is intended for use in any aircraft with a wing natural frequency up to 4 cycles per second, is illustrated in Figs. 14, 15, and 16, opposite. In the back view (Fig. 14) can be seen a cantilever spring of length 10 in., with a brass mass of about 2 lb. on the end, which constitute the main spring and main mass. Such a heavy mass is used in order that the applied accelerations may develop sufficient force to operate mechanical counters without appreciable change in the readings. The end of the cantilever spring is attached to two coil springs which are held in tension by a continuous tape passing over two rollers. This system is the secondary spring, which is in tension so that it can transmit compression as well as tension loads. The tape is fastened to the upper roller (not visible in the illustrations) to provide a positive drive. The upper roller is connected through 1-to-9 step-up gearing to a hollow aluminium cylinder which rotates in the annular space between the poles of a permanent magnet, and a fixed central iron core. The roller, gearing and aluminium cylinder form part of the secondary rotary

* *The Design and Use of Counting Accelerometers.* By J. Taylor (Ministry of Supply report, to be published in Report and Memoranda Series).

ACCELEROMETER FOR DETERMINING AIRCRAFT FLIGHT LOADS.

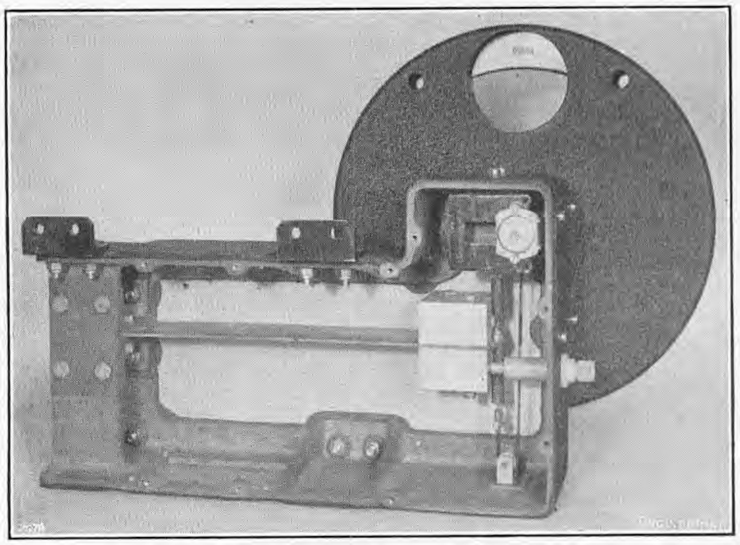


FIG. 14. BACK VIEW OF COUNTING ACCELEROMETER.

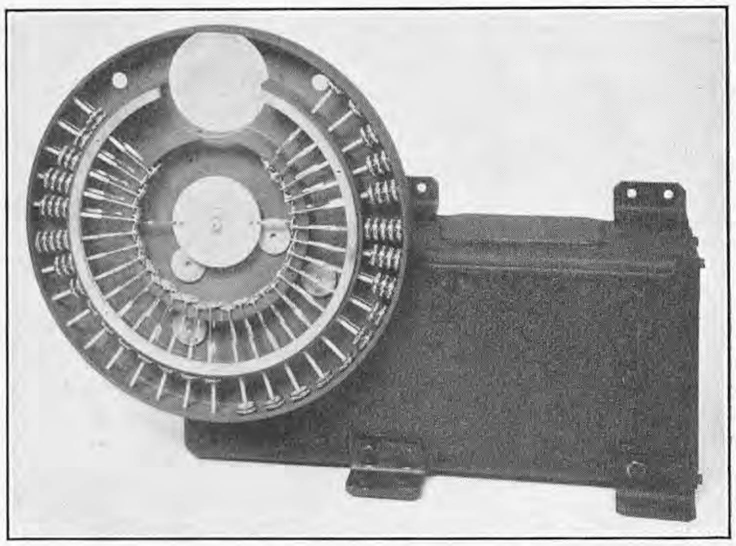


FIG. 15. INSTRUMENT WITH FRONT FACE REMOVED.

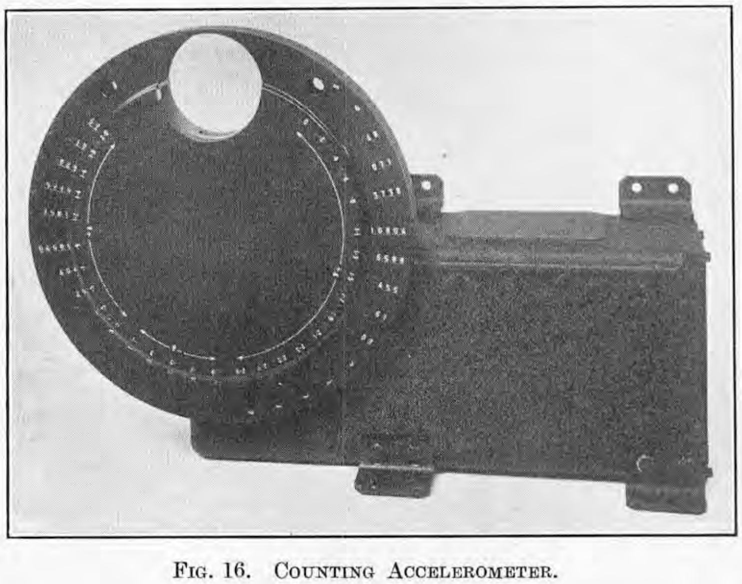


FIG. 16. COUNTING ACCELEROMETER.

inertia. The remainder of the rotary inertia is included in the pointer, visible in Fig. 15, and is on the same shaft as the roller. The damping is produced by the eddy currents set up in the aluminium cylinder when it rotates. Measurements have been made of the damper resistance, which was found to be proportional to the angular velocity to within 1 per cent.; after one year's operational use there was no measurable change. The upper roller, to which the continuous tape is attached, is restricted to a rotation of 180 deg. because of the tape attachment. The pointer is on the same shaft as the roller so that it also is restricted to a rotation of 180 deg. To save space in fitting the counters, both ends of the pointer are used to operate the counters at alternate thresholds.

A count is made in two stages. In the first stage, the end of the pointer passes over a ratchet wheel, and the resistance is only the friction between the light pointer arm and the ratchet wheel as the pointer is raised up the tooth of the wheel. Subsequently, as the imposed acceleration is reduced, the pointer engages the tooth of the ratchet wheel and moves it on one tooth before slipping out of engagement, a change of approximately $0 \cdot 1g$ being required to do this. A flexible drive is used between the ratchet wheel and the counter, so that the inertia which has to be overcome directly by the pointer is a small portion of the whole inertia of the counter mechanism. Consequently, there is an increase in the rate at which a threshold can be crossed without a count of more than one being made, but a further period is necessary to operate the main counter through the flexible drive. Tests on the instrument have shown that it does not miscount for a virtually instantaneous change of acceleration of up to $2g$. Moreover, any one counter will count successive impulses up to 10 per second. Overload tests showed that no breakdown of counting was imminent at either of these two conditions.

Fig. 16 shows the accelerometer with its front face in position. The levels of the thresholds of acceleration are shown; since both ends of the pointer operate counters, successive levels are on opposite side of the face. Each threshold has a width of approximately $0 \cdot 1g$ but, for convenience in marking the face, only the value of the level of the edge of the threshold furthest from $1g$ (i.e., straight and level flying) is used. Thus, for example, the threshold $1 \cdot 3g$ to $1 \cdot 4g$ is marked as $1 \cdot 4g$ and the threshold $0 \cdot 7g$ to $0 \cdot 8g$ is marked $0 \cdot 7g$. The full range is in steps of $0 \cdot 1g$ from 0 to $2g$ and in steps of $0 \cdot 2g$ from $-1g$ to 0 and from $2g$ to $3g$. When it is required to photograph the counters at intervals, a camera is attached to the back of the accelerometer and views the counters through the circular hole and through a mirror placed in front of the counters. The counting accelerometer weighs 12 lb. and has overall dimensions of 18 in. by $5\frac{1}{2}$ in. by 13 in. high.

The accelerometer was installed in aircraft used for experimental flying in January, 1950, and since then the instrument has behaved satisfactorily for over 400 flying hours in a number of aircraft. Instruments are now installed in selected aircraft of two British air-transport companies, and it is expected that statistical data on gusts met in flying up to heights of 40,000 ft. will rapidly become available. The instrument has been carried on a road vehicle and on a ship, and has counted accelerations satisfactorily.

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Appendix.—Equations of motion of a main mass and spring, with a secondary spring connecting the main mass. to a rotary inertia with damping proportional to angular velocity.

The system is shown in Fig. 1, on page 473, *ante*, which includes some of the notation used.

Suppose that at time t—

$-a \sin \omega t$ = the vertical deflection of the accelerometer case, where a is a constant and $2\pi\omega$ is the frequency of the acceleration;

y = the vertical deflection of the main mass relative to the case;

x = the vertical deflection of the bottom of the secondary spring relative to the case.

Also suppose

$C\, b^2 \dfrac{d}{dt}\left(\dfrac{x}{b}\right)$ = damping couple, $\dfrac{I}{b^2} = M_2$ = equivalent secondary mass, C being a constant.

The equation of motion of the main mass can be written as

$$M_1 \frac{d^2 y}{dt^2} + (\mu_1 + \mu_2)\, y - \mu_2\, x = M_1\, a\, \omega^2 \sin \omega t. \quad (1)$$

The equation of motion of the rotary inertia can be written as

$$M_2 \frac{d^2 x}{dt^2} + C \frac{dx}{dt} + \mu_2\, x - \mu_2\, y = 0. \quad . \quad (2)$$

Equations (1) and (2) can be combined to give the following equation for x:—

$$M_1 M_2 \frac{d^4 x}{dt^4} + (M_1 \mu_2 + M_2 \mu_1 + M_2 \mu_2) \frac{d^2 x}{dt^2} + \mu_1 \mu_2 x$$
$$+ M_1 C \frac{d^3 x}{dt^3} + (\mu_1 + \mu_2)\, C \frac{dx}{dt} = a\, \omega^2 M_1 \mu_2 \sin \omega t. \quad (3)$$

Dividing throughout by $\mu_1 \mu_2$ and putting

$$\frac{\mu_1}{M_1} = p^2, \quad \frac{\mu_2}{\mu_1} = s, \quad \frac{M_2}{M_1} = m, \quad \frac{2\pi\omega}{2\pi p} = N, \text{ and } \frac{C}{p M_1} = K,$$

equation (3) can be re-written non-dimensionally as

$$\frac{m}{s} \frac{1}{p^4} \frac{d^4 x}{dt^4} + \left(1 + m + \frac{m}{s}\right) \frac{1}{p^2} \frac{d^2 x}{dt^2} + x + K \frac{1}{s} \frac{1}{p^3} \frac{d^3 x}{dt^3}$$
$$+ K\left(1 + \frac{1}{s}\right) \frac{1}{p} \frac{dx}{dt} = a\, N^2 \sin \omega t. \quad (4)$$

The solution of equation (4), when the applied acceleration has been applied for sufficient time for steady conditions to have become established, is

$$\frac{x}{a N^2} = \frac{\sin(\omega t - \epsilon)}{\left\{\left[1 - \left(1 + m + \frac{m}{s}\right) N^2 + \frac{m}{s} N^4\right]^2 + N^2 K^2 \left[\left(1 + \frac{1}{s}\right) - \frac{1}{s} N^2\right]^2\right\}^{\frac{1}{2}}}, \quad (5)$$

where ϵ is the phase lag and is given by

$$\tan \epsilon = \frac{N K \left(1 + \frac{1}{s}\right) - \frac{1}{s} N^2}{1 - \left(1 + m + \frac{m}{s}\right) N^2 + \frac{m}{s} N^4}.$$

The amplitude-response ratio,

$$R = \frac{x}{a N^2 \sin(\omega t - \epsilon)},$$

has a maximum with respect to frequency when

$$\frac{d}{d(N^2)} \left(\frac{x}{a N^2 \sin(\omega t - \epsilon)}\right) = 0. \quad . \quad (6)$$

If a maximum occurs at zero frequency equation (6) reduces to

$$\left(1 + \frac{1}{s}\right)^2 K^2 - 2\left(1 + m + \frac{m}{s}\right) = 0. \quad . \quad (7)$$

With the value of K given in equation (7) the amplitude-response ratio R and the phase lag ϵ are given by

$$R = \frac{1}{\left\{A^2 + B^2\right\}^{\frac{1}{2}}}, \quad . \quad . \quad . \quad (8)$$

$$\tan \epsilon = \frac{B}{A}, \quad . \quad . \quad . \quad (9)$$

where

$$A = 1 - \left(1 + m + \frac{m}{s}\right) N^2 + \frac{m}{s} N^4$$

$$B = \sqrt{2\left(1 + m + \frac{m}{s}\right)}\, N \left(1 - \frac{1}{1 + s} N^2\right).$$

NOTES ON NEW BOOKS.

Les Barrages en Terre.

By C. MALLET and J. PACQUANT. Editions Eyrolles 61, Boulevard Saint-Germain, Paris, 5e, France. [Price 2,500 francs.].

THE great advances made during the past 25 or 30 years in the science of soil mechanics have brought into a new prominence the possibilities of the earth dam, and this book—the first on the subject in modern French engineering, as Professor Karl Terzaghi points out in his preface to it—admirably reviews the present state of knowledge on the subject. Earth dam engineering, as he observes, is now entering upon its "mature" stage, in which "the ardour of the scientist is already tempered by bitter experience" and "a store of knowledge . . . supplements and qualifies the conclusions based on analysis." Mr. Mallet, who enjoys a high repute as a hydraulic engineer, has been ably assisted by his co-author, head of the Bureau des Etudes Techniques in Algeria, in compiling this study, which covers the reasons governing the choice of earth dams, consideration of sub-soils and foundations, the design of the dams, methods of dealing with infiltration and ensuring watertightness, the choice of materials and methods of construction, etc. In the appendix, Professor Terzaghi has added a number of personal comments on particular references in the text. The book is well illustrated, the quality of the line diagrams being specially praiseworthy; and there is a useful bibliography. In our opinion, the publishers might consider the desirability of an English translation.

A Short History of the Firm of Thomas Walker and Son, Limited.

By J. E. WILLMOTT, J.P. Prepared by the firm at 58, Oxford-street, Birmingham, 5, for private circulation.

IN these days of precise navigation, it is difficult to appreciate how greatly the old-time seaman depended on knowing the speed of his ship through the water, and what a boon it was to be able to rely upon a registering mechanical log in place of the traditional log-ship and sand-glass. This well-written and attractively produced booklet records not only the history of a firm, but, for all practical purposes, that of the reliable log; for Thomas Walker (1805-1871) was a nephew of Edward Massey, whose "perpetual" log, patented in 1802, was the first successful adaptation of the principle of using a screw, rotated in the water by the passage of the ship towing it, to operate a counter mechanism to measure the distance traversed in a given time. Thomas Walker took over the manufacture of the Massey log, and, with his son, Thomas Ferdinand Walker, devised in 1861 their own improvement on it, the Walker harpoon log—the first of their several types, eventually to become almost standard equipment in ships of all nations. Although intended primarily as a record of the development of the business—one of the "family" type to which British industry owes so much—the book is also a definite contribution to maritime history.

Spring Design and Calculations.

Compiled by JOHN A. ROBERTS. Fifth edition. Technical Research Laboratory, Herbert Terry and Sons, Limited, Redditch. [Price 12s. 6d.]

A BOOK that is published by a firm of specialists on the subject and has reached its fifth edition in four years needs no commendation in a review; it is sufficient to inform the uninitiated of its contents. Mr. Roberts has compiled a useful book of data for designers who are faced with spring problems. He deals with helical compression and extension springs, volute, conical, square-section and rectangular-section, flat, and multiple-leaf or laminated springs. Guidance is also given on the design of valve springs and there is a chapter on the problem of surging of valve springs. The method of determining the natural frequency of a spring, and of a spring and single-mass system, is described. Other calculations given include those for ascertaining the power of clock-type springs, and the velocity attained by a suddenly-released helical spring. In addition, there are chapters on Belleville washers, circlips or retaining rings, and combined axial and horizontal loading of compression springs.

INTERNATIONAL RADIO AND ELECTRONICS EXHIBITION OF INDIA, 1952.—Owing to the failure of the monsoon last year and the consequent shortage of water and electricity in the city of Bombay at the beginning of this year, the International Radio and Electronics Exhibition, which was to have been held at Bombay in February last, has had to be postponed. It will now be held from Monday, November 10, to Sunday, November 30, 1952, both dates inclusive. The exhibition is being organised by the Radio and Electronics Society of India, Fateh Manzil, Opera House, Bombay, from which further information may be obtained.

LAUNCHES AND TRIAL TRIPS.

S.S. "ST. CERGUE."—Single-screw vessel, equipped for carrying grain, edible oils and general cargo, built and engined by William Gray & Co., Ltd., West Hartlepool, for the Société Suisse-Atlantique de Navigation Maritime S.A., Lausanne, Switzerland. Main dimensions: 406 ft. between perpendiculars by 56 ft. by 36 ft. 10½ in. to shelter deck; deadweight capacity, 8,890 tons on a draught of 25 ft. Triple-expansion engine with Bauer Wach steam turbine and two oil-fired boilers. Trial trip, March 7.

M.S. "LUCERNA."—Single-screw oil tanker, built by Smith's Dock Co., Ltd., South Bank-on-Tees, for H.E. Moss & Co., Liverpool. Second tanker of a series of three for these owners. Main dimensions: 528 ft. 10 in. overall by 69 ft. 6 in. by 38 ft.; deadweight capacity, about 16,500 tons on a draught of 29 ft. 9 in. Hawthorn-Doxford five-cylinder two-stroke opposed-piston oil engine, developing 5,500 b.h.p. at 112 r.p.m. in service, constructed by R. and W. Hawthorn, Leslie & Co., Ltd., Newcastle-upon-Tyne. Service speed, about 13½ knots. Launch, March 12.

S.S. "SANDCHIME."—Single-screw self-propelled grab hopper dredger built and engined by Wm. Simons & Co., Ltd., Renfrew, for the Scottish Home Department, Edinburgh. Main dimensions: 105 ft. overall by 24 ft. 6 in. by 9 ft.; hopper well capacity, 110 by 120 cub. yds. Vessel has a steam-driven grab crane capable of working to a maximum radius of 25 ft. and a maximum depth of 55 ft. Triple-expansion surface-condensing steam engine and one coal-burning multitubular boiler. Service speed, 7 to 8 knots, according to loading. Launch, March 14.

M.S. "ESTRID TORM."—Single-screw cargo vessel, with accommodation for twelve passengers, built by the Nakskov Shipyard, Ltd., Nakskov, Denmark, for the Steamship Company Torm, Copenhagen, Denmark. Main dimensions: 390 ft. between perpendiculars by 57 ft. 9 in. by 34 ft. 9 in.; deadweight capacity, 7,375 tons. Six-cylinder two-stroke single-acting Diesel engine, developing 5,530 i.h.p., to give a loaded speed of 16 knots, constructed by Burmeister & Wain, Copenhagen. Trial trip, March 20.

M.S. "CORATO."—Single-screw oil tanker, built by the Greenock Dockyard Co., Ltd., Greenock, for the Hadley Shipping Co., Ltd., London, E.C.3. Main dimensions: 542 ft. 6 in. overall by 69 ft. by 38 ft. 6 in.; gross tonnage, 11,386; deadweight capacity, 16,636 tons. Scott-Doxford five-cylinder opposed-piston oil engine, developing 5,500 b.h.p. at 115 r.p.m. in service, constructed by Scotts' Shipbuilding and Engineering Co., Ltd., Greenock, and installed by Rankin and Blackmore, Ltd., Greenock. Speed, 13¾ knots. Trial trip, March 21.

S.S. "NESTOR."—Single-screw cargo liner, built by the Caledon Shipbuilding and Engineering Co., Ltd., Dundee, for the Australian trade of Alfred Holt & Co., Liverpool. Main dimensions: 489 ft. overall by 64 ft. by 35 ft. 3 in. to upper deck; deadweight capacity, 9,500 tons. Three-cylinder cross-compound high-pressure impulse-type steam turbine, developing 8,000 s.h.p. at 112 r.p.m., constructed by the Metropolitan-Vickers Electrical Co., Ltd., Manchester. Two Foster Wheeler oil-fired boilers, supplied by D. Rowan & Co., Ltd., Glasgow. Speed at sea, 16 knots. Launch, March 25.

M.S. "CALTEX KENYA."—Single-screw oil tanker, built and engined by William Doxford and Sons, Ltd., Sunderland, for the Overseas Tankship (U.K.), Ltd., London, W.1. First vessel of four. Main dimensions: 490 ft. overall by 61 ft. 9 in. by 36 ft. 3 in.; deadweight capacity, 12,300 tons on a draught of 28 ft. 2½ in. Doxford five-cylinder opposed-piston oil engine, developing 5,150 b.h.p. at 108 r.p.m. Service speed, 13¾ knots. Trial trip, March 27.

M.S. "LLANTRISANT."—Single-screw cargo vessel, built by Bartram and Sons, Ltd., Sunderland, for the Ethel Radcliffe Steamship Co., Ltd., and the Anthony Radcliffe Steamship Co., Ltd. (Managers: Evan Thomas Radcliffe & Co.), Cardiff. Main dimensions: 445 ft. between perpendiculars by 61 ft. 9½ in. by 40 ft. 2 in. to shelter deck; deadweight capacity, about 10,700 tons on a draught of 26 ft. 10½ in. Swan Hunter-Doxford four-cylinder opposed-piston airless-injection oil engine, developing 4,400 b.h.p. at 116 r.p.m. in service, constructed by Swan, Hunter, and Wigham Richardson, Ltd., Newcastle-upon-Tyne. Service speed, 13½ knots. Launch, March 27.

S.S. "CLAN MACINNES."—Single-screw cargo liner, with accommodation for twelve first-class passengers, built by the Greenock Dockyard Co., Ltd., Greenock, for the Clan Line Steamers, Ltd., London, E.C.3. One of a series of vessels built for these owners. Main dimensions: 438 ft. between perpendiculars by 60 ft. 6 in. by 37 ft. 9 in.; deadweight capacity, 8,780 on a mean draught of about 26 ft.; gross tonnage, about 6,800. Doxford six-cylinder opposed-piston Diesel engine, developing 6,000 b.h.p. at 108 r.p.m. in service, installed by John Brown & Co., Ltd., Clydebank. Service speed, 15 knots. Launch, April 9.

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.

Gears for Turbine Drives.—A new specification, B.S No. 1807: Part 1, has been prepared by the Institution as a development of the work done in the preparation of specification B.S. No. 1498, covering gear-hobbing machines for toroidal and similar drives. The new publication deals with the accuracy requirements for high-grade gears for turbine and similar drives. It does not, at present, however, cover tooth-form design or gear loading. The specification is concerned with three classes of gears, of which Class A 1 and Class A 2 are generally appropriate for pitch-line speeds in excess of 10,000 ft. per minute, or where any other factor demands the highest grade. The standards of accuracy laid down for Class B would be generally appropriate for lower pitch-line speeds. The specification deals, among other matters, with the nomenclature of double-reduction gear trains and the accuracy of reference surfaces on the blanks. Work is proceeding on the preparation of Part 2 of the specification, which will deal with tooth form and gear loading. [Price 3s. 6d., postage included.]

Gears for Instruments and Clockwork Mechanisms.—Another newly-issued publication concerned with gears is a revision of specification B.S. No. 978: Part 1, which covers gears for instruments and clockwork mechanisms. The specification was first published in 1941 and it has been decided to produce the new edition in four parts. Part 1, that now issued, relates to involute spurs, helical and crossed helical gears. Parts 2, 3 and 4 are in course of preparation. Part 2 will cover cycloidal-type spur gears, part 3 bevel gears, and part 4 worm gears. Part 1 applies to gears having diametrical pitches ranging from 20 to 200 in., and two classes of gears are covered. Class "A" is for use where a high degree of accuracy is required and Class B for all other applications. The new publication differs from the 1941 edition, in so far as the basic rack is concerned, by the reduction of the radius at the tip in order to increase the tolerance allowable on the depth of engagement. In addition, the dedendum has been reduced and the radius of clearance space has been increased in order to avoid excessive undercutting. Two basic racks are illustrated; one is intended for use when minimum backlash is required and the other for use where backlash allowance is needed. [Price 2s. 6d., postage included.]

BOOKS RECEIVED.

Proceedings of the Institute of British Foundrymen. Vol. XLIV. 1951. Edited by G. LAMBERT. Offices of the Institute, Saint John-street Chambers, Deansgate, Manchester, 3.

C. T. R. Wilson and the Cloud Chamber. Cambridge Monograph No. 4. Cambridge Instrument Company Limited, 13, Grosvenor-place, London, S.W.1.

Department of Scientific and Industrial Research. A Bibliographical Survey of German and Japanese Experience in the Extraction of Low-Grade Non-Ferrous Ores and the Recovery of Non-Ferrous Metals and Compounds. Report No. RMS-3. H.M. Stationery Office, Kingsway, London, W.C.2. [Price 3s. 6d. net.]

How the Civil Service Works. By BOSWORTH MONCK. Phoenix House Limited, 38, William IV-street, London, W.C.2. [Price 25s. net.]

Data Book for Civil Engineers. By ELWYN E. SEELYE. Second edition. Vol. I. *Design.* Vol. II. *Specifications and Costs.* John Wiley and Sons, Incorporated, 440, Fourth-avenue, New York 16, U.S. [Price, Vol. I, 10 dols.; Vol. II, 13 dols.]; and Chapman and Hall, Limited, 37, Essex-street, Strand, London, W.C.2. [Price, Vol. I, 80s. net; Vol. II, 104s. net.]

Principles of Radio. By KEITH HENNEY and PROFESSOR GLEN A. RICHARDSON. Sixth edition. John Wiley and Sons, Incorporated, 440, Fourth-avenue, New York 16, U.S.A. [Price 5.50 dols.]; and Chapman and Hall, Limited, 37, Essex-street, Strand, London, W.C.2. [Price 44s. net.]

Plastics in Building. By JOSEPH B. SINGER. The Architectural Press, 9-13, Queen Anne's Gate, London, S.W.1. [Price 18s.]

Physics as a Career. By NORMAN CLARKE. The Institute of Physics, 47, Belgrave-square, London, S.W.1. [Price 6s. net.]

Indonesia. Review of Commercial Conditions. H.M. Stationery Office, Kingsway, London, W.C.2. [Price 2s. 6d. net.]

Department of Scientific and Industrial Research. Road Research Technical Paper No. 24. *The Suction of Moisture held in Soil and Other Porous Materials.* By D. CRONEY and others. H.M. Stationery Office, Kingsway, London, W.C.2. [Price 2s. net.]